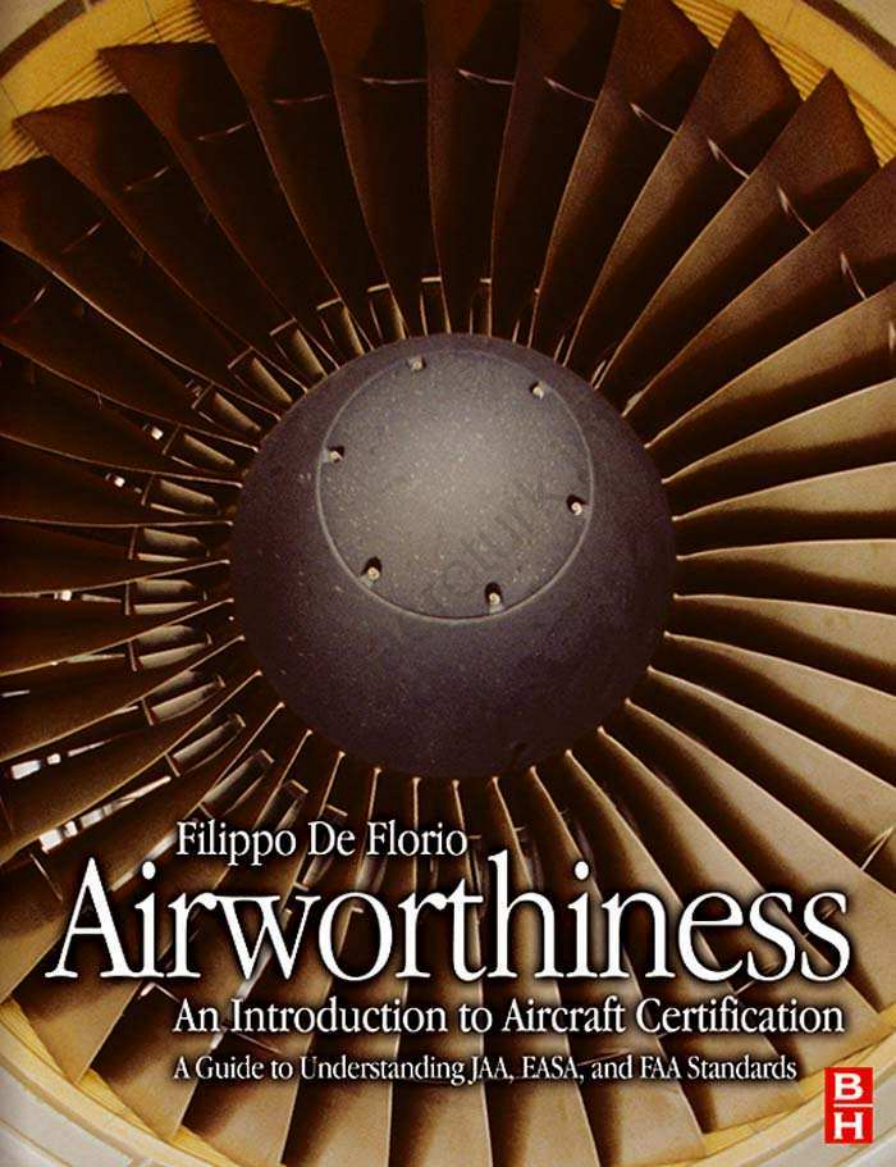
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An Introduction to Aircraft Certification
A Guide to Understanding JAA, EASA, and FAA Standards
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An Introduction to Aircraft Certification

A Guide to Understanding JAA, EASA, and FAA Standards

Filippo De Florio

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Preface

This book is based on my book *Aeronavigabilita* (Airworthiness), written in Italian at the end of the 2002, and published by IBN Editore, Rome.

Despite their many commonalities, EASA, the FAA, and other national aviation authorities regulate airworthiness in different ways. For this reason this book retains concepts that can be applied generally, avoiding, as far as possible, references to a specific national system or to detailed procedures that are likely to be quickly superseded.

Here is what I wrote in 2002 as the Foreword to *Aeronavigabilita*:

> *I wrote these notes in order to provide the book I wish I had when, 'in the last century', I began to be interested in aircraft certification.*
>
> *The book has an informative character; it is written to offer a panoramic view of airworthiness and it is not intended to be a 'certification manual'. I have tried to express the concepts of airworthiness from a general point of view, without going into the detail of procedures which are likely to evolve quickly with the substantial changes that are foreseen in the aviation certification authorities. Regardless of this the basic philosophies of airworthiness are unlikely to change significantly and familiarity with the basic principles of the subject – either from the point of view of the regulating authority, or the aircraft owner or operator – will assist any engineer or other aviation professional in their work. This is a subject that depends not only on formalities and equations, but on a good deal of common sense and on the collective experience of engineers and professionals acquired over more than a century of aeronautical activity.*
>
> *I hope this book will be a basis on which those in this field can understand and master the regulations and procedures which effect the professional training and practical work that certification engineers have to undertake in both regulatory authorities and in aircraft engineering enterprises.*

December 2002

Developments since 2003

The years since the publication of my first book have been very eventful and for this reason I have updated and significantly developed the text.

The establishment of the European Aviation Safety Agency (EASA) mentioned in Chapter 3 has been the most important event in European airworthiness regulation.

Likewise, the approval of Light-Sport aircraft is a significant event in the United States, and is destined to have an impact on general aviation worldwide.

Other key issues, such as the development of UAV regulations, have occurred and each of these developments is considered.

Although JAR requirements have been mostly replaced by EASA requirements, they are still referred to in the text for the sake of continuity or where, in certain cases, the JAR requirements remain valid, awaiting the approval of the corresponding EASA requirements.

This book is not a certification *manual*. When requirements are discussed, they are summarized and therefore their phrasing may differ from the official version and they might contain omissions. This is because my intention is to make the requirements easier to read and their underlying philosophy easier to understand.

A word of caution: there are variations between British English and American English usage for terms that describe the same things, for example, aeroplane – airplane; aerobatic – acrobatic; etc. Furthermore, JAA/EASA use British English spellings such as organisation, authorisation, etc. that for the FAA are spelled organization, authorization, etc. In this book these have been standardized as far as possible to the '-ize' variants throughout for consistency. Elsewhere, other differences of spelling have been standardized to the US usage. Although clearly these will differ in the actual JAA/EASA documents the basic meaning is unaffected.

Filippo De Florio

Acknowledgments

I would like to thank Francesca De Florio, my daughter, who provided fundamental linguistic and editing support. I am also grateful to my wife Giovanna and my son Sergio for their encouragement.

A special thank you to Jonathan Simpson, Elsevier, for his invaluable contribution in assessing the content of my original manuscript and his advice on updating and expanding the scope and depth of its content.

I am also grateful to Miranda Turner and all the team at Elsevier for their professional assistance.

The EASA, FAA, ICAO, and JAA websites have been a fundamental source of information as regards the content relating to the history and organization of these institutions.

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About the author

Mr Filippo De Florio was Director of the Italian RAI-ENAC Type Certification Division from November 1992 to February 2000. In the same period, he was a member of the JAA Certification Committee.

As a member of the JAR 22 and JAR-VLA Study Groups since the 1970s, he contributed to the creation and development of such standards.

He performed flight activity as a sailplane and aeroplane pilot for 25 years, and he is a member of the OSTIV Sailplane Development Panel and Honorary Member of UVS International.

Mr De Florio presently lives in France with his wife Giovanna. They have two children, Sergio and Francesca.

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Abstract

The design of an aircraft is a synthesis of different disciplines like aerodynamics, flight mechanics, aeronautical structures, etc.

Furthermore, to allow an aircraft to be operational in normal air traffic, it is necessary to demonstrate that its design and construction are in compliance with the applicable requirements; the verification of such compliance is entrusted to the competent authorities.

Airworthiness introduces aerospace engineering students and engineers into this world consisting, on the one hand, of designers, manufacturers and operators, and, on the other, of airworthiness authorities, in two disciplines that should work in unison, because they should aim at a common goal: **flight safety**.

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Chapter 1

Flight Safety

Safety is a concept generally ingrained in the human mind; we will consider 'absence of danger' as its principal definition. Safety is something related to all human activities and therefore every civil society is organized (or should be organized) to guarantee public safety in relation to one's own or others' activities. This is certainly a moral obligation, but it is also a practical demand because accidents, causing damage to persons and properties, have a social cost. This is also the reason why human activities that could cause damage to persons and properties are controlled by national states through regulations.

We will deal specifically with safety related to aeronautical activities, starting by considering what we have defined as the main conventional **flight safety factors**: **man**, the **environment**, and the **machine**.

1 **Man** is intended here as an active part of the flight operations; we then consider pilots, maintenance manpower, air traffic controllers, and others. Clearly, it is important to be able to rely on very skilled people in order to avoid errors that cause accidents or catastrophes in flight operations. It is then of paramount importance to place these people in a legislative and organized context to guarantee a suitable level of professional training, updating of techniques and procedures, and psychological and physical fitness. National states entrust special public institutions with the responsibility for such obligations.
2 The **environment** covers all the external factors that can have an influence on the flying of an aircraft. This includes meteorological conditions, traffic situations, communications, aerodromes, etc. It is equally important to avoid situations that could jeopardize the aircraft itself. Then we should consider correct meteorological information, rules for the vertical and horizontal separation of the aircraft, suitable aerodromes, etc.
3 The **machine** does not need a definition, but it is easy to understand the importance of a good project, sound construction, and efficiency in relation to the operations to be carried out. Also, in this case, national states entrust special public bodies with the responsibility of assuring that the project, the construction, and the operating instructions comply with flight safety.

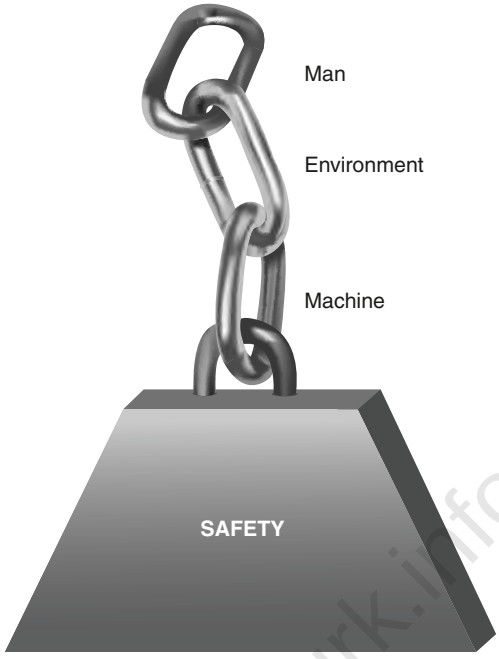


Figure 1.1 *Flight safety represented as three links in a chain*

An important point regarding these safety factors is that they act in series and not in parallel. They can be seen as three links of a chain representing flight safety.

The failure of a single link is sufficient for an accident to happen. A pilot's error can put the best aircraft in jeopardy, and the best pilot cannot compensate for a serious failure in an aircraft. Accident reports offer countless examples of this; however, accidents are often caused by a combination of factors that could involve all these safety factors. Nevertheless, the accident always begins with the failure of one of the above-mentioned links.

In this book we will deal particularly with one of these safety factors: the machine.

We will discuss design rules, the people who make them, who formulates the verifications from design to construction, and who is responsible for the organization of manufacturers and operators.

We are going to deal with **airworthiness**.

Chapter 2

Airworthiness

A definition of 'airworthiness' can be found in the Italian RAI-ENAC Technical Regulations: 'For an aircraft, or aircraft part, [airworthiness] is the **possession of the necessary requirements** for flying in **safe conditions**, within **allowable limits**.'

In this definition, three key elements deserve special consideration: safe conditions, possession of the necessary requirements, and allowable limits.

1 We can take for granted the meaning of **safe conditions** relating to the normal course and satisfactory conclusion of the flight.
According to one definition, safety is the freedom from those conditions that can cause death, injury or illness, damage to/loss of equipment or property, or damage to the environment.
2 **Possession of the necessary requirements** means that the aircraft, or any of its parts, is designed and built according to studied and tested criteria to fly in safe conditions, as mentioned above.
Regulations are intended to promote safety by eliminating or mitigating conditions that can cause death, injury, or damage.
Who establishes these regulations? The airworthiness authorities appointed by the national states. These are obtained through the publication of airworthiness standards (see details in the following chapters) containing a series of design requirements: from the strength of the structures to the flight requirements (flight qualities and performance), criteria for good design practice, systems, fatigue and flutter, necessary tests, flight and maintenance manual content, and so on. These standards are different for different types of aircraft. Obviously, it is not possible to design a sailplane, a 'Jumbo', or a helicopter using the same rules. An important peculiarity of these standards is their evolution as time passes. Generally, a standard does not precede aeronautical progress, it follows it and sometimes accompanies it. A 'blocked' standard would prevent aeronautical progress. It follows that the rules have to continuously fit with technical aeronautical evolution. Moreover, very often

accident analysis leads to additional rules which, had they been applied to the design, might have prevented the accident or at least limited its effects; this process could be regarded as 'afterthoughts', but it is better to consider it as 'experience'. The changing of the standards (normally with the purpose of adding something new or different) makes the design compliance to the rules more and more expensive, but this is the price to pay to improve flight safety.

3 **Allowable limits**. Aircraft are designed for operation within a certain 'flight envelope', which depends mainly on speed and structural load factors. In addition, the maximum weight of the aircraft can be established differently for different types of operations. Operational conditions of the aircraft, such as day-VFR, night flight, instrumental flight, in or out of icing conditions, etc., are also established. Exceeding these conditions and limits can cause accidents. Overweight take-off, aerobatic maneuvers performed with aircraft designed with load factors for non-aerobatic operations, flights in icing conditions without suitable protection, and exceeding the speed limits are just a few examples of the importance of flying within the allowable limits. Pilots are made aware of these limits through the flight manual, through the markings and placards displayed in the cockpit, and of course through training.

Chapter 3

The ICAO and the Civil Aviation Authorities

3.1 The ICAO (International Civil Aviation Organization)

The first recorded flight by a heavier-than-air machine was by the Wright brothers on 17 December 1903 in North Carolina.

Since the earliest years of aviation, far-seeing people envisaged a new dimension of transport that would go beyond national boundaries. In 1910, the first conference on air navigation international law was hosted by France in Paris, with the attendance of 18 European states.

The First World War fostered considerable development of aeronautical techniques, also demonstrating the potential for transport of goods and people. After the war, it became increasingly evident that this advanced means of transport would require international attention.

These problems were debated at the Paris Conference of Peace in 1919, and the discussions led to the establishment of an Aeronautical Commission. To succeed in the purpose of making aviation an instrument of peace, an International Air Convention was written and ratified by 38 states. The Convention contemplated all aspects of civil aviation and also the establishment of an International Commission for Air Navigation (ICAN) in order to monitor the development of civil aviation and to propose measures for this development.

The years between the two world wars marked a continuous development of civil aviation both in the technical and the commercial fields.

The Second World War, apart from the horrors also caused by the operations of progressively more sophisticated military aeroplanes, had a major effect upon the technical development of the aeroplane, compressing a quarter of a century of normal peacetime development into six years.

The possibility of carrying a great number of people and a large quantity of goods over long distances became a reality. For these reasons, the Government of the United States conducted

exploratory discussions with other allied nations from the early months of 1944. On the basis of these talks, invitations were sent to 55 allied and neutral states to meet in Chicago in November 1944. Of these 55 states, 52 attended. The outcome of five weeks of meetings was the Convention on International Civil Aviation, consisting of a preamble and 96 articles.

The ICAO officially came into existence on 4 April 1947. At the invitation of the Government of Canada, Montreal was chosen as the site for its headquarters. Presently, the Contracting States number more than 180.

The aims and objectives of the ICAO are to develop the principles and techniques of international air navigation and to foster the planning and development of international air transport so as to:

1 Ensure the safe and orderly growth of international civil aviation throughout the world.
2 Encourage the arts of aircraft design and operation for peaceful purposes.
3 Encourage the development of airways, airports and air navigation facilities for international civil aviation.
4 Meet the needs of the peoples of the world for safe, regular, efficient and economical air transport.
5 Prevent economic waste caused by unreasonable competition.
6 Ensure that the rights of the Contracting States are fully respected and that every Contracting State has a fair opportunity to operate international airlines.
7 Avoid discrimination between Contracting States.
8 Promote safety of flight in international air navigation.
9 Promote generally the development of all aspects of international civil aeronautics.

3.1.1 The International Standards

Since the ICAO was created, a main technical task of the organization has been the achievement of standardization in the operation of a safe, regular and efficient air service. This has resulted in high levels of reliability in the many areas that collectively shape international civil aviation, particularly in relation to the aircraft, their crews, and the ground-based facilities and services.

Standardization has been achieved through the creation, adoption, and amendments of 18 Annexes to the Convention, identified as **International Standards** and **Recommended Practices**.

Standards are directives which ICAO members agree to follow. If a member has a standard different from an ICAO Standard, that member must notify the ICAO of the difference.

Recommended practices are desirable but not essential practices. The basic principle for deciding whether a particular issue should be a Standard is an affirmative answer to the question: 'Is uniform application by all Contracting States essential?'

On the basis of the Convention, the Contracting States are engaged to achieve the highest practical degree of worldwide uniformity in regulations, organizing procedures in relation to aircraft, personnel, airways, and auxiliary services, whenever this will facilitate and improve air safety, effectiveness, and regularity.

The 18 Annexes are described as follows:

- **Annex 1. Personnel Licensing** – provides information on licensing of flight crews, air traffic controllers, and aircraft maintenance personnel, including medical standards for flight crews and air traffic controllers.
- **Annex 2. Rules of the Air** – contains rules relating to visual and instrument-aided flight.
- **Annex 3. Meteorological Service for International Air Navigation** – provides meteorological services for international air navigation and reporting of meteorological observations from aircraft.
- **Annex 4. Aeronautical Charts** – contains specifications for the aeronautical charts used in international aviation.
- **Annex 5. Units of Measurement to be used in Air and Ground Operations** – lists dimensional systems to be used in air and ground operations.
- **Annex 6. Operation of Aircraft** – enumerates specifications to ensure a level of safety above a prescribed minimum in similar operations throughout the world. The three parts of this Annex are as follows:
  - Part I. International Commercial Air Transport – Airplanes
  - Part II. International General Aviation – Airplanes
  - Part III. International Operations – Helicopters.
- **Annex 7. Aircraft Nationality and Registration Marks** – specifies requirements for registration and identification of aircraft.
- **Annex 8. Airworthiness of Aircraft** – specifies uniform procedures for certification and inspection of aircraft.
- **Annex 9. Facilitations** – provides for the standardization and simplification of border crossing formalities.
- **Annex 10. Aeronautical Telecommunications** – Volume 1 provides for standardizing communications equipment and systems, Volume 2 standardizes communications procedures.
- **Annex 11. Air Traffic Services** – includes information on establishing and operating ATC, flight information, and alerting services.
- **Annex 12. Search and Rescue** – provides information on organization and operation of facilities and services necessary for search and rescue (SAR).
- **Annex 13. Aircraft Accident Investigation** – provides for uniformity in notifying, investigating, and reporting on aircraft accidents.
- **Annex 14. Aerodromes** – contains specifications for the design and equipment of aerodromes.
- **Annex 15. Aeronautical Information Services** – includes methods for collecting and disseminating aeronautical information required for flight operations.

- **Annex 16. Environmental Protection** – Volume 1 contains specifications for aircraft noise certification, noise monitoring, and noise exposure units for land-use planning, Volume 2 contains specifications for aircraft engine emissions.
- **Annex 17. Security – Safeguarding International Civil Aviation against Acts of Unlawful Interference** – specifies methods for safeguarding international civil aviation against unlawful acts of interference.
- **Annex 18. The Safe Transport of Dangerous Goods by Air** – specifies requirements necessary to ensure hazardous materials are safely transported in aircraft while providing a level of safety that protects the aircraft and its occupants from undue risk.

Because aeronautical technology is continuously developing, the Annexes are constantly reviewed and updated when necessary. The **typical content** of an Annex is based upon:

1 Standards intended as specifications when their application is considered as *necessary* for the safety and regularity of international air navigation.
2 Recommended practices intended as specifications when their application is considered as *a recommendation* in the interest of safety, regularity, and efficiency of international air navigation.
3 Appendices dealing with the preceding points.
4 Definitions of the used terminology.

The Contracting States have issued norms not strictly copying the contents of the Annex, which essentially state some of the principles or objectives to attain. The norms contain the requirements used to reach the objectives. Furthermore, while the principles can remain the same, the requirements are often influenced by the state of the art (technical evolution, new technology, and acquired experience), and they are then likely to be improved and amended.

The applicable JAA/FAA/EASA airworthiness standards for the certification of aircraft to be internationally recognized are issued in accordance with the ICAO Annexes. Then, from a practical point of view, the certification process is based on these airworthiness standards rather than (directly) on the ICAO International Standards.

In order to remain within the scope and objectives of this book, we will consider the content of the three Annexes that are directly connected with airworthiness:

- **Annex 6. Operation of Aircraft.** This Annex contains the standards and recommendations relating to the operation of aircraft for international commercial air transport, including the regulation for the certification of the operators. It also contains the technical and operational regulations for general international aviation activities, including maintenance.
- **Annex 8. Airworthiness of Aircraft.** This Annex contains the standards defining the minimum level of airworthiness for the development of the type certification requirements *as a basis for the international recognition of the certificates of airworthiness for aircraft* (according to Article 33 of the Convention) in order to fly into and land in the Contracting States. It also contains indications and provisions for the organization and functions of the civil aviation authorities.

- **Annex 16. Environmental Protection.** This Annex contains the standard applicable to the *aircraft noise* certification in relation to different noise levels proportionate to the type of aircraft (propeller-driven, jet-propelled, helicopters). It states with accuracy the test procedures for an effective and unequivocal measurement. The standard contained in this Annex is normally used as proposed because it is directly applicable to all of the technical requirements. The Annex also contains the standard relating to the *aircraft engine emission* certification with reference to the toxicity of some chemical components, such as azoth oxide. This is a particularly discussed Annex at present, because it deals with a sensitive social matter, noise, for people living near aerodromes, and the conflict between the sometimes opposing demands of economic development and the protection of citizens.

3.2 The Civil Aviation Authorities

3.2.1 Origins

The national states of developed countries have established institutions and authorities to guarantee flight safety. In many cases, these organizations evolved from pre-existing institutions for the safety of marine and river navigation. It is of interest to point out that, historically, the mainspring for the improvement of the safety of navigation is not a social principle, but an economical choice made by insurance companies.

The word 'register' was adopted by various navigational institutions and has a precise origin. In fact, it is derived from a register that a certain Edward Lloyd, owner of a tavern situated in the area of the river port of London at the end of the seventeenth century, filled with information on marine traffic gathered while talking to customers, such as ship owners and sailors. The collected information could be related to ships, traffic and, most importantly, to accidents resulting in the loss of men, goods and ships. This was the origin of the highly esteemed newsletters, 'Lloyd's News', that were first issued in 1696.

At the same time, marine insurance began to flourish and Lloyd's tavern rapidly became an important negotiation center. Lloyd was a practical man, well aware of the importance of the information he owned for the insurance business. Finally, Lloyd's, the incorporated society of underwriters in London, was born and was destined to become a world reference in the insurance field.

When Lloyd died in 1713, his heirs continued his work; 'Lloyd's List', filled with lists, data, and marine news, highly appreciated in the circle of marine traffic, was first published in 1734; the List, originally handwritten, first appeared in printed form in 1760.

Meanwhile, other lists with various ship classification criteria were published by different ship owners, until all the publications were unified into the 'Lloyd's Register' in 1833, the first register in the world, which acquired legal status in 1871. Other national registers were subsequently instituted in Europe.

Safety is obviously a matter of great importance for insurance companies: fewer accidents mean fewer indemnities to pay. It is also for this reason that the registers began to issue safety requirements for navigation.

Since the beginning of aviation, the operation of aircraft posed problems of an analogous nature to that of marine traffic, hence the necessity of the establishment of specific institutions, similar to the already existing institutions for marine traffic. In some cases, particular marine institutions took on the responsibilities of aviation regulations and control. Later, the growth of aviation led to the creation of autonomous registers and national authorities, dealing with aircraft and air navigation.

3.2.2 Tasks of airworthiness authorities[1]

From a general point of view, an airworthiness authority has the following tasks:

1 **To prescribe** airworthiness requirements and procedures. In the following chapters we will deal with these prescriptions, ranging from aircraft type certification, construction, and operation, to the relevant organizations.
2 **To inform** the interested parties regarding the above-mentioned prescriptions. This is performed in different ways. The authority publishes technical regulations, technical standards, circulars, etc., to be obtained on request or by other means. At present, much information can be found on the Internet.
3 **To control** aeronautical material, design, and manufacturing organizations, and aircraft operators. This is to ensure that all pertinent prescriptions are complied with. Control can be performed in different ways, with the appropriate involvement of the relevant authority.
4 **To certificate** aeronautical material and organizations. This is to declare in a legal form compliance with the applicable requirements of an aircraft or part of it, or a change to a type certificate, the capability of an organization, and so on.

3.3 The Joint Aviation Authorities (JAA)

The Joint Aviation Authorities (JAA) is an associated body of the European Civil Aviation Conference (ECAC)[2] representing the civil aviation regulatory authorities of a number of European states who have agreed to co-operate in developing and implementing common safety regulatory standards and procedures.

The JAA's work started in 1970 (when it was known as the Joint Airworthiness Authorities). The aim was to develop a harmonized airworthiness standard to meet the needs of the industry in Europe, particularly for products manufactured by international consortia. Since 1987, JAA activities have been extended to operations, maintenance, and licensing and certification design standards for all classes of aircraft.

JAA membership is based on the approval of the JAA Arrangements that the State Members signed in 1990 in Cyprus. Membership is open to the ECAC's members, which at present consist of 41 countries.

The JAA has a two-phase membership system. The current procedures start with a familiarization visit by a 'candidate' authority to the Central JAA (CJAA). After a satisfactory conclusion, the authority can formally apply for membership, expressing its willingness to commit itself to the terms and commitments in the Arrangements. At this stage, if the application is accepted, the authority becomes a 'candidate member' and will have access to meetings, documentation, etc., without voting rights.

Full membership is achieved after the JAA's satisfactory evaluations of the candidate member according to established procedures.

At present, the JAA consists of 33 full members and six candidate members.

Based on the Arrangements and related commitments, the JAA's objectives and functions may be summarized as follows.

3.3.1 Objectives

1 *Aviation safety*. To ensure, through co-operation among Member States, that JAA members achieve a high, consistent level of aviation safety.
2 *Transition from the JAA to the EASA*. To ensure the highest level of contribution to the European Union for establishing an Aviation Safety Agency that absorbs all functions and activities of the JAA in as short a time as possible and ensures the full participation of JAA non-EU Members.
3 *Business effectiveness*. To achieve a cost-effective safety system so as to contribute to efficient civil aviation.
4 *Consolidation of common standards*. To contribute, through the uniform application of common standards and through regular revision of existing regulations, to fair and equal competition within Member States.
5 *Worldwide aviation safety improvement*. To co-operate with other regional organizations or national authorities of states who are playing an important role in civil aviation, in order to reach at least the JAA safety level and to foster the worldwide implementation of harmonized safety standards and requirements through the conclusion of international arrangements.

3.3.2 Functions

1 To develop and adopt Joint Aviation Requirements (JARs) in the fields of aircraft design and manufacture, aircraft operations and maintenance, and the licensing of aviation personnel.
2 To develop administrative and technical procedures for the implementation of the JARs.

3 To implement JARs and the related administrative and technical procedures in a co-ordinated manner.
4 To adopt measures to ensure, whenever possible, that pursuance of the JAA safety objective does not unreasonably distort competition between the aviation industries of Member States or place companies of Member States at a competitive disadvantage with companies of non-Member States.
5 To provide the principal center of professional expertise in Europe on the harmonization of aviation safety regulations.
6 To co-operate on the harmonization of requirements and the procedures with other safety regulatory authorities, particularly the Federal Aviation Administration (FAA).

3.3.3 Organization of the JAA

The JAA system is run by the governing body in which a JAA Board (JAAB) and a JAA Committee (JAAC) work closely together.

The **JAA Board** consists of the Director Generals of Civil Aviation and an appropriate European Community representation.

The functions of the JAA Board are to determine the general policy and long-term strategy of the JAA, and to control the finances of the JAA.

The **JAA Committee** is comprised of the representatives of the National Aviation Authorities and of the European Commission. It takes technical decisions concerning products, services, organizations, and people, to cover all the fields of competence of the JAA. It controls the Executive and reports to the JAA Board as specified in the Arrangements.

The Committee also has an **Executive Board** of seven members selected by the JAA Committee, one being the seat of the EASA, who meet more regularly to decide day-to-day matters, to prepare work for the full Committee, and to make provisional decisions.

The CJAA staff is headed by a Chief Executive.

The JAA deals with almost all aviation safety problems, except for air traffic control. In Europe, air traffic control is co-ordinated by EUROCONTROL,[3] an organization that maintains close relations with the JAA.

3.3.4 Transition from the JAA to the EASA

With the adoption of Regulation (EC) No. 1592/2002, the national regulation for EU Member States has been replaced by EU Regulation. Also, all certification tasks have been transferred from the national authorities (NA) to the EASA. Non-EU states retain their accountability in all fields.

While the EASA is building its own organization, the JAA continues to exist, ensuring the highest level of contribution to the EASA, which is subsequently to absorb all its functions and activities. Since 2002, the JAA has actively participated in the transition to the EASA by developing, in consultation with the Commission, a transition plan focused on regulatory aspects.

On 28 November 2003, the EASA signed the Cyprus arrangement, becoming a full member of the JAA. This arrangement allowed the EASA to simplify the relationship with the JAA, with the potential to act in the name of all EU Member States.

Within this new framework the JAA maintains all its functions and responsibilities in operation and licensing, while acting as service provider to the EASA in certification and maintenance.

3.3.5 The future of the JAA

A set of options for the future of JAA/EASA relations was discussed during the ECAC's 51st Special Meeting of Director Generals of Civil Aviation (DGCA) in Yalta, from 30 August to 2 September 2002. It was decided that the so-called Option 3, by which the regulatory and certification activity would be conducted within the EASA system but with transparency to non-EASA Member States for the relevant decisions, offered the best prospects for the transition period. It was also agreed that Option 4 should be the ultimate goal, under which JAA activities would be fully integrated with the EASA.

In light of the above decisions, the JAA Board took the initiative to develop a 'roadmap' for the establishment of clear milestones for its medium-term activities. Accordingly, a working group on the Future of the JAA (FUJA) was established to develop this roadmap under clearly defined objectives.

The main objective of the FUJA working group was to produce a detailed document regarding the future of the JAA (the so-called roadmap), inclusive of a precise indication as to when, where, and how each activity performed by the JAA would be transferred or disbanded (milestones), and to consider the most suitable means to continue the association with non-EU ECAC states in ongoing safety-related activities in Europe.

The final report was presented to the ECAC Director Generals at their Special Meeting on 26 August 2005 in Romania, at which time the report, together with the main decisions, were adopted.

3.3.6 General remarks

The activity of this worthy organization, which is to be replaced by the EASA, has very often been limited by its own nature. It is worth mentioning that we are talking about **authorities**, not **authority**. This means that the JAA did not have the legal status of an authority and therefore a legally recognized power. They did not have the power, for example, to issue certificates.

Instead, they could only 'recommend' to the national authorities the release of such certificates under the relevant terms and conditions. For the same reasons, they could not impose rules and procedures – unless they became European directives – but only 'recommend' their implementation. The shortcomings of such a situation are clear, considering the variety of rules and laws in force in the Member States. This is why the institution of a true European authority was increasingly felt to be a necessity.

This is now a reality with the institution of the EASA, which has benefited from the substantial and complex work carried out by the JAA.

3.4 The European Aviation Safety Agency (EASA)

The EASA is an independent European Community body with a legal identity and autonomy in legal, administrative, and financial matters.

This single authority has been created by the adoption of a European Parliament and Council Regulation (EC) No. 1592/2002 of 15 July 2002 in order to put in place a Community system of air safety and environmental regulation.

The activity of the EASA started, as planned, on 28 September 2003 and, after a transitory period in Brussels, the Agency has now moved to Cologne (Germany).

3.4.1 Main tasks

1 To assist the European Commission in preparing legislation, and support the Member States and industry in putting the legislation into effect.
2 To assist the European Commission in monitoring the application of European Community legislation.
3 To adopt its own certification specification and guidance material, conduct technical inspections, and issue certificates where centralized action is more efficient.

The Agency will develop its know-how in all the fields of aviation safety and environmental protection in order to assist Community legislators in the issuing of common rules for:

1 The certification of aeronautical products, parts, and appliances.
2 The approval of organizations and personnel engaged in the maintenance of these products.
3 The approval of air operations.
4 The licensing of aircrew.
5 The safety oversight of airports and air traffic services operators.

The EASA, as a body of the European Community, is subject to the provisions of the Financial Regulations applicable to the general budget of the European Communities, the EASA Financial

Regulations, and the relevant directives relating to the co-ordination of procedures for the award of public contracts.

3.4.2 EASA partnerships

The EASA works closely with representatives of other organizations to ensure that it takes their views into account:

1 Interested parties in industry, which are subject to rules drafted by the EASA, are pivotal in ensuring the success of civil aviation safety standards by assisting in the drafting and correct application of European Community and EASA rules.
2 European aviation authorities perform a critical role in assisting the EASA with the performance of its core rulemaking, certification, and standardization functions.
3 International aviation organizations such as the Joint Aviation Authorities, EUROCONTROL, and the International Civil Aviation Organization work together with the EASA to promote international civil aviation standards.
4 International aviation authorities such as the Federal Aviation Administration, Transport Canada, DAC/CTA (Brazil), and the Interstate Aviation Committee (Russia) work with the EASA to ensure compliance with international standards and to facilitate trade in aeronautical products.
5 Accident investigation bodies issue safety recommendations and analysis that guide the Agency's safety strategy.

3.4.3 Structure of the EASA

The EASA Headquarters includes:

1 Executive Directorate
2 Rulemaking Directorate
3 Certification Directorate
4 Quality and Standardization Directorate
5 Administrative Directorate.

The **Executive Director** is appointed by the Agency's **Management Board**. This Board, which brings together representatives of the Member States' authorities and the Commission, is responsible for the definition of the Agency's priorities, the establishment of the budget, and for monitoring the Agency's operation.[4]

The **Rulemaking Directorate** contributes to the production of all EU legislation and implementation of material related to the regulation of civil aviation safety and environmental compatibility. It submits opinions to the European Commission and must be consulted by the Commission on any technical question in its field of competence. It is also in charge of the related international co-operation. Experts within the Rulemaking Directorate have direct

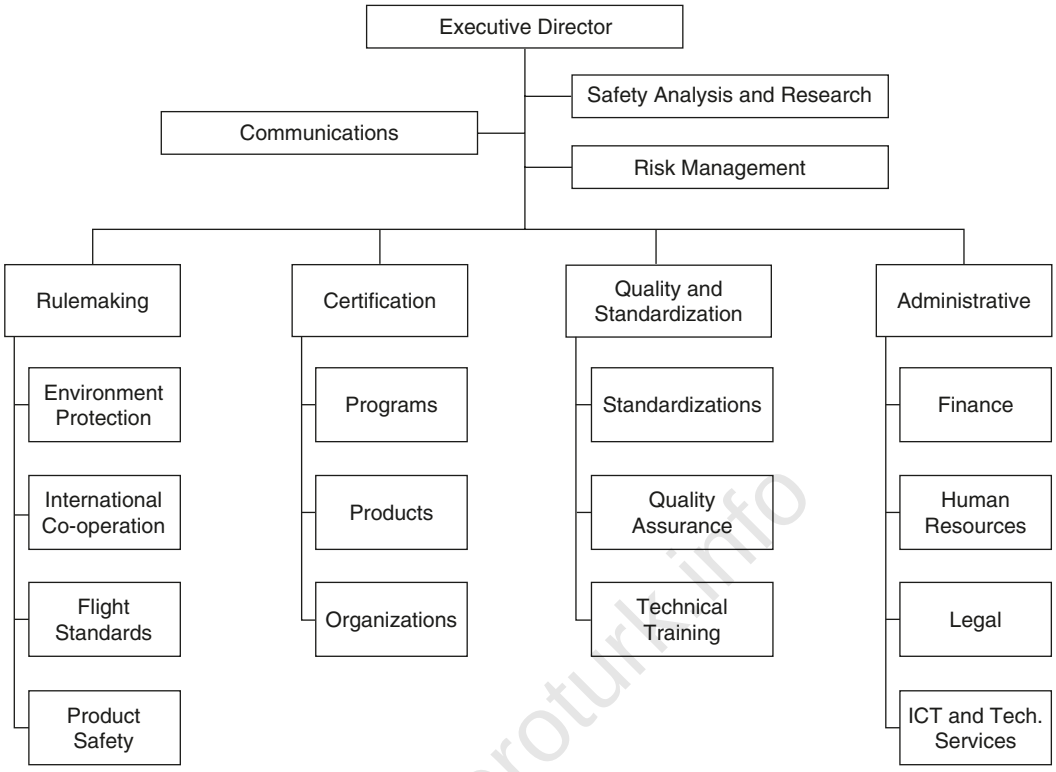


Figure 3.1 *EASA organizational chart*

contact with all relevant stakeholders, and make use of the knowledge available within the industry and national administrations across the European Union. The Agency's team of experts is comprised of people with a recognized background in aviation and Community regulations.

Currently, the Basic Regulation establishes Community competence only for the regulation of the airworthiness and environmental compatibility of aeronautical products, parts, and appliances. Work is underway to extend the scope of this regulation to embrace the regulation of pilot licensing, air operations, and third country aircraft. It is also envisaged to extend the scope of the Basic Regulation to the safety regulation of airport operations and air traffic control services.

The **Certification Directorate**. On 28 September 2003, the Agency took over responsibility for the airworthiness and environmental certification of all aeronautical products, parts, and appliances designed, manufactured, maintained, or used by persons under the regulatory oversight of EU Member States.

The Agency's certification work also includes all post-certification activities, such as the approval of changes to, and repairs of, aeronautical products and their components, as well as the issuing of Airworthiness Directives to correct any potentially unsafe situation. All type certificates

are therefore now issued by the European Aviation Safety Agency and are valid throughout the European Union.

On the same date, the Agency became the competent authority to approve and oversee the organizations involved in the design of aeronautical products, parts, and appliances. It also carries out the same role for foreign organizations involved in the manufacture or maintenance of such products.

To execute its tasks within the present period of building up its resources, the Agency relies on *national aviation authorities* who have historically filled this role and concludes contractual arrangements to this effect.

The **Quality and Standardization Directorate**. Where Community law is implemented at Member State level, the Agency assists the Commission in overseeing its effective application and its uniform understanding.

The necessary standards are therefore being developed and maintained properly, uniformly, and consistently across the European Union.

Accordingly, the Agency conducts inspections of undertakings as well as national authorities throughout the EU, both to monitor the application of EU rules on aviation safety and to assess the effectiveness of these rules. The Agency also provides technical training, which is essential to achieve overall consistency.

The **Administrative Directorate** supports the operational activities of the Agency. Its role is to help the Agency to plan and manage its resources within the limits set out in the regulatory framework. The Directorate's specialists deal with human resource issues, budgeting and finance, infrastructure, legal affairs, and procurement.

3.4.4 EASA certification

3.4.4.1 Design approval

The Certification Directorate is responsible for the management of all applications for design approval and for the issue of related certificates or approvals, and may use either internal or external resources to deal with technical investigations.

According to Regulation (EC) No. 1592, the EASA takes responsibility for the design approval of products, parts, and appliances designed, manufactured, or used by persons under the regulatory oversight of EU Member States, **except for those excluded by its Annex II**.[5]

The European Commission then adopted *Regulation (EC) 1702/2003*, which specifies *inter alia* the requirements applicable to products, parts, and appliances, and also provides for the

grandfathering of pre-existing certificates under conditions that aim at ensuring that they meet the level of safety required by the Basic Regulation (EC) No. 1592/2002 and its rules of implementation.

Consequently, only the products that comply with one of the provisions below are deemed to have been issued a type certificate compliant with Regulation (EC) No. 1592/2002, unless the Agency determines differently:

1 Products certificated in accordance with the JAA rules and procedures.
2 Products certificated by a Member State, acting as the State of Design, on the basis of a well-known airworthiness code.
3 Products certificated by a Member State in the framework of a bilateral agreement with the State of Design, on the basis of that State's airworthiness codes.

Products that do not benefit from these grandfathering provisions will remain under the national administrations' oversight until the time the Agency has determined their type certificates. This will be done by 28 March 2007.

Though the EASA is directly responsible for type certifications, at present some certification tasks can be executed by the national authorities to ease the necessary period of transition.

In relation to the products already type certificated, the Agency will expedite, in co-operation with the concerned Member States of design, the review of the type certification bases of these products with the view to determine their EASA type certificate and thus take over responsibility for their continued airworthiness.[6]

Aircraft which were permitted to fly before 20 September 2003 and cannot be issued an EASA type certificate will remain under the responsibility of the Member State of Registry under applicable national regulations.

3.4.4.2 Organization approval

The Certification Directorate is responsible for:

1 The management of *all* applications for *Design Organization Approval*,[7] the issue of related certificates and their continued surveillance.
2 The management of all applications from *non-EU countries* (or from EU countries on request of the competent authority), for *Production Organization Approval*,[8] the issue of related certificates and their continued surveillance.
3 The management of all applications from *non-EU countries* for *maintenance and maintenance training organization approval*. All *EU production, maintenance, and maintenance training organizations* are approved by the *local competent authority*, in accordance with the rules of implementation.

3.4.4.3 General remarks

At the end of 2004, the EASA was still in the organization phase. According to *Flight International* (October 2004):

> *The EASA is currently engaged in extending its powers beyond its existing responsibility for airworthiness and maintenance into the operations arena. According to approved plans for centralizing all aviation safety rulemaking, the EASA is preparing to assume responsibility for operational issues, including air traffic management, airports and pilots, mirroring the US Federal Aviation Administration.*

> *Mr Goudou*[9] *used a speech to the European Parliament to address claims from several national aviation authorities, that supplementary national requirements licensing will continue to be enforced in the future. But, unlike the predecessor, the Joint Aviation Authorities, the EASA will not merely recommend regulations. As an agency of the EU's executive, the European Commission, it will have the power to enforce compliance.*

In spite of Mr Goudou's goodwill, in the same article *Flight International* mentioned that the EASA has had a setback in its recruitment of 95 certification staff by the end of 2004, mainly because of the Agency's move from Brussels to Cologne, which could not be considered attractive for experienced people living in other locations.

In any case, it is worth reading what Goudou wrote in an article (for a UVS International Publication):

> *During the set-up and transition phase, the keyword of the Agency's activities is 'continuity'. Indeed, it goes without saying that the Agency is not going to reinvent the wheel, as its initial tasks are based on the activities and existing procedures of the Joint Aviation Authorities (JAA), and on national know-how, which enables the Agency to provide continuity in terms of the certification work and the progressive resumption, without major upheaval, of the work carried out now by the JAA and national authorities. As such, no project has been delayed since the Agency has become operational.*

The future will tell if the choice of having all the certification staff in Cologne is the right one.

In a further development, in a letter to *Flight International* (December 2004), Gerd Muehlbauer[10] proposed the institution of regional EASA offices:

> *This would allow technical resources from national airworthiness authorities to be used and would suit those who are unwilling to move to the EASA's office in Cologne.*

> *The FAA approach works, financed by the ticket fee,*[11] *with its headquarters in Washington and regional offices around the nation, strategically located close to the industry.*

3.5 The Federal Aviation Administration (FAA)

3.5.1 Origins

The Air Commerce Act of 20 May 1926 was the cornerstone of the Federal government's regulation of civil aviation. This landmark legislation was passed at the behest of the aviation industry, whose leaders believed the aircraft could not reach its full commercial potential without Federal action to improve and maintain safety standards. The Act charged the Secretary of Commerce with fostering air commerce, issuing and enforcing air traffic rules, licensing pilots, certificating aircraft, establishing airways, and operating and maintaining aids to air navigation. A new Aeronautics Branch of the Department of Commerce assumed primary responsibility for aviation oversight.

3.5.2 Early responsibility

In fulfilling its civil aviation responsibilities, the Department of Commerce initially concentrated on functions such as safety rulemaking and the certification of pilots and aircraft.

In 1934, the Aeronautics Branch was renamed the Bureau of Air Commerce to reflect its enhanced status within the Department. As commercial flying increased, the Bureau encouraged a group of airlines to establish the first three centers for providing air traffic control (ATC) along the airways. In 1936, the Bureau itself took over the centers and began to expand the ATC system.

3.5.3 The Civil Aeronautics Act

In 1938, the Civil Aeronautics Act transferred the Federal civil aviation responsibilities from the Commerce Department to a new independent agency, the Civil Aeronautics Authority.

In 1940, President Franklin Roosevelt split the Authority into two agencies, the Civil Aeronautics Administration (CAA) and the Civil Aeronautics Board (CAB). The CAA was responsible for ATC, airman and aircraft certification, safety enforcement, and airway development. The CAB was entrusted with safety rulemaking, accident investigation, and economic regulation of the airlines. Both organizations were part of the Department of Commerce.

3.5.4 The birth of the FAA

The approaching introduction of jet airliners and a series of mid-air collisions spurred passage of the Federal Aviation Act of 1958. This legislation transferred the CAA's functions to a new independent body, the Federal Aviation Agency (FAA), that had broader authority to combat aviation hazards. The act took safety rulemaking from the CAB and entrusted it to the new FAA. It also gave the FAA sole responsibility for developing and maintaining a common

civil–military system of air navigation and air traffic control, a responsibility the CAA previously shared with others.

3.5.5 From agency to administration

In 1966, Congress authorized the creation of a cabinet department that would combine major Federal transportation responsibilities. This new Department of Transportation (DOT) began full operations on 1 April 1967. On that day, the FAA became one of several modal organizations within the DOT and was given a new name, the **Federal Aviation Administration**. At the same time, the CAB's accident investigation function was transferred to the new National Transportation Safety Board (NTSB).

3.5.6 Structural changes

The FAA's organizational structure has continued to evolve since its creation. The agency's first Administrator favored a management system under which officials in Washington exercised direct control over programs in the field. In 1961, however, his successor began a decentralization process that transferred much authority to regional organizations. This pattern generally endured until a 1988 'straightlining' again charged managers at national headquarters with more direction of field activities.

3.6 FAA activities

3.6.1 Safety regulations

The FAA issues and enforces regulations and minimum standards covering manufacturing, operating, and maintaining aircraft. It also certifies airmen and airports that serve air carriers.

3.6.2 Airspace and traffic management

The safe and efficient use of navigable airspace is one of the FAA's primary objectives. The FAA operates a network of airport towers, air route traffic control centers, and flight service stations. It also develops air traffic rules, assigns the use of airspace, and controls air traffic.

3.6.3 Air navigation facilities

The FAA builds or installs visual and electronic aids to air navigation. It also maintains, operates, and assures the quality of these facilities, and sustains other systems to support air navigation and air traffic control, including voice and data communications equipment, radar facilities, computer systems, and visual display equipment at flight service stations.

3.6.4 Civil aviation abroad

The FAA promotes aviation safety, encourages civil aviation abroad, and takes part in international conferences. Aeronautical information is exchanged with foreign authorities. The FAA certifies foreign repair shops, airmen and mechanics, provides technical aid and training, negotiates 'Bilateral Safety Agreements' (BASA) with other authorities with the 'Implementation Procedures for Airworthiness' (IPA) to allow and facilitate the mutual certification of aeronautical products which are imported or exported between the USA and a signatory country, as well as promoting technical co-operation in matters of airworthiness, including maintenance, flight operations, and environmental certification.

The FAA deals with all the problems related to flight safety in the United States, but has representatives on five continents committed to ensuring and promoting the safety, security, and efficiency of international civil aviation. The FAA engages in dialog with its counterparts in 188 countries and works closely with the ICAO. This effort includes providing technical assistance and training, ensuring that countries with airlines flying to the USA meet international standards, and harmonizing global standards so that passengers can benefit from a seamless air transportation network.

It is clear that all these international activities have the final and institutional purpose of guaranteeing flight safety in the USA. However, we cannot ignore the considerable drive given by the FAA to the growth of safety on a global scale.

3.6.5 Commercial space transportation

The FAA regulates and encourages the US commercial space transportation industry. It licenses commercial space launch facilities and private launches of space payloads on expendable launch vehicles.

3.6.6 Research, engineering, and development

The FAA conducts research on and develops the systems and procedures needed for a safe and efficient system of air navigation and air traffic control. It helps develop better aircraft, engines and equipment, and tests or evaluates aviation systems, devices, materials, and procedures. The FAA also carries out aero-medical research.

3.6.7 Other programs

The FAA registers aircraft and records documents reflecting title or interest in aircraft and their parts. It administers an aviation insurance program, develops specifications for aeronautical charts, and publishes information on airways, airport services and other technical subjects in aeronautics.

3.6.8 Summary of FAA activities

The FAA is responsible for the safety of civil aviation. Its main roles include:

1 Regulating civil aviation to promote safety.
2 Encouraging and developing civil aeronautics, including new aviation technology.
3 Developing and operating a system of air traffic control and navigation for both civil and military aircraft.
4 Researching and developing the National Airspace System and civil aeronautics.
5 Developing and carrying out programs to control aircraft noise and other environmental effects of civil aviation.
6 Regulating US commercial space transportation.

3.7 FAA certification

The organization of the FAA is very complex; this is understandable considering the plurality of tasks, the size of the USA, and its relationship with the rest of the world.

From an airworthiness point of view, we will try to describe which structure deals with each relevant issue.

In the vast FAA organizational chart we can find the **Aviation Safety** headquarters located in Washington which, among its many offices (like the Office of Accident Investigation, Office of Aerospace Medicine, etc.), hosts the **Aircraft Certification Service**, structured as shown in Figure 3.3.

Figure 3.4 summarizes the main tasks of this Service.

3.7.1 The Aircraft Certification Service

The Aircraft Certification Service administers the type certification program to determine compliance with the prescribed regulations and to maintain certificate integrity (continued airworthiness).

The Service is composed of three headquarters divisions, four certifications directorates, an International Airworthiness Program Staff, and an Aircraft Certification Division located in Brussels, Belgium.

The Aircraft Certification Service's responsibility *for administering the Federal Aviation Regulations* is divided as follows:[12]

1 The **Aircraft Engineering Division** is responsible for overall policy and guidance for engineering portions of the Aircraft Certification Regulatory Program (ACRP).[13]

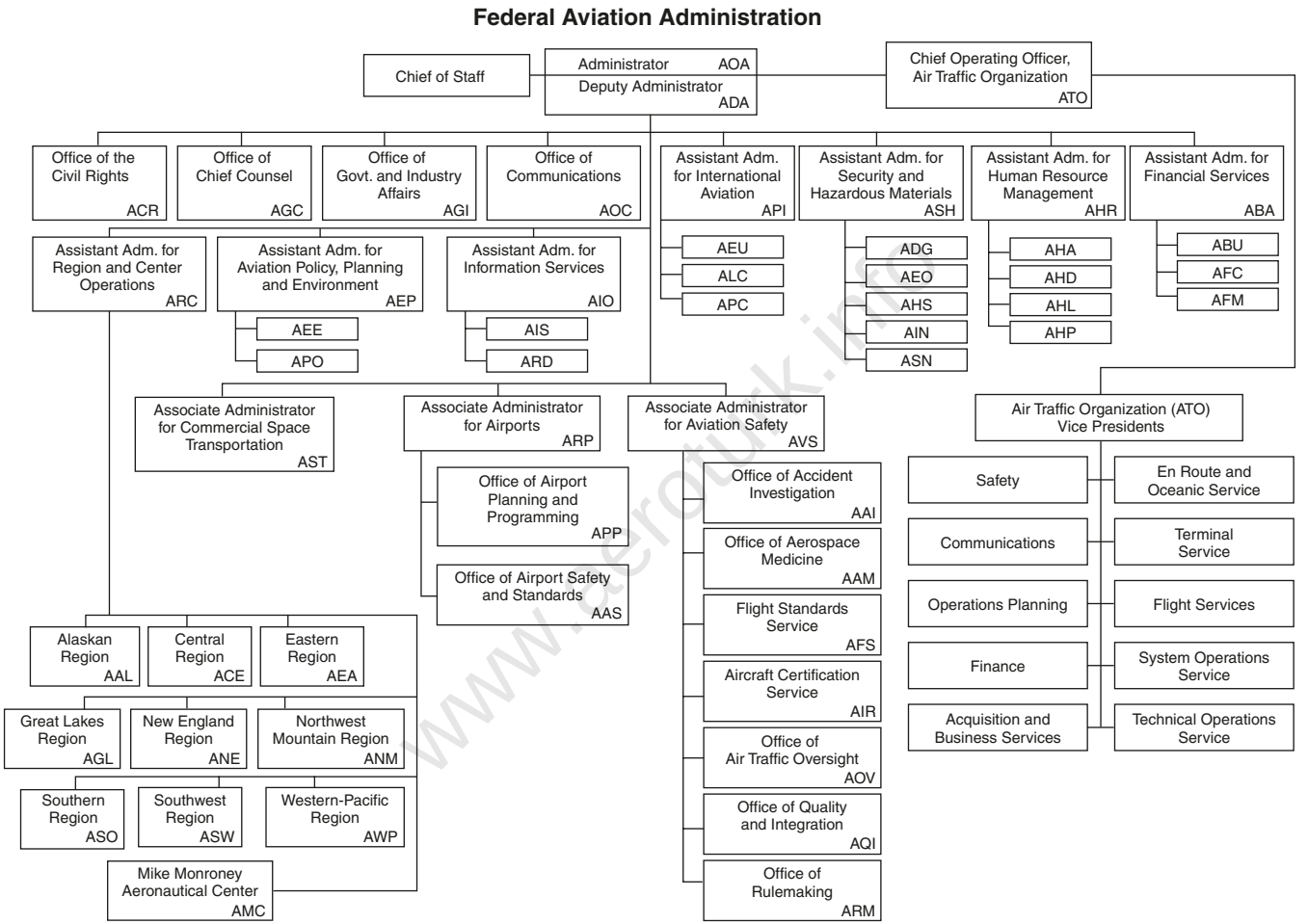


Figure 3.2 *Organization of the Federal Aviation Administration (FAA)*

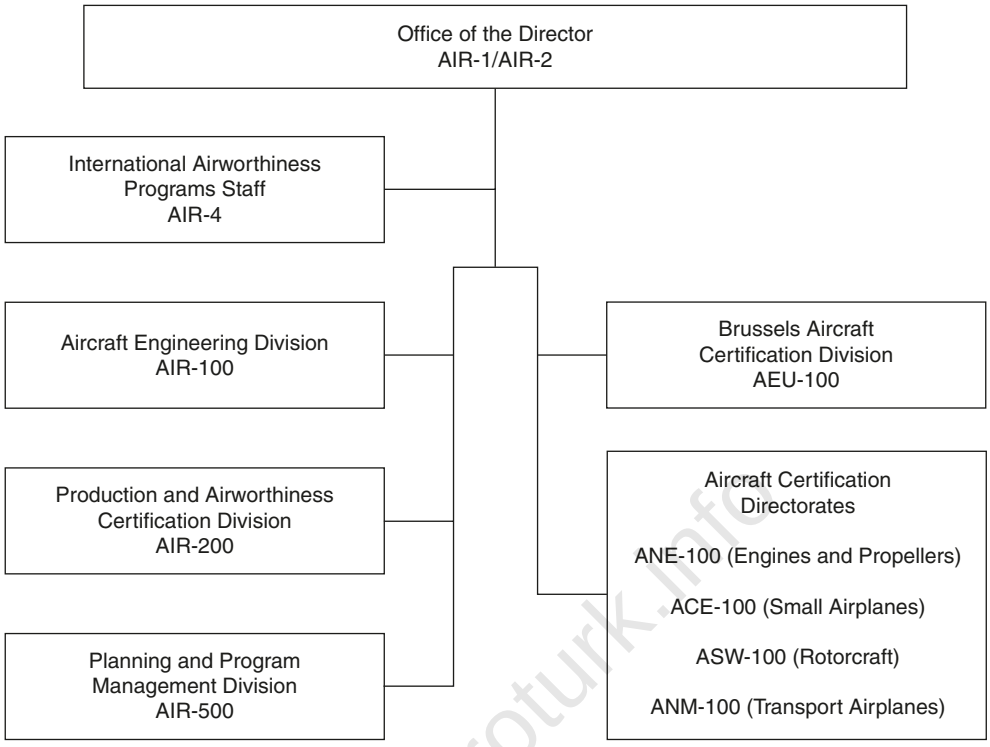


Figure 3.3 *Structure of the Aircraft Certification Service*

Furthermore, it is responsible for FAR 21, 39, and all Special FARs[14] pertaining to type certification.

2 The **Production and Airworthiness Certification Division** is responsible for the overall policy and guidance for manufacturing and airworthiness certification portions of the Aircraft Certification Regulatory Program. It is also responsible for FAR 21, 43, 45, 183, and all Special FARs pertaining to certification conformity, airworthiness certification, and production.

3 The **Planning and Program Management Division** is responsible for the co-ordination of the Service's strategic and tactical planning initiatives and processes. It is also responsible for service technical, general and managerial training requirements, administrative and program management guidance, co-ordination, and support for Service headquarters organizations.

4 The **Small Airplane Directorate** (Central Region) is responsible for FAR 23, 31, technical guidance for FAR 23 Restricted category airplanes; airworthiness standard for gliders and airships, and technical guidance for Primary category airplanes; FAR 23, glider and airship import TC projects from Europe, Africa, and Israel.

5 The **Transport Airplane Directorate** (Northwest Mountain Region) is responsible for FAR 25 and technical guidance for FAR 25, Restricted category airplanes,[15] and FAR 25, import TC projects from Europe, Africa, and Israel.

<table>
<tr><th colspan="3">Aircraft Certification Service – Products and services</th></tr>
<tr><th>Design Approvals</th><th>Production Approvals for Aircraft, Engines, and Propellers</th><th>Airworthiness Certification</th></tr>
<tr><td>• Transport airplanes
• Small airplanes
• Engines and propellers (including APUs)
• Rotorcraft
• Airships
• Manned free balloons</td><td>• Production certificate
• Production under a type certificate only
• Approved Production Inspection System (APIS)</td><td>• Standard airworthiness certificate
• Special airworthiness certificate (amateur-built)
• Approved Production Inspection system (APIS)
• Special flight authorization
• Export approvals
• Import approvals</td></tr>
<tr><th>Design Modifications for Aircraft, Engines, and Propellers</th><th>Design and Production Approvals for Parts/ Articles/Appliances</th><th>Representatives of the Administrator (Designees)</th></tr>
<tr><td>• Amended type certificate
• Supplemental type certificate
• Field approval</td><td>• Parts Manufacturer Approval
• Technical Standard Order authorization</td><td rowspan="3">• Designee resources
• Designee process overview
• Designee/FAA selection and appointment process
• Designee training</td></tr>
<tr><th>Continued Operational Safety</th><th>International Aviation</th></tr>
<tr><td>• Airworthiness Directives (AD) process
• Alternate Method of Compliance (AMOC)
• Design approval holder reporting requirements</td><td>• Bilateral agreements</td></tr>
</table>

Figure 3.4 *Main tasks of the Aircraft Certification Service*

6 The **Rotorcraft Directorate** (Southwest Region) is responsible for FAR 27 and 29, technical guidance for FAR 27 and 29 Restricted category rotorcraft, powered lift aircraft, and guidance for primary category aircraft; FAR 27 and 29 import TC projects from Europe, Africa, and Israel.

7 The **Engine and Propeller Directorate** (New England Region) is responsible for FAR 33 and 35, technical guidance on auxiliary power units (APUs).

The Service also has other functions:

1 The **International Airworthiness Program Staff (AIR-4)** is responsible for policy guidance on bilateral agreements, import and export of aeronautical products, and other international airworthiness issues, programs, and procedures.
2 **Aircraft Certification Offices (ACOs)**. Each directorate incorporates three or more ACOs within their geographical areas issuing the actual certification of aircraft and products. They work directly with the applicant and provide the main interface between the public and the FAA.
3 **Aircraft Evaluation Group (AEG)**. A Flight Standards group is co-located with each directorate and it is responsible for determining operational acceptability and continuing airworthiness requirements of newly certified or modified aircraft, engines, and propellers intended to be operated under the provisions of the FARs.

We will now describe in more detail the four Directorates mentioned above.

3.7.2 The Small Airplane Directorate

The Small Airplane Directorate (Central Region) consists of the **Directorate headquarters** located in Kansas City; four **Aircraft Certification Offices (ACO)** located in *Anchorage*, *Atlanta*, *Chicago* and *Wichita*; and seven **Manufacturing Inspection District Offices (MIDOs)**[16] located in *Atlanta*, *Cleveland*, *Kansas City*, *Minneapolis*, *Orlando*, *Vandalia*, and *Wichita*.

The primary functions of the Directorate headquarters in Kansas City are to:

1 Provide administrative support and resource management for the Directorate field offices.
2 Develop type certification policies and regulations for *small airplanes*, *airships*, and *balloons*, and ensure standardized application of the policies and regulations.
3 Administer type certification of small airplanes, airships, and balloons in field offices outside the Directorate.
4 Monitor *service difficulty information* and process airworthiness actions for small airplanes, airships, and balloons.

The Small Airplane Directorate is responsible for several aspects of aviation, such as:

1 Continued airworthiness and general aviation safety
2 Type certification
3 Technical Standard Orders (TSO)
4 Parts manufacturer approval (PMA)
5 Field approval.[17]

3.7.3 The Transport Airplane Directorate

The Transport Airplane Directorate (Northwest Mountain Region), functionally, has oversight responsibility for transport category airplane design approvals and modifications worldwide, as well as oversight responsibility for over 900 production approval holders. The Transport Airplane Directorate works closely with other FAA offices throughout the country and with foreign regulatory authorities to accomplish this goal.

Among the FAA offices working with the Directorate, it is worth mentioning:

1 The **Aircraft Certification Services** (**ACOs**; in Seattle, Los Angeles, and Denver).
2 The **Manufacturing Inspection District Offices** (**MIDOs**; in Renton, WA, Phoenix, AZ, Lakewood, CA, and Van Nuys, CA) – one Certificate Management Office in Renton, WA, with Certificate Management Units in Everett, WA, Renton, WA, Auburn, WA, and Long Beach, CA.

The Directorate relies on **Designated Representatives**[18] of the Administrator to act on behalf of the FAA. This Designee force includes Engineering Designees, Manufacturing Designees, and Organization Designees.

The Directorate's three most important responsibilities are:

1 Continued operational safety
2 Regulations and policy for all transport category airplanes
3 Design, production, and airworthiness certification.

3.7.3.1 Continued operational safety

1 Monitoring the transport category airplane fleet to ensure that airplanes continue to meet regulations and are safe throughout their operational life cycle.
2 Looking for conditions that affect the safety of airplanes. This is done by surveillance, inspection, review, investigation and analysis of service difficulties, incidents, and accidents.
3 If an unsafe condition is identified, this will trigger the following actions:
   (a) Work with the manufacturers to mandate corrective action through Airworthiness Directives (ADs), or
   (b) Revision of regulations/policy, or
   (c) Issuing of new regulations/policy.
4 Performing surveillance and oversight of production approval holders.

3.7.3.2 Regulations and policy for all transport airplanes

1 Developing and establishing FAA type design and airworthiness standards for all transport category airplanes.
2 The type design standards are codified in Title 14, Code of Federal Regulations (14 CFR), Part 25. This is commonly referred to as Part 25 of the Federal Aviation Regulations (FAR).

3 These FAR 25 standards are applied to aircraft worldwide, working with other civil aviation authorities to 'harmonize' these standards whenever possible.

3.7.3.3 Design, production, and airworthiness certification

1 The Directorate is responsible for the release of design, production, and airworthiness approvals of all aircraft and aircraft parts in Washington, Oregon, Idaho, Montana, Colorado, Wyoming, California, Arizona, Utah, Nevada, Hawaii, and the Pacific Rim countries.
2 Determining if and ensuring that each aircraft design meets the applicable regulations (**design certification**).
3 When an applicant shows that its aircraft design meets the standards, a type certificate is issued.
4 Ensuring that each manufacturing facility is capable of producing aircraft to the approved design (**production certification**).
5 Ensuring that each aircraft produced in the manufacturing facility is built to the approved design.
6 Ensuring that each aircraft produced is in a condition for safe operation (**airworthiness certification**).

3.7.4 The Rotorcraft Directorate

The Rotorcraft Directorate (Southwest Region) approves the design and production for all aircraft manufactured or modified in Texas, New Mexico, Oklahoma, Arkansas, and Louisiana for those seeking a type certificate, Supplemental type certificate, parts manufacturer approval, or a Technical Standard Order approval.

In addition to certifying all aircraft, the Directorate has the responsibility for writing rules and policy for rotorcraft and working with all the **Aircraft Certification Offices (ACOs)** – also outside the above-mentioned territory – to achieve standardized application of the rules for rotorcraft. Furthermore, it works with its counterparts in other countries to issue domestic approvals for foreign manufactured rotorcraft.

The Rotorcraft Directorate has one **Manufacturing Inspection District Office (MIDO)** in Oklahoma City and one in San Antonio. The rest of the Directorate, which includes three **Aircraft Certification Offices (ACOs)**, a **Manufacturing Inspection District Office (MIDO)**, the **Directorate Staff**, and the necessary administrative support and management, is located in the Southwest Regional Office, 2601 Meacham Blvd, Fort Worth, TX 76193.

1 Of the three Aircraft Certification Offices, two certify the engineering design of airplanes and one certifies rotorcraft.
2 The Manufacturing Inspection District Offices certify the production aspects of all products.
3 The Rotorcraft Standards Staff writes rules/policy and establishes standardized application of the rotorcraft certification rules, and
4 The necessary administrative support staff and management to operate the organization.

3.7.5 The Engine and Propeller Directorate

The Engine and Propeller Directorate (New England Region) is located in Burlington, MA. It is responsible for original type certification or changes to approved designs of aircraft engines and propellers in addition to Technical Standard Order (TSO) approvals of auxiliary power units (APUs).

The Engine and Propeller Directorate (E&PD) is responsible for developing rules, policy, and guidance for these products, and assures standardization across all FAA **Aircraft Certification Offices (ACOs)** that perform certification work on these products. The E&PD Standards Staff is the working element of the E&PD that directly carries out these functions.

The **Engine Certification Office (ECO)** and each of the **Aircraft Certification Offices (ACOs)** that perform E&PD-related certification work are accountable for planning, directing, and controlling engine and propeller type certification programs in addition to TSO approvals of auxiliary power units. Both the ECO's and ACOs' primary responsibilities are to find compliance to the applicable Airworthiness Standards (i.e. FAR 33 and 35 and TSO-C77B) and assure continued airworthiness of these products once in service.

The **Manufacturing Inspection Office (MIO)** is responsible for assuring aviation parts are manufactured to approved standards and issuing production certificates to manufacturers in accordance with the requirements of FAR 21.

3.8 'One world, one goal: aviation safety'

In this chapter, in dealing with the JAA, we have emphasized the necessity of having in place a legally recognized European authority. In fact, in spite of a huge amount of work accomplished for unification of regulations and procedures in Europe, the JAA did not have the authority to impose these rules.

The EASA now has this power and can perform as a single authority. For instance, once an aircraft is type certificated by the EASA, this type certificate is valid for all the Member States, without being just a 'recommendation' for the issue of a national type certificate. Today, we have a single European Agency instead of 25 national authorities, and a single certificate for aeronautical products instead of 25.

Another shortcoming of the JAA was the complexity of bilateral agreements[19] with authorities like the FAA or Transport Canada. For example, an Airbus certificated by the JAA could be accepted in the United States only when it was in possession of a type certificate issued by a European Member State.

The JAA has carried out long and complex work with the FAA and Transport Canada for the release of new bilateral agreements, also relating to single European Member States.

The new legal reality requires European Member States to comply with European Law; they cannot deviate from common European rules, nor impose additional requirements or conclude

agreements with third countries. As a consequence, Member States are represented by the EASA. Furthermore, Member States are bound by and must reflect the Agency's decisions and positions when carrying out their representative roles in frameworks like the ICAO and ECAC.

The Agency is committed to establishing proper relations with non-EU members of the ECAC and to pursue relationships with other international partners through special arrangements, associations, partnerships, and mutual recognition agreements. It must also recognize that, legally, bilateral safety agreements are a competence of the European Commission.

At present, although the EASA has already agreed to some working arrangements with a certain number of non-EU states (Brazil, Canada, China, Israel, Russia, and the USA), no bilateral agreement has been formalized. Therefore, from a strictly legal point of view, the existing bilateral agreements of the EU Member States are still in force.

In this context, the EASA is carrying on the tradition of an annual US–Europe International Aviation Safety Conference. The Europe–US Aviation Safety Conference has been taking place for 50 years to promote co-operation and mutual recognition of safety standards.

The Europe–US International Aviation Safety Conference on 7–9 June 2005 was jointly organized by the European Aviation Safety Agency (EASA), the Joint Aviation Authorities (JAA), and the Federal Aviation Administration (FAA) of the USA. For many years, this event provided a forum for open discussion between the JAA and other civil aviation authorities and industry representatives on current initiatives and strategic directions. Today, this annual conference also provides a forum for interested parties to participate in harmonization and safety enhancement activities, and to present initiatives of their own to the global community.

More than 350 high-level aviation experts from all over the world came together in Cologne, Germany, to discuss future trends in aviation safety. Under the title 'Aviation Safety Regulation – Setting the Sights for the Future', this conference hosted by the EASA focused on bilateral agreements and future regulation in aviation safety.

In opening the conference, Patrick Goudou, Executive Director of the EASA, said:

> *Our mission is to set and achieve the highest common standards of safety and environmental protection in civil aviation. I am confident we can achieve our goals through international co-operation and a strong partnership with the United States in particular.*

Notes

1 This can be considered as the part of an aviation authority dealing with airworthiness.
2 The ECAC (European Civil Aviation Conference) was founded in 1955 as an intergovernmental organization. The ECAC's objective is to promote the continued development of a safe, efficient, and sustainable European air transport system. In so doing, the ECAC seeks to harmonize civil

aviation policies and practices amongst its Member States, and promote understanding on policy matters between its Member States and other parts of the world. Close liaisons are maintained with the ICAO, EUROCONTROL (see note 3), and the JAA.

3 EUROCONTROL has the role of co-ordinating the development of a uniform system of Air Traffic Management (ATM) throughout Europe (41 states), working with its partners in the air transport industry to provide a range of services: from air traffic controller training to managing air traffic flow, from regional control of airspace to development of innovative technologies and procedures.

4 The **Advisory Body of Interested Parties** assists the Management Board in this work. It comprises organizations representing aviation personnel, manufacturers, commercial and aviation operators, the maintenance industry, training organizations, and air sport.

5 Aircraft for which a type certificate or a certificate of airworthiness has not been issued on the basis of this EASA Regulation and its implementing rules. (Generally, aircraft with a Special certificate of airworthiness as defined in Chapter 8 and ultralights.)

6 See Chapter 5, 'Instructions for continued airworthiness'.

7 See Chapter 5, 'Design Organization Approval'.

8 See Chapter 7, 'Production Organization Approval'.

9 Patrick Goudou, Executive Director of the EASA.

10 President of MT Propeller Entwicklung.

11 This is another proposal following the US system where the FAA is supported by '$1 per airline ticket'. This is why the FAA does not charge for certification. 'To charge fees for certification could kill small and medium enterprises in aviation, especially in general aviation.'

12 Details on the quoted FARs can be found in Chapter 4.

13 The Federal Aviation Act of 1958 directs the FAA to promote safety of flight of civil aircraft in air commerce prescribing and revising minimum standards for design, materials, construction, etc. The ACRP was developed to accomplish this goal.

14 Special FARs establish additional airworthiness standards for aircraft to cope (normally) with particular operation. For instance, Special FAR No. 23 is for aircraft to be certificated in the Normal category for a reciprocating or turbopropeller multi-engine-powered small airplane that is to be certificated to carry more than 10 occupants and that is intended for use in operations under FAR 135.

15 See Chapter 8.

16 MIDOs assist with: production approval and certification (manufacturing); airworthiness certification; manufacturing facilities approval holder issues; manufacturing designee oversight; support to ACOs during design approvals.

17 Field approval is a maintenance performance approval for a major repair or major alteration that is performed by a Flight Standards Service, Aviation Safety Inspector.

18 A Designee is a representative of the FAA Administrator authorized by law to examine, test, and/or make inspections necessary to issue airman or aircraft certificates.

19 See Chapter 5, 'Type certification of imported products'.

Chapter 4

Airworthiness Requirements

4.1 Requirements, regulations, and standards

Before dealing with EASA regulations, it is worth considering the JAA requirements, which are the basis of these regulations, and their relationship with their FAA analogs. Even if the JAA requirements are to be superseded, it is necessary to start with them in order to establish continuity and gain an understanding of their origin.

Having already mentioned the **standards** as the technical documents issued to define design criteria, we will now consider the '**requirements**' (in the JAA terminology) or '**regulations**' (in the FAA terminology): the compulsory standards.

The OSTIV,[1] for example, publishes a standard for the design of sailplanes and powered sailplanes entitled 'OSTIV Airworthiness Standard'. This document defines this organization's vision on this subject. However, if anyone applies for the certification of a sailplane in Europe, they must make reference to JAR 22,[2] 'Sailplanes and Powered Sailplanes', because this is the only set of sailplane airworthiness standards with legal value, adopted by all JAA national authorities. This means that the OSTIV Standard[3] can only be a guide as well as a valuable reference point (also for the JAR 22 Study Group).

4.2 JARs and FARs

When the JAR requirements were first issued in the 1970s, several different standards for aircraft certification were in force in different countries. If we consider the western world only, among the most renowned we can quote the Federal Aviation Regulations (FARs) issued by the FAA, adopted in the United States as well as in many other countries. In the UK, for example, the Civil Aviation Authority that in 1972 replaced the Air Registration Board (ARB) made use of the British Civil Air Regulations (BCARs). In France the *Direction Générale de*

l'Aviation Civile (DGAC) had the *Régles AIR*. In Germany the *Luftfahrt Bundesamt* had its own regulations for sailplanes. This situation posed many difficulties in aircraft exportation.

Finally, on 1 January 1992, the JARs became part of the regulations of the European Community, assuming legal status in the Community Countries (all existing equivalent regulations had to be superseded). At present, only JARs (now replaced by the EASA regulations, as we will see) and FARs (or derivative regulations) are in practical use.

4.3 List of JARs and FARs[4] directly or indirectly related to airworthiness certification

4.3.1 JAR 1/FAR 1. Definitions and Abbreviations

These codes contain definitions and abbreviations of terms used in other JAR/FAR codes. JAR 1 is based partly on those definitions contained in ICAO Annexes and partly on FAR 1. FAR 1 also contains *rules of constructions*, i.e. characterization of wording like the use of '*shall*', '*may*', '*a person may not*', '*includes*'.

4.3.2 JAR 11. JAA Regulatory and Related Procedures

This code contains the requirements applicable to:

1 The retention by the Central JAA of documents related to the development and production of JARs.
2 The format and structure of JARs.
3 The development of JARs and amendments to JARs until their publication by the JAA.
4 The procedures for granting exemptions in the JARs.
5 The procedures for consultation on special conditions.
6 The development of ACJ until their publication by the JAA.

4.3.3 FAR 11. General Rulemaking Procedure

This part applies to the issuance, amendment, and repeal of any regulation for which the FAA follows public rulemaking procedures under the Administrative Procedure Act ('APA'). In this context the code prescribes requirements applicable to:

1 Procedures for issuing a rule, from the 'advanced notice of proposed rulemaking' (ANPRM), through the 'notice of proposed rulemaking' (NPRM), to the 'final rule'.
2 Petitions for exemptions (from individual or entity).
3 Petitions for rule-making (from individual or entity).
4 Issuing of special conditions.

4.3.4 JAR 21. Certification Procedures for Aircraft and Related Products and Parts

See relevant paragraph in this chapter.

4.3.5 FAR 21. Certification Procedures for Products and Parts

See relevant paragraph in this chapter.

4.3.6 JAR 22. Sailplanes and Powered Sailplanes[5]

See relevant paragraph in this chapter.

4.3.7 JAR-VLA. Very Light Aeroplanes[6]

See relevant paragraph in this chapter.

4.3.8 JAR 23. Normal, Utility, Aerobatic and Commuter Category Aeroplanes

See relevant paragraph in this chapter.

4.3.9 FAR 23. Airworthiness Standards: Normal, Utility, Acrobatic and Commuter category airplanes

See relevant paragraph in this chapter.

4.3.10 JAR 25. Large Aeroplanes

See relevant paragraph in this chapter.

4.3.11 FAR 25. Airworthiness Standards: Transport category airplanes

See relevant paragraph in this chapter.

4.3.12 JAR 26. Additional Airworthiness Requirements for Operations

This code prescribes specific additional airworthiness requirements with which operators must ensure that compliance has been established if operating in accordance with the Part of JAR-OPS relevant to the particular type of operations.

1 Subpart B relates to Commercial Air Transportation (Aeroplanes).
2 Subpart C (*reserved*) relates to General Aviation (Airplanes).
3 Subpart D (*reserved*) relates to Commercial Air Transportation (Helicopters).
4 Subpart E (*reserved*) relates to General Aviation (Helicopters).

4.3.13 JAR 27. Small Rotorcraft

See relevant paragraph in this chapter.

4.3.14 FAR 27. Airworthiness Standards: Normal category rotorcraft

See relevant paragraph in this chapter.

4.3.15 JAR 29. Large Rotorcraft

See relevant paragraph in this chapter.

4.3.16 FAR 29. Airworthiness Standards: Transport category rotorcraft

See relevant paragraph in this chapter.

4.3.17 FAR 31. Airworthiness Standards: Manned free balloons[7]

See relevant paragraph in this chapter.

4.3.18 JAR-E. Engines

This code is based on the English BCAR Section C and contains the airworthiness requirements for engines. Subsections B and C deal specifically with piston engines; subsections D and E deal specifically with turbine engines.

4.3.19 FAR 33. Airworthiness Standards: Aircraft engines

This part prescribes airworthiness standards for the issue of type certificates for aircraft engines and changes to those certificates. Subparts C and D deal specifically with reciprocating aircraft engines; Subparts E and F deal specifically with turbine aircraft engines.

4.3.20 JAR-APU. Auxiliary Power Units[8]

This code is based on FAA Technical Standard Order TSO-C77a and provides airworthiness requirements for the release of JTSO authorizations for turbine powered auxiliary power units for use on aircraft.

4.3.21 FAR 34. Fuel Venting and Exhaust Emission Requirements for Turbine Engine Powered Airplanes[9]

The provisions of this subpart are applicable to all in-use aircraft gas turbine engines of the classes specified, certificated for operations within the United States.

As regards foreign airplanes, this FAR applies only to those foreign civil airplanes that, if registered in the United States, would be required by applicable Federal Aviation Regulations to have a US standard airworthiness certificate in order to conduct the operations intended for the airplane.

4.3.22 JAR-P. Propellers

The requirements of this code apply to propellers of conventional design.

4.3.23 FAR 35. Airworthiness Standards: Propellers

This part prescribes airworthiness standards for the issue of type certificates and changes to those certificates for propellers.

4.3.24 JAR 36. Aircraft Noise

The applicable noise requirements for the publication of a type certificate for an aircraft are prescribed according to the provisions of Chapter 1 of ICAO Annex 16.

4.3.25 FAR 36. Noise Standards: Aircraft type and airworthiness certification

This part prescribes noise standards for the issue of the following certificates:

1 Type certificates, and changes to those certificates, and standard airworthiness certificates for subsonic transport category large airplanes and for subsonic jet airplanes regardless of category.

2 Type certificates, and changes to those certificates, standard airworthiness certificates, and restricted category airworthiness certificates for propeller-driven, small airplanes and for propeller-driven, commuter category airplanes, except those airplanes that are designed for 'agricultural aircraft operations' (as defined in FAR 137.3, as effective on 1 January 1966) or for dispersing fire-fighting materials to which FAR 36.1583 does not apply.
3 A type certificate, and changes to that certificate, and standard airworthiness certificates for Concorde airplanes.
4 Type certificates, and changes to those certificates, for helicopters, except those helicopters that are designated exclusively for 'agricultural aircraft operations', for dispensing fire-fighting materials or for carrying external loads.

4.3.26 FAR 39. Airworthiness Directives

The regulations in this part provide a legal framework for the FAA's system of Airworthiness Directives.[10]

4.3.27 FAR 43. Maintenance, Preventive Maintenance, Rebuilding, and Alterations

See relevant paragraph in Chapter 9.

4.3.28 FAR 45. Identification and Registration Marking

This part prescribes the requirements for:

1 Identification of aircraft, and identification of aircraft engines and propellers, that are manufactured under the terms of a type or production certificate.
2 Identification of certain replacement and modified parts produced for installation on type certificated products.
3 Nationality and registration marking of US-registered aircraft.

4.3.29 JAR-TSO. Joint Technical Standard Orders

While the requirements for issue of JTSOs are found in JAR 21 Subparts O and N–O, the code provides the list of JTSOs as follows:

- **Index 1**: the JTSOs that are technically similar to FAA TSOs.
- **Index 2**: the JTSOs that are applicable only to JAR (different from FAA TSOs, or corresponding FAA TSOs not existing).

4.3.30 JAR-OPS 1. Commercial Air Transportation (Aeroplanes)

This code prescribes requirements applicable to operation of any civil aeroplane for the purpose of commercial air transportation by any operator whose principal place of business is in a JAA Member State, with exceptions indicated in the same code.

4.3.31 JAR-OPS 3. Commercial Air Transportation (Helicopters)

This code prescribes requirements applicable to any civil helicopter for the purpose of commercial air transportation by any operator whose principal place of business is in a JAA Member State, with exceptions indicated in the same code.

4.3.32 JAR-MMEL/MEL. Master Minimum Equipment List/Minimum Equipment List

See relevant paragraph in Chapter 5.

4.3.33 FAR 91. General Operating and Flight Rules

Except as provided in cases indicated, this part prescribes rules governing the operation of aircraft (other than moored balloons, kites, unmanned rockets, and unmanned free balloons, which are governed by FAR 101, and ultralight vehicles operating in accordance with FAR 103) within the United States, including the waters within three nautical miles of the US coast.[11]

4.3.34 FAR 101. Moored Balloons, Kites, Unmanned Rockets, and Free Balloons

This part prescribes rules governing the operation in the United States, of moored balloons, kites, unmanned rockets, and free balloons, whose characteristics and limitations (as applicable: weight, gas capacity, quantity and quality of propellant, etc.) are defined.

4.3.35 FAR 103. Ultralight Vehicles

This part prescribes rules governing the operation of ultralight vehicles in the United States. For the purposes of this part, ultralights are defined in terms of maximum weight (powered and unpowered), maximum speed (powered), and maximum stalling speed; the operations are limited to a single occupant and their use to recreation or sport purposes only.

4.3.36 FAR 119. Certification: Air Carriers and Commercial Operators

This part applies to each person operating or intending to operate civil aircraft as an air carrier or commercial operator, or both, in air commerce or, when common carriage is not involved,[12]

in operations of US-registered civil airplanes with a seat configuration of 20 or more passengers, or a maximum payload capacity of 6000 lb or more. This part prescribes in particular the certification requirements an operator must meet in order to obtain and hold a certificate authorizing operations under FAR 121, 125, or 135.

4.3.37 FAR 121. Operating Requirements: Domestic, flag, and supplemental operations

This part prescribes rules governing (in particular):

1 The domestic, flag, and operations of each person who holds an Air Carrier Certificate or Operating Certificate under FAR 119.
2 Each person employed or used by a certificate holder conducting operations under this part, including maintenance, preventive maintenance, and alteration of aircraft.

4.3.38 FAR 125. Certification and Operations: Airplanes having a seating capacity of 20 or more passengers or a maximum payload capacity of 6000 pounds or more; and rules governing persons on board such aircraft

This part prescribes rules governing the operations of the above-mentioned US-registered civil airplanes when common carriage is not involved, unless they are required to be operated under FAR 121, 129, 135, or 137, and unless other cases described in this part are applicable.

4.3.39 FAR 129. Operations: Foreign air carriers and foreign operators of US-registered aircraft engaged in common carriage

This part prescribes rules governing the operations within the Unites States of each foreign air carrier holding (defined) permits issued by the Civil Aeronautic Board of the US Department of Transportation.

4.3.40 FAR 133. Rotorcraft External-Load Operations

This part prescribes airworthiness and operating certification rules for rotorcraft used in the above-mentioned operations in the United States by anyone, with the exceptions defined in the same document.

4.3.41 FAR 135. Operating Requirements: Commuter and on-demand operations and rules governing persons on board such aircraft

This part prescribes rules governing the commuter or on-demand operations of each person who holds or is required to hold an Air Carrier Certificate or Operating Certificate under FAR 119 and relevant items.

4.3.42 FAR 137. Agricultural Aircraft Operations

This part prescribes rules governing agricultural operations within the United States and the issue of commercial and private agricultural aircraft operator certificates for those operations.

4.3.43 FAR 145. Repair Stations

This part describes how to obtain a repair station certificate. This part also contains the rules a certificated repair station must follow relating to its performance of maintenance, preventive maintenance or alterations of an aircraft, airframe, aircraft engine, propeller, appliance, or component part to which FAR 43 applies. It also applies to any person who holds, or is required to hold, a repair station certificate issued under this part.

4.3.44 FAR 147. Aviation Maintenance Technician Schools

This part prescribes the requirements for issuing aviation maintenance technician school certificates and associated ratings and the general operating rules for the holders of those certificates and ratings.

4.3.45 JAR-AWO. All Weather Operations

This code prescribes requirements for:

1 Automatic landing systems.
2 Airworthiness certification of aeroplanes for operations with decision heights of 60 m (200 ft) down to 30 m (100 ft) – Category 2 operations.
3 Airworthiness certification of aeroplanes for operations with decision height below 30 m (100 ft) or no decision height – Category 3 operations.
4 Directional guidance for take-off in low visibility.

4.3.46 JAR/CS-VLR. Very Light Rotorcraft

See relevant paragraph in this chapter.

4.3.47 References for certification of parts of aircraft

1 Joint Technical Standard Order authorization (JTSO) (JAR 21 Subpart O).
2 Technical Standard Order (TSO) (FAA AC 20–110).
3 Joint Part Approval authorization (JPA) (JAR 21 Subpart P).
4 Part Manufacturer Approval (PMA) (FAR 21.303).
5 Military and industrial specifications.
6 Specifications written in the aircraft certification process.

Note. We will deal with this subject in more detail in Chapter 5, in the section 'Parts and appliances approval'.

4.3.48 General remarks

The airworthiness standards dealing with the same products[13] have been put in sequence in the above list. The list shows the existence of operational standards in addition to the product type certification standards. These operational standards contain airworthiness requirements that influence the aircraft configuration in relation to their particular operations.[14]

A JAR/FAR 23 aeroplane, for example, can obtain a type certificate with the installation (as flight and navigation instruments) of an airspeed indicator, an altimeter, and a magnetic direction indicator only. However, in order to obtain a certificate of airworthiness (the document which authorizes the flight), other instruments and equipment that depend on the particular type of operation (for example, tourism, aerial work) and on the flight conditions (VFR, IFR, night flight, etc.) must be installed as prescribed by the operational rules.

Furthermore, the environmental standards such as FAR 34 and JAR/FAR 36 must be considered. For the FAA and EASA, compliance with the environmental protection requirements is part of the type certification.[15]

The JAA requirements are adopted by the JAA Member States, the EASA requirements are now used by the EU Member States, and the FAA regulations are used in the United States[16] (Canada has equivalent rules).

Nevertheless, the manufacturing companies wanting to sell their products on both sides of the Atlantic must perform a double certification, with a substantial increase in costs, especially when the standards are different. For many years the transport aeroplane industry has been penalized because the contents of JAR 25 and FAR 25 were not equivalent (and with the same paragraph numbering). JAR 25 originated under a strong English influence, with philosophies borrowed from BCAR Section D. It is also because of manufacturers' complaints that, for many years now, the JAA and FAA have carried out a harmonization process which is well advanced, but not yet accomplished. The situation is better for JAR/FAR 23 aeroplane standards and for the JAR/FAR 27 and 29 rotorcraft[17] standards, because the JAR requirements were produced with the co-operation of the FAA, with the common will of avoiding the situation that has penalized transport aeroplanes: these standards are now almost harmonized.

We will see in the subsequent chapters how it is possible to minimize the burden related to the acceptance of certifications made by different authorities.

4.4 Advisory material

Some rules can be interpreted in different ways. This is the reason why the authorities issue advisory material for the explanation of the rule or, in certain cases, suggest suitable procedures to perform a demonstration of compliance to the same rule.

The FAA publishes 'Advisory Circulars' (ACs) as documents separate from the standards, while the JAA and EASA include similar documents at the end of the JAA/EASA standards.

If we look at the JARs, in Section 2, these standards contain the 'Advisory Circulars – Joint' (ACJs) that are 'Acceptable Means of Compliance, and Interpretations'.[18] The ACJs provide a means, *but not the only means*, by which a requirement can be met.[19] A numbering system is adopted in which the ACJ uses the same number as the paragraph of the JAR to which it is related.

By the same approach, the EASA Certification Standards (CS) contain the 'Acceptable Means of Compliance' (AMC), with the same meaning as the ACJs.

For the Implementing Rules of the EASA, like Part 21, Part M, Part 145, etc., documents containing the Acceptable Means of Compliance (AMC) and Guidance Material (GM) have been issued.

The AMC have the meaning already defined, while the GM helps to illustrate the meaning of a specification or requirements.

4.5 EASA regulations

Figure 4.1 depicts the EASA's regulation organizational structure.

4.5.1 The Basic Regulations

The Basic Regulations (EC) of the EASA are contained in No. 1592/2002 already mentioned, which outlines the tasks of the Agency starting from the necessity that 'a high and uniform level of protection of the European citizen should at all times be ensured in civil aviation, by the adoption of common safety rules and by measures ensuring that products, persons and organizations in the Community comply with such rules and those adopted to protect the environment.'

'As a consequence, aeronautical products should be subject to certification to verify that they meet essential airworthiness and environmental protection requirements relating to civil aviation.

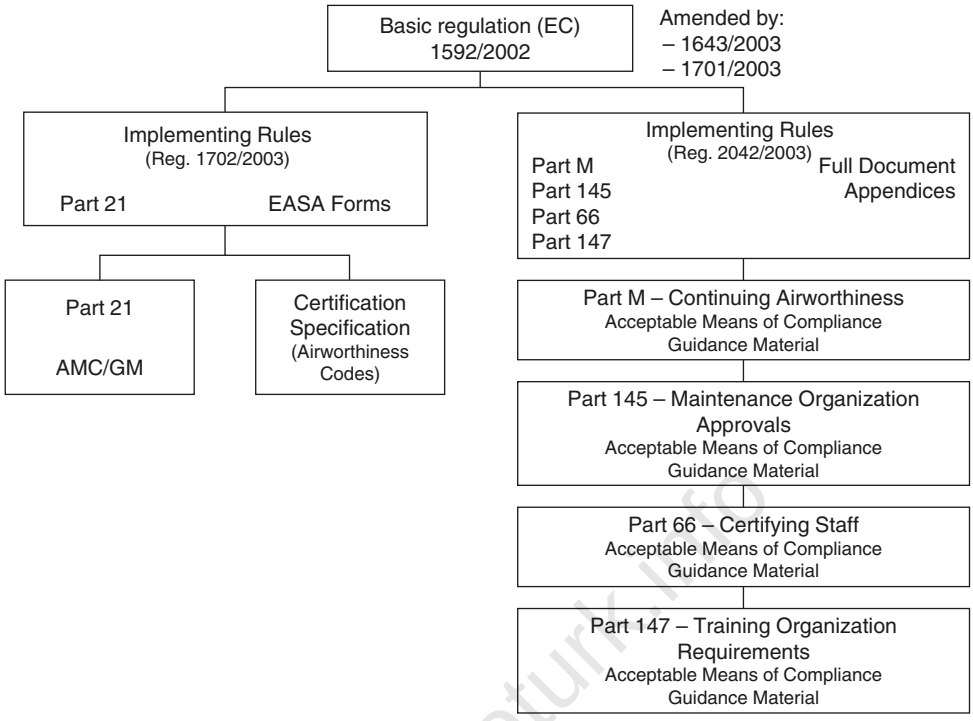


Figure 4.1 *EASA regulations*

Appropriate essential requirements should be developed within one year after the entry into force of this Regulation to cover operation of aircraft and flight crew licensing and application of the Regulation to third-country aircraft and, thereafter, other areas in the field of civil aviation safety.'

On these bases, the EU Member States must adopt common rules in matters of civil aviation.

The EASA has produced, with the JAA's co-operation, a set of regulations that we will now summarize.

The Basic Regulations define the activities to be achieved through formalities detailed in second-level regulations adopted by the European Commission and defined as follows.

4.5.2 Implementing Rules (IR)

These Implementing Rules contain documents defined as **Parts**, which are divided into two sections: Section A, detailing the requirements to be satisfied by aeronautical subjects; and Section B, containing the procedures to be followed by the national authorities.

The Implementing Rules (EC) No. 1702/2003 of 24 September 2003 for the airworthiness and environmental certification of aircraft and related products, parts, and appliances, as well as for the certification of design and production organizations, specify:

1 The issuing of type certificates, Restricted type certificates, and changes to those certificates.
2 The issuing of certificates of airworthiness, Restricted certificate of airworthiness, permit to fly, and authorized release certificates.
3 The issuing of repair design approval.
4 The showing of compliance with environmental protection requirements.
5 The issuing of noise certificates.
6 The identification of products, parts, and appliances.
7 The certification of certain parts and appliances.
8 The certification of design and product organizations.
9 The issuing of Airworthiness Directives.

Annex to this document is **Part 21, 'Certification of aircraft and related products, parts and appliances, and design and production organizations'**.

This document replaces JAR 21, which remains the core of the same document. The changes to the JAR document reflect the new legal status of the EASA towards the national authorities, and a full revision of the document in the light of the JAA certification experience.

The Implementing Rules (EC) No. 2042/2003 of 20 November 2003 specify the continuing airworthiness of aircraft and aeronautical products, parts, and appliances, and the approval of organizations and personnel involved in these tasks.

Annexes to this document are:

1 **Annex I, Part M** establishes the measures to be taken to ensure that airworthiness is maintained, including maintenance. It also specifies the conditions to be met by persons and organizations involved in such continuing airworthiness management.
2 **Annex II, Part 145** establishes the requirements to be met by an organization to qualify for the issue or continuation of an approval for the maintenance of aircraft and components.
3 **Annex III, Part 66** establishes the requirements for the issue of an aircraft maintenance license and conditions of its validity and use, for aeroplanes and helicopters.
4 **Annex IV, Part 147** establishes the requirements to be met by organizations seeking approval to conduct training and examination as specified in Part 66.

4.5.3 Acceptable Means of Compliance (AMC) and Guidance Material (GM) for Part 21, Part M, Part 145, Part 66, and Part 147[20]

As already mentioned, Acceptable Means of Compliance (AMC) illustrate a means, but not the only means, by which a specification contained in an airworthiness code or a requirement in

an implementing rule can be met. Guidance Material (GM) helps to illustrate the meaning of a specification or requirement.

4.5.4 Airworthiness Codes

All airworthiness codes are directly derived from the JARs. The JAR denomination has been changed in CS (Certification Specification).

Currently, the airworthiness codes are the following:

1 **CS-Definitions.** Derived from JAR 1.
2 **CS-22 Sailplanes and Powered Sailplanes.** Derived from JAR 22.
3 **CS-23 Normal, Utility, Acrobatic and Commuter Aeroplanes.** Derived from JAR 23.
4 **CS-25 Large Aeroplanes.** Derived from JAR 25.
5 **CS-27 Small Rotorcraft.** Derived from JAR 27.
6 **CS-29 Large Rotorcraft.** Derived from JAR 29.
7 **CS-VLR Very Light Rotorcraft.** Derived from JAR-VLR.[21]
8 **CS-VLA Very Light Aeroplanes.** Derived from JAR-VLA.
9 **CS-E Engines.** Derived from JAR-E.
10 **CS-P Propellers.** Derived from JAR-P.
11 **CS-34 Aircraft Engine Emission and Fuel Venting.** Derived from JAR 34.
12 **CS-36 Aircraft Noise.** Derived from JAR 36.
13 **CS-APU Auxiliary Power Units.** Derived from JAR-APU.
14 **CS-ETSO European Technical Standard Orders.** Derived from JAR-TSO.
15 **CS-AWO All Weather Operations.** Derived from JAR-AWO.

For the certification of parts of aircraft, the references are the following:

1 European Technical Standard Order authorization (ETSO) (Part 21 Subpart O).
2 Specifications written in the aircraft certification process.
3 Standard parts in accordance with officially recognized standards.

4.6 General considerations on airworthiness standards

Before considering the single standards (at least the more representative ones relating to the information this book is aimed to provide), it is worth considering the 'philosophies' that are the basis of their compilation.

4.6.1 Publication

The standards are made by Working Groups that are responsible for their compilation and amendments. Before publication, the Authorities concerned (the JAA, FAA, or EASA) submit

the standards to public evaluation, allowing interested people and organizations to express their opinions on the matter. The relevant rules and the procedures for these phases are contained in JAR 11, 'Regulatory and Related Procedures', and in FAR 11, 'General Rulemaking Procedures'.

The EASA does not yet have a similar standard.

4.6.2 Special conditions

As mentioned earlier, the standards do not anticipate aeronautical progress. Therefore, in several cases a 'non-conventional aircraft' is the object of the certification, or one with some peculiarities for which the 'applicable' airworthiness requirements of the relevant JAR/FAR/CS do not contain adequate or appropriate safety standards. As we have also considered that a 'blocked' standard might prevent aeronautical progress, what should be done in such situations? JAR/FAR 21, paragraph 16, and EASA Part 21, paragraph 21A.16B, provide an answer mentioning '**special conditions**'. It is a matter of adding such safety standards as the authority finds necessary to establish a level of safety equivalent to that established in the applicable JAR/FAR/CS. The special conditions are issued in accordance with JAR/FAR 11.

We will return to the 'level of safety' concept. However, to mention just one of the numerous possible examples, special conditions were issued for turbine engine installations on FAR 23 aircraft when FAR 23 did not yet contain safety standards for this kind of installation. It is not difficult to imagine the number of special conditions issued for the certification of 'Concorde' in the 1960s.

In many cases, if design peculiarities that require special conditions become commonplace in the aeronautical field – 'winglets', for example – such special conditions are included (after discussions and evaluations according to JAR/FAR 11) in the JAR/FAR/CS standards via amendments.

4.6.3 Severity of the airworthiness standards

The 'level of safety' concept is a matter of serious concern regarding the compilation of the standards. The authorities could be tempted to play safe by issuing very restrictive standards. The immediate result would be to make it impossible for an aircraft to be certified for technical or simply for economical reasons.[22] Within airworthiness standards it is therefore necessary to balance criteria of **acceptability** (from the safety point of view) and the **practicability** of the same criteria.

The application of a rule involves expense. Increase of safety is not always proportional to the severity of the rule, even before considering the expense: at and beyond a certain point, negligible safety increases incur great expenditure. At this point the rule is no longer 'practicable'.

Various airworthiness standards have been produced for different types of aircraft (aeroplanes, rotorcraft, etc.), but also for different categories of the same type of aircraft (for weight,

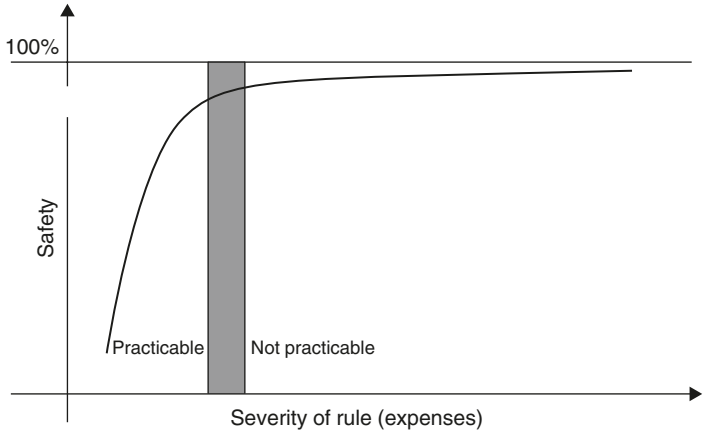


Figure 4.2 *Airworthiness rules*

passengers number, etc.). An attempt has been made to arrange the aircraft in groups that are as 'homogeneous' as possible. Neglecting the obvious necessity to distinguish free balloons from transport aeroplanes, a distinction was made, for example, among the categories of aeroplanes named Normal, Utility, Aerobatic, and Commuter in JAR/FAR 23 and the Large Aeroplanes/Transport category airplanes in JAR/FAR 25. We must not infer that the airworthiness standards are different because the transport aeroplanes should be safer than other types of aircraft. Safety must be maximized for all aircraft, taking into account the criteria of 'practicability' mentioned above. As a fundamental concept, simple aircraft should have simple airworthiness standards to comply with.

It is certainly less easy to understand why a 19 000-lb commuter certified according to JAR/FAR/CS-23, if it 'adds on weight' by some pounds, then comes under the JAR/FAR/CS-25 regulations. However, it is clear that the creation of classes implies that significant parameters are established, consequently involving precise numbers.[23] The designer should be capable of choosing the right airworthiness standard in light of the possible development of the project.

In any case, it is worthwhile considering that airworthiness, like medicine, is not an exact science!

4.6.4 Stalling speed for single-engine aeroplanes

In cases of 'acceptability', 'practicability', and examples of 'philosophies', we will now see how single-engine aeroplanes are regulated from a particular point of view: the stalling speed. A single-engine aeroplane, in case of engine failure, by definition can only glide. If this condition is not manageable in safety terms, it should 'never' happen. In fact, despite the great progress made in engineering techniques, the engine that 'never'[24] fails does not exist. We can also add that the present engine failure rate should not be compatible – and therefore not acceptable – with safety if any engine failure were to cause an accident. It is then necessary that the gliding and (especially) the power-off landing of a single-engine aeroplane be managed by a

pilot of average skill.[25] It is evident that the result of an out-of-field landing is mainly influenced by the approach speed. However, the minimum gliding approach speed in the landing configuration is a function of the power-off stalling speed in the same configuration; hence, a limitation of this speed is required. As a result, the stalling speed of single-engine aeroplanes in landing configuration (V_{so}) is limited to 61 knots. The same limitation exists for twin-engine aeroplanes that cannot meet a certain minimum rate of climb with an inoperative engine.

For all other twin-engine aeroplanes (even with an engine failure probability that is double that of a single-engine aeroplane), the probability of a twofold engine failure in the same flight is considered close to 'never', and therefore acceptable, so that no stalling speed limit is prescribed.[26]

It is interesting to note that, on the basis of the above-mentioned principles, JAR-VLA[27] contains a speed limitation in landing configuration of 45 knots, because it allows the installation of JAR 22 powered sailplane engines that, at least in principle, are considered less reliable than the engines installed on JAR/FAR 23 aeroplanes.

A stalling speed limitation in landing configuration was also introduced in JAR 22, because the trend towards the increase of water ballast quantity for speed contests was producing such an increase in wing loading, and therefore in the stalling speed, to jeopardize the possibility of a safe landing in the case, for example, of an aborted take-off or breaking of the tow rope; normally, in these cases, there is insufficient time to dump the water ballast.

4.6.5 Crashworthiness

We have mentioned a stalling speed limitation of 61 knots. However, is it really true that such a limitation could produce a safe power-off landing?

When limitations of this type are introduced, generally they are the result of experience and analysis of accidents that occurred in relevant situations. They are certainly not chosen at random. Nevertheless, the limitation cannot take into consideration all the conditions of the area where the aeroplane is likely to land (or crash if the ground is particularly uneven). Then the possibility of a crash must be considered, for whatever reasons and not only for single-engine aeroplanes. The airworthiness standards have become more and more stringent from this point of view. This is what we call **crashworthiness**.

JAR/FAR/CS-23 contains appropriate safety standards for emergency landing conditions. It deals with structural rules for the occupants' protection, also requiring expensive static and dynamic tests for the seat/restraint system, the seats, and the fuselage structure supporting the same.

FAR 23 prescribed something more. In order to allow the certification of speedy single-engine aeroplanes (turbine engine-powered), the design of which is severely penalized by the 61-knot limitation, these regulations enable an increase of stalling speed to be 'exchanged' with the

additional severity of the crashworthiness regulations; we again encounter the acceptability/practicability balance. At the time of writing, JAR 23/CS-23 has not (yet) adopted this amendment.

Crashworthiness concerns all types of aircraft.

The JAR 22 Study Group tried to avoid dynamic tests for aircraft such as sailplanes and powered sailplanes. These aircraft are normally produced in such small numbers that it becomes economically difficult for the manufacturers to sustain the cost of dynamic crash tests. Nevertheless, the problem does exist and it is a serious one because these machines, for which an out-of-field landing is not even an emergency, tend to crash land quite frequently. We therefore have to consider the classical configuration of these aircraft that, in principle, does not offer suitable protection for the occupants.

We could think of a 'survival cage' able to bear some tens of grams, but this is not the solution because, even if the cage does not break, the occupants could still sustain extended or maybe fatal injuries. The OSTIV Sailplane Development Panel (SDP) studied this problem for some time, appointing a Crashworthiness Panel and reaching solutions recalling (to a certain extent) those adopted in Formula 1. The criteria they adopted could be summarized as 'stiff cage and soft nose', i.e. a sufficiently strong structure to protect the occupants but with a yielding front part, able to absorb impact energy. The OSTIV also provided advice on the seat design; these should be devised as 'energy absorbing'.[28] Standards for headrests were introduced, very effective items in the rebound phase after impact. The seat profile and the safety harness configuration were studied; the accident analysis pointed out the possibility of spine damage due to sliding under the safety harness in the impact phase, a movement defined as 'submarining'. Furthermore, the accident analysis showed that the landing gear standards did not offer sufficient energy absorption, with consequences for the occupants' spine. Therefore, these standards were improved.

The criteria coming from the OSTIV SDP are very often introduced in JAR 22, after evaluation of the relevant Study Group.

JAR-VLA contains a paragraph dealing with crash landing, which has not been updated since the original publication in 1990 and could be considered in need of modernization.

Dynamic crash tests should also be avoided for these aeroplanes, but an update of the crashworthiness criteria is reasonable – for instance, taking into consideration the studies performed for sailplanes.

The airworthiness standards for transport aeroplanes (JAR/FAR/CS-25) and for rotorcraft (JAR/FAR/CS-27 and -29) contain paragraphs on crash landing inclusive of dynamic crash tests.

4.6.6 Fire protection

An aircraft has engines, electrical installations, and other components, making it subject to fire hazard. Firstly, the 'fire zones' of the aircraft, i.e. those where a fire can develop, must be

located – an engine compartment, for example. There are essentially three methods of protecting the occupants from fire: (a) abandoning the aircraft;[29] (b) passive protection in order to contain the fire for the time necessary for landing; (c) active protection by means of extinguishers. Of course, the combination of these last two means is possible. For military aircraft, normally carrying explosive material, abandoning the aircraft is favored (unless the fire is so limited that it can be put out by means of extinguishers), the active or passive protection being limited to the time necessary for the acknowledgment of the situation by the crew and their bailing out.

In the case of civil aircraft, passive protection is prescribed in order to allow a safe emergency landing whenever possible. This is achieved by suitable isolation of the fire zones so that essential structures and installations can be protected for the time necessary for landing. The use of extinguishers is not excluded, but they are not considered as primary protection.

Active protection, by means of portable or fixed extinguishers, is prescribed in some categories of aircraft (e.g. transport and commuter aeroplanes), for accidental fires in the cockpit, the cabin, and the baggage or cargo compartments.

The airworthiness standards also provide rules for materials used for the cabin interiors, from the points of view of flammability and noxious smoke emissions.

Because the requirements must normally be substantiated by tests, the certification standards provide acceptable procedures for such tests. To give an idea of the content of these documents, an example can be found in Appendix F to FAR 23, 'Test Procedure', of which an extract is reported here.[30]

4.6.6.1 Acceptable test procedure for self-extinguishing materials for showing compliance with paragraphs 23.853, 23.855, and 23.1359

1 **Conditioning.** Specimens must be conditioned to 70°F, ±5°F, and at 50 ±5 per cent relative humidity until moisture equilibrium is reached, or for 24 hours.

2 **Specimen configuration.** Except as provided for materials used in electrical wire and cable insulation and in small parts, materials must be tested either as a section cut from a fabricated part as installed in the airplane or as a specimen simulating a cut section, such as a specimen cut from a flat sheet of the material or a model of the fabricated part. The specimen may be cut from any location in a fabricated part; however, fabricated units, such as sandwich panels, may not be separated for a test. The specimen thickness must be no thicker than the minimum thickness to be qualified for use in the airplane, except that: (1) thick foam parts, such as seat cushions, must be tested at 1/2-inch thickness; (2) when showing compliance with paragraph 23.853(d)(3)(v) for materials used in small parts that must be tested, the materials must be tested at no more than 1/8-inch thickness; (3) when showing compliance with paragraph 23.1359(c) for materials used in electrical wire and cable insulation, the wire and cable specimens must be the same size as used in the airplane. In the case of fabrics, both the warp and fill directions of the weave must be tested to determine the most critical flammability conditions. When performing the tests prescribed in paragraphs (d) and (e) of this appendix, the

specimen must be mounted in a metal frame so that: (1) in the vertical tests of paragraph (d) of this appendix, the two long edges and the upper edge are held securely; (2) in the horizontal test of paragraph (e) of this appendix, the two long edges and the edge away from the flame are held securely; (3) the exposed area of the specimen is at least two inches wide and 12 inches long, unless the actual size used in the airplane is smaller; and (4) the edge to which the burner flame is applied must not consist of the finished or protected edge of the specimen, but must be representative of the actual cross-section of the material or part installed in the airplane. When performing the test prescribed in paragraph (f) of this appendix, the specimen must be mounted in a metal frame so that all four edges are held securely and the exposed area of the specimen is at least eight inches by eight inches.

3 **Vertical test.** A minimum of three specimens must be tested and the results averaged. For fabrics, the direction of weave corresponding to the most critical flammability conditions must be parallel to the longest dimension. Each specimen must be supported vertically. The specimen must be exposed to a Bunsen or Tirrill burner with a nominal 3/8-inch I.D. tube adjusted to give a flame of 1.5 inches height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the center of the flame must be 1550°F.

4 **Horizontal test.** A minimum of three specimens must be tested and the results averaged. Each specimen must be supported horizontally. The exposed surface when installed in the airplane must be face down for the test. The specimen must be exposed to a Bunsen or Tirrill burner with a nominal 3/8-inch I.D. tube adjusted to give a flame of 1.5 inches height. The minimum flame temperature is measured.

5 **Forty-five-degree test.** A minimum of three specimens must be tested and the results averaged. The specimens must be supported at an angle of 45° to a horizontal surface. The exposed surface when installed in the aircraft must be face down for the test. The specimens must be exposed to a Bunsen or Tirrill burner with a nominal 3/8-inch I.D. tube.

6 **Sixty-degree test.** A minimum of three specimens of each wire specification (make and size) must be tested. The specimen of wire or cable (including insulation) must be placed at an angle of 60°.

7 **Burn length.** Burn length is the distance from the original edge to the furthest evidence of damage to the test specimen due to flame impingement, including areas of partial or complete consumption, charring or embrittlement, but not including areas sooted, stained, warped or discolored, nor areas where material has shrunk or melted away from the heat source.

4.6.7 Safety assessment

Let us consider the control system of a light aeroplane: cables, pulleys, perhaps some rods. These items are very often in view and easy to inspect. For such systems, if designed according to good design practice and applicable airworthiness standards and maintained following the maintenance manual instructions (providing the replacement of worn parts), no particular studies will be needed to assure the system's safety during the entire operating life of the aeroplane. We can therefore talk of a system that 'never' fails. It is quite different if, considering a more sophisticated aircraft, the control system depends on the electrical and hydraulic systems, or even the mechanical transmissions are eliminated, as for fly-by-wire systems, with computers playing an important part.

The above example on control systems can obviously be extended to all aircraft systems and equipment.

In this case, the safety assessment would require more refined rules and instruments. The essentially informative nature of this book cannot provide a thorough discussion on this very specific topic. Nevertheless, it is worth outlining some basic concepts.

The rules for safety assessment are contained in different aircraft airworthiness standards at paragraph XX.1309,[31] and advisory material in the respective ACJs/ACs/AMC&GM. As specified by the title of paragraph 1309, they are related to 'Equipment, Systems and Installations'.

As a consequence, these rules do not apply to performance, flight qualities, and structural strength of Subparts B and C,[32] but they can influence every system installed in order to comply with these subparts.

As a typical example (contained in FAA AC 23-1309-1A), paragraph 23.1309 does not apply to the stall characteristics of paragraph 23.201, but nevertheless it applies to a stick pusher (stall barrier) installed to satisfy the latter paragraph.

That being said, if we were to ask a layman (better still, a passenger) what kind of reliability a vital aircraft system should have, the answer would be immediate: 100 per cent. It has nevertheless been demonstrated that such reliability is an impossibility. As an example, setting in parallel '*n*' items (redundancy), 100 per cent reliability can be obtained for '*n*' tending to infinity!

A system with a high degree of redundancy would be heavy, expensive, and complex: so subject to drawbacks that it would make such redundancy questionable. It is then more convenient to design such systems with a minimum degree of redundancy (the reliability of the single components can be increased), in order that its reliability, even if not amounting to 100 per cent, is such as to ensure **an acceptable safety level**.

The definition of an acceptable safety level implies the definition of an **acceptable accident rate**; this cannot be defined as abstract wishful thinking, but on the basis of what is **practicable**.

What is practicable for the future can be forecast by the analysis of past accident rates. Therefore, after taking into consideration the accident rate in commercial (occidental) aviation in the 10-year period from 1970 to 1980, a rate of catastrophic accidents[33] a little less than 1×10^{-6} flight hours was detected. (An extrapolation forecasts a probable accident rate of 0.3×10^{-6} accidents in the 1990s). From this accident analysis it was also found that about 10 per cent of the catastrophic accidents could be attributed to system failures. Hence, the portion of catastrophic accidents attributed to systems was of the order of 1×10^{-7} flight hours.

Starting from the arbitrary hypothesis that a commercial large aircraft could present some 100 hazards (potential failure conditions) leading to a catastrophic effect, it follows that, for each system, the acceptable probability of a catastrophic failure is less then 10^{-9} flight hours.

This is the basic concept for 'the maximum probability of a catastrophic effect for a single system'[34] of a transport aeroplane.

The general intention is that effects of a catastrophic nature should virtually never occur in the fleet life of a particular type of aircraft. This would mean (for example) that in the case of a fleet of 100 aircraft of a particular type, each flying 3000 hours per annum, one or more of the various catastrophic effects might be expected to occur once in 30 years, which is close to the concept of 'virtually never',[35] a situation near to that 'never' we have already considered.

We have to bear in mind that there are some systems operating constantly and others operating in a certain flight phase only (the latter could make up as much as 80 per cent of the total: a landing gear system, for example). Hence, a probability failure per flight hours of such systems can be established by dividing the probability by the average flight duration estimated for the particular type of aircraft.

4.6.7.1 Failure conditions

Failure conditions are defined as effects on the aircraft and its occupants, both direct and consequential, caused or contributed to by one or more failures, considering relevant adverse operational or environmental conditions. Failure conditions may be classified according to their severity as follows (AMJ 25.1309):

1 **Minor.** Failure conditions which would not significantly reduce aeroplane safety, and which involve crew actions that are well within their capability.
2 **Major.** Failure conditions which would reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions to the extent that there would be, for example, a significant reduction in safety margins or functional capabilities, a significant increase in crew workload or in conditions impairing crew efficiency, or discomfort to occupants, possibly including injuries.
3 **Hazardous.** Failure conditions which would reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions to the extent that there would be:
   (a) A large reduction in safety margins or functional capabilities
   (b) Physical distress or higher workload such that the flight crew cannot be relied upon to perform their tasks accurately or completely, or
   (c) Serious or fatal injury to a relatively small number of the occupants.
4 **Catastrophic.** Failure conditions that would prevent continued safe flight and landing.

An **inverted relationship** between the **severity** of the failure conditions and the **probability** of occurrence is established.[36] Hence:

1	Minor failures	become	probable
2	Major failures	become	remote
3	Hazardous failures	become	extremely remote
4	Catastrophic failures	become	extremely improbable.

Each of the above probabilities has a maximum value assigned, which depends on the type of aircraft considered – for example, for large aircraft, extremely improbable is 10^{-9}, as we have already seen; extremely remote is 10^{-7}; remote is 10^{-5}, etc.

Figures 4.3 and 4.4, extracted from Book 2 of CS-25, show the above criteria.

We can gain a better indication of the safety levels relating to the above figures through another example. A single aircraft might fly a total of 5×10^4 hours and a large fleet of 200 aircraft (same type) might then accumulate a fleet total of 10^7 hours. Thus:

1 A catastrophic failure condition (at worst 10^{-9}) would be unlikely to arise in the whole fleet's life.
2 A hazardous failure condition (at worst 10^{-7}) might arise once in the whole fleet's life.
3 A major failure condition (at worst 10^{-5}) might arise once in an aircraft's life and would arise several times in the whole fleet's life.
4 A minor failure could arise several times in the aircraft's life.

The safety assessment of equipment, systems, and installation is a very important (and fascinating) part of aircraft design. It is of paramount importance to start the assessment from the very beginning of the design. A late assessment could bring unpleasant surprises, leading to expensive design changes.

As mentioned before, the techniques of safety assessment are a specialist matter.

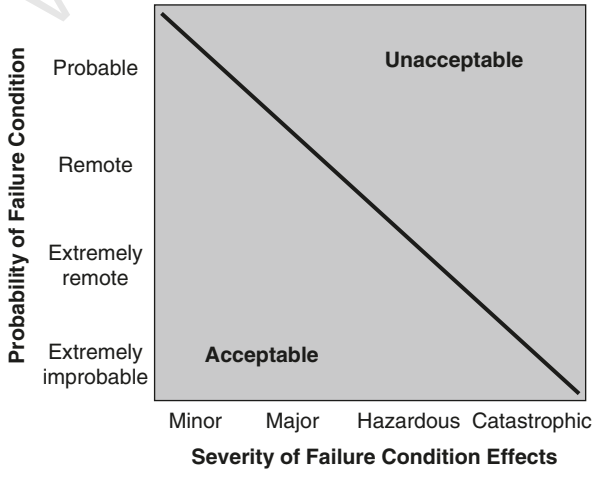


Figure 4.3 *Classification of failure conditions*

Effect on aeroplane	No effect on operational capabilities or safety	Slight reduction in functional capabilities or safety margins	Significant reduction in functional capabilities or safety margins	Large reduction in functional capabilities or safety margins	Normally with hull loss
Effect on occupants excluding flight crew	Inconvenience	Physical discomfort	Physical distress, possibly including injuries	Serious or fatal injury to a small number of passengers or cabin crew	Multiple fatalities
Effect on flight crew	No effect on flight crew	Slight increase in workload	Physical discomfort or a significant increase in workload	Physical distress or excessive workload impairs ability to perform tasks	Fatalities or incapacitation
Allowable qualitative probability	No probability requirement	<...Probable...>	<...Remote...>	Extremely <.....> Remote	Extremely improbable
Allowable quantitative probability: Average probability per flight hour on the order of:	No probability requirement	$<10^{-3}$ <.....> Note 1	$<10^{-5}$ <.....>	$<10^{-7}$ <.....>	$<10^{-9}$
Classification of failure conditions	No safety effect	<...Minor...>	<...Major...>	<...Hazardous...>	Catastrophic

Note 1: A numerical probability range is provided here as a reference only. The applicant is not required to perform a quantitative analysis, nor substantiate by such an analysis, that this numerical criteria has been met for minor failure conditions. Current Transport category aeroplane products are regarded as meeting this standard simply by using current commonly-accepted industry practice.

Figure 4.4 *Relationship between probability and severity of failure conditions*

4.6.8 Fatigue strength

In order to remain within the limits of general information and guidance, leaving the rules, the advisory material, and the numerous treatises dealing with the subject as direct reference for further studies, we can see in summary how the airworthiness standards confront the structural fatigue that has caused so many air crashes, especially in the past.[37]

The airworthiness standards essentially consider two types of structure:

1 **Single load path** structures, where the applied loads are eventually distributed through a single member, the failure of which would result in the loss of the structural capability to carry the applied loads.[38]
2 **Multiple load path** structures, identified with redundant structures in which (with the failure of an individual element) the applied loads would be safely distributed to other load-carrying members.[39]

In the first case, the structure must result in **safe-life**, i.e. be able to sustain a certain number of events such as flights, landings or flight hours, during which there is a low probability that the strength will degrade below its design ultimate value due to fatigue cracking.

In the second case, the structure must be of **damage-tolerance** design, i.e. be able to retain its required residual strength for a period of unrepaired use after the failure or partial failure of a principal structural element due to fatigue, corrosion, accidental damage, and bird strikes.[40] Such a structure is defined as **fail-safe**.

For large aeroplanes and large rotorcraft, the relevant airworthiness standards require fail-safe structures,[41] unless this entails such complications that an effective damage-tolerant structure cannot be reached within the limitations of geometry, inspection, or good design practice. Under these circumstances, a design that complies with the safe-life fatigue evaluation requirements is used. A typical example of a structure that might not be conducive to damage-tolerance design is the landing gear and its attachments.

The divided opinions within the National Transportation Safety Board (NTSB)[42] at the end of 2002, as described by *Flight International*, give an idea of the importance of the choice between fail-safe and safe-life. The question was whether a component with exceptional reliability needs to be fail-safe.

A report on a January 2000 MD-83 crash led to the conclusion that the stabilizer was jammed fully, leading edge up, pitching the aircraft nose-down so strongly that elevator forces could not counteract it. The failure of the screw-jack assembly controlling the horizontal stabilizer pitch angle, due to inadequate lubrication, was also ascertained. Because the screw-jack mechanism is the sole component that sets and limits stabilizer pitch, its failure becomes catastrophic. Therefore, in some NTSB staff's opinion, the mechanism should have been redesigned according to a 'more rational' fail-safe criterion. Other NTSB staff argued that the component was reliable (the retrofit would have involved more than 800 civil aircraft), because:

1 The same basic mechanism has been used in all MD DC-9, MD-80, and -90 aircraft since 1965.
2 This kind of accident was the only one in more than 100 million flying hours.
3 The accident was caused by inadequate maintenance (the carrier was fined by the FAA).

In the end, common sense prevailed and the issue was resolved without modifications to the mechanism. The FAA issued an Airworthiness Directive[43] (AD 2000-15-15) providing inspection, check, and test 'to prevent loss of pitch trim capability due to excessive wear of the jackscrew assembly of the horizontal stabilizer, which could result in reduced controllability of the airplane …'.

The AD prescribes in particular the replacement of the jackscrew assembly with a new or serviceable assembly in case of metallic parts deterioration, corrosion, pitting, or distress.

The section 'Airworthiness Limitations' of the 'Instructions for Continued Airworthiness' must contain the inspections, replacement of parts, and other procedures necessary to prevent accidents caused by structural failures.

For JAR/FAR/CS-23 aeroplanes, it is possible to choose between the two philosophies safe-flight/fail-safe. Exceptions are made for composite airframe structures that must be designed according to fail-safe criteria, excluding the already mentioned cases of impracticability.

The previous remarks about continued airworthiness are also applicable to these aircraft.

For JAR/FAR/CS-27 rotorcraft that are prone, like all rotorcraft, to particular fatigue problems, mixed criteria are generally followed, based mainly on time change items (parts to be replaced according to prearranged and approved schedules). Everything must obviously be clear in the 'Instructions for Continued Airworthiness'.

For JAR/CS-VLA aeroplanes and JAR/CS-22 sailplanes, the airworthiness standards contain very little information on fatigue,[44] similar to the old airworthiness standards for light aeroplanes. As matter of fact, the low average utilization of these aircraft (100–200 flight hours/year) was not worrisome. However, after several years, and the intensive use of the machines in certain kinds of operation (e.g. school, aerial work, air taxi), fatigue problems became one of the causes of accidents, so much so that step by step the fatigue airworthiness standards have been amended in JAR/FAR 23. Similar problems also occurred for sailplanes (perhaps less for VLAs as they are 'younger'), so that no sailplane or VLA is now certified without fatigue assessment made by the manufacturers and authorities. For instance, LBA, in Germany, a long time ago issued standards for fatigue assessment of sailplane composite airframe structures.

In the case of loads and loading spectra, the assumptions made for fatigue assessment are:

1 **For rotorcraft**, it is explicitly required that for each portion of the flight structure of which failure could be catastrophic, loads or stresses must be verified (or determined) by in-flight measurements; the same must be done for the loading spectra being considered. Then the identification of these 'critical' structural items is of paramount importance.
2 **For large aeroplanes**, the principal loads that should be considered in establishing a loading spectrum are flight loads (gust and maneuver), ground load, and pressurization loads. The loading spectra are based on measured statistical data derived from government and

industry load history studies and, where no sufficient data are available, on a conservative estimate of the anticipated use of the aeroplane. In assessing the possibility of serious fatigue failures, the design is examined to determine probable points of failure in service. In this examination, consideration is given, as necessary, to the results of stress analysis, static and fatigue tests, strain gauge surveys, tests of similar structural configurations, and service experience.

3 **For JAR/FAR/CS-23 aeroplanes**, criteria similar to the above are adopted.

4 **For sailplanes and VLAs**, apart from the general design recommendation to avoid stress concentration areas as far as possible, fatigue tests are performed, but only if they are essential, for economic reasons. If possible, reference is made to data resulting from fatigue tests performed on similar structures and service experience. Another way to avoid fatigue tests is the design of critical structures with stress levels under the fatigue limit of the material involved. Obviously, this must be properly demonstrated by static tests and strain gauge surveys.

If fatigue tests are necessary, the technical literature provides typical load spectra and programs for the repeated application of loads.

Apart from the consideration made for sailplanes and VLAs, the fatigue life assessment is performed through analysis, and fatigue tests on structures or single parts, according to criteria that are detailed in airworthiness standards and ACJs/ACs/AMC&GM. All analysis and test schedules are normally agreed with the authorities.

Fatigue test programs for large aeroplanes can last some years; hence, it is not generally possible to complete them before the aeroplanes' type certification. It is therefore required that at least one year of safe operations be demonstrated when the type certificate is issued. Subsequently, in order to maintain the validity of the type certificate, the fatigue life substantiation must always exceed the number of cycles/flight hours reached by the 'oldest' aeroplane (lead aeroplane).

4.7 JAR/FAR 21

JAR/FAR 21 contains the 'Certification Procedures for Aircraft and Related Products and Parts' for JAA and FAA certification respectively. JAR 21 deals with:

1 Procedural requirements for the issue of type certificates and changes to those certificates, the issue of standard certificates of airworthiness, and the issue of Export Airworthiness Approvals.

2 Procedural requirements for the approval of certain parts and appliances.[45]

3 Procedural requirements for the approval of organizations related to the subject of the previous points.

4 Rules governing the holders of any certificate or approval specified in the previous points.

In a similar way, FAR 21 deals with:

1 Procedural requirements for the issue of type certificates and changes to those certificates, the issue of production certificates, the issue of airworthiness certificates, and the issue of Export Airworthiness Approvals.
2 Rules governing the holders of any certificate specified in paragraph (a)(1) of paragraph 21.1 (Applicability).
3 Procedural requirements for the approval of certain materials, parts, processes, and appliances.

JAR/FAR 21 are therefore the rules upstream of the airworthiness standards, dictating, so to speak, the 'rules of the game'. The relationship between authorities and enterprises for certification of design and production of aeronautical materials are established. We will return to these issues in subsequent chapters.

4.8 EASA Part 21

As we previously mentioned, this document replaces JAR 21, which remains the core of the same document. The changes to the JAR document reflect the new legal status of the EASA towards the national authorities and a full revision of the document in light of the JAA certification experience.

Without attempting a full comparison between the two documents, it is worth making the following observations.

4.8.1 Type certificates[46]

Subpart H of Part 21 (Article 21A.184) includes the 'Restricted type certificates'[47] missing in JAR 21.

4.8.2 Airworthiness certificates[48]

Subpart H of Part 21 (Article 21A.173) classifies the airworthiness certificates as follows:

1 A certificate of airworthiness shall be issued to aircraft which conform to a type certificate that has been issued in accordance with this Part.
2 Restricted certificates of airworthiness shall be issued to aircraft:
   (a) that conform to a Restricted type certificate that has been issued in accordance with this Part, or
   (b) that have been shown to the Agency to comply with specific certification specifications ensuring adequate safety
3 Permits to fly shall be issued to aircraft that do not meet, or have not been shown to meet, applicable certification specifications but are capable of safe flight under defined conditions.

The certificates in 1 are equivalent to the Standard certificates of airworthiness of JAR 2.[49]

The certificates in 2 are consequent to the Restricted type certificates and do not exist in JAR 21.

The certificates in 3 have the characteristics of the Special certificates of airworthiness[50] currently issued by national authorities and are not included in JAR 21.

As explained in Chapter 8, the Special certificates of airworthiness (present, for example, in FAR 21) constitute a very complex and much discussed matter for which there is no harmonization amongst EU Member States. It is possible that in the future the EASA will deal with this issue more meticulously.

4.8.3 Environmental protection

Part 21 of the type certification includes the designation of applicable environmental protection requirements and certification specifications, missing in JAR 21.

4.9 Structure of aircraft airworthiness standards

If we look at the airworthiness standards for aircraft certification (JAR/CS-22, JAR/CS-VLA, JAR/CS-VLR, JAR/FAR/CS-23, -25, -27, and -29), we note a common structure that entails a certain unity and uniformity. Apart from the forewords, the lists of pages, etc., we find 'subparts' and 'appendices'. As mentioned previously, the JARs/CS also contain advisory material. Each subpart contains paragraphs under a title (e.g. 'Ground Loads', 'Control Systems', etc.), and it is of interest to see that, in all the above standards, the same topics are generally dealt with in paragraphs bearing the same number (e.g. 'Weight limits' paragraph XX.25; 'Materials and workmanship' paragraph XX.603; etc.). This makes it easier to pass from one standard to another, and to define comparisons when that is needed.

Some details of this structure are as follows:

1 **Subpart A: General.** This Subpart provides information about the types and categories of aircraft to which the standard is applicable.
2 **Subpart B: Flight.** This Subpart deals with the flight tests to be carried out to show compliance with the requirements for performance, controllability and maneuverability, stability, etc. It is worth stating that this Subpart does not exclusively cover certification flight tests; other Subparts contain some requirements that must be complied with through flight tests.
3 **Subpart C: Structure.** This Subpart contains the requirements for flight and ground load assessment, and for structural design of airframes, control systems, landing gears, and other components. Crashworthiness and fatigue requirement parameters are also provided.

4 **Subpart D: Design and Construction.** This Subpart deals with the design technique, materials, safety factors, control system and landing gear design, structural tests to be carried out, cockpit and passenger cabin design, fire protection and flutter requirements, etc.
5 **Subpart E: Power Plant.** This Subpart contains the requirements for power plant installations and related systems (like fuel, oil, exhaust systems, etc.). Power plant controls, accessories, and fire protection are also considered.
6 **Subpart G: Operating Limitations and Information.** This Subpart provides requirements for all the information that must be available to the pilot and other personnel for correct aircraft operations: from marking and placards, to the flight manual content.
7 **Appendices.** These documents are of various natures; they can provide simplified design load criteria, test procedures for assessment of material flammability, instructions for continued airworthiness, and other information.

4.10 Aircraft airworthiness standard applicability

As mentioned above, Subpart A of aircraft airworthiness standards defines types and categories of specific aircraft. We will consider this in more detail.

4.10.1 JAR/CS-22. Sailplanes and Powered Sailplanes

1 Sailplanes with a maximum weight not exceeding 750 kg.
2 Single-engine (spark or compression ignition) powered sailplanes with a design value W/b^2 (weight to span^2) not greater than 3 (W in kg, b in m), and maximum weight not exceeding 850 kg.

The maximum number of occupants for both sailplanes and powered sailplanes must not exceed two.

The term 'powered sailplane' includes those powered sailplanes which may be incapable of complying with the minimum rate of climb required by paragraph 22.65 and maximum take-off distance required by paragraph 22.51, and which must consequently be prohibited from taking off solely by means of their own power (so they are launched like sailplanes). These powered sailplanes are referred to as 'self-sustaining powered sailplanes' and additional requirements of Appendix I are applicable to them.

JAR/CS-22 contains a Subpart H and a Subpart J with standards for engines and propellers to be installed on powered sailplanes (engines and propellers certificated according to JAR-E and JAR-P as relevant can, of course, be installed).

Note. In JAR/CS-22 the term 'sailplane' is related both to sailplanes and powered sailplanes. In JAR 22 the requirements applying only to powered sailplanes are annotated with the letter P in the margin.

Sailplane categories are as follows:

1 **Utility.** Sailplanes intended for normal soaring flight and some aerobatic maneuvers (listed in the requirements) if demonstrated during type certification.
2 **Aerobatic.** Sailplanes intended for aerobatic maneuvers additional to those permitted in the Utility category. The permitted aerobatic maneuvers must be established during type certification.

Notes. Powered sailplanes are considered as 'sailplanes with an auxiliary engine'. That is why the installation of power plants complying with less severe requirements is allowed. Furthermore, unlike aeroplanes, powered sailplanes are allowed to fly with the engine off (and retracted if that is possible), like sailplanes. Flight tests must be carried out both with power on and power off – and power plant retracted when this is possible.

In order to explain that strange-looking parameter W/b^2, we can say that, when the first standards for powered sailplanes began to appear, some manufacturers envisaged the possibility of producing aeroplanes 'disguised' as powered sailplanes. The intent was to comply with requirements that were less severe – at that time. It is clear that for an 850-kg powered sailplane, the formula W/b^2 not greater than 3 leads to a minimum wing span of 16.8 m, which gives the aircraft an appearance more like a sailplane than an aeroplane.

4.10.2 JAR/CS-VLA. Very Light Aeroplanes

This includes aeroplanes with a single engine (spark or compression ignition) having no more than two seats, with a maximum certificated take-off weight of not more than 750 kg and a stalling speed in the landing configuration of not more than 45 knots (CAS). The approval to be given must be for day-VFR[51] only.

Notes. JAR-VLA was issued as a simplification of FAR 23 (JAR 23 did not yet exist). Unfortunately, while other requirements have been continuously updated by the relevant study groups, JAR-VLA has remained practically unchanged since publication; this is why some inaccuracies are still present as well as some old-fashioned concepts (e.g. in crashworthiness matters). An increase in maximum take-off weight would also be advisable, because 750 kg is somewhat insufficient, especially in the case of composite airframes (avoiding expensive carbon fibers).

In the United States, where the requirements have been adopted (see note 6 of this chapter), the VLA certification for night flight and IFR[52] is possible, in compliance with the additional requirements of AC 23–11. In Europe, this possibility has not yet been approved.

4.10.3 JAR/FAR/CS-23. Normal, Utility, Aerobatic, and Commuter Category Aeroplanes

1 Aeroplanes in the Normal, Utility, and Aerobatic categories that have a seating configuration, excluding the pilot seat(s), of nine or fewer and a maximum certificated take-off weight of 5670 kg (12 500 lb) or less.

2 Propeller-driven, twin-engine aeroplanes in the Commuter category that have a seating configuration, excluding the pilot seat(s), of 19 or fewer and a maximum certificated take-off weight of 8618 kg (19 000 lb) or less.

Aeroplane categories are as follows:

1 **Normal.** The Normal category is limited to non-aerobatic operations. Non-aerobatic operations include stalls (except whip stalls) and some simple maneuvers (listed in the requirements) in which the angle of bank is not more than 60°.
2 **Utility.** The Utility category is limited to the operations of the Normal category, spins (if approved for the particular type of aeroplane), and some aerobatic maneuvers (listed in the requirements) in which the angle of bank is between 60° and 90°.
3 **Acrobatic.** The Acrobatic category has no restrictions other than those shown to be necessary as a result of required flight tests.
4 **Commuter.** The Commuter category is limited to any maneuver incident to normal flying, stalls (except whip stalls), and steep turns in which the angle of bank is 60° or less.

4.10.4 JAR/CS-25. Large Aeroplanes/FAR 25. Transport Category Airplanes

These comprise:

- Large turbine-powered aeroplanes (JAA/EASA)
- Transport category airplanes (FAA).

Note. There are no limitations as regards weight, number of engines, and number of occupants.

Maximum weights corresponding to the airplane's operating conditions (such as ramp, ground or water taxi, take-off, en route, and landing), environmental conditions (such as altitude and temperature), and loading conditions (such as zero fuel weight, center of gravity position, and weight distribution) are established so that they are not more than:

1 The highest weight selected by the applicant for the particular conditions.
2 The highest weight at which compliance with each applicable structural loading and flight requirement is shown.
3 The highest weight at which compliance is shown with the certification requirements of FAR 36.

JAR 25 takes into account turbine-powered aeroplanes only. Actually, large aeroplanes powered by reciprocating engines have not been designed for many years. FAR 25, issued before JAR 25 as a derivation of older regulations, does not have this limitation. In effect, transport aeroplanes powered by reciprocating engines are still flying in some parts of the world, with valid type certificates.

4.10.5 JAR/CS-27. Small Rotorcraft/FAR 27. Normal Category Rotorcraft

Rotorcraft with a maximum weight of 3175 kg (7000 lb) or less and nine or less passenger seats.

Multi-engine rotorcraft may be type certificated as **Category A** provided the requirements referenced in Appendix C are met.

Note. For Category A definition, see the Notes on JAR/FAR/CS-29.

4.10.6 JAR/CS-29. Large Rotorcraft/FAR 29. Transport Category Rotorcraft

Rotorcraft categories are as follows:

1 Rotorcraft must be certificated in accordance with either the **Category A** or **Category B** requirements of JAR/FAR/CS-29. A multi-engine rotorcraft may be certificated as both Category A and Category B, with appropriate and different operating limitations for each category.
2 Rotorcraft with a maximum weight greater than 9072 kg (20 000 lb) and 10 or more passenger seats must be type certificated as Category A rotorcraft.
3 Rotorcraft with a maximum weight greater than 9072 kg (20 000 lb) and nine or less passenger seats may be type certificated as Category B rotorcraft provided the Category A requirements of Subparts C, D, E, and F of JAR/FAR/CS-29 are met.
4 Rotorcraft with a maximum weight of 9072 kg (20 000 lb) or less but with 10 or more passenger seats may be certificated as Category B rotorcraft provided the Category A requirements of JAR/FAR/CS-29.67(a)(2), 29.87, 29.1517, and of Subparts C, D, E, and F of JAR/FAR/CS-29 are met.
5 Rotorcraft with a maximum weight of 9072 kg (20 000 lb) or less and nine or less passenger seats may be type certificated as Category B rotorcraft.

Notes. Category A means a multi-engine rotorcraft designed with engine and system isolation features specified in JAR/CS-27/JAR/CS-29 and capable of operations using take-off and landing data scheduled under a critical engine failure concept, which assures adequate designated surface area and adequate performance capabilities for continued safe flight or safe rejected take-off in the event of an engine failure.

Category B means a single-engine or multi-engine rotorcraft that does not meet Category A standards. Category B rotorcraft have no guaranteed capability to continue safe flight in the event of an engine failure, and unscheduled landing is assumed.

4.10.7 FAR 31. Manned Free Balloons

1 Captive gas balloons deriving lift from a captive lighter-than-air gas.
2 Hot-air balloons deriving lift from heated air.

Notes. There are no limitations on weight and number of occupants. The certification maximum weight is the highest weight at which compliance with each applicable requirement of this part is shown.

4.10.8 JAR/CS-VLR. Very Light Rotorcraft

Very light rotorcraft with a single engine (spark or compression ignition) having no more than two seats, with a maximum certificated take-off weight of not more than 600 kg. The approval has to be for day-VFR only.

Note. The Italian RAI-ENAC issued a standard for this type of rotorcraft in the 1990s (it was approved on 22 April 1996), in order to allow the certification of ultralight helicopters which were limited, by the relevant low in Italy, to a maximum weight of 450 kg. Such a maximum weight was considered inadequate and, furthermore, these ultralights had no certification standards.

RAI-VLR (this was the title of the standard) was issued as a simplification of JAR 27, following a path resembling that adopted for the issue of JAR-VLA (simplification of FAR 23). RAI-VLR is now a national standard that could lead to a type certification and the issue of Standard certificates of airworthiness.[53] Nevertheless, because the RAI was bound to the Cyprus agreement, an Elementary Aircraft category was created in Italy, for which a special certification is required.

Then, the standard was 'offered' to the JAA, which set up a study group for the evaluation and eventual revision of this document, in order to finally issue a JAR-VLR.

The JAR-VLR was issued in September 2003 and than adopted by the EASA as CS-VLR.

4.11 Airworthiness standards for unmanned aircraft

These aircraft are internationally known as **Unmanned Aerial Vehicles (UAVs)** or **Uninhabited Aerial Vehicles (UAVs)**, and also as **Remotely Piloted Vehicles (RPVs)** and **Remotely Operated Aircraft (ROAs)**.

The most common denomination for this type of aircraft is **UAVs**, and we will use this abbreviation.[54]

UAVs have been mainly used by the world's armed forces for wartime operations for more than 60 years, for battlefield observations in the past, and more recently as a wartime means of attack. We can therefore argue that UAVs have already reached a technical maturity and this is going to evolve as for any other kind of aircraft. However, up to the present, UAV missions have been limited on battlefields, to restricted flying areas, outside the zones open to civil aircraft operations.

Today, when the great potential of this type of machine has been recognized, the global industry has requested the opportunity of also using them commercially in civil airspace. This possibility

is also of interest to the defense industry, because they can achieve better operational flexibility – for example, in the case of transfer flights.

We have mentioned the potential of UAVs for civil applications. We now consider what kind of applications these might be.

As a first example, thousands of rotary wing UAVs are used for agricultural purposes in Japan (crop spraying – pesticides and fertilizers). These machines, all built in Japan, carry a useful load of 25–150 kg.

Some classifications have been drafted and the list below includes just a few examples taken from the multitude of possible UAV uses:

- Forestry services – fire control and other kinds of surveillance.
- National weather services – atmospheric sampling, meteorology, etc.
- Agriculture and wildlife – agricultural monitoring, river and estuary surveys, illegal waste disposal surveys, crop dusting, mapping, fishing law enforcement, etc.
- Electricity authorities – monitoring nuclear facilities, power line verification, etc.
- Postal services – urgent package delivery in remote areas.
- Coastguards – surveillance for counter narcotics, illegal alien intrusion detection, illegal fishing control, search and rescue missions, etc.
- Civil aviation – noise measurement for aircraft certification purposes.
- Telecommunications – as telecom relays (replacing satellites), local TV coverage, etc.

It is clear from these examples that, in many cases, the scope of UAVs is to carry out the 'dirty jobs', i.e. dangerous tasks, or tasks too long or too tedious for a crew.

Can UAVs be legally defined as 'aircraft'? An answer has been given by the ICAO EURNAT Office: UAVs are aircraft as defined by Annex 2 of the ICAO. Furthermore, the Chicago Convention in Article 8 declares that:

> *No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without the special authorization by that State and in accordance with the terms of that authorization. Each contracting State undertakes to ensure that the flights of such aircraft without pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft.*

Put simply, the flight of UAVs is allowed in regions open to civil aircraft only if authorized by the concerned states (something existing also for other aircraft) and if they do not cause any danger to other aircraft.

Therefore, the real problem is now to develop concepts for the safe integration of UAVs in general air traffic. It is then necessary to develop rules harmonized with the existing rules for air traffic control.

The issues concerning the above rules can be easily classified, as for 'manned' aircraft, into three basic segments:

1 Personnel licenses
2 Air traffic management
3 Airworthiness.

Hence we return to the main safety factors discussed in Chapter 1: man, the environment, and the machine.

Studies and conferences on the above subjects have been taking place for many years. In Europe there are some institutes and associations dealing with these issues. One is the European UVS International (formerly EURO UVS), equivalent to the AUVSI (Association for Unmanned Vehicle System International) in the United States. A great contribution to this discussion has also been made by EUROCONTROL, particularly concerning air traffic management matters. Other initiatives have been taken all over the world. In this book, we will limit our discussion to the airworthiness of UAVs.

4.11.1 Airworthiness standards

We should not be misled by the title: at the time of writing (July 2005), no official airworthiness standards for UAVs exist.

In the 1990s, at the request of the national industry, the Italian RAI-ENAC issued a draft of a UAV airworthiness standard. This document was presented at the annual EURO UVS conference in June 1999, triggering great debate on the subject. It was indeed probably the first attempt to define some sort of airworthiness standards for civil UAVs. Instead of attempting to invent everything from scratch, the JAR-VLA standard was chosen as a basic standard to be adapted to fixed-wing UAVs up to 750 kg.

It could be argued that, in order to transform a standard for 'manned' aircraft into a UAV standard, it would be sufficient to delete all requirements inherent to the occupants, such as the cockpit and the passenger cabin requirements. But it is not so simple because the airworthiness 'philosophies' we have considered in the previous chapters would not be fully utilized in doing so.

It is therefore necessary to set up new philosophies specific for UAVs before trying to convert them into new standards.

The definition of 'airworthiness' given at the beginning of Chapter 2 is perfectly suitable to UAVs ('requirements' and 'allowable limits' should also exist for these machines), provided

that we clarify the meaning of 'safe condition'. In other words, what constitutes 'safety' for UAVs? This is a topic that requires debate and validation.

If we consider the various airworthiness standards, we clearly understand that they are written having in mind the **occupant's protection**. The protection of people and properties on the ground is an added purpose of the safety obtained through compliance with the standards. For some categories of aircraft (aerobatic aeroplanes, sailplanes, and powered sailplanes) the abandonment of the aircraft in emergency cases is even considered. (The presence of a pilot on board could, in certain cases, avoid or limit the damage on the ground, but this is not guaranteed, as demonstrated by various accident reports.)

On the other hand, it is always very difficult to establish exactly what to do to avoid damage on the ground when considering air accidents: the most reasonable way to approach this problem is by trying to prevent the accident from occurring.

From the above considerations we can logically assume that we need to approach UAV standards, which by definition have no occupants, from a totally different perspective.

If we start from a general, but fundamental, safety principle of the protection of human beings, we can state that the UAV standards should aim to avoid any damage to people (and properties) in the UAV's range of action. This can only mean one thing: **to avoid in-flight collisions and uncontrolled ground impact**.

This can be achieved by applying the system safety assessment concepts that we have already mentioned in this chapter, and the standards for flight, structural strength, etc., which can be acquired from the current standards for 'manned' aircraft. This also leads to an additional parameter, **mission effectiveness**, which applies equally to UAVs and manned aircraft. This can be achieved by taking from the current standards, based on a century of experience, everything that might be applicable to UAVs.

In the case of UAV safety assessment, it is clear that the **severity of failure conditions** for UAVs will be very different compared to 'manned' aircraft.

For example, for 'manned' aircraft, a **catastrophic failure condition** is one that **would prevent continued safe flight and landing**. For a UAV this situation would be not at all catastrophic if the aircraft has a 'Flight Termination System' (FTS) capable (using parachutes, for instance) of bringing the machine back to the ground. An FTS failure could instead become catastrophic and there are other numerous examples supporting this argument.

We can infer that a new setting of standards taken from paragraph XX.1309 has to be arranged for the determination of **severity failure conditions** and **probability of occurrence**. But in the case of JAR-VLA, for example, we have seen that paragraph 1309 has a small number of applicable requirements.[55] Therefore, we have to provide something different for a UAV standard based on JAR-VLA.

Furthermore, the installation of anti-collision systems, certainly not installed on VLAs, should be compulsory.

Another peculiarity of UAV standards should be the incorporation of requirements for the 'Air Vehicle Station' (AVS) – the ground guidance station – that have to be considered as an integral part of the flying material and should be consistent with it.

In conclusion, we can argue from the analysis made so far that, in order to produce UAV airworthiness standards, many difficulties must be overcome; these difficulties are not so much related to UAV technology, which already exists and is evolving, but specifically associated with the creation of the related airworthiness philosophies and their correct transfer into the standards to be issued for the different UAV categories (also to be defined).

4.11.2 The state of the art

At the beginning of this review of airworthiness standards for UAVs, it was stated that: 'at the time of writing (July 2005), no official airworthiness standards for UAVs exist'.

When *Aeronavigabilità* was written at the end of 2002, it was emphasized that:

> *In any case we must be able to discuss such requirements only when these problems will be faced with determination by authorities like the FAA and JAA (and subsequently the EASA).*

So, why bring up this issue now?

The answer is that, even without having achieved common and approved rules, much work has been carried out in the last two years.

Peter van Blyenburgh, President of UVS International, produced a summary of the major achievements in this field in the publication 'UAVs – A Global Perspective 2004'. In particular, the creation in October 2002 of a Joint JAA/EUROCONTROL UAV Task Force, under the auspices of the JAA and EUROCONTROL, has led to progress in this area.

This Task Force had several unique characteristics:

1 It was a multi-national effort (France, Germany, Greece, Italy, the Netherlands, Sweden, UK, USA).
2 It consisted of all major stakeholders – the JAA, EUROCONTROL, NATO, European National Civil Aviation Authorities, the FAA, AECMA, and UVS International – representing the UAV industry.
3 It was a European initiative, in which the FAA and US industry representatives participated.

4 It was a one-year non-funded study, which had as its objective the concurrent formulation of concepts (outline and guiding principles) to drive the establishment of UAV-related airworthiness and certification rules.
5 This was the first international effort of its kind and the UAV Task Force's final report, which came out in May 2004, is certain to have an important international outcome.

Furthermore, a number of studies and initiatives have now been initiated by civil aviation authorities (in Australia, France, Italy, Japan, South Africa, Sweden, Switzerland, the UK, and the USA), military flight safety authorities (Belgium, Finland, France, Germany, the Netherlands, Singapore, South Africa, Sweden, UK, and USA), and in some cases UAVs can already, with certain restrictions and special waivers, operate in civil managed airspace (Australia, Belgium, Finland, France, Germany, Switzerland, UK, and USA).

From the EASA standpoint, in the same aforementioned publication, the Executive Director M. Goudou pointed out that an action to consider appropriate certification specifications for the UAV system was earmarked for action in the Agency's rulemaking planning in the future, with contributions from UVS International and other stakeholders.

As a result, substantial international movement is under way and it will able to solve the issues summarized here, also taking into consideration the vast experience available in the field of manned aircraft, which is certainly the starting point.

Notes

1 The OSTIV (Organisation Scientifique et Technique International du Vol à Voile) is an independent organization linked to the FAI (Fédération Aéronautique Internationale). The organization's aim is to encourage and internationally co-ordinate the science and techniques of sailplane flight and design.
2 Now CS-22.
3 Before the issue of JAR 22, this was adopted as a national requirement by some states.
4 The correct denomination of the FAA regulations should be FAR Part XX (Ex. Part 11). For the sake of practicality, and to clearly see the difference from JAA and EASA requirements, we use the denomination 'FAR XX (Ex. FAR 11)'.
5 The FAA adopted JAR 22 as an acceptable standard for the certification of sailplanes and powered sailplanes in the United States.
6 An equivalent FAA standard does not exist. The FAA adopted these requirements for the certification of very light aeroplanes in the USA. The acceptable criteria for the adoption of JAR-VLA are included in AC 21.17–2A. The FAA also issued adjunctive rules in AC 23–11 to authorize IFR and night flight of such aeroplanes.
7 The JAA has not issued requirements for free balloons.
8 The FAA rules for APU certification are contained in the Technical Standard Order (TSO) C 77 B.
9 Exhaust emissions refer to substances emitted into the atmosphere from the exhaust nozzle of an aircraft engine. Fuel venting emissions refer to raw fuel, exclusive of hydrocarbons in the exhaust

emissions, discharged from aircraft gas turbine engines during all normal ground and flight operations.

10 The FAA's Airworthiness Directives are legally enforceable rules that apply to the following products: aircraft, aircraft engines, propellers, and appliances.

11 While this part is essentially operative, airworthiness is recalled for equipment, instrument, and certification requirements. The same applies to other operative parts like FAR 121, 125, 129, 133, 135, JAR-OPS, and JAR-AWO.

12 See Chapter 9, 'The operational standard – definitions'.

13 According to JAR and FAR, products are aircraft, aircraft engines, and propellers.

14 Obviously, the JAA and FAA operational standards are related to the aircraft registered in the country having those standards as legal operational rules.

15 See Chapter 5, 'Type certification of aircraft, engines, and propellers'.

16 Many states adopt the FAA regulations as a basis for their national regulations.

17 The term 'rotorcraft' is not limited to helicopters, but also includes gyroplanes (even if they are less common).

18 JAR 11 defines ACJ as 'an accompanying text, containing explanations, interpretations or acceptable means of compliance, in order to clarify and to provide guidance for the application of requirements'.

19 This means that the designer (or better, the 'applicant', as it is normally defined) can choose other means of compliance, but in this case has to convince the authority about the validity of the choice.

20 See also the 'Advisory material' section in this chapter.

21 See the 'JAR-VLR' section in this chapter. At the end of 2002 it was still in a status of NPA (Notice of Proposed Amendment).

22 It used to be said that the limit trend of the airworthiness standards was to make aircraft certification impossible!

23 The same also applies for boxers' categories or for tax brackets.

24 We will see later the meaning of 'never' in flight safety assessment.

25 As a basic concept, an aircraft must be manageable in all foreseen conditions, by a crew of average skill (for that class of aircraft), and not necessarily by over-skilled people.

26 We can understand the lack of single-jet engine aeroplanes in the civil market, because they have performance normally incompatible with the above stalling speed limitation. We will mention this issue again with regard to 'crashworthiness'.

27 As we will see, this airworthiness standard concerns aeroplanes up to 750 kg maximum weight.

28 It may seem trivial, but how many people know that foam rubber cushions can be dangerous? They could indeed return most of the absorbed impact energy.

29 Independently of the fire emergency, the abandonment of the aircraft is considered in limited categories of civil aircraft like sailplanes/powered sailplanes and aerobatic aeroplanes. This is necessary for the hazard of flight collisions, especially during thermal flights of sailplanes, and for the hazard of the structure overloading and the critical situation that can occur during aerobatic operations. The applicable airworthiness standards provide suitable rules for this type of emergency.

30 JAR and EASA standards contain equivalent procedures.

31 JAR 22 does not contain this paragraph; JAR-VLA provides general indications only in order to minimize hazards in case of failure. This is consistent with the (generally) simple systems of the relevant aircraft.

32 See the 'Structure of aircraft airworthiness standards' section in this chapter.

33 A 'multi-fatality' accident, normally leading to the loss of the aircraft.
34 Accident analysis for other types of aircraft leads to different values. For example, for JAR 23 single engines it becomes 10^{-6}.
35 Total hours per year 3×10^5. In 30 years, 9×10^6, near to 10^7, which could imply a catastrophic accident (considering all aircraft systems).
36 Where the effects are less hazardous, they are permitted to occur more frequently.
37 Example: the 'Comet' crashes in the 1950s, due to fatigue caused by fuselage pressurization.
38 Example: a wing-fuselage attachment made by a single structural element. Such an arrangement is common in light aircraft.
39 Example: a multiplex wing-fuselage attachment, made by several structural elements. Such an arrangement is classical in large aeroplanes.
40 The bird strike is considered for large aeroplanes only, but it could be the object of special conditions for other types of aircraft.
41 Rotorcraft structures include rotors, rotor drive systems between the engines, and rotor hubs, controls, fuselage, fixed and movable control surfaces, engine and transmission mountings, landing gear, and their related primary attachment.
42 NTSB: the US organization dealing with aircraft accidents and issuing recommendations based on the investigation performed.
43 Airworthiness Directives: documents issued by the authority making particular mandatory actions (changes, inspections, etc.).
44 JAR-VLA offers some simplified criteria, but these must be considered carefully.
45 Appliance means any instrument, mechanism, equipment, part, apparatus, appurtenance or accessory, including communications equipment, that is used or intended to be used in operating or controlling an aircraft in flight, is installed in or attached to aircraft, and is not part of an airframe, engine, or propeller.
JAR 21 normally uses 'parts and appliances' together, to include also the 'parts' of airframes, engines, and propellers.
46 See Chapter 5, 'The type certificate'.
47 See Chapter 8, 'Restricted certificates of airworthiness', which defines and comments upon the Restricted type certificates.
48 See Chapter 8.
49 See Chapter 8, 'Standard certificates of airworthiness'.
50 See Chapter 8, 'Special airworthiness certificates'.
51 VFR: Visual Flight Rules.
52 IFR: Instrumental Flight Rules.
53 See Chapter 8.
54 ROA (Remotely Operated Aircraft) is preferred by the FAA and NASA. From a technical point of view it seems to be the most appropriate.
55 JAR-VLA deals with a simple aeroplane and the safety of two occupants. A UAV of the same weight is a sophisticated machine if we look at the systems, and we have also to consider the lives of the three or four hundred people aboard a large aircraft that could be brought down.

Chapter 5

Type Certification

5.1 Type certification of aircraft, engines, and propellers

5.1.1 The type certificate

The **type certificate** is a document by which the authority states that an applicant has demonstrated the compliance of a **type design** to all applicable requirements. This certificate is not in itself an authorization for the operation of an aircraft, which must be given by an **airworthiness certificate**.[1]

5.1.2 The type design

The type design of a product,[2] which must be adequately identified according to EASA Part 21 (paragraph 21A.31) and FAR 21 (paragraph 31), consists of:[3]

1 The drawings and specifications, and a listing of those drawings and specifications. They are necessary to define the configuration and the design feature of the product shown to comply with the applicable type certification basis and environmental protection requirements.
2 Information on materials and processes and on methods of manufacture and assembly of the product needed to ensure the conformity of the product.
3 An approved airworthiness limitations section of the instructions for continued airworthiness[4] as defined by the applicable airworthiness code.
4 Any other data necessary to allow, by comparison, the determination of the airworthiness, the noise characteristics, fuel venting, and exhaust emission (where applicable) of later products of the same type.

In other words, the type design 'freezes' not only the product configuration, but also the production methods. Every deviation from the type design becomes a 'change' which must be approved, as we will see. This is to make sure that the series products are not inferior to the prototype identified by the type design, in terms of flight safety.

5.1.3 Environmental protection

EASA Part 21 and FAR 21, for type certification, include the designation of applicable environmental protection requirements and certification specifications, missing in JAR 21.

According to Annex 16 of the Convention of Chicago, the environmental protection includes noise requirements and emission requirements (prevention of intentional fuel venting and emissions of turbo-jet and turbofan engines).

Subpart I of EASA Part 21 includes the instructions for the issue of **noise certificates.** Such documents do not exist in the FAA certification.[5]

An example of the influence that the environmental protection requirements can have on the design of an aircraft is the case of **supersonic business aeroplanes (SSBJ)**. Supersonic transport ended with the withdrawal of 'Concorde'. The big aerospace companies at present are not likely to produce new supersonic transport (SST), struggling as they are to find new markets for more efficient and economic transport aeroplanes. The competition between Boeing and Airbus, with their new models B 787 and A 350 still on paper, is an example.

Nevertheless, the supersonic aeroplane is still attractive in the market of business jets. 'Time is money …' *Flight International* of October 2004 states about some initiatives and ideas related to SSBJ projects.

One of the thorniest issues for the operation of (civil) supersonic aeroplanes is how to persuade regulators and legislators to change the rules banning supersonic overland flight. It is clear that an SSBJ being forced to fly subsonically over land is not worth operating. On the other hand, the only way to change the rules is **a reduction of the sonic boom** to an acceptable level for people on the ground.

The idea of quiet supersonic transport (QSST) is not new. One of the pioneers of this concept was Allen Paulson, the founder of Gulfstream. He pursued the dream of an SSBJ until his death in 2000. At his father's bequest, his son Michael Paulson engaged the notorious Skunk Works[6] to design an SSBJ using an innovative airframe shape to reduce the sonic boom.

Other studies and research have been carried out in the United States, all with the aim of reducing the sonic boom. NASA, of course, is involved in this.

If the research for low boom technology is to be validated, some prototypes will have to be built, adding costs of many millions of dollars.

In any case, it is worth reading the cautiously optimistic conclusions of *Flight International*:

> … it is now more likely than at any time in recent history that a supersonic business jet will become a reality within the next 10 years. And if an SSBJ enters service it will only be a matter

of time before a larger aircraft – possibly a 50-seat transatlantic jet to replace Concorde, perhaps a 300-seat transpacific airliner – takes to the skies.

5.1.4 Design organization

So far we have dealt with airworthiness authorities and their commitment. Now we will consider the designer's perspective,[7] i.e. the 'person' defined as the **applicant** becoming the **type certificate holder (TCH)** once the type certificate is issued. It goes without saying that designing and demonstrating compliance with the applicable requirements needs a technical organization adequate for this kind of project; this could range from very few to several hundred technicians.

JAR 21, paragraph 21.13, states that the applicant must hold (or have applied for) an appropriate[8] Design Organization Approval (DOA). The requirements for a **JAA Design Organization Approval (JA DOA)** are contained in Subpart JA of JAR 21.

In a similar way, EASA Part 21 states in paragraph 21A.14 that 'any organization applying for a type certificate or restricted type certificate shall demonstrate its capability by holding a **Design Organization Approval** issued by the Agency in accordance with Subpart J of Part 21'.

By way of derogation, as an alternative procedure to demonstrate its capability, an applicant may seek Agency agreement for the use of procedures setting out specific design practices, resources, and sequence of activities necessary to comply with Part 21 when the product is one of the following:

1 A very light aeroplane or rotorcraft, a sailplane or a powered sailplane, a balloon, a hot-air ship, or
2 A small aeroplane meeting all the following elements:
   (a) Single piston engine, naturally aspirated, of not more than 250 hp maximum take-off power (MTOP)
   (b) Conventional configuration
   (c) Conventional material and structure
   (d) Flights under VFR, outside icing conditions
   (e) Maximum of four seats including the pilot and maximum take-off mass limited to 3000 lb (1361 kg)
   (f) Unpressurized cabin
   (g) Non-power-assisted controls
   (h) Basic acrobatic flights limited to +6/−3 g, or
   (i) A piston engine, or
   (j) An engine or a propeller type certificated under the applicable airworthiness code for powered sailplanes, or
   (k) A fixed or variable pitch propeller.

The EASA has an internal working procedure called '*Alternative Procedures to Design Organization Approval (ADOAP)*' describing how the Agency will internally handle the investigation of an applicant's alternative procedures in the absence of Design Organization Approval.

The FAA has a different approach. FAR 21 does not mention a formal approval of a design organization. In this chapter we will further consider the FAA type certification procedures in more detail.

5.1.5 Design Organization Approval (DOA) – JAA and EASA

We have already quoted that the requirements for acquiring this approval are contained in Subpart JA of JAR 21[9] and in Subpart J of EASA Part 21. It may be useful to illustrate the main characteristics of the DOA.[10]

The main duties and responsibilities of a design organization are:

1 To design.
2 To demonstrate compliance with the applicable requirements.
3 To independently check the statements of compliance.
4 To provide items for continued airworthiness.
5 To check the job performed by partners/subcontractors.
6 To independently monitor the above functions.
7 To provide the authority with the compliance documentation.
8 To allow the authority to make any inspection and any flight and ground tests necessary to check the validity of the statements of compliance.

A crucial point, besides the normal design organization, is the institution of a **Design Assurance System (DAS)** for control and supervision of the design, and design changes to the product covered by the application. This includes all the activities for the achievement of the type certificate, the approval of changes, and the maintenance of continued airworthiness.

In particular, the DAS should include an organizational structure to:

1 Control the design.
2 Show compliance with the applicable certification standard and environmental requirements.
3 Show compliance with protection requirements.
4 Independently check this compliance.
5 Liaise with the Agency.
6 Continuously evaluate the design organization.
7 Control subcontractors.

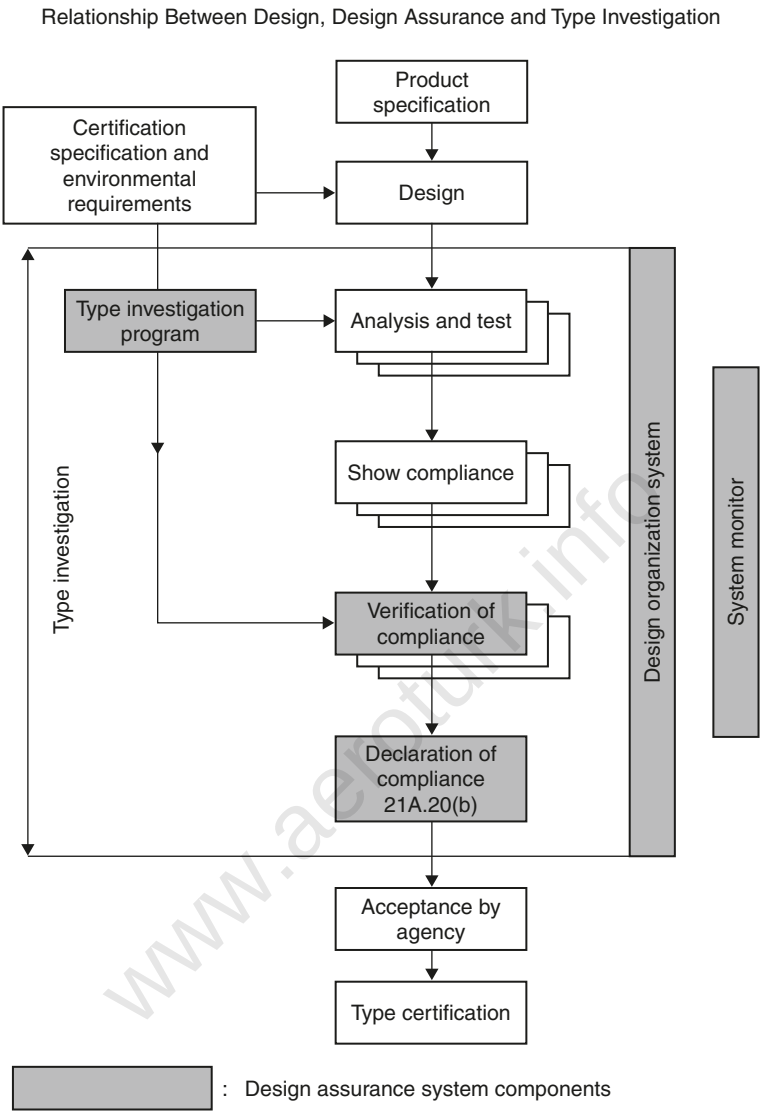


Figure 5.1 *Relationship between design, design assurance, and type investigation*

All of these functions are essentially accomplished through the action of:

- A staff of **Certification Verification Engineers (CVEs)** responsible for checking and signing all the documents of compliance with the applicable requirements. The CVEs may work in conjunction with the individuals who prepare compliance documents, but may not be directly involved in their creation (this is to ensure independent checking).
- **System Monitoring**, which has the task of ensuring that all the responsibilities of the DAS are properly discharged, proposing corrective and preventive measures for continuous effectiveness. Normally this is done through targeted audits. The System Monitoring could be

a functional emanation of the applicant's Quality Assurance System. The person responsible for the System Monitoring always reports to the **Head of Design Organization**.

A peculiarity of the organization is the **Office of Airworthiness** which, among its main tasks, ensures liaison between the design organization and the authority with respect to all aspects of type certification. This office carries out a true co-ordination action within the design organization; moreover, it issues and updates the **DOA Handbook**, which is the basic document of the organization, containing its description, the object of the certification, staff functions, all the procedures concerning design activities, tests, and others.

JAR 21 (paragraph 21.20) and EASA Part 21 (paragraph 21A.20) require that the applicant must declare, at the end of the type investigation, that he or she has shown compliance with all applicable requirements. The **declaration of compliance** must be signed by the Head of Design Organization.

From a legal point of view, the declaration of compliance is issued by the authority through the type certificate, after the inspections, flights, and ground tests necessary to check the validity of the declaration of compliance.

An important feature of the DOA is shown by the **privileges** stated in paragraph 21.A263. This states the possibility that the compliance documents for the applicable requirements may be accepted[11] by the Agency without further verification; furthermore, the design organization may obtain, following the prescribed investigations and within its terms of approval:

1 A type certificate or approval of a major change to the type design, or
2 A Supplemental type certificate, or
3 An ETSO authorization, or
4 A major design approval.

The holder of the DOA shall be entitled, within its terms of approval and under the relevant procedures of the design assurance system, to:

1 Classify changes to the type design and repairs as 'major' or 'minor' (we will discuss this further in the present chapter).
2 Approve minor changes to type design and minor repairs under procedures agreed with the authority.[12]
3 Approve documentary changes to the aircraft flight manual and issue such changes.[13]
4 Approve the design of major repairs to products for which it holds the type certificate or the Supplemental type certificate.[14]

Design Organization Approval can be considered as a significant improvement in the relationship between the applicant and the authority.[15] Many authorities have, for a long time, performed surveillance on designs and aeronautical material that can be defined as 'control of the control'. All the aircraft were inspected and also checked in flight.[16] This kind of surveillance was expensive from the point of view of human resources and could only be justified

to compensate the lack of organization in an enterprise. 'Control of the control' is a philosophically incoherent praxis because, in order to be effective, it should involve other levels of control (the control of the control of the control, i.e. *quis custodiet ipsos custodes?*) until safety is assured.[17] The impossibility, but also the poor efficiency, of such a system is evident.

Hence, it is necessary that the applicant assumes the whole responsibility of safety, without the caveat that 'if there is something wrong, the authority will correct it'.

But where is the real interest of the authority? The authority, through certification processes such as DOA (and Production Organization Approval – POA – in the case of production), promote the enterprise to a condition of self-control leading to the creation of a product that is safe independently of the authority's surveillance. Hence, there is a transfer of responsibilities for the authority from the control of the **product** to the control of the **organization**; this is being ensured by means of audits of products[18] and audits of systems.[19]

Furthermore, the DOA privileges allow a more efficient authority's involvement, because the authority can choose what to see and what to approve, with focused interventions. This is also an advantage for the authority's technicians as they do not lose contact with aeronautical materials and tests, an indispensable prerequisite for training and updating.

From a certain point of view, the DOA privileges also become the authority's privileges.

Unfortunately, the alternative procedures replacing the DOA do not allow the above privileges. It should then be reasonable to prompt small organizations to instigate a DOA too, even if they normally deal with products for which the DOA is optional. This is rather difficult considering the way in which Subparts JA of JAR 21 and J of EASA Part 21 are now written, clearly with medium/large organizations in mind. The JAA have, for a long time, discussed the possibility of issuing advisory material that, without distortion of the basic philosophy, could make the DOA certification of small organizations easier. This would be an improvement in terms of both safety and efficiency of the authority.

5.1.6 Changes in type design

We have previously seen that all deviations from a type design are 'changes' that have to be approved by the authority (in a direct or indirect way). Because these deviations can range, for example, from a simple correction of a drawing to the opening of a large door in the fuselage of an aircraft for conversion in a cargo aircraft, JAR/FAR 21/EASA Part 21 consider two kinds of changes:

1 **Minor changes**, i.e. those that have *no appreciable effect* on the mass, balance, structural strength, reliability, operational characteristics (noise, fuel venting, exhaust emission),[20] or other characteristics affecting the airworthiness of the product.
2 **Major changes**, i.e. all other changes.

FAR 21 has the same classification with some difference in wording and definition of **acoustical change** for different types of aircraft.

The classification of changes is important because it makes a difference to the authority's involvement in the approval phase (we will also see its importance for establishment of the 'certification basis'). We have already considered that an organization having a DOA can make a minor change approval without direct verification from the authority. But even without a DOA, the authority's attitude is less severe towards such changes. Nevertheless, the classification of changes is a delicate problem because, when the changes are not clearly minor or major as in the above example, that *appreciable effect* in the minor change definition can lead to a range of uncertainties. This is the reason why design organizations must have approved procedures for this classification, and why only design organizations with DOAs are allowed to make such classifications without further authority verification.

In any event, minor changes in a type design are approved:

1 EASA – by the Agency, or by appropriately approved design organization under a procedure agreed with the Agency.
2 FAA – by a method acceptable to the Administrator.

GM 21A.91 of EASA Part 21 provides guidance on the classification of major changes (as opposed to minor changes as defined in paragraph 21A.91). Furthermore, in order to make the classification easier, it provides a few major change examples per discipline: structure, cabin safety, flight, systems, propellers, engines, rotors and drive systems, environment, and power plant installations.

Figure 5.2 presents an outline of the change classification process.

We could question how much a certificated type design could be changed without the application for another type certificate. As an example: can a single-engine aeroplane be converted to a twin-engine aeroplane as a change to the same TC? The answer used to be provided by paragraph 21.19 of JAR 21 (an approach arising from the now superseded FAR 21) and was negative. The paragraph lists other cases for which the application for a new TC was required, as follows.

For **aircraft**, an application for a new TC is required if the proposed change is:

1 In the number of engines or rotors.[21]
2 To engines or rotors using different principles of operation.[22]

For an **engine**, an application for a new TC is required if the proposed change is in the principle of operation.

For a **propeller** an application for a new TC is required if the proposed change is in the number of blades or principle of pitch change operation.

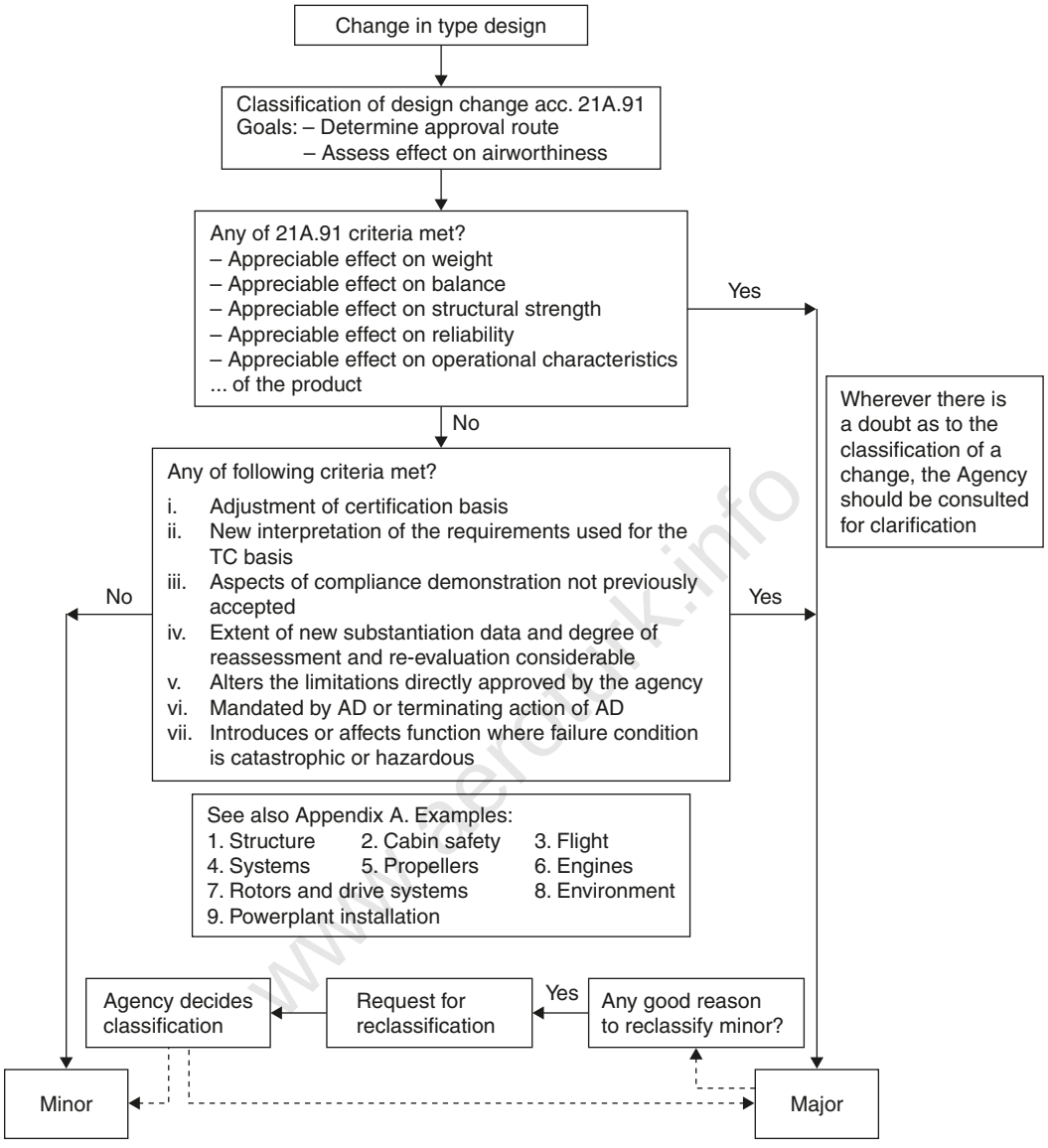


Figure 5.2 *Classification of changes in type design*

The paragraph also prescribes a general principle establishing that a new application for a TC must be made if the authority finds that the proposed change in design, configuration, power, power limitations, speed limitations, or weight is so extensive that a substantially complete investigation of compliance with the applicable requirements is required.

This general principle can also be found in paragraph 21A.19 of EASA Part 21 and paragraph 21.19 of FAR 21, simply stating (with slightly different wording) that a new application for a type certificate must be made if the Agency/Administrator finds that the change in

design, power, thrust, or mass is so extensive that *a substantially complete investigation of compliance with the applicable type certification basis (applicable regulations) is required*.

5.1.7 Designation of the type certification basis[23]: the derivative prototype

During the operational life of an aircraft, many changes, minor or major, are normally introduced (after the authority's approval) for various reasons.

It also happens that the type certificate holder, after type certification, needs to differentiate the type design (normally for commercial reasons) in so-called 'derivative' aircraft.[24]

The changes could be a different maximum take-off weight, replacement of the engine type, a different fuselage length to contain a major (or minor) number of passengers – there are numerous examples.

The introduction of changes or the design of a derivative prototype are sometimes realized several years after the type certification of the product (which is called the 'basic product'), and the applicable requirements may have been changed substantially in this period. The first thing to do, in any case, is to establish whether it is possible to type certificate the changed product as a **change to a TC** or whether there is a need for an application for a **new TC**.

As mentioned above, the FAR/EASA paragraphs 21.19/21A.19 establish when an application for a new TC is required. Nevertheless, that generic wording, leaving the final decision to the authority, has very often caused contention with the applicant. In fact, applicants usually prefer to start from a basic product because, if an application for a new TC is made, they have to start over again, and with the most recent basis for certification.

As a general rule (exceptions are given in FAR 21), the certification of a type design change should comply with the requirements applicable **at the date of the application** for the change.

There is also the possibility of adopting an earlier amendment (compared with the one existing at the date of application for change approval)[25] as follows.

Paragraph 21.101 of FAR 21 and paragraph 21A.101 of EASA Part 21 introduce the concept of changes considered by the Administrator/Agency as **non-significant**.

Changes that meet one of the following criteria are automatically considered **significant**:

1 The general configuration or the principles of construction are not retained.
2 The assumptions used for certification of the product to be changed are no longer valid.

Having introduced these criteria, the above-mentioned paragraphs 101 state that an applicant may show that a changed product *complies with an earlier amendment* for any of the following:

1 A change that the Administrator/Agency finds *not to be significant*.
2 Each area, system, component, equipment, or appliance that the Administrator/Agency finds is *not affected by the change*.
3 Each area, system, component, equipment, or appliance that is affected by the change for which the Administrator/Agency finds that compliance with a regulation applicable at the date of the application *would not contribute materially to the level of safety of the changed product or would be impractical*.

Furthermore, an application for a change to an aircraft (other than a rotorcraft) of 2722 kg (6000 lb) or less maximum weight, or to a non-turbine rotorcraft of 1361 kg (3000 lb) or less maximum weight may show that the *changed product complies with the regulations incorporated by reference in the type certificate*. However, if the Agency/Administrator finds that the change is significant in an area, the Agency/Administrator may designate compliance with an amendment to the regulation incorporated by reference in the type certificate that applies to the change and *any* regulation that the Agency/Administrator finds is directly related, unless the Agency/Administrator also finds that compliance with that amendment or regulation would not contribute materially to the level of safety of the changed product or would be impractical.

This last provision of the above-mentioned paragraphs is less stringent for the approval of type design changes concerning general aviation aircraft.

With regard to the certification basis for a changed product it is obvious that, with the same criteria used for the basic product type certification, if the Administrator/Agency finds that the regulations in effect on the date of the application for the change do not provide adequate standards with respect to the proposed change because of a novel or unusual design feature, the applicant must also comply with **special conditions**, and amendments to those special conditions, to provide a level of safety equal to that established by the regulations in effect on the date of the application for the change.

At this point it is also important to introduce the concept of **substantial change**,[26] requiring the application for a new TC.

5.1.8 Advisory material

As we have illustrated so far, the definition of a type certification basis is a complex matter, involving a multitude of different cases and requiring experience and common sense. We may, for instance, consider that a series of step-by-step changes to a type design can lead to a cumulative effect such as to create a substantial change. Then it may be necessary to go through the family's 'history' of related products case by case.

FAR/JAR 21 and EASA Part 21 define the basic criteria, and it would be impossible to make these criteria operational on a uniform basis without advisory material. After years of discussion this advisory material is provided by **EASA GM 21A.101** and **FAA AC 21.101-1**, which give guidance for establishing the type certification basis for a product and identifying the conditions under which an applicant for a design change is required to apply for a new type certificate.

The GM/AC also provide guidance as to the assessment of **significant** vs. **non-significant** changes to the type certificated product.

Definition of **substantial** changes is provided with guidance for their determination. The GM/AC are applicable to all major changes to the type design of aircraft, engines, and propellers.

Minor changes are considered to have no appreciable effect on airworthiness and are therefore by definition not significant.

These documents are also applicable to all significant changes to aircraft (other than rotorcraft) of 6000 lb or less maximum weight or to non-turbine rotorcraft of 3000 lb or less maximum weight (already mentioned above).

The GM/AC are full of examples to make practical application of a very complicated matter easier, and difficult items such as the influence of 'service experience' are discussed to demonstrate that the introduction of the last amendment is unnecessary.

Another valuable feature of these documents is the fact that all products (large and small aeroplane, rotorcraft, engines, etc.) are considered.

Figure 5.3, extracted from the GM (the FAA AC includes a very similar figure), shows the establishment of the type certification basis for changed products.

5.1.9 The Supplemental type certificate (STC)

We have so far implied that changes are designed by the type certificate holder. Nevertheless, another possibility does exist, and it is provided by Subpart E of JAR/FAR 21/EASA Part 21: any person who alters a product by introducing a **major** change, not sufficient to require a new application for a type certificate (see previous paragraph), shall apply to the authority for a Supplemental type certificate.

To provide just a couple of the countless possible examples: a design organization (other than the TCH) can design an agricultural system for crop spraying to be installed on a type certificated aircraft; in a similar way, a passenger transport aeroplane can be transformed into a cargo aeroplane.

Any organization applying for a JAR/EASA STC shall demonstrate its capability by holding a Design Organization Approval (DOA) or, by way of derogation, alternative procedures setting out the specific design practices, resources, and sequence of activities necessary to comply with the applicable requirements.

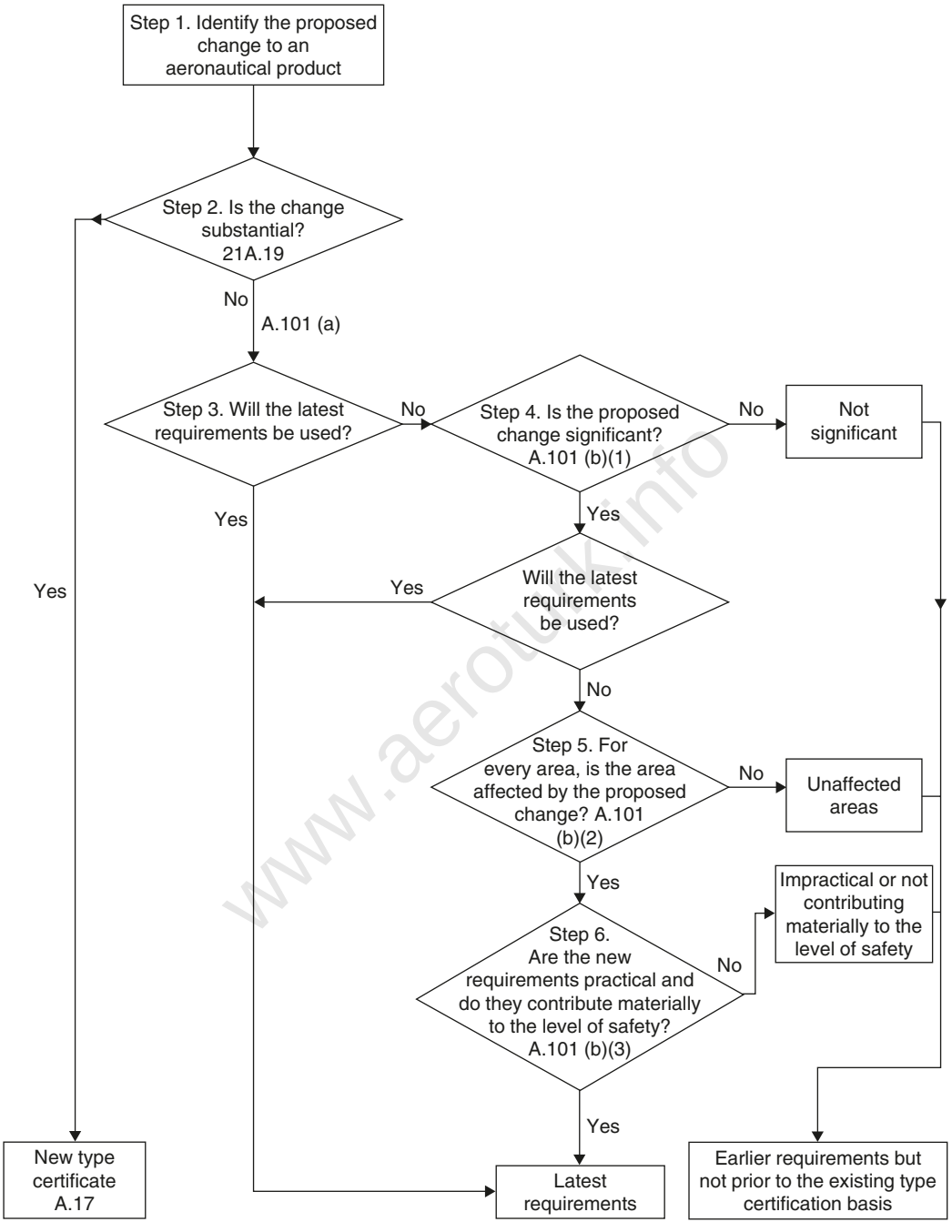


Figure 5.3 *Type certification basis for changed products*

EASA GM 21A.112B provides guidance in order to establish in which cases alternative procedures can be accepted.

For applications concerning an FAA STC, as we have mentioned dealing with the product type certification, there is no formal approval of the design organization.

Another peculiarity of the requirements governing the JAA/EASA STC which cannot be found in the analogous FAA regulations requires justifications that the applicant is provided with all the information on the type design necessary to design the change, based either on the applicant's own resources or through an arrangement with the type certificate holder.

In the last case, the TCH shall not have technical objection to the above-mentioned information, and shall collaborate with the STC holder to ensure discharge of all obligations for continued airworthiness of the changed product.

Because the STC is the approval of a major change in type design, what we have discussed about the 'change in type design' in this chapter is entirely applicable.

The certification process of an STC is similar to the type certification process of a product (aircraft, engine, and propeller).

Nevertheless, to cope with the peculiarity of this process, the EASA issued an Internal Working Procedure 'Supplemental Type Certification Procedure (STCP)', while the FAA issued AC 21-40, 'Application Guide for Obtaining a Supplemental Type Certificate'.

In relation to the practical introduction of an STC, a person may change an aircraft, engine, propeller or appliance based on an existing STC only if the person requesting the change is the holder of the STC or has permission from the holder to make the change.

The FAA considers the following privileges for a holder of an STC:

1 In the case of aircraft, obtain airworthiness certificates.
2 In the case of other products, obtain approval for installation on certificated aircraft.
3 Obtain a production certificate for the change in type design that was approved by that Supplemental type certificate.

5.2 Parts and appliances approval

All parts and appliances installed on certificated products (aircraft, engines, and propellers) must be approved. According to Subpart K of JAR/FAR/EASA Part 21, compliance with applicable requirements may only be made:

1 Where applicable, under the **JTSO/TSO/ETSO authorization** procedures of Subpart O of JAR/FAR 21/EASA Part 21, or

2 In conjunction with the type certification procedures for the product (or its change) in which it is to be installed, or
3 In the case of **Standard Parts**, in accordance with officially recognized standards, or
4 Where applicable (and JAA certifications) under the **Joint Part Approval authorizations (JPA auth.)** procedures of Subpart P of JAR 21, or
5 Where applicable (and FAA certification) under the **Parts Manufacturer Approval (PMA)** issued under FAR 21.303, or
6 In any other manner approved by the Administrator (the FAA).

We will now try to describe this concept more thoroughly (the bold numbers below correspond to the list above).

1. Subpart O of the JAR/FAR 21/EASA Part 21 prescribes procedural requirements for the issue of Joint Technical Standard Order authorizations (JTSO)/FAA Technical Standard Order (TSO)/European Technical Standard Order authorization (ETSO), to mark parts (defined 'articles' in Subpart O) with the appropriate JTSO/TSO/ETSO marking. The authorization is an approval of the design and for the production of an article which has been found to meet a specific JTSO/TSO/ETSO.

A **Technical Data** document must be produced according to the applicable JTSO/TSO/ETSO.

Furthermore, a **Declaration of Design and Performance (DDP)** has to be issued, containing the information for the definition of the article type design, the rated performance of the article, a statement of compliance certifying that the applicant has met the appropriate JTSO/TSO/ETSO, reference to relevant test reports, and reference to the appropriate maintenance, overhaul, and repair manual.

An article manufactured under a JTSO/TSO/ETSO authorization is, in principle, acceptable for installation in an aircraft. Nevertheless, some other technical requirements may be applied to the article by the participating authorities in accordance with the type certification regulations applicable to the aircraft in which the article is fitted (e.g. JAR/FAR/CS-25), and the compatibility with the characteristics of the product must be ascertained.[27]

Applicants for an ETSO authorization shall demonstrate their capabilities as follows:

(a) **For production**, by holding a Production Organization Approval (POA)[28] or through compliance with Subpart F procedures.[29]
(b) **For design**, for an auxiliary power unit (APU) by holding a Design Organization Approval (DOA); for all other articles, by using procedures setting out the specific design practices, resources, and sequences of activities necessary to comply with the applicable requirements.[30]

For an FAA TSO authorization:

(a) **For production**, a quality control organization is required in compliance with FAR 21.143.
(b) **For design**, a formal Design Organization Approval is not required as mentioned in the 'Design organization' section in this chapter.

The code **JAR-TSO** contains the agreed common comprehensive and detailed aviation requirements for obtaining a Joint Technical Standard Order authorization by showing compliance with the requirements of JAR 21. In Subpart B there are two Indexes:

- Index 1 lists all those JTSOs that are technically similar to FAA TSOs.
- Index 2 lists all those JTSOs that are applicable only to JAR. Examples are:
  (a) Jointly agreed deviations from an FAA TSO, or
  (b) When an FAA TSO does not exist for a particular application.

The code **CS-ETSO** contains the technical conditions an article should comply with in order to obtain a European Technical Standard Order (ETSO) Authorization pursuant to Part 21, Subpart O. The technical conditions are contained in the respective ETSOs and are part of this code. Subpart B of CS-ETSO contains two Indexes with the same criteria as JAR-TSO.

The **AC 20-110L** 'Index of Aviation Technical Standards Order' describes the public procedures the FAA uses to develop and issue TSOs. Furthermore, the AC presents an index of the FAA TSOs that contain minimum performance standards for specific materials, parts, processes, and appliances used on civil aircraft.

2. The JTSO/TSO/ETSO articles are only a part of what is installed on an aircraft and sometimes, as described previously, are not compatible with the same aircraft. It is therefore necessary to obtain the approval of parts and appliances specially designed for the product to be certificated or for a change approval. The production (and also the design) of parts and appliances for a product to be certificated or for a change approval can also be performed by external organizations, but the applicant is solely responsible for the airworthiness of such items.

The qualification procedure is generally similar to the JTSO/TSO/ETSO Authorization. In this case, a Technical Specification and a Declaration of Design and Performance must also be issued. A classification of the equipments, based on their criticality (the consequences of their failure), is performed, and according to this classification the authority's intervention is normally established.

The qualification procedure has also to consider compliance with paragraph XX.1309 of the relevant JAR/FAR/CS, if applicable to that part of the product.

It may be useful to remember that, while JTSO/TSO/ETSO parts and appliances can be installed in any product (except in the cases we have previously considered), the parts and appliances approved in conjunction with the type certification process of the relevant product can only be installed in products of the same type.

A misunderstanding could arise at this point: is an applicant compelled to install a JTSO/TSO/ETSO article when available?

This has often been the cause of contention between applicants and authorities, especially for certification of small aircraft in the General Aviation category. It must be clear that this

obligation does not exist, provided the above-mentioned rules are followed. The contention can become harsher when the applicant wants to install items originating from car production or other non-certificated production (e.g. ultralights). Why not? Everyone can testify about the reliability of instruments and various accessories in his or her own car (often proving to be serviceable and reliable for many years).

Nevertheless, direct transfer of a part from the counter of a car dealer to an aircraft is not possible. A qualification procedure similar (as far as possible) to that mentioned above must be put into action, ranging from knowledge of the item to its compatibility with the aircraft's operational conditions and installations (e.g. environmental and electromagnetic compatibilities); an acceptance procedure also needs to be established (vendors generally are unable to issue certificates of conformity). In conclusion, the qualified equipment should have its own part number so as not to be automatically interchangeable with the commercial equivalent.

All this costs time and money, in contrast to the installation of a JTSO/TSO/ETSO article, whose sole disadvantage is that it is normally more expensive: its cost may be a few times higher than the equivalent car or ultralight equipment. Hence a choice has to be made. An investment in non-JTSO/TSO/ETSO equipment will be beneficial as regards the savings obtained in series production, allowing for a lower selling price and thus a more favorable position in the market.

Nevertheless, if the series production is uncertain, and there is an urgent need for a type certificate, the installation of JTSO/TSO/ETSO articles may be more convenient.

Another cause of contention in 'light' aviation is when, say, applicant A pretends to install in his own aeroplane non-certificated equipment already adopted by applicant B. Part of the above-mentioned consideration is that equipment certificated with a product is valid for that product only; applicant A does not have applicant B's knowledge of the equipment, and does not know the changes that may have been made to that equipment and the acceptance procedures. In this case, applicant A has to carry out equipment qualification for his product, like applicant B.

Of course, common sense should prevail in certification activities too. There are many non-critical parts (most parts) for which the authority, from a general point of view, could accept simplified qualification procedures, based on previous experience, technical evaluations, etc.

We have previously mentioned that all parts and appliances installed on certificated products (aircraft, engines, and propellers) must be approved. Nevertheless, we have to consider the case of installation of equipment not specifically required for the aircraft's airworthiness, a case that occurs frequently. This equipment can be identified as follows:

(a) Entertainment equipment
(b) Domestic equipment
(c) Aerial work installations

(d) Experimental installations
(e) Instruments for additional information.[31]

In these cases, the **No Hazard** criterion is adopted, with the aim of ensuring that the above-mentioned equipment is not dangerous in itself, and that its presence on board will not jeopardize the performance and function of the aircraft's systems and, in general, the aircraft's airworthiness. It must be clear that the above criteria provide no guarantee for the correct function and nominal performance of this equipment that, from an airworthiness point of view, we can define as 'tolerable'.

3. This case applies to parts in accordance with standardization norms (e.g. Military Standards, Society of Automotive Engineers Inc., Electronic Industries Association Standards Institute, American National Standards Institute, AIA-NAS), or with norms issued by the manufacturers of parts or products, and accepted by the authority as different from standardization norms. The above-mentioned norms are technical specifications that become parts of the product type design or change of the same.

4. Subpart P of JAR 21 prescribes procedural requirements for the issue of a Joint Part Approval authorization (JPA auth.) for replacement and modification parts (only minor changes are allowed) for installation on a type certificated product. These parts are manufactured by people other than the type certificate holder, holding or having applied for a suitable Production Organization Approval. As a consequence of the JPA authorization, the parts are identified with a JPA marking.

Subpart P is 'not applicable' for EASA Part 21.

According to EASA Part 21A.804(a)(3), all parts and appliances produced in accordance with approved design data not belonging to the type certificate holder of the related product, except for ETSO articles, need to be marked with the letters EPA (European Part Approval).

This approach is different from the JPA marking as this referred to parts and appliances produced in accordance with design data belonging to the type certificate holder.[32]

5. The FAA describes procedural regulations for the Parts Manufacturer Approval (PMA), which is similar to JPA. These replacement parts are important especially for operators' fleet maintenance. In fact, these parts are generally less expensive than the original ones.

(a) *For the design* of these parts, the applicant must produce test reports and computations necessary to show that the design meets the airworthiness requirements of the Federal Aviation Regulations applicable to the product on which the part is to be installed, unless the applicant shows that the design of the part is identical to the design of a part that is covered under a type certificate. If the design of the part was obtained by a licensing agreement, evidence of that agreement must be presented.

(b) *For the production* of these parts, each holder of a Parts Manufacturer Approval shall establish and maintain a fabrication inspection system that ensures that each completed part conforms to its design data and is safe for installation on applicable type certificated products.

6. 'In any other manner approved by the Administrator' is a general FAA statement for the approval of materials, parts, processes or appliances outside the methodologies illustrated above.

5.3 The master minimum equipment list/minimum equipment list

This concept does not originate directly from the product type certification standards, but from operational standards such as **JAR-OPS 1** (Commercial Air Transport – Aeroplanes), **JAR-OPS 3** (Commercial Air Transport – Helicopters),[33] and **FAR 91**.

5.3.1 The master minimum equipment list (MMEL)

The MMEL is a master list (approved by the authority) appropriate to an aircraft type which determines those instruments, items of equipment or function that, while maintaining the level of safety intended in the applicable standards, may temporarily be inoperative either due to the inherent redundancy of the design, and/or due to specified operational and maintenance procedures, conditions and limitations, and in accordance with the applicable procedures for continued airworthiness.

This implies that all systems related to the airworthiness of the aircraft and not included in the list are automatically required to be operative, while non-safety-related equipment, such as galley equipment and passenger convenience items, do not need to be listed.

The MMEL covers the type of operations for which the aircraft is certificated.

Certain MMEL items need to be supported by operational and maintenance procedures which have to be identified to the authority during the MMEL approval process.

The creation of the master list, as is obvious, is strictly related to the safety assessment criteria discussed in Chapter 4, and therefore it must be **prepared by the type certificate holder**.

5.3.2 The minimum equipment list (MEL)

The MEL is a list which provides for the operation of aircraft, under specified conditions, with particular instruments, items of equipment or functions inoperative at the commencement of the flight. This list is **prepared by the operator** for his own aircraft taking account of the relevant operational and maintenance conditions, in accordance with a procedure approved by the authority.

The MEL is based (without being less restrictive) upon the relevant MMEL approved by the authority.

FAR 91 gives criteria for instruments and equipment which may not be included in an MEL.

Criteria are also provided for operations conducted (under FAR 91) with inoperative instruments and equipment and without an approved MEL.

In any case (according to FAR 21.197), if an aircraft with inoperative instruments or equipment is considered capable of safe flight for *particular purposes* (for example, delivering or exporting the aircraft, production flight testing new production aircraft, etc.), it can be operated under a **special flight permit**.[34]

5.4 Type certification of imported products

The certification of an imported product is normally carried out through the assessment of the type certification performed in the exporting state, made by the authority of the importing state. The aim of this assessment is to ensure that the imported product meets a level of safety equivalent to that provided by the applicable laws, regulations, and requirements which would be effective for a similar product in the importing state. The result of this assessment is the type certificate **validation**.

The TCH and the exporting authority are then ready to negotiate individually with the different importing authorities. The matter could also be further complicated by different requirements in different states.

This was simplified in Europe when the JAA Member States adopted the same JARs.

Furthermore, the JAA joint certifications and validations (and now the EASA certifications and validations), leading to the issue of a common type certificate, have further simplified the matter. Hence, the national authorities, in order to issue an airworthiness certificate, have only to check the compliance of single aircraft with the national operational requirements.[35]

In order to simplify the TC validation processes, **bilateral agreements**[36] have been made between states; these agreements are based on a high degree of mutual confidence in the technical competence and regulatory capacity of the exporting authority for performing aircraft certification functions within the scope of the agreement. A bilateral agreement is not a trade agreement, but a technical agreement providing that 'the importing state shall give the same validity to the certification made by the competent aeronautical authority of the exporting state as if the certification had been made by its (the importing country's) own competent aeronautical authority in accordance with its own applicable laws, regulations, and requirements'.[37] Nevertheless, because these laws, regulations, and requirements could be different,

the agreement permits the importing state to prescribe **additional technical conditions** 'which the importing state finds necessary to ensure that the product meets a level of safety equivalent to that provided by its applicable laws, regulations, and requirements which would be effective for a similar product produced in the importing state'.[38]

Subpart N of JAR 21 prescribes the procedural requirements for certification of imported products, parts, and appliances in a JAA Member State, and approval of major changes under Supplemental type certificate procedures when such changes are designed by a person that is not the TC holder and is located in a non-JAA country. As far as the USA is concerned, similar procedures are contained in FAR 21 paragraphs 24, 29, and Subpart N. Moreover, the FAA AC 21-23A provides ample advisory material on this subject.

As regards the EASA, Subpart N is 'not applicable'. Nevertheless, the same criteria are expressed in Article 9 of the EASA Internal Working Procedure 'Type Certification' document.

With reference to the above-mentioned AC, we will quote as a matter of interest some points relating to the FAA's involvement in the validation of imported (in the USA) products and inherent changes. This involvement, of which it is important to be aware because it is also related to European exports to the United States, consists of the following:

1 To provide for the FAA familiarity with the general design, performance, and operational characteristics of the product, for the purpose of establishing the US certification basis to the extent necessary, and for the FAA to meet its post-certification responsibilities after the product enters service on the US registry.
2 To establish the US type certification basis and the means of compliance for the product under application by determining the US airworthiness and environmental standards that would be applied to a similar product if it were to be produced in the USA.
3 To understand the airworthiness certification system (including the airworthiness and environmental standards, policies, and certification practices) applied by the exporting authority in their domestic certification of the product; this will include an understanding of the level of the exporting authority's involvement with prototype conformity inspections, tests, and flight programs.
4 To compare the airworthiness and environmental standards, policies, and practices applied by the exporting authority in their domestic certification with the US type certification basis or design requirements and certification policies and practices.
5 To define and explain any additional technical conditions that should be met for FAA certification to provide for equivalency with the applicable US airworthiness and environmental standards.
6 To maintain sufficient liaison and technical dialog with the exporting authority to ensure that technical questions and issues which might affect US certification of the product are identified and resolved between the FAA and the exporting authority as early as possible.
7 To provide for effective management of the certification project and for the most cost-effective utilization of FAA resources on the project.

5.4.1 Certification basis[39]

The applicable **US airworthiness standards** are those in effect on the date of application for the US TC,[40] while the applicable **US environmental standards** are those in effect on the date of the US type certification.[41]

Another way to define the FAA certification basis is the addition of **technical conditions (ATCs)** to the certification basis of the exporting authority. These ATCs take into account the following:

1 Differences in the basic airworthiness and environmental standards of the USA and exporting state.
2 Non-compliance with the exporting authority airworthiness or environmental standards because of exemptions[42] or equivalent safety findings[43] granted by the exporting authority.
3 Special conditions issued by the FAA because of novel or unusual design features of the product that are not required in an equivalent manner by the exporting authority.
4 Mandatory airworthiness actions (i.e. Airworthiness Directives – ADs) directed by the exporting authority to correct unsafe conditions experienced during operation prior to application for FAA approval.
5 Optional conditions identified by the FAA to assist any eventual US operator to comply with current US operational or maintenance requirements.

Figure 5.4 illustrates how the US type certification basis can be determined.

In the second option, if the findings of compliance are applicable to the US Standards, the FAA will not develop any ATCs.

The identification and discussion of the problems arising from the above-mentioned issues are reported in the Issue Papers (similar to the JAA CRIs[44]) and the exporting authority is required to have a substantial involvement.

As mentioned above, also describing AC 21-23A, the TC validation is a rather complex process, sometimes more difficult than the original type certification itself. Of course, the process can be simplified when two authorities have acquired sufficient experience as regards importing/exporting, but above all if the personnel are well aware of the philosophy of bilateral agreements.

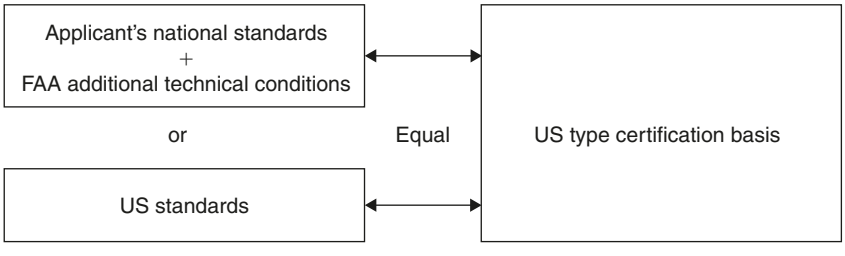


Figure 5.4 *US type certification basis*

Some problems arose in the early years of FAA/JAA validations, with complaints about manufacturing on both sides of the Atlantic, because it seemed that the validation teams had no clear vision of what they had to (or had not to) verify. This situation forced the JAA and FAA (and later the Canadian Authority as well) to discuss the matter and eventually come up with the 'JAA/FAA Validation Procedures'. This is a manual which explains the validation process, fixes organizational procedures, and above all the nature of the validation team's examinations and the team's relationship with the exporting authority. Furthermore, training courses for validation team members are organized both in Europe and the USA.

5.5 Transfer of a type certificate

It is sometimes necessary to transfer a TC from one TC holder to another for various reasons: the sale or the bankruptcy of an enterprise, the sale of a certificate type design, etc.

Procedural requirements for this transfer are prescribed by JAR/FAR 21.47 and EASA Part 21A.47. According to the JAA and EASA, the new TCH must be able to:

1 Undertake the responsibility of a TCH as defined in paragraph 21.44/21A.44.
2 Demonstrate the ability to qualify for an appropriate Design Organization Approval or have the authority's agreement for an alternative procedure.[45]

The approved design organization of the new TCH is a prerequisite for the transfer of the type certificate according to JAR 21 and EASA Part 21.

The FAA's approach is different. According to FAR 21.47:

> *A type certificate may be transferred to or made available to third persons by licensing agreements. Each grantor shall, within 30 days after the transfer of a certificate or execution or termination of a licensing agreement, notify in writing the appropriate Aircraft Certification Office. The notification must state the name and address of the transferee or licensee, date of the transaction, and in the case of a licensing agreement, the extent of authority granted the licensee.*

This could be interpreted as the possibility of transferring the TC independently of the new TCH's organization. Actually, there is a possibility that the TC relates to aircraft no longer in existence, and in such a case the presence of a design organization is irrelevant. Of course, the Administrator will intervene when the new TCH begins to produce aircraft according to the transferred TC, or it assumes the responsibility of the continuing airworthiness of a series of aircraft type certificated according to the same TC.

Significantly, the conditions for a correct management of the type design have to be maintained or recreated, both for production and continued airworthiness. Nevertheless, it is necessary to clarify that the transfer is also possible if the new TCH does not have a production organization. In this case, the TCH's responsibilities must be limited to the management of

continuous airworthiness, which is a vital function for the already certificated and operational aircraft of the type covered by the TC.

The authority could therefore have to deal with various situations. We will consider some examples:

1 The TC holder is an enterprise with a production organization, which is sold and changes its corporate name, but without substantial organizational changes. This case is the easiest to solve because, apart from some inevitable red tape, everything continues unchanged.
2 The TC is transferred to a different enterprise intending to continue with the production (or take it up again). In this case the authority, besides the assessments relating to the responsibilities of a TC holder (paragraph 21.44), must also deal with the production organization[46] according to Subpart F or G of JAR/FAR/21/EASA Part 21. If the new enterprise does not have Production Organization Approval to expand with the new production, it is likely to begin with JAR/FAR 21/EASA Part 21 Subpart F procedures. The task of the authority is now a complex one, because conformity with the certificated type design must be ensured in a completely new environment that could also benefit from better means of production, but may require some type design changes which have to be approved. It is certain that the authority, for the certification of the first aircraft produced, will not be satisfied by the normal verifications prescribed for the series aircraft; repetition of ground tests carried out for the aircraft type certification and a spot check of the certification flight tests could be required. All this is to ensure that the new series of aircraft are not inferior to the previous ones from a safety point of view.
3 The TC is transferred to an enterprise that does not have its own means of production. The case has already been considered at the beginning of the chapter where we mentioned that the task of the enterprise is limited to the management of continuous airworthiness. In the next point we will see how important this TC transfer is, even if the aircraft production is interrupted – in a temporary or definitive manner.
4 The TC holder disappears or is no longer able to cope with his or her responsibilities. This is not unusual, especially for small aeronautical enterprises, and serious problems could arise for the relevant aircraft that remain, so to speak, 'orphans'. In this case two scenarios are possible:
   (a) The authority replaces the TC holder as far as responsibility for continued airworthiness is concerned. This is likely to happen for small aircraft of the General Aviation which normally request a lesser engagement for this task. This also allows the obligations towards the national authorities of the states that have imported aircraft of the concerned type to be maintained.
   (b) The authority does not intend to (or cannot) assume the TC holder's responsibilities. In such a case the type certificate could be suspended, pending the application for a new TCH or, in the worst case, the type certificate could be revoked. It is evident that the suspension or revocation of the TC will have similar consequences regarding the certificate of airworthiness issued for the aircraft of the type concerned if still operating.

5.6 Instructions for Continued Airworthiness

Flight safety begins with the design of the aircraft. This means not only that the structures, systems, flight performance, flight qualities, etc. must comply with the applicable requirements, but they also need to provide instructions for maintenance of the aircraft and for repairs during its operational life.

JAR/FAR 21/EASA Part 21 use different wording, but have the same meaning. They require the following.

5.6.1 Provision of Instructions for Continued Airworthiness

The holder of a design approval, including either the type certificate or Supplemental type certificate for an aircraft, aircraft engine, or propeller, shall furnish at least one set of complete Instructions for Continued Airworthiness, prepared in accordance with the applicable requirements, to the owner of each type of aircraft, aircraft engine, or propeller upon its delivery, or upon issuance of the first standard airworthiness certificate for the affected aircraft, whichever occurs later, and thereafter make those instructions available to any other person required by the regulation to comply with any of the terms of these instructions. In addition, changes to the instructions for continued airworthiness shall be made available to any person required by this regulation to comply with any of those instructions.

The above-mentioned applicable requirements are the relevant certification standard, FAR/JAR/CS-23, -25, -27, -29, -33, -35, etc.

For instance, FAR 23 has the following requirement **(23.1529 Instructions for Continued Airworthiness)**:[47] 'The applicant must prepare Instructions for Continued Airworthiness in accordance with **Appendix G** to this part that are acceptable to the Administrator. The instructions may be incomplete at type certification if a program exists to ensure their completion prior to delivery of the first airplane or issuance of a standard certificate of airworthiness, whichever occurs later.'

To complete the example, we report an *extract* of Appendix G. This appendix specifies requirements for the preparation of Instructions for Continued Airworthiness as required by paragraph 23.1529.

> *General.* The Instructions for Continued Airworthiness for each airplane must include the Instructions for Continued Airworthiness for each engine and propeller (hereafter designated products), for each appliance required by this chapter, and any required information relating to the interface of those appliances and products with the airplane. If Instructions for Continued Airworthiness are not supplied by the manufacturer of an appliance or product installed in the airplane, the Instructions for Continued Airworthiness for the airplane must include the information essential to the continued airworthiness of the airplane.
>
> *Format.* The Instructions for Continued Airworthiness must be in the form of a manual or manuals as appropriate for the quantity of data to be provided.

Content. The contents of the manual or manuals must be prepared in the English language. The Instructions for Continued Airworthiness must contain the following manuals or sections, as appropriate, and information:

1 *Airplane maintenance manual or section*
   (a) Introduction information that includes an explanation of the airplane's features and data to the extent necessary for maintenance or preventive maintenance.
   (b) A description of the airplane and its systems and installations including its engines, propellers, and appliances.
   (c) Basic control and operation information describing how the airplane components and systems are controlled and how they operate, including any special procedures and limitations that apply.
   (d) Servicing information that covers details regarding servicing points, capacities of tanks, reservoirs, types of fluids to be used, pressures applicable to the various systems, location of access panels for inspection and servicing, locations of lubrication points, lubricants to be used, equipment required for servicing, two instructions and limitations, mooring, jacking, and leveling information.

2 *Maintenance instructions*
   (a) Scheduling information for each part of the airplane and its engines, auxiliary power units, propellers, accessories, instruments, and equipment that provides the recommended periods at which they should be cleaned, inspected, adjusted, tested, and lubricated, and the degree of inspection, the applicable wear tolerances, and work recommended at these periods. The recommended overhaul periods and necessary cross reference to the Airworthiness Limitations section of the manual must also be included. In addition, the applicant must include an inspection program that includes the frequency and extent of the inspections necessary to provide for the continued airworthiness of the airplane.
   (b) Troubleshooting information describing probable malfunctions, how to recognize those malfunctions, and the remedial action for those malfunctions.
   (c) Information describing the order and method of removing and replacing products and parts with any necessary precautions to be taken.
   (d) Other general procedural instructions including procedures for system testing during ground running, symmetry checks, weighing and determining the center of gravity, lifting and shoring, and storage limitations.
   (e) Diagrams of structural access plates and information needed to gain access for inspections when access plates are not provided.
   (f) Details for the application of special inspection techniques including radiographic and ultrasonic testing where such processes are specified.
   (g) Information needed to apply protective treatments to the structure after inspection.
   (h) All data relative to structural fasteners such as identification, discard recommendations, and torque values.
   (i) A list of special tools needed.

3 *Airworthiness Limitations section*
   The Instructions for Continued Airworthiness must contain a section titled Airworthiness Limitations *that is segregated and clearly distinguishable* from the rest of the document. This section must set forth each mandatory replacement time, structural inspection interval, and related structural inspection procedure required for type certification. If the Instructions for Continued Airworthiness consist of multiple documents, the section required by this paragraph must be included in the principal manual.

5.7 Repairs

5.7.1 Introduction

An aircraft is subject to damages which have to be repaired. A 'repair' means elimination of damage and/or restoration to an airworthy condition of a product, part, or appliance.

Elimination of damage by replacement of parts or appliances without the necessity for design activity does not require authority approval (under subpart M of JAR 21/EASA Part 21).

Because a repair normally involves a change of configuration, it is considered as a change to the type design and consequently must be approved.

There are types of damage that can be anticipated so that the repair of this damage can be studied in advance. Manual and other instructions for continued airworthiness (such as Manufacturer Structural Repair Manual) are provided by the type certificate holder for the aircraft operators, and contain useful information for the development and approval of repairs.

When these data are explicitly identified and approved, they may be used by the operators without further approval to cope with anticipated in-service problems arising from normal usage provided that they are used strictly for the purpose for which they have been developed.

Of course, damage that cannot be anticipated has to be approved on a case-by-case basis.

5.7.2 Subpart M of JAR 21/EASA Part 21

Subpart M (Repairs) of JAR 21/EASA Part 21 prescribes procedural requirements for the approval of repairs made on products, parts, and appliances. A summary of these requirements is given below.

5.7.2.1 Classification of repairs

A repair can be 'major' or 'minor' and the classification must be made in accordance with the criteria applicable for a change in type design (see 'Changes in type design' section in this chapter).

According to, in particular, EASA GM 21A.435, a repair is classified as 'major' if it needs extensive static, fatigue, and damage tolerance strength justification and/or testing, or if it needs unusual methods, techniques, or practices.

Furthermore, repairs requiring reassessment and re-evaluation of the original certification substantiation data to ensure that the aircraft still complies with all the relevant requirements are considered as 'major' repairs.

Repairs whose effects are considered to be minor and require minimal or no assessment of the original certification substantiation data to ensure that the aircraft still complies with all the relevant requirements are considered as 'minor'.

5.7.2.2 Demonstration of capability

An applicant for major repair design approval shall demonstrate its capability by holding a Design Organization Approval issued by the Agency.

By way of derogation, as an alternative procedure to demonstrate its capability, an applicant may seek the Agency's agreement for the use of procedures compatible with the requirements of Subpart M.

5.7.2.3 Repair design

The applicant shall:

1 Show compliance with the type certification basis and environmental protection requirements incorporated in the type certificate or Supplemental type certificate, as applicable, plus any amendments to those requirements or special conditions the Agency find necessary to establish a level of safety equal to that established by the type certification basis.
2 Submit all necessary substantiation data, when requested by the Agency.
3 Declare compliance with the requirement above.
4 Where the applicant is not the TC or STC holder, compliance with the TC basis may be done through the use of its own resources or through an arrangement with the TC or STC holder as applicable.

5.7.2.4 Issue of a repair design approval

When it has been declared and shown that the repair design meets the applicable conditions, it shall be approved:

1 By the Agency, or
2 By an appropriately approved organization that is also the TC or STC holder under a procedure agreed with the Agency, or
3 For minor repairs only, by an appropriately approved design organization, under a procedure agreed with the Agency.

5.7.2.5 Repair embodiment

The embodiment of a repair shall be made by an appropriately approved maintenance organization or by a production organization appropriately approved in accordance with the privileges of Subpart G of Part 21.[48]

5.7.2.6 Instructions for Continued Airworthiness

A holder of the repair approval shall furnish at least one complete set of those changes to the instructions for continued airworthiness which result from the design of repair, comprising descriptive data and accomplishment instructions prepared in accordance with the applicable requirements, to each operator of aircraft incorporating the repair.

Repair manuals are provided by the type certificate holder for the aircraft operators, and contain useful information for the development and approval of repairs.

When these data are explicitly identified and approved, they may be used by the operators without further approval to cope with anticipated in-service problems arising from normal usage provided that they are used strictly for the purpose for which they have been developed.

Of course, damage that cannot be anticipated has to be approved case by case.

Figures 5.5 and 5.6, extracted from EASA AMC&GM for Part 21, although appearing complicated at first sight, give a clear idea of the repair process approval for products where the state of design is an EU Member State and when the state of design is not a Member State respectively.

5.7.2.7 General remarks

We may question why a major repair needs an instruction for continued airworthiness to be added to the instruction of the relevant product.

The answer is that major repairs can change the existing maintenance practices or inspection intervals. For example, major structural repairs may need more inspection. Repairs on static engine components could even influence the life limits of critical rotating parts. The person holding the inspection authorization or authority to approve the return to service is responsible for determining if any changes are necessary to the existing product instructions for continued airworthiness resulting from the major repair.

5.7.3 FAA repairs

FAR 21 does not have a subpart dedicated to repairs.

FAR 1 defines a *major alteration* as an alteration not listed in the aircraft, aircraft engine, or propeller specifications that might appreciably affect weight, balance, structural strength, performance, power plant operation, flight characteristics, or other qualities affecting airworthiness, or that is not done according to accepted practices or cannot be done by elementary operations.

FAR 1 defines a *major repair* as a repair that, if improperly done, might substantially affect weight, balance, structural strength, performance, power plant operation, flight characteristics, or other qualities affecting airworthiness, or that it is not done according to accepted practices or cannot be done through elementary operations.

A *minor repair* is a repair other than a major repair.

FAR 43 (Maintenance, Preventive Maintenance, Rebuilding, and Alteration) prescribes rules governing the maintenance, preventive maintenance, rebuilding, and alteration of any aircraft having a US airworthiness certificate, foreign-registered civil aircraft used in common

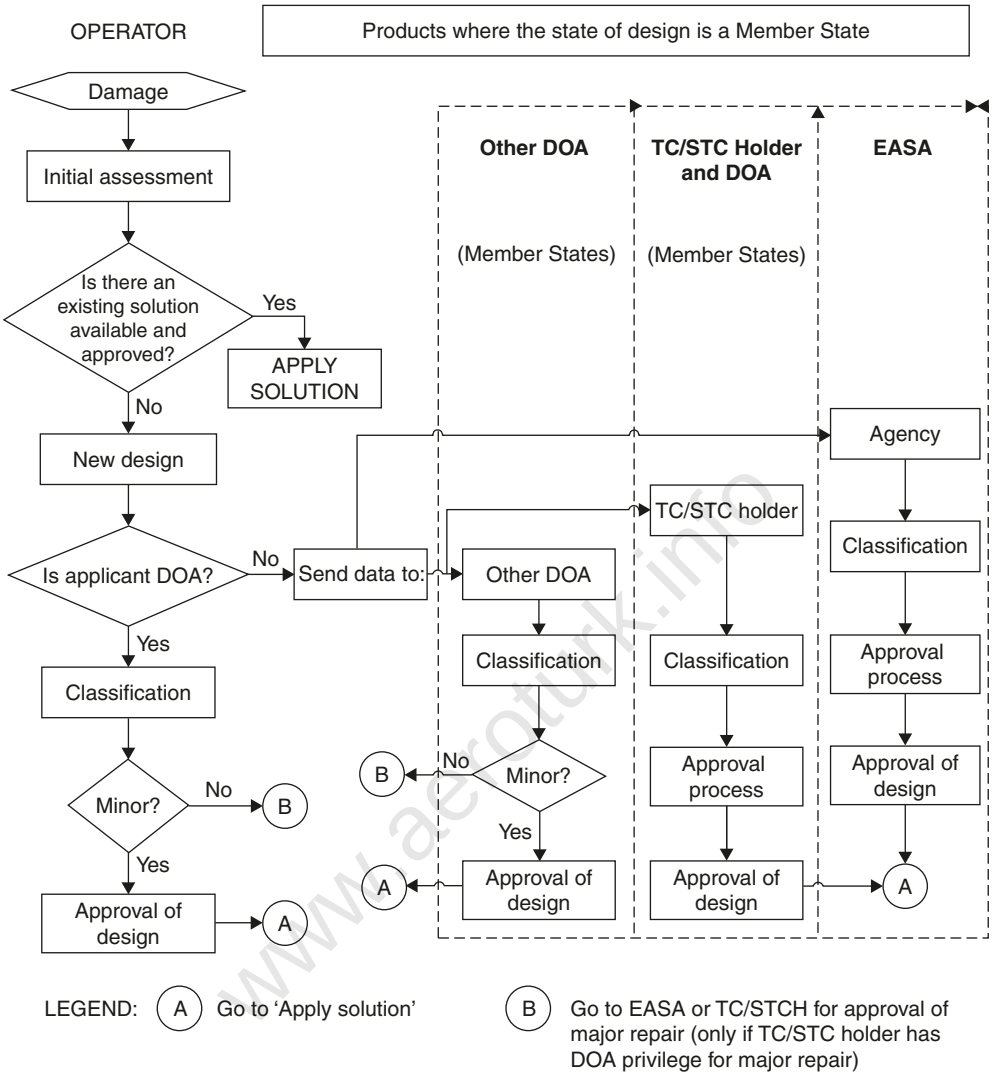


Figure 5.5 *Repair process approval where the state of design is an EU Member State*

carriage or carriage of mail under the provisions of FAR 121 or 135, and airframe, aircraft engines, propellers, appliances, and component parts of such aircraft.

We will report an excerpt of Appendix A to FAR 43: major alterations, major repairs, and preventive maintenance.

5.7.3.1 Major repairs

1 **Airframe major repairs.** Repairs to the following parts of an airframe and repairs of the following types, involving the strengthening, reinforcing, splicing, and manufacturing of primary structural members or their replacement, when replacement is by fabrication such as

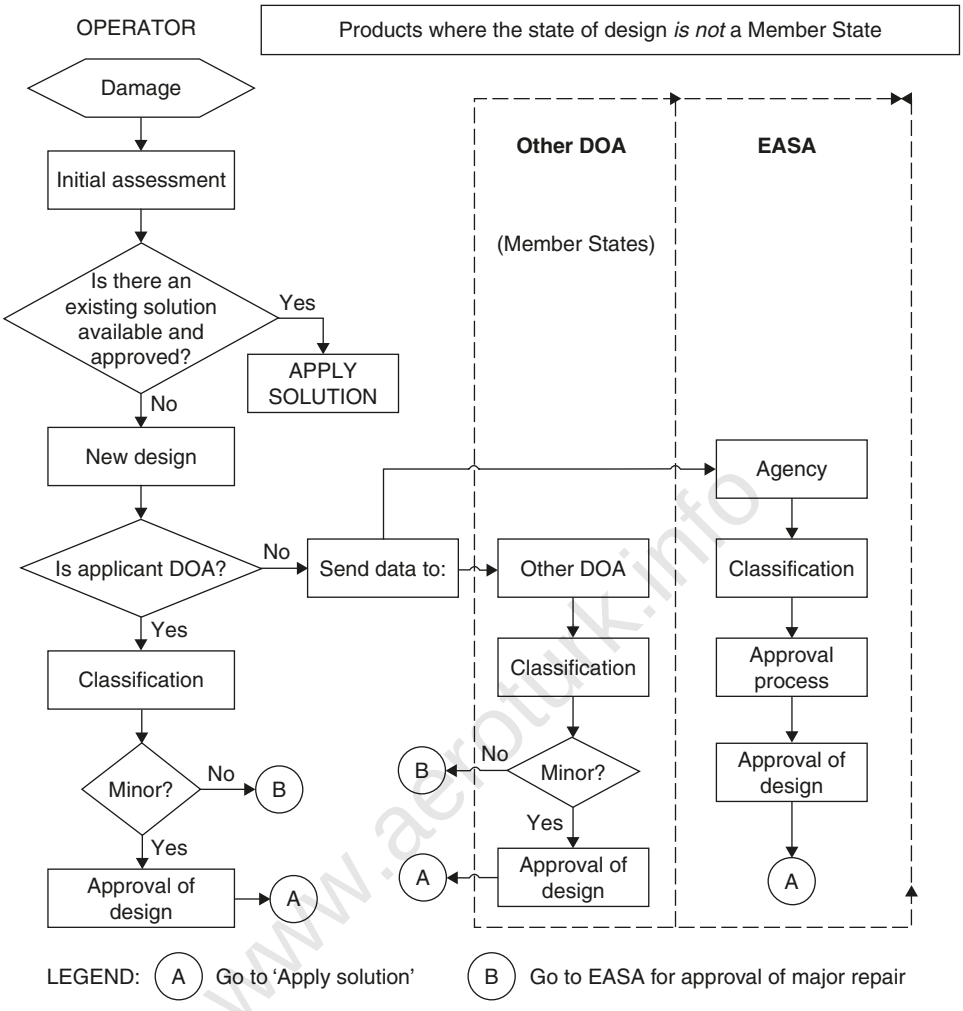


Figure 5.6 *Repair process approval where the state of design is not an EU Member State*

riveting or welding, are airframe major repairs. (i) Box beams. (ii) Monocoque or semi-monocoque wings or control surfaces. (iii) Wing stringers or chord members. (iv) Spars. (v) Spar flanges. (vi) Members of truss-type beams. (vii) Thin sheet webs of beams. (viii) Keel and chine members of boat hulls or floats. (ix) Corrugated sheet compression members which act as flange material of wings or tail surfaces. (x) Wing main ribs and compression members. (xi) Wing or tail surface brace struts. (xii) Engine mounts. (xiii) Fuselage longerons. (xiv) Members of the side truss, horizontal truss, or bulkheads. (xv) Main seat support braces and brackets. (xvi) Landing gear brace struts. (xvii) Axles. (xviii) Wheels. (xix) Skis and ski pedestals. (xx) Parts of the control system such as control columns, pedals, shafts, brackets, or horns. (xxi) Repairs involving the substitution of material. (xxii) The repair of damaged areas in metal or plywood stressed covering exceeding six inches in any direction. (xxiii) The repair of portions of skin sheets by making additional seams. (xxiv) The splicing of skin sheets.

(xxv) The repair of three or more adjacent wing or control surface ribs or the leading edge of wings and control surfaces, between such adjacent ribs. (xxvi) Repair of fabric covering involving an area greater than that required to repair two adjacent ribs. (xxvii) Replacement of fabric on fabric covered parts such as wings, fuselages, stabilizers, and control surfaces. (xxviii) Repairing, including rebottoming, of removable or integral fuel tanks and oil tanks.

2 **Power plant major repairs.** Repairs of the following parts of an engine and repairs of the following types are power plant major repairs. (i) Separation or disassembly of a crankcase or crankshaft of a reciprocating engine equipped with an integral supercharger. (ii) Separation or disassembly of a crankcase or crankshaft of a reciprocating engine equipped with other than spur-type propeller reduction gearing. (iii) Special repairs to structural engine parts by welding, plating, metalizing, or other methods.

3 **Propeller major repairs.** Repairs of the following types to a propeller are propeller major repairs. (i) Any repairs to, or straightening of, steel blades. (ii) Repairing or machining of steel hubs. (iii) Shortening of blades. (iv) Retipping of wood propellers. (v) Replacement of outer laminations on fixed pitch wood propellers. (vi) Repairing elongated bolt holes in the hub of fixed pitch wood propellers. (vii) Inlay work on wood blades. (viii) Repairs to composition blades. (ix) Replacement of tip fabric. (x) Replacement of plastic covering. (xi) Repair of propeller governors. (xii) Overhaul of controllable pitch propellers. (xiii) Repairs to deep dents, cuts, scars, nicks, etc., and straightening of aluminum blades. (xiv) The repair or replacement of internal elements of blades.

4 **Appliance major repairs.** Repairs of the following types to appliances are appliance major repairs. (i) Calibration and repair of instruments. (ii) Calibration of radio equipment. (iii) Rewinding the field coil of an electrical accessory. (iv) Complete disassembly of complex hydraulic power valves. (v) Overhaul of pressure type carburetors, and pressure type fuel, oil and hydraulic pumps.

FAR 145 (Repair Stations) prescribes the requirements for issuing repair station certificates and associated ratings to facilities for the maintenance and alteration of airframes, power plants, propellers, or appliances, and prescribes the general operating rules for the holders of those certificates and ratings.

We can conclude that the FAA prescribes the rules for *repairs* in the same context as the rules for *alteration* and, more generally, in the frame of *maintenance*, an issue that is discussed in Chapter 9 of this book.

Notes

1 See Chapter 8.
2 Products are aircraft, engines, and propellers.
3 The text is that of EASA Part 21. FAR 21 has slightly different wording, but with the same meaning. JAR 21 is similar, without reference to the environmental protection requirements.
4 Continued airworthiness. This can be defined as the airworthiness of products during their operational life. Hence the relevant information gives a description of the product and its characteristics, servicing information and maintenance instructions, etc.

5 The noise certification is part of the type certificate.
6 See Chapter 6, 'Construction of prototypes and test articles'.
7 We do not say the 'manufacturer's perspective' because the manufacturer and the designer could be different 'entities' (in a legal sense).
8 That is, adequate to the design which is the object of the certification.
9 JAR 21 also contains a Subpart JB, which is a DOA for design organizations designing parts and appliances. The authority accepts such applications if it is agreed that the approval is appropriate for the purpose of assisting applicants for or holders of type certificates or Supplemental type certificates in showing compliance with the applicable requirements. The JB DOA is issued with reference to the above-mentioned applicants or holders. The JB DOA does not have privileges.
10 Detailed explanations are contained in AMC&GM for Part 21.
11 This must be agreed upon with the authority.
12 That is, without direct intervention by the authority.
13 They must contain a statement making reference to the DOA privilege.
14 See 'The Supplemental type certificate (STC)' section in this chapter.
15 We will use the term 'authority' in a general sense; of course, the Agency is intended as an authority.
16 In the United States this problem was overcome a long time ago through different forms of organization. Thousands of aircraft per year were built before the crisis of general aviation, so that the FAA could not cope using 'traditional' surveillance.
17 This is something like the safety assessment of control.
18 Audit of product: checks performed on single tests or single test articles in order to ensure the correct realization of the actions required to demonstrate compliance with the applicable requirements.
19 Audit of system: checks performed on the applicant's organization, personnel, and procedures in order to ensure compliance with the applicable requirements.
20 Noise, fuel venting, and exhaust emissions are in EASA Part 21 only.
21 Normally, with reference to an increase in number. Nevertheless, in some cases, a **reduction** in number has been accepted in the same TC (e.g. a three-engined aircraft converted to a twin-engined aircraft).
22 Examples are a reciprocating engine replaced by a jet engine and a mechanically driven rotor replaced by a jet rotor.
23 The applicable airworthiness code as established in paragraphs 17 and 101 of JAR/FAR 21 and EASA Part 21A as appropriate, special conditions, equivalent level of safety findings, and exemptions applicable to the product to be certificated.
24 One example among many others: Airbus aircraft of series A340-200, 300, 500, and 600.
25 The earlier amendment may not precede the corresponding regulation incorporated for reference in the type certificate.
26 **Substantial change**: a design change of an extent sufficient to require a substantially complete investigation of compliance with the applicable requirements, and consequently a new TC in accordance with JAR/FAR 21.19/EASA Part 21A.19.
27 A simple example: if an altimeter is limited to 30 000 ft, it cannot be installed in an aircraft with a maximum operating altitude of 50 000 ft.
28 See Chapter 7.
29 See Chapter 7, 'Production without Production Organization Approval'.
30 JAR 21 is more generic on this point.
31 Information not required for aircraft operation.

32 An EASA Part 145 approved organization can only fabricate parts for its own use in accordance with approved design data (paragraph 145A.42(c)). If those data come from the TC holder, paragraph 21A.804(a)(3) would not be applicable and those parts will not need EPA marking. If the data come from an STC holder, minor change approval holder, or repair approval order, the parts will have to be marked as prescribed in the applicable data, which should include an EPA marking.
33 JAR-OPS 2 (General Aviation) has not been issued yet. At the time of writing, no EASA operational standard has yet been published.
34 A permit to fly can be issued under EASA Part 21.185.
35 See Chapter 4, 'JARs and FARs'.
36 For example, the FAA Bilateral Aviation Safety Agreements (BASAs) and inherent Implementation Procedures of Airworthiness (IPAs), which are to replace the old Bilateral Airworthiness Agreements (BAAs).
37 FAA AC 21-23A.
38 See note 37.
39 See Chapter 6, 'Type certification basis'.
40 Unless the bilateral agreement states otherwise, the date of application to the exporting authority could be accepted.
41 This is a very strict requirement because these standards could be amended at the last moment.
42 'Exemption' means formal acceptance by the authority of non-compliance to a specific requirement.
43 Equivalent safety finding: any airworthiness provisions not complied with, compensated for by factors that provide an equivalent level of safety.
44 See Chapter 6, 'Certification review items'.
45 See the 'Design organization' section in this chapter.
46 See Chapter 7, 'The production organization'.
47 The other aircraft standards have the same number for the corresponding paragraph. JAR/CS-23 has equivalent requirements.
48 See Chapter 7, 'The production organization'.

Chapter 6

The Type Certification Process

6.1 JAA joint certifications and national certifications

This section, written at the end of 2000, mainly aims to provide an historical perspective because the EASA has since introduced new procedures.

It is, however, interesting to see how the JAA have operated over many years, and this is presented in 6.1.1 and 6.1.2.

In the previous chapters we described how the JAA perform joint type certifications in order to simplify the exchange of aeronautical products among the Member States. Not being a legal authority, the JAA cannot issue a type certificate, but just a 'recommendation' at the end of the process, allowing each Member State to issue a TC without further verification. Hence, the national authorities can issue certificates of airworthiness on this basis for single products, after the assessment of compliance with operational rules in force in the relevant states.

Joint certifications are essentially performed according to two procedures.

6.1.1 JAA multinational procedure

This is for type certification of products of the 'higher' range. Without listing them all, we can mention large aircraft, commuters, turbine engines, etc.[1] Teams of specialists (in structures, flight tests, and systems, for example) from different national authorities are put together for the certification of such products. In summary, the national authorities propose some specialists for each certification; these specialists are evaluated on the basis of their experience (a curriculum vitae is required), and then the JAA assess and approve the composition of the team. A Program Manager, with the main task of co-ordinating the team's work, is appointed in similar way.

6.1.2 JAA local procedure

This is for type certification of products of the 'lower' range, like very light aeroplanes, sailplanes and powered sailplanes, some JAR 23 single-engine aeroplanes, etc.[2] Type certification of this kind of product involves, in general, a smaller team and less complex management. Therefore, the certification process is assigned to a national authority (possibly the applicant's national authority), which must be acknowledged by the JAA as the **Primary Certification Authority (PCA)**. This happens after an assessment of the national authority's suitability, performed by a JAA commission. The PCA's job is monitored by the JAA Certification Division, which issues the usual recommendation for national type certifications, at the end of the type certification process.

It is nevertheless worth considering that an applicant is not bound to perform a joint certification. In consideration of the legal status of the JAA, national certification is still possible. In this case, of course, the validity of the type certificate is limited to the state of the national authority, so that the TC must be validated by each country importing the product (the same procedure existing before the joint certifications).

There are several examples of applicants who have chosen national certifications in the last few years. At first sight this could appear to be a lack of awareness, but it is in reality a technical and economic choice. JAA certifications, especially if multinational, are necessarily more complex than national certifications, and take more time. Furthermore, they are unbalanced from the authorities' tariffs point of view because there is no 'joint' charging system. This means, for example, that a certification team that is predominantly English is much more expensive than a team that is predominantly French. All that considered, if an enterprise has no immediate interest in the European market, because it is looking at the national and (possibly) the US market (an FAA validation is due for both joint and national certifications), the choice of a national certification can be judged to be more convenient.

We are, however, in a period of transition towards the establishment of the EASA. It is certain that new rules will be enacted, and national certifications could also be abolished.[3]

6.2 The main phases and items of the JAA/EASA type certification process

Although the basic philosophical concepts of type certification procedures are generally the same for the JAA, EASA, and FAA, there are some peculiarities in the type certification process that necessitate a separate description of the FAA process.

We will deal with this subject also keeping in mind that the same basic concepts are applicable for changes to TC, Supplemental type certificate approvals, and Joint/European Technical Standard Order authorizations.

The following information is based on JAA certification/validation processes and the already quoted EASA Internal Working Procedure 'Type Certification (TCP)', which is the applicable document in Europe at present.

6.2.1 Application

The applicant sends in an application for a type certificate to the competent authority complying with all the necessary formalities. The application must be accompanied by the documents listed in paragraphs 21.15 of JAR 21 and 21A.15 of EASA Part 21.

Applications for an EASA type certificate shall be sent to the EASA Manager of Applications Certifications (MAC). If the application is accepted, the MAC will inform the applicant about the certification team that is going to perform the technical investigation. This is because the team could be either an EASA team or a national authority team. Actually, the MAC has to check with the responsible EASA Certification Manager (CM) if the application could be further processed internally or if the technical investigation should be allocated to an external party.

For a JAA/EASA type certification, if the applicant does not hold Design Organization Approval, he or she has to apply for the same, unless the product is one for which the DOA is optional.[4]

6.2.2 Allocation of technical investigation tasks

In cases where the technical investigation will be performed internally, the CM will establish an appropriate investigation team using EASA staff and/or NAA[5] staff under appropriate contractual arrangements.

In cases where the technical investigation is allocated to an external party that will handle the technical investigation on behalf of the EASA, the selected external party may only be, for the time being, an NAA that is appropriately accredited and has an appropriate contractual arrangement with the EASA.

For EU product certification, in cases where the technical investigation is performed by an external party, the authority involved could be either the NAA of the state of design or another EU Member State NAA, on the basis of availability and necessary competence.

For non-EU products, where the technical investigation is performed by an external party, the CM will check which of the NAAs fulfill the requirements for the work to be done and select an NAA from those willing to carry out the technical investigation.

6.2.3 Familiarization with the design

The EASA, having accepted the application, if necessary will attend an initial briefing organized by the applicant for a general familiarization with the project.

6.2.4 Certification team members' selection

The investigation process for type certification of a product is performed by a team of specialists led by a **Project Certification Manager (PCM)**, who is accountable with his team to the responsible EASA CM.

Following the general familiarization, the EASA CM will, depending on the category of the product and complexity of the project, appoint the above-mentioned team led by a PCM. The certification team may consist of EASA staff and/or staff from NAAs with which the EASA has appropriate contractual arrangements.

Where the extent of the investigation does not justify the need for a team, one person may perform the investigation (for example, for a propeller certification).

The certification of a large transport aircraft may need more specialists covering different disciplines: flight test pilot, flight test engineer, performance, structures, power plant installation, fuel systems, hydro-mechanical systems, electrical systems, avionic systems, transmissions, electronic controls and software, cabin safety, environmental control systems and icing, noise and environmental protection.

The certification of a JAR/CS-VLA aeroplane or a sailplane normally requires a reduced and less complex team.

Once the types of specialist have been decided, the physical number of specialists can be variable because, having estimated the work to accomplish, there may be, for example, the necessity of two hydraulic system specialists, and just one for both electrical and avionic systems.

Trainees, at no cost to the applicant, may be assigned to the team.

In cases where the technical investigation is allocated to an external party, the certification team will be appointed by this party, taking into account the principles of the EASA TCP.

For the certification of derivatives or major changes or major repairs, the certification team involved in the initial certification of the concerned product and its continuing airworthiness should be used as much as possible, without prejudice to adjust team size to the nature and complexity of the project.

The applicant sends the authority the names of its own specialists and its PCM.

6.2.5 Phases of type certification

The EASA type certification process can generally be divided into the following phases:

- Phase I – Technical familiarization and establishment of the type certification basis
- Phase II – Agreement of the certification program

- Phase III – Compliance determinations
- Phase IV – Final report and issue of a type certificate.

6.2.5.1 Phase I – Technical familiarization and establishment of the type certification basis

The objective of this phase is to provide technical information about the project to the team specialists to enable the definition of and agreement on the initial EASA type certification basis.

The type certification basis is generally given by the applicable JAR/CS that is effective on the date of application, plus special conditions[6] if deemed necessary. These special conditions are not necessarily all issued at the beginning of the certification process, because they could also be the result of better design knowledge during the certification process. In Chapter 5 we described how the establishment of the certification basis could become somewhat complex in cases like changes to TCs and TC validations.

6.2.5.2 Phase II – Agreement of the certification program

The objective of this phase is the definition of and agreement on the proposed means of compliance with each paragraph of the certification basis and the identification of the team involvement.

When defining the certification team involvement, full use should be made of applicant Design Organization Approval (DOA) privileges,[7] in particular for the agreement on the compliance document to be accepted without further verification.

To enter a little more specifically into this matter we define some technicalities associated with this phase:

1 **Terms of reference (ToRs).** A list of all paragraphs and subparagraphs of the relevant certification basis is normally produced by the authority's PCM, with the identification of the specialists responsible for compliance with the same requirements. There could be different specialists who are responsible for the same paragraph (e.g. a specialist on systems, one on structures, and one on the flight manual). Each has to do their own part of the job, and co-ordination among them will be provided in order to ensure that the whole paragraph be complied with.
2 **Means of compliance (MoC) definition.** The MoCs are the categorization of the means used to demonstrate compliance with the requirements. A requirement can be complied with, for example, by a flight test, a static test, and/or a substantiation report. These MoCs are defined in the JAA procedures, and some examples are as follows:
MC2: Calculation/analysis. Reports for the evaluation of loads, strength, performance, flying qualities, or other characteristics.
MC3: Safety assessment. Documents describing safety analysis philosophy and methods, safety evaluation plans (software), system safety assessment, zonal safety assessment, and others.

MC6: Flight tests. Reports of flight tests written in the 'Flight Test Program' and performed by a flight test crew.

MC7: Inspections. Conformity inspections to verify that materials, parts, processes, and fabrication procedures conform to the type design. Aircraft inspection to verify the compliance with the requirement, which cannot be determined adequately from evaluation of technical data only.

The MoC definition is a very important phase of the certification process because it lays the foundations of the job to be carried out. For this reason, the authority's team and the applicant must agree with it and in sufficient detail to ensure good mutual understanding.

3 **The compliance checklist (CCL).** A record of compliance with every applicable certification requirement must be produced by the applicant. This record, based on the above-mentioned MoCs, must refer to the documents necessary to demonstrate compliance with the applicable requirements and will take the form of **compliance record sheets (CRS)**. As the demonstration of compliance progresses, when a single paragraph is 'closed' the compliance record sheets will be entered in the **compliance checklist**, containing all references able to single out the compliance demonstrations that have been carried out (identification of the relevant report, its title and edition, page number, reference to other documents).

The CCL is a key document in type certification; it actually allows tracing back to the compliance documents, even from many years in the past. It is therefore fundamental in the post-TC phase for approval of changes, in cases that are contested due to incidents/accidents or for other reasons.

6.2.5.3 Phase III – Demonstration of compliance

The objective of this phase is the demonstration of compliance with the certification basis and the acceptance of the compliance demonstrations.

Having established and agreed the MoCs, the applicant must provide the authority with tests and calculations demonstrating compliance with the certification basis, normally by means of documents and reports. The reports must make precise references to the inherent requirements, not only quoting the paragraph, but also which is the MoC concerned, in cases where different MoCs have to be complied with.

In the compliance checklist, each document mentioned must contain a statement by the applicant declaring (total or partial) compliance with the applicable requirements.

We will now describe some implications of this crucial phase.

1 **Tests on prototypes and test articles.** We have previously mentioned that demonstrations of compliance often require tests to be carried out on the prototype(s), but also on single parts of the aircraft.[8]

Something apparently obvious, but that should be clearly kept in mind, is that the prototype or single part to be tested must be *representative* of the type design. To this end, it

is required that for any certification test the applicant submits in advance a statement of conformity to the type design or, in the presence of deviations, a statement that such deviations are not influential on the test to be performed.

To give a clear example, the assessment of the stall characteristics of an aeroplane with a cabin configuration with deviation from the type design, or with an inefficient system that has nothing to do with the flight controls, will not be influenced by these anomalies. It should be different for an unapplied change referring to flaps or control surfaces.

Therefore, it is of paramount importance to establish the correct configuration control of prototypes and test articles during the certification process. It is also necessary to check what would be the effect of a type design change on tests already performed and on documentation already produced. An integration of the above-mentioned tests and documentation could be necessary or, in the worst case, a need for them to be rewritten.

2 **The certification review item (CRI).** The certification review item is a document recording each step leading to the closure of a subject in particular cases like the following:
   (a) To record the process followed to define the content of the type certification basis (CRI A-1)
   (b) To develop and administer special conditions
   (c) To administer new policies, e.g. unusual means of compliance/interpretations
   (d) To administer exemptions[9] or equivalent safety findings[10]
   (e) To deal with subjects involving controversial discussions between the team and the applicant.

   The authority's PCM, in the 'conclusion' statement of his or her report, will document the decision on how to resolve an issue when this has been reached (sometimes with the concourse of the authority at higher level).

3 **The action item (AI).** The purpose of an action item is to administer the progress of an item not requiring a CRI, but requiring special attention of the applicant or the team. An AI may be opened in the following cases:
   (a) To review the suitability of compliance demonstration of selected subjects
   (b) To follow up a 'closed' CRI, when necessary[11]
   (c) To administer matters interfacing certification and flight operations
   (d) Any other case, as deemed necessary.

   The AI will define the characteristics to be checked, the relevant requirements, the interpretations to be used, the actions, the responsibilities, and the basis for conclusions, as necessary.

6.2.5.4 Phase IV – Final report and issue of a type certificate

The objective of this phase is the establishment of a project final report recording details of the type investigation and, based on approval of the final report by the responsible CM, the issue of the EASA type certificate.

1 **Statement of compliance.** On completion of the certification program, the applicant shall provide a declaration of compliance that the type design of the product to be type certificated complies with the type certification basis.

The team members issue a statement of satisfaction to the PCM with the applicant's compliance declaration of the disciplines involved.
On acceptance of all necessary statements of satisfaction by the EASA certification team, the PCM shall issue a compliance statement to the responsible EASA CM confirming that the type design of the product complies with the type certification basis.

2 **Final certification report.** The PCM, in conjunction with the team, shall produce and present to the responsible EASA CM a report which will record the type design on which the type investigation process is based, the significant subjects investigated, the details of that investigation, the CRIs that have been discussed, the process followed, and the conclusions regarding compliance with the type certification basis.[12]
If there are some open actions, the so called **post-TC items**, a list of the same has to be issued, making sure that this is not a mere excuse to postpone some demonstrations of compliance which are necessary for the TC issue.

3 **Type certificate.** After approval of the final report, the responsible EASA CM shall take the necessary steps inside EASA for the issue of the type certificate.
A **type certificate data sheet** (TCDS)[13] will form part of the EASA type certificate.

We will now describe this final phase in more detail.

Normally, a final **type certificate board meeting**[14] is held:

1 **To ratify:**
   (a) Closure of action items
   (b) Completion of certification review items
   (c) Approval of compliance record sheets/compliance checklist
   (d) Authority's flight tests results.
2 **To approve:**
   (a) Aircraft flight manual and airworthiness limitation section
   (b) Certification maintenance requirements
   (c) Type design definition
   (d) Post-TC items
   (e) Draft of type certificate data sheet (TCDS).
3 **To endorse:** the applicant's statement of compliance and the team's statement of compliance.

6.2.6 The authority's involvement

In Chapter 5 we mentioned that the authority's intervention can be modulated on the basis of the DOA privileges, if the applicant has achieved Design Organization Approval (DOA).

Of course, the authority has to be particularly involved in those phases of the certification process we can define as 'preliminary phases': familiarization, certification basis definition, compliance record sheet approval. It must also deal with the administration of certification

review items. Nevertheless, the authority has the choice of arranging with the applicant which reports should be checked and which tests should be witnessed.

In the case of flight tests, the authority usually employs its own flight personnel and carries out a flight test program based upon the applicant's flight test reports.

It goes without saying that it is impossible to establish definite rules about the authority's intervention, because this is influenced by various factors such as the design complexity and, above all, the design organization experience demonstrated in previous type certifications.

If the applicant does not have DOA because the object of the application does not require a DOA, the DOA privileges being absent, the authority is not allowed to delegate anything and, in principle, it is involved in each report and each test.

Also, in this case, the nature of the design and the applicant's experience are very important. This means that it is up to the authority team's professionalism to decide whether their checks are sufficient or if they should 'revise all the calculations'.

6.2.7 Post-TC activities

After the TC issue, the same certification team is usually involved in the following activities:

1 Changes in the type design made by the type certificate holder (TCH)
2 Changes in the type design made by someone other than the TCH
3 Continued airworthiness actions, including approval of service bulletins[15] and issuance of Airworthiness Directives[16]
4 Approval of repairs.

6.3 The FAA type certification process

6.3.1 Introduction

In dealing with the applicant design organization, we have found that FAR 21 does not mention a formal approval.

In order to understand the FAA type certification, we encounter a fundamental peculiarity of the FAA's organization: **delegation**.

The Federal Aviation Act of 1958 was the original statute that allowed the FAA to delegate activities to authorized private individuals employed by aircraft manufacturers. Although paid by the manufacturers, these **designees** act as surrogate for the FAA in examining aircraft design, production quality, and airworthiness. The FAA is responsible for overseeing the designees' activities and determining whether the designs meet the FAA's requirements for safety.

It is important to note that, according to the Code of Federal Regulations, where the regulations make reference to the 'Administrator', this also includes any person authorized by the Administrator to exercise or perform that specific power, duty, or function.

Private individuals have been examining, testing, and inspecting aircraft as part of the FAA's regulatory system for aviation safety since at least 1927. The FAA's Act of 1958 gives the current legislative authority to appoint a wide variety of designees to issue certificates.

The functional roles and responsibilities for designees are set forth in FAA Orders 8110.37 for **Designated Engineering Representatives (DER)** and 8100.8 for **Designated Manufacturing Inspection Representatives (DMIR), Designated Airworthiness Representatives (DAR)**, and **Organizational Designated Airworthiness Representatives (ODAR)**.

The FAA relies on both individual and organizational delegations in the certification process. Delegation is used to the maximum practicable extent with appropriate oversight safeguards as defined in the FAA's delegation management process policies.

The FAA and the applicant agree to manage all designee activity within the regulations and policy regarding designee appointment, procedures, and oversight. It is essential that the FAA and the public have confidence in the integrity of the designee system and that it functions properly. Both the FAA and applicant agree to foster an environment where open communication between the designees and applicant's management and between the designees and their FAA counterparts is standard practice. That environment should encourage the designees, within the scope of their delegation, to openly communicate certification items with the FAA which is necessary to maintain confidence in the designee system. The applicant agrees to create a working environment where designees can make judgments on compliance and conformity findings free from undue pressure and with the support and knowledge of the FAA. It should be clearly understood by FAA personnel and designees that their objective is to find compliance with the regulations and not to dictate design.

6.3.2 Designated Engineering Representatives (DERs)

The DER may approve engineering technical data within the limits of his or her authority and, when authorized by the ACO,[17] may witness FAA compliance tests and perform compliance inspections. DERs will follow the procedures of FAA Order 8110.4, 'Type Certification Process'. The specific role, authorized area, and responsibility of the DER will be established by agreement between the ACO and the DER.

6.3.2.1 Company DERs

An individual may be appointed to act as company DER for their employer and may only approve, or recommend approval to the FAA, technical data for the company. Company DERs may perform their FAA functions at different administrative levels, as agreed upon

between the FAA and the company. In some cases, a DER may personally evaluate and approve technical data. In other cases, a DER may ensure, through the company management system, the proper evaluation of technical data by other persons; then the DER will approve data by certifying that the data complies with the applicable regulations.

6.3.2.2 Consultant DER

An individual may be appointed to act as an independent (self-employed) consultant DER to approve, or recommend approval of, technical data to the FAA for a client.

6.3.2.3 The DER's designation

DERs are experts acting within well-defined limits of their appointment. The list includes:

1 Structural DERs
2 Power plant DERs
3 System and equipment DERs
4 Radio DERs
5 Engine DERs
6 Propeller DERs
7 Flight analyst DERs
8 Flight test pilot DERs
9 Acustical DERs.

Order 8110.37 specifies the items of competence of each DER.

It is also worth mentioning some 'special' delegations/authorizations, which are appointments not specifically listed in the above-mentioned items of competence. The following are examples of 'special' delegations.

6.3.2.4 Administrative/Management DERs

A qualified person may be appointed as an administrative co-ordinator or as a manager of an applicant's certification program. These designations free the FAA from having to carry out the normal project administration, technical co-ordination, and guidance usually associated with a certification program.

1 **Administrative DER.** Usually a company DER acts as a focal point for FAA co-ordination activity, including organizing technical DER activity, correspondence, scheduled meetings, conformity inspections, and FAA participation in official tests.
2 **Management DER.** Usually a consultant DER, performs FAA certification management duties similar to the FAA program manager. This includes organizing the certification program, directing, overseeing, and managing the task of technical assessment and finding of compliance. The DER assures that all technical data required to show compliance is reviewed and approved by the appropriate DER, except in those areas reserved by the FAA for approval.

6.3.3 Guidance material for the type certification process

Fundamental guidance material for the type certification process is provided by:

1 **Order 8110.4, 'Type Certification'**, which prescribes the responsibilities and procedures for FAA aircraft certification personnel responsible for certification process of civil aircraft, engines, and propellers.
2 **'The FAA and Industry Guide to Product Certification' (CPI Guide)** containing a description of the purpose and vision of the improved certification process. It also includes an overview of the phases of product certification, including the process flow and detailed descriptions of the key players' roles. This guide describes how to plan, manage, and document an effective, efficient product certification process and working relationship between the FAA and an applicant. The guide can be used for type certification, Supplemental type certification, significant amendments to TC or STC, production approval, and other design approvals, including PMA and TSO authorization. The guide is used as a supplement to existing FAA guidance.

A more in-depth understanding of this subject can be gained by consultation of these documents, training, and on-job training; we will describe the main issues of the FAA type certification process on the basis of these two documents.

6.4 The CPI Guide

We begin with a summary of the **CPI Guide**, starting from the description of two documents which are the basis of the type certification process.

6.4.1 Partnership for Safety Plan (PSP)

The PSP is a written 'umbrella' agreement between the FAA and the applicant that defines *generic procedures* for product certification, establishes the general expectation or operating norms, and identifies deliverables.[18] The PSP also defines the general discipline and methodology to be used in planning and administering certification projects, and it includes project schedule milestone development, generic delegation procedures, conformity procedures, communications protocol, an issues resolution process, and the generic operating norms for developing metrics for project evaluation.

Appendix I of the CPI Guide provides instruction for producing the PSP.

6.4.2 Project Specific Certification Plan (PSCP)

The PSCP applies the agreed upon principles of the PSP to a *specific certification project*. Each project will have a PSCP designed to be used as a project management tool, providing

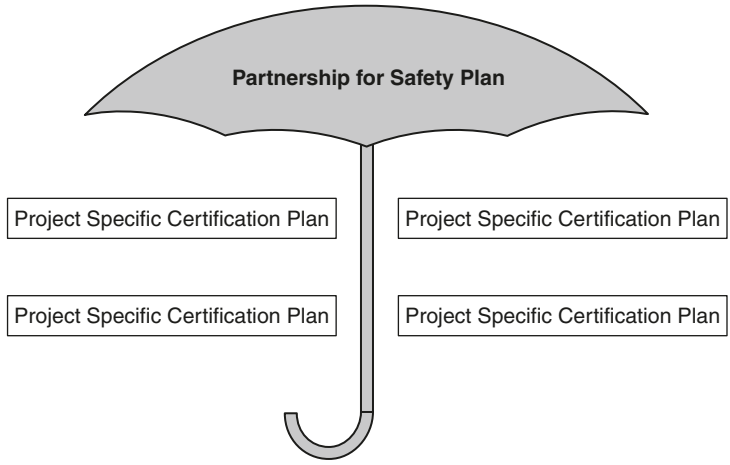


Figure 6.1 *Relationship between the Partnership for Safety Plan (PSP) and Project Specific Certification Plans (PSCPs)*

milestones, performance measures, and information unique to a certification project. The PSCP captures procedures based on the generic methodologies of the PSP and applies them to a specific project.

Figure 6.1 is a diagrammatic representation of the relationship between the PSP and PSCPs.

6.4.3 Phases of type certification

There are five certification phases. They range from early project concept and initiation through post-certification activities. The five phases are illustrated in Figure 6.2.

We will only cover the definitions of the five phases. The CPI Guide contains detailed descriptions of each phase, including the phase's definition, tasks, required information, deliverables, and criteria for success.

Furthermore, each table is followed by a phase evaluation checklist as a tool for project evaluation during the appropriate phase.

The FAA and applicant Project Managers (PMs) should jointly prepare a phase evaluation checklist at the end of each phase of a product certification. These forms should be continuously evaluated by the applicant/FAA team for immediate improvement of the process.

6.4.3.1 Phase I – Conceptual design

This phase is initiated when the applicant begins a design concept for a product that may lead to a viable certification project. The intent is to ensure early, value added, joint involvement

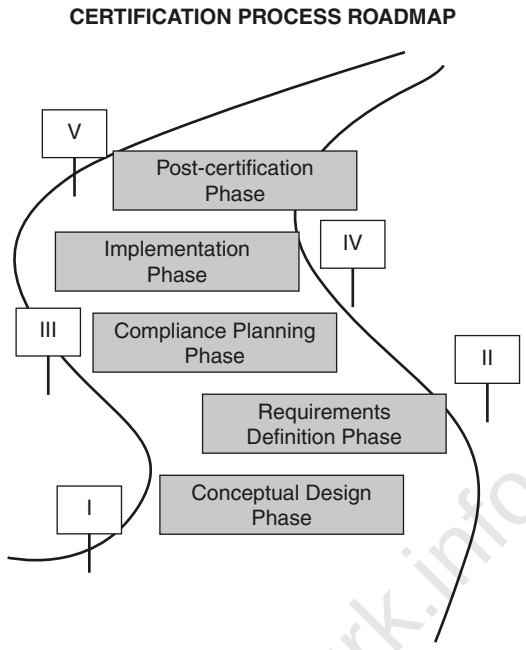


Figure 6.2 *'Roadmap' of the certification process*

with the expectation of covering critical areas and the related regulatory issues, and to begin formulating a preliminary Project Specific Certification Plan (PSCP). This is an opportunity to apply the PSP principles to develop a mutual understanding of potential new projects.

6.4.3.2 Phase II – Requirement definition

Efforts in this phase clarify the product definition and the associated risks, and conclude with a mutual commitment to move forward with product certification. Specific regulatory requirements and methods of compliance or critical issues are formulated. A more formal PSCP is developed.

6.4.3.3 Phase III – Compliance planning

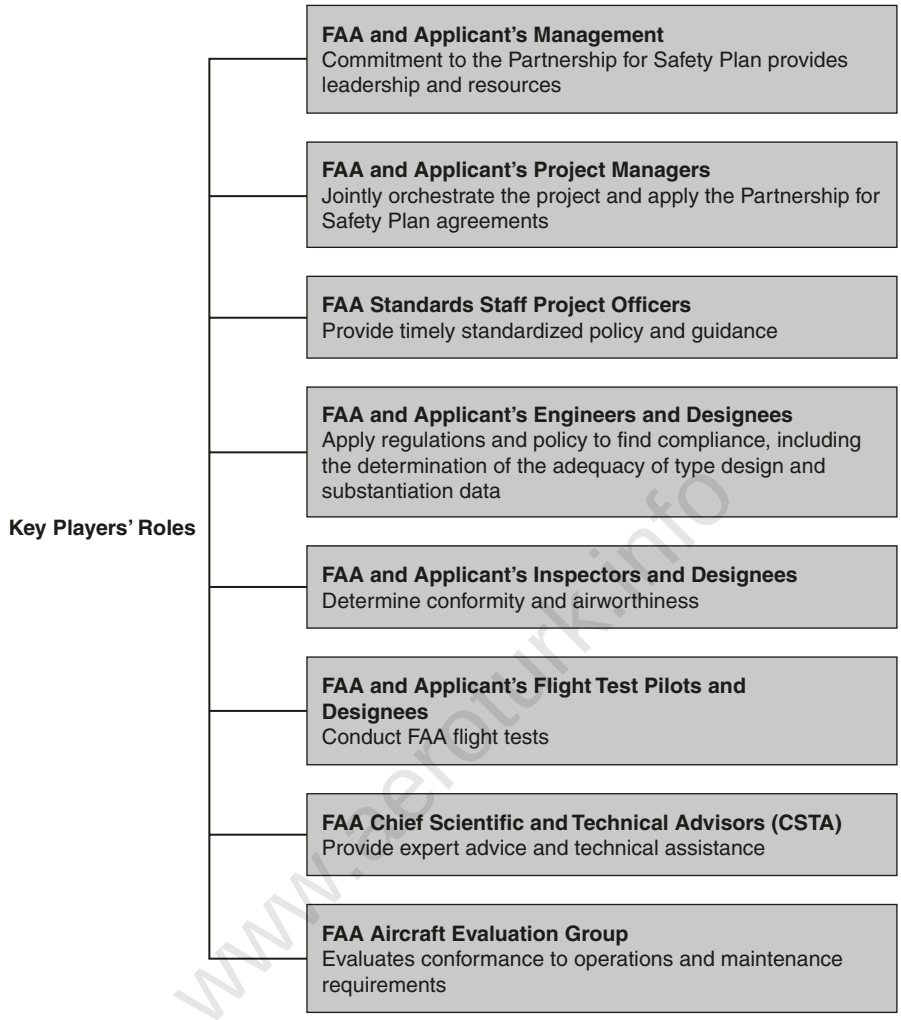
During this phase a PSCP is completed. The plan is a tool to which the responsible parties commit and use to manage the product certification project.

6.4.3.4 Phase IV – Implementation

During this phase the applicant and FAA work closely in managing, refining, and achieving their agreed PSCP to ensure that all agreed upon product-specific certification requirements are met.

6.4.3.5 Phase V – Post-certification

During this phase close-out activities provide the foundation for continued airworthiness activities and certificate management for the remainder of the product's life cycle.



Note: Appendix III describes key players' roles and responsibilities as they apply to avionics approvals

Figure 6.3 *The 'key players' involved in the type certification process*

6.4.4 The 'key players' of the type certification process

Figure 6.3 gives a breakdown of the people involved in all phases of the type certification process and descriptions of their roles.

We will provide only a brief description of the key players; the CPI Guide contains detailed information on their responsibilities, accountability, communication, etc.

1 **FAA and applicant's management** – provide leadership and resources. The applicant and the FAA work to establish a PSP to reach a clear common understanding of their respective

responsibilities for the design and production definition and the certification requirements. The respective managements provide leadership and resources to product certification teams through the **Project Managers** in order to accomplish the project and resolve issues. The management has ultimate responsibility through the product certification team for the quality of compliance finding work, standard application of regulatory compliance policy and procedures, and the timely, efficient completion of the product certification projects.

2 **FAA and applicant's Project Managers** – orchestrate the project and get the job done. The FAA, designees, and applicant's Project Managers are the principal focal points for the project. They co-ordinate and direct the certification team's effort and ensure things are kept moving to achieve the product certification objectives.

3 **FAA Standard Staff Project Officer** – co-ordinates the directorate interaction. The Standard Staff Project Officer provides the certification team with clear and timely regulatory and policy guidance specific to the project. He or she is the focal point within the responsible project directorate for that policy and for engaging other appropriate directorate staff on installation issues across FAR Parts, e.g. engines, propellers, APUs.

4 **FAA engineers and/or designees** – apply regulations and policy to find compliance. The engineers as assigned for appropriate disciplines are the principal contacts for the applicant. Their activity is always in co-ordination with the FAA Project Manager and follows the agreed PSCP for guiding the certification process, communication guidelines, and how rules and policy will be applied. The engineers and designees understand the technical details of the project, application of applicable rules and policy, and are responsible for the majority of the compliance findings associated with the project. They also evaluate sufficiency of the type design and substantiation data with the discretion to review any of the data therein, such as critical material process specifications.

5 **FAA inspectors and/or designees** – determine conformance and airworthiness. The FAA aviation safety inspectors provide consultation and advice on production processes proposed in the design. They conduct and oversee, through designees, a variety of conformity inspections, evaluations of aircraft airworthiness, and issue airworthiness certificates or other approvals. They conduct progressive evaluation of the manufacturer's quality and production systems for eventual production approvals. The inspector is made aware of conformance issues on critical parts that cannot be determined solely from type design data. This would then require focused process control, inspection, or evaluation within the production quality system.

6 **FAA flight test pilots and/or designees** – Conduct product certification flight tests. The flight test pilots provide technical advice to the team on aircraft configuration, operation, flight testing, and instrumentation needed for compliance determinations. They conduct FAA flight tests and other appropriate evaluations, find compliance to flight test requirements, and provide guidance to the applicant on preparing the flight manual and related operational procedures.

7 **FAA Chief Scientific and Technical Advisor (CSTA)** – Provides expert advice and technical assistance. The CSTA provide professional technical guidance, advice, and assistance in their discipline. They are a direct link to an extensive professional network in the R&D community, professional and academic organizations, industry, other government, and national and international experts in their discipline.

8 **FAA Aircraft Evaluation Group** – evaluates conformance to operations and maintenance requirements. The FAA Aircraft Evaluation Group (AEG) provides a link to applicable Flight Standards technical services. This lends an aircraft operational and maintenance perspective to the type design assessment, thereby allowing FAA engineering and their designees to determine appropriate compliance requirements in those areas. The AEG carries knowledge of the product and how it was type certificated to the aircraft Maintenance Review Board, Flight Operations Evaluation Board, and Flight Standardization Board activities.

6.5 FAA Order 8110.4, 'Type Certification'

The CPI Guide, as we have seen, is an operative document that should be used by the FAA and applicants together in order to fulfill their respective roles and expedite certification of products focusing on safety significant issues.

FAA Order 8110.4 is essentially orientated to prescribe the responsibility and procedures for FAA aircraft certification personnel for the certification of civil products under FAR 21.

We will now give a summary of this valuable document to better understand how the responsibilities are distributed and to better clarify certain aspects of the type certification process.

Figure 6.4 provides a summary of the type certification process.

6.5.1 Application for TC, amended TC, STC, and PC[19]

Information is provided for submission of application for the various certifications, including the FAA forms to be used, the documents to be enclosed, the applicable paragraphs of FAR 21, etc.

6.5.2 Establishment of TC project

1 **General.** An applicant submits a TC, amended TC, or STC application to the geographically responsible ACO.[20]

2 **Certification Project Notification (CPN).** The ACO is responsible for assigning a project number, a project manager, and notifying the accountable directorate of each project completing the CPN with information on the project. On the basis of the importance of the project, National Resources Specialists (NRS) and the Aircraft Evaluation Group (AEG) are requested. The accountable directorate assigns a project officer for significant projects.

   The Project Manager and the Project Officer are the focal points for the ACO and the accountable directorate, respectively.

3 **Assignment and duties of the Project Manager.** The PM is responsible for planning, reviewing, evaluating, and co-ordinating all aspects of a certification project in accordance

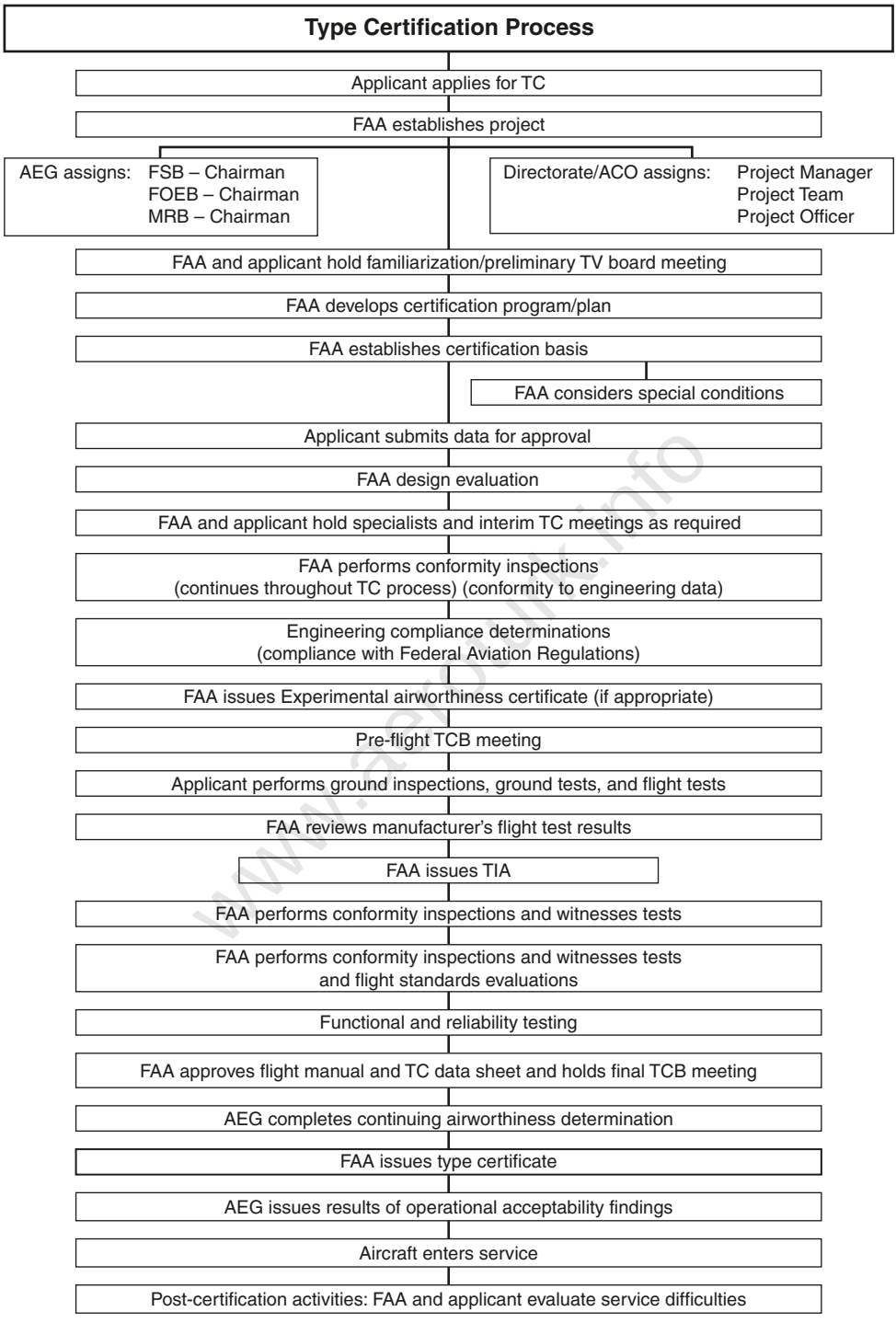


Figure 6.4 *Summary of the type certification process*

with the Certification Program Plan (CPP), which is a fundamental document in the certification process (it will be discussed later). The PM is responsible for initiating this CPP and co-ordinating with the project officer and the Certificate Management ACO (CMACO). The PM also co-ordinates with the appropriate manager(s) in the selection of other team members.

4 **Project team.** A project team is established for all projects that require significant involvement by technical personnel and normally consist of the following:
   (a) A Project Manager
   (b) Engineers or technical specialists
   (c) Pilots and/or flight test engineers
   (d) Manufacturing inspectors
   (e) Operations and/or airworthiness inspectors from the AEG
   (f) A Project Officer and other staff at the discretion of the accountable directorate.

6.5.3 'Type Certification' Board (TCB)

1 **General.** A TCB is established for all aircraft and engine projects in which complete type certification is involved. For instance, TCBs are not always required for STC projects.

The purposes of a TCB are to acquaint the applicant and the FAA with the certification project, resolve significant problems, establish milestones and schedules for the overall accomplishment of the type certification program, review the applicant's certification plan, review the proposed basis for certification, and assure all outstanding certification issues are resolved.

2 **TCB members.** The FAA members are:
   (a) The ACO Manager
   (b) The Project Manager
   (c) The managers, supervisors, or senior personnel from the appropriate engineering disciplines, flight test, manufacturing inspection, and AEG.

In addition, there is a list of participants, other than TCB members, who may be invited to participate on an advisory basis – for example, Washington Headquarters, National Resources Specialists, additional AEG personnel, etc., applicants and their representatives.

3 **TCB meetings.** The following TCB meetings are normally organized:
   (a) Familiarization TCB meeting
   (b) Preliminary TCB meeting
   (c) Interim TCB meeting
   (d) Pre-flight TCB meeting
   (e) Final TCB meeting.

Depending on the type and/or the size of the project, all of the TCB meetings may not be necessary.

The ACO Manager or his/her representative serves as Chairman. (Order 8110.4 provides details on each of the above-mentioned TCB meetings.)

6.5.4 Certification Program Plan (CPP)

The CPP defines the working relationship between the accountable directorate and the geographic ACO, or within an accountable directorate during a specific TC project. The CPP is the principal program co-ordination tool and is updated throughout the program by the Project Manager, as required.

An applicant's certification plan may take the place of the CPP if it includes all information that would be addressed in the CPP and is co-ordinated with the Project Officer.

6.5.5 Issue paper

An issue paper provides means for the identification and resolution of significant technical, regulatory, and administrative issues that occur during a certification process. Issue papers are primarily intended to provide an overview of significant issues, a means to determine the status of issues, and a post-certification summary statement on how issues were resolved.

6.5.6 Issue book

The Project Manager assembles issue papers and publishes them in the form of an issue book, which is distributed to the TCB members, project team members, applicant, and accountable aircraft certification directorate.

6.5.7 Type certification basis

The proposed certification basis is established by the FAA at the beginning of a TC program. The applicant is advised of all aspects at the beginning of the program, including operational requirements.

Once the certification basis has been established and agreed to by the FAA and applicant, new policy will not be introduced unless an unsafe condition is found to exist in a product that has a design feature affected by that policy.

1 **Special class of aircraft.** Special class of aircraft include airships, gliders, motor gliders, very light airplanes, and other non-conventional aircraft for which airworthiness standards have not been issued under FAR 21. The procedures necessary to establish and receive approval for the certification basis are provided by the relevant Advisory Circulars (Order 8110.4 provides the list).
2 **Changes.** Order 8110.4 provides instruction for the establishment of a certification basis for the different cases we have described in Chapter 5.
3 **Additional requirements.** Additional requirement are the following:
   (a) Special conditions. Starting from the definition, Order 8110.4 provides instructions and guidance for the issue of special conditions.

(b) Equivalent level of safety findings. These are made when literal compliance with a certification regulation cannot be shown and compensating factors exist that can be shown to provide an equivalent level of safety. They are normally proposed by the applicant to the ACO and submitted to the directorate.
(c) Exemptions. In a type certification program, any interested person may petition the FAA for a temporary or permanent exemption from an FAR. The petition for exemption is made to the accountable directorate through the ACO and processed according to Order 8110.4 information.
(d) Applicable requirement of FAR 34 and FAR 36 for environmental protection.

6.5.8 Type certification program

In this paragraph, Order 8110.4 provides a great amount of information and instructions for the applicant's submission to the FAA of the type design, test reports, and computations necessary to show that the product to be certificated meets the applicable type certification basis. In particular, the content of the applicant test plan is defined.

Information/instructions are also provided to the FAA about the use to be made of data submitted by the applicant, for the witnessing of tests, conformity inspections, notifications of non-compliance, etc.

6.5.9 Type inspection authorization (TIA)

The TIA, prepared by the ACO, is issued to authorize official conformity airworthiness inspections, and ground and flight tests necessary to fulfill certain certification requirements. Order 8110.4 provides information/instructions for TIA issuance.

6.5.10 Operational and airworthiness evaluations

Aircraft Evaluation Groups (AEGs)[21] are responsible for the operational and maintenance aspects of the aircraft type certification process and, once the aircraft enters service, become the co-ordination point for activities involving Flight Standards.

The AEGs advise manufacturers of pertinent operational and maintenance requirements during the design and certification process.

The AEGs have the primary responsibility for evaluation of aircraft and its systems for operational suitability and continued airworthiness.

Each directorate AEG is responsible for those AEG functions dealing with the TC product for which its directorate has responsibility.

The AEG makes recommendations to FAA field offices regarding operations specifications, training and maintenance program, and airmen qualification through management of several FAA boards, such as the Flight Standardization Board (FSB), Flight Operations Evaluation Board (FOEB), and Maintenance Review Board (MRB).

6.5.11 Flight manual

The ACO responsible for the project approves flight manuals including revisions and supplements.

The flight manual should not be approved until:

1 The FAA project flight test pilot and/or flight test engineer, the AEG operation specialist, and appropriate FAA engineers concur with the operational limitations and normal and emergency procedures.
2 The FAA flight test engineer recommends approval of the performance section of the flight manual.
3 The AEG has reviewed and co-ordinated information in the flight manual.

6.5.12 Type certificates

The certifying ACO issues a type certificate when an applicant completes the requirements of the applicable FAA Regulations for the product. Order 8110.4 provides guidance for the preparation of the applicable FAA form.

6.5.13 The type certificate data sheet (TCDS)

The type certificate data sheet (TCDS), which is part of the TC, provides a concise definition of the configuration of a type certificated product. Therefore, a standard format for the TCDS is necessary to allow information about a specific product to be easily found. The Order also provides guidance for the preparation of this document.

FAA Order 8110.4 contains a multitude of other information that we will not go into here because it is outside the scope of this book, which is not a 'certification manual' but a means to enable technical people to understand the principles of airworthiness.

6.6 Construction of prototypes and test articles

Type certification consists mainly of type design approval. A TC is actually valid even if, for whatever reason, there are no more aircraft of that type. Nevertheless, it is not possible to carry out a type certification 'on paper'. One or more prototypes[22] and test articles have to be built.

The applicant's design organization could be part of an enterprise that has the means of mass production and even the POA,[23] otherwise it could be an independent organization working with an enterprise having these capabilities. In the first case the DO has two options:

1 To perform the prototype construction inside the production organization of the enterprise.
2 To perform the prototype construction inside an **experimental department**.

In case 1 the DO has the advantages emanating from well-organized production, because the authority has already given approval. Hence, when the product is type certificated it will be ready for mass production. The disadvantage of such an arrangement comes from the necessity of being subject to rules that, especially in the case of large companies, are rather complex. For instance, the acquisition of a changed part can be subject to a long delay. If we consider that, during type certification, changes are frequently required, it is clear why the second option is preferred in many cases.

Inside an experimental department, the DO technicians are in close contact with the prototype material, making the introduction of changes simpler and the activities easier, so time can be saved. Because aeronautical production is at stake, the department must respect the quality assurance rules, with its own controllers and procedures. A possible guide for departmental organization can be found in Subpart F of JAR/FAR21/EASA Part 21, 'Production without Production Organization Approval', even if this relates to already certificated products and parts.

In the case of an applicant being an independent DO, working with an enterprise with production facilities, the above-mentioned remarks are still valid in principle, and the choice between the two solutions could also depend on the size of the enterprise.

Having defined some principles, it is not possible to establish fixed rules, because there could be many different situations and suitable choices. A large enterprise would prefer to arrive at the end of the type certification with an industrialized product ready for mass production. A small enterprise could have built the product by hand, could have it certificated this way, and be considering future industrialization (changes in the type design would be necessary) if mass production is possible.

For example, one of the best known experimental departments is Lockheed Martin's **Skunk Works**, which began under the direction of the legendary Kelly Johnson, the designer of the P-38 'Lightning' (just one of his many celebrated aircraft). In 1943 he was commissioned to design the first American jet fighter and to build a prototype in only 180 days. For reasons of secrecy, Kelly Johnson rented a big circus tent and set up shop next to a noxious plastic factory, whose stench kept the curious at bay. One day one of the engineers went to work wearing a gas mask as a gag, and another employee picked up a ringing phone and announced, 'Skonk Works'. That was a fashionable expression at the time, originating from All Capp's cartoons and referring to special juice made by a dead skunk. The expression became popular

and, changed to 'Skunk Works' for editorial reasons, became the registered name of the department. The P-80 'Shooting Star' was built in only 143 days, 37 days ahead of schedule; it is thought that it was probably the smell that spurred Kelly's workers to build the aeroplane in such a short time!

Among the most celebrated designs of Skunk Works are the F-104 'Starfighter', the U-2 spy plane capable of flying at 70 000 ft (in the 1950s), and the SR-71 'Blackbird', capable of flying at Mach 3 and at an altitude of more than 80 000 ft (in the 1960s).

In the 1980s, the creation of the stealth aeroplane F-117A was destined to begin a new era in the design of military aircraft, exploiting some theoretical principles discovered by Russian scientists, but never before put in practice in the Soviet Union.

One of Kelly Johnson's basic rules was that 'engineers must always work within a stone's throw of the airplane being built'.

Skunk Works represents a brains trust where nothing is impossible, having carried out previous testing and demonstrations.

Notes

1 A precise list of these products is documented.
2 Refer to note 1.
3 This prediction has become reality.
4 See Chapter 5, 'Design organization'.
5 National Aviation Authority.
6 See Chapter 4, 'Special conditions'.
7 See Chapter 5, 'Design Organization Approval (DOA)'.
8 For example, a drop test of a landing gear unit, a static test of a flap, an aileron, etc.
9 See Chapter 5, 'Certification basis'.
10 See Chapter 5, 'Certification basis'.
11 The CRI is 'closed' when a *decision* about the actions to be carried out has been reached; the *realization* of these actions represents a further phase.
12 The Internal Working Procedure TCP in its appendix defines working procedures addressing the content and presentation of such a final report.
13 TCDS: document attached to the TC, containing the product's main characteristics, the certification basis, the type certification date, etc.
14 The TCB meetings are official meetings attended by the team, the design organization, and some authority representatives responsible for the type certification. Normally, these meetings open and close the type certification process, with some intermediate meetings assessing the state of the certification process.
15 Documents issued by the TCH containing instructions for corrective actions (changes, inspections, etc.), improvements, etc.

16 Documents issued by the authority making mandatory particular actions (changes, inspections, etc.). See Chapter 9.
17 Aircraft Certification Office.
18 Deliverables: prerequisites for subsequent phases to be completed before entering a new phase.
19 Product certificate. See Chapter 7.
20 For FAA organization, see Chapter 3.
21 This is a Flight Standard group co-located with each directorate and is responsible for determining operational acceptability and continued airworthiness requirements for newly certified products.
22 In the type certification of sailplanes and light aeroplanes, for economic reasons, only one prototype is often built.
23 See Chapter 7, 'Production Organization Approval'.

Chapter 7

Production of Products, Parts, and Appliances

After the prototype phase of a product has led to the type certification, what typically follows is its mass production. In the previous chapters we explained how this mass production could be performed by an individual who is not the type certificate holder. In any case, the TCH is required to collaborate with the production organization to ensure:

1 Satisfactory co-ordination of design and production.
2 Proper support for the continuing airworthiness of the product.

7.1 The JAA/EASA production organization

JAR 21/EASA Part 21 provide two options as regards the production organization:

1 **Production Organization Approval (POA)** according to Subpart G.
2 **Production without Production Organization Approval** according to Subpart F.

In the first case, the approval bears similarity with the DOA.[1] As for the POA, the approval aims to highlight the responsibility of the organization, allowing the authority to perform less fiscal, but more efficient, control.

For example, it has always been the norm for the authorities to survey the construction of every single aircraft, and to also carry out flight tests in order to issue a certificate of airworthiness. The holder of a POA, on the basis of the POA privileges, may obtain a certificate of airworthiness upon presentation of a statement of conformity, with no further showing.

All this obviously requires that the authority obtains a deep knowledge of the organization, performing careful checks to ensure the continuous validity of the organization approval.

The second case (Subpart F of JAR21/EASA Part 21) is applicable to manufacturing organizations for which a production approval under Subpart G would be inappropriate – for example,

because production is limited to a number of units, or because production is initiated under this Subpart F in advance of issue of a POA under Subpart G. Such an organization does not have the privileges of POA; this means that it will also be exposed to closer authority supervision for the issue of the final certification. We have previously noted how something similar can happen for design organization without a DOA.

We will now describe these two types of production organization in more detail.

7.1.1 Production Organization Approval (POA)

As we have just mentioned, if an applicant for POA is not the TCH, he or she must have an appropriate co-operation agreement with the TCH.

Production is intended to relate to products (aircraft, engines, and propellers), parts, and appliances (JTSO/ETSO articles, JPA parts, and other parts)[2] and changes in type design certificated as Supplemental type certificates (STCs).[3]

Among the most important characteristics of a POA are:

1 A **Quality System** to enable the organization to ensure that each product, part, or appliance produced by the organization, or by its partner or supplied from or subcontracted to outside parties, conforms to the applicable design data and is in condition for safe operation. This structure (the tasks are defined in detail in Appendix B of JAR 21 and AMC&GM of EASA Part 21) provides the organization with all control procedures and, among others, the following are most important:
   (a) Manufacturing processes
   (b) Verification of incoming materials
   (c) Vendor and subcontractor assessment, audit, and control
   (d) Non-conforming item control
   (e) Personnel competence and qualification
   (f) Inspection and testing, including production flight tests
   (g) Airworthiness co-ordination with the TCH
   (h) Internal quality audits and resulting corrective action.

   This structure provides all involved personnel with written information in order to allocate their relevant responsibilities.

   The Quality System must include an **Independent Quality Assurance Function** to monitor compliance with, and adequacy of, the documented procedures of the Quality System. 'Independent' is related to the lines of reporting, authority, and access within the organization, and assumes an ability to work without technical reliance on the monitored functions.

   The aim is to have the organization able to produce, in conformity with the applicable design, products, parts, and appliances in condition for **safe operation**.[4] In order to ensure the above, the Quality Assurance Function has to perform planned, continuing, and systematic evaluations or audits of factors that affect the conformity and safe operation.

2 The **Organization**. The following individuals have to be appointed:
   (a) A manager **accountable** to the authority. He or she should be responsible for the organization's activities on these matters and has the corporate authority for ensuring that all production work is carried out to the required standards. The authority may be delegated in writing to another manager of the organization.
   (b) A manager or group of managers with responsibilities and tasks clearly defined, reporting (directly or indirectly) to the manager accountable. One of these managers, normally known as the **Quality Manager**, is responsible for monitoring the organization's compliance with Subpart G of JAR 21/EASA Part 21; he or she should have a direct link with the manager accountable.
   (c) Staff at all levels with appropriate authority to be able to fulfill their allocated responsibilities, with full and effective co-ordination within the part of the production organization dealing with airworthiness matters.
   (d) **Certifying staff.** Defined as those employees who are authorized to sign final documents (e.g. statements of conformity, JAA Form One/EASA Form 1[5]).
   (e) **Privileges.** As in DOA, privileges exist in POA in order to release the organization from strict authority control. Then the organization may, without further showing:
      (i) Obtain, in the case of complete aircraft and upon presentation of a statement of conformity, an aircraft certificate of airworthiness and a noise certificate
      (ii) Issue, in case of other products, parts, and appliances, authorized release certificates (JAA Form One/EASA Form 1)[6]
      (iii) Maintain a new aircraft produced by the organization and issue a certificate of release to service in respect of that maintenance.
3 **Exposition.** The organization must supply a **Production Organization Exposition**, a document similar to the DOA Handbook we have previously mentioned. The document provides a general description of the organization and its scope of work, titles and names of managers with their duties and responsibilities, a list of certifying staff, a description of the Quality System, inherent procedures, etc.

We can make the same considerations for POA that we made for DOA in Chapter 5. Furthermore, in POA there is a true leap of quality, leading to a condition of self-control for the organization, with advantages for safety and authority efficiency.

Because it is of great importance that both the authority and the enterprise have a clear knowledge of the basic concepts of POA, training courses are organized under the auspices of the JAA and the national authorities.

7.1.2 The EASA production organization procedure (internal working document)

The EASA will internally handle the approval of product organizations located outside the territory of EU Member States or, on specific request from a Member State, the approval of a production organization located inside the territory of the Member State.[7]

Applications will have to be sent to the EASA Manager for Certification Application (MAC) and made in accordance with Part 21A.134.

7.1.3 Production without Production Organization Approval

We previously mentioned cases where Subpart F of JAR 21/EASA Part 21 applies, which we can now summarize:

1 The authority considers production approval under Subpart G inappropriate.
2 Production is initiated under Subpart F in advance of issue of a POA under Subpart G.

Applicants may apply showing conformity of individual products, parts, or appliances under Subpart F, if they hold or have applied for an approval covering the design of that product, part, or appliance, or (as for POA) have a suitable agreement with the applicant for or holder of an approval of such design, which ensures satisfactory co-ordination between production and design.

7.1.4 The organization

Without going into details that can be found in Subpart F and inherent advisory material, the following are required:

1 **A Production Inspection System.**
2 An **Organization Manual** that describes the production inspection system required, ensuring that each product, part, or appliance conforms to the applicable design data and is in condition for safe operation. This means that procedures must be established, for example, for control of incoming materials (and bought or subcontracted parts), processes, manufacturing techniques, design changes (including material substitutions), etc. Furthermore, it must contain a general description of the organization.

In this organization we find the same basic concepts defined by POA. The Product Inspection System is the equivalent of the POA Quality System. The Organization Manual contains items bearing similarity with those provided by the POA Exposition. (In any case, we do not believe that an aircraft built under Subpart F could be less safe than one built under Subpart G.)

What is then the difference between the two types of organization?

The true difference is the presence, in the POA, of the Independent Quality Assurance System, which, through Quality System monitoring, has the responsibility of making the organization truly reliable, independent of authority intervention.

In the production organization without POA, this monitoring task pertains to the authority, which has to perform control quite different compared to that performed with POA.

Because in many cases (but not always) Subpart F relates to small organizations and simple products, the procedures can be conveniently simplified. It is therefore clear why POA privileges are not granted to these organizations.

In conclusion, with or without POA, the right balance must be found in order to ensure that the production responds to the safety concepts acquired in the type certifications and approvals of products, parts, and appliances.

7.2 Production under FAR 21

FAR 21 also provides two alternatives for production:

1 A production certificate, under Subpart G.
2 Production under type certificate only, under Subpart F.

7.2.1 The production certificate

7.2.1.1 Applicability

According to Subpart G of FAR 21, a type certificate holder or private individuals holding the right to benefit from that type certificate under a licensing agreement, or a Supplemental type certificate holder, may apply for a production certificate for the product concerned.

7.2.1.2 Privileges

A PC holder has the privileges specified in FAR 21.163. In addition, a PC holder is eligible to have a qualified employee(s) designated as DMIR.[8] The PC holder may also be authorized to represent the Administrator as an ODAR.[9] Among the above-mentioned privileges, the PC holder can:

(a) Obtain an aircraft airworthiness certificate without further showing, except that the Administrator may inspect the aircraft for conformity with the type design.
(b) In the case of other products, obtain approval for installation on type certificated aircraft.

As we have seen for the JAA/EASA POA, the privileges tend to release the manufacturer from strict Administrator control.

In order to obtain such privileges, manufacturers must show that they have established and can maintain a **Quality Control System** for any product, for which they request a production certificate, so that each article will meet the design provisions of the pertinent certificate.

7.2.1.3 Quality Control System

Paragraph 21.143 prescribes a list of data to be submitted to the Administrator, describing the inspection and test procedures necessary to ensure that each article produced conforms to the type design and is in condition for safe operation. In particular, what is required is:

(a) A statement describing assigned responsibilities and delegated authority of the quality control organization, together with a chart indicating the functional relationship of the quality control organization to management and to other organizational components, and indicating the chain of authority and responsibility within the quality control organization.
(b) A description of inspection procedures for raw materials, purchased items, and parts and assemblies produced by manufacturers' suppliers, including methods used to ensure acceptable quality of parts and assemblies that cannot be completely inspected for conformity and quality when delivered to the prime manufacturer's plant.
(c) A description of the methods used for production inspection of individual parts and complete assemblies, including the identification of any special manufacturing processes involved, the means used to control the processes, the final test procedure for the complete product, and, in the case of aircraft, a copy of the manufacturer's production flight test procedures and check-off list.
(d) An outline of the materials review system, including the procedure for recording review board decisions and disposing of rejected parts.
(e) An outline of a system for informing company inspectors of current changes in engineering drawings, specifications, and quality control procedures.
(f) A list or chart showing the location and type of inspection stations.

7.2.1.4 Processing an application for a PC

The application, made on the relevant FAA form, is submitted to the manager of the competent Manufacturing Inspection Office (MIO) in the directorate in which the applicant's principal manufacturing facility is located.

After a preliminary audit, a team is selected to make the suitable evaluations.

Of course, the FAA provides plenty of guidance documents for the advancement of this process.

7.2.1.5 Periodic FAA production flight tests

FAA production flight tests will be conducted periodically at the PC holder's facility to ensure continued compliance with all parameters as specified in pertinent type certificate data with respect to performance, flight characteristics, operation qualities, equipment operations, etc.

7.2.1.6 PC holder's responsibility

The PC holder is responsible for maintaining the Quality System in conformity with the data and procedure approved for the PC, and/or determining that each completed product submitted for airworthiness certification or approval conforms to the TC or STC and is in condition for safe operation.

7.2.2 Production under type certificate only

7.2.2.1 Applicability

According to Subpart F of FAR 21.123, each manufacturer of a product being manufactured under a type certificate only shall:

(a) Make each product available for inspection by the Administrator.
(b) Maintain at the place of manufacture the technical data and drawings necessary for the Administrator to determine whether the product and its parts conform to the type design.
(c) Except as otherwise authorized by the Aircraft Certification Directorate Manager for the geographic area in which the manufacturer is located, for products manufactured more than six months after the date of issue of the type certificate, establish and maintain an approved production inspection system that insures that each product conforms to the type design and is in condition for safe operation.
(d) Upon the establishment of the approved production inspection system (as required by paragraph (c) of this section) submit to the Administrator a manual that describes that system and the means for making the determinations required by paragraph 21.125(b).

7.2.2.2 Privileges

A manufacturer of a product or part(s) in accordance with Subpart F of FAR 21 is not granted any privileges.

However, upon establishment of an Approved Production Inspection System (APIS), the APIS holder is eligible to have a qualified employee(s) as Designated Manufacturing Inspection Representative (DMIR). The APIS holder may also be authorized to represent the Administrator as an Organizational Designated Airworthiness Representative (ODAR).

To better understand the matter, a manufacturer who has been issued a type certificate is given six months under FAR 21.123(c) to establish and implement a production inspection system, unless the manufacturer has applied for a production certificate under FAR 21 Subpart G. During the six-month period, each complete product or part thereof is subjected to FAA inspection prior to the issuance of airworthiness certificates. This procedure is normally time consuming and is likely to allow only a very slow production rate. Therefore, it is to the manufacturer's advantage to develop and implement an approvable production inspection system as quickly as possible. As the manufacturer's individual fabrication, assembly, and inspection operations are found to be in compliance with the regulations, they may be FAA approved on a progressive basis. When areas are found to be in compliance, the FAA may thereafter reduce its inspection and increase its reliance on the manufacturer's production inspection system. When the total production inspection system is found to be in compliance with the regulations, the established ACO will issue the letter of Approval of the Production Inspection System (APIS). Subsequent FAA inspections will be for the purpose of surveillance of the approved system to determine continued compliance.

7.2.2.3 Production Inspection System: Material Review Board

An effective Material Review Board is of primary importance for an efficient Production Inspection System, since it controls the inspections, identification, rework, and use of damaged or non-conforming articles, including the isolation or scrapping of unusable articles.

An APIS is based on compliance with the inspection standards specified in FAR 21.125. The APIS holder is required to establish a Material Review Board (to include representatives from the inspection and engineering department). He or she is also required to have process specifications, Material Review Board records, test procedures, and flight check forms that are acceptable to the FAA. It would be advantageous to the TC applicant to develop these data concurrently with the manufacture, inspection, and testing of prototypes of the product.

7.2.2.4 TC holder's responsibility

Prior the issuance of an APIS, a TC holder or licensee who makes a product is particularly responsible for complying with paragraphs 21.123, 21.127 (Tests: aircraft), 21.128 (Tests: aircraft engines), 21.129 (Tests: propellers), and 21.130 (Statement of conformity), as appropriate for the particular product concerned.

Notes

1 See Chapter 5, 'Design Organization Approval'.
2 See Chapter 5, 'Parts and appliances approval'.
3 See Chapter 5, 'The Supplemental type certificate (STC)'.
4 It is worth emphasizing that the safety goal is intrinsic to the organization and independent of the authority's control.
5 JAA Form One/EASA Form 1 (Authorized Release Certificate) identifies the **conformity** or **airworthiness** and eligibility status of products/parts/appliances/components/assemblies (referred to as 'part' or 'parts') after manufacture or to release maintenance work carried out under the authority's approval. There are two types of certificate:
   1 JAA Form One/EASA Form 1 **for airworthiness purposes**, related to parts that fully conform to an approved design standard, and then qualified for installation and operation.
   2 JAA Form One/EASA Form 1 **for conformity**, related to parts that conform to designs and data that are not yet approved. For example, a landing gear unit undergoing certification dynamic tests could match a design, but it will not necessarily be in compliance with the applicable certification standards. Furthermore, even if the tests are successful, the part could be damaged by tests and then eventually be no longer airworthy.
6 See note 5.
7 As mentioned in the 'EASA certification' section in Chapter 3, EU product organizations are normally approved by the local competent authority.
8 Designated Manufacturing Inspection Representative.
9 Organizational Designated Airworthiness Representative.

Chapter 8

Certificates of Airworthiness

8.1 Introduction

In this chapter, we will describe the basics of the requirements governing the certificates of airworthiness – airworthiness certificates for the FAA. However, we will not report these requirements in their entirety. Therefore, to find practical applications of these requirements, the reader will have to refer directly to JAR/FAR 21/EASA Part 21, other standards cited in the requirements, and finally, relevant advisory material.

Generally, aircraft for which certificates of airworthiness have been issued in accordance with a JAR/FAR 21/EASA Part 21 type certificate comply with ICAO Annex 8 and therefore have international recognition according to Article 33 of the Chicago Convention for flying and landing in Contracting States.

Special certificates of airworthiness – with some exceptions, like the Restricted certificate and other certificates which require type certification – can be defined in the same way as the EASA's permits to fly, i.e. issued to aircraft that do not meet, or have not been shown to meet, applicable certification specification but are capable of safe flight under defined conditions.

Special certificates of airworthiness are generally not recognized in compliance with ICAO Annex 8, but there may be exceptions to be evaluated case by case.

Recalling what was mentioned in Chapter 5, the type certificate is not an authorization for aircraft operation which is obtained when a certificate of airworthiness is issued.

With regard to the duration, as a general rule, unless suspended or revoked sooner, or a termination date is otherwise established by the authority, a certificate of airworthiness is effective within any period specified therein, as long as maintenance is performed in accordance with the applicable requirements, and provided the aircraft remains in the same register.

A certificate of airworthiness is invalid when the type certificate under which it is issued is suspended or revoked by the authority.

8.2 General classification

The general classification of the certificates is provided by JAR 21, EASA Part 21, and FAR 21.

8.2.1 JAR 21 certificates of airworthiness

1 Subpart H provides requirements for the issue of **Standard certificates of airworthiness**.
2 Subpart L provides requirements for **Export Airworthiness Approval**.

8.2.2 EASA Part 21 certificates of airworthiness

At present, Subpart H provides requirements for:

1 **Certificates of airworthiness** issued to aircraft in accordance with Part 21.
2 **Restricted certificates of airworthiness**.
3 **Permits to fly**.

8.2.3 FAR 21 airworthiness certificates

1 Subpart H provides requirements for:
   (a) **Standard airworthiness certificates** – airworthiness certificates issued for aircraft type certificated in one of the Normal, Utility, Acrobatic, Commuter, or Transport categories, and for manned free balloons, and for aircraft designated by the Administrator as *special classes of aircraft*.[1]
   (b) **Special airworthiness certificates** – Primary, Restricted, Limited, Light-Sport, and Provisional airworthiness certificates, special flight permits, and Experimental certificates.
2 Subpart I provides requirements for **Provisional airworthiness certificates**.
3 Subpart L provides requirements for **Export Airworthiness Approvals**.

8.3 JAR 21 certificates of airworthiness

8.3.1 Standard certificates of airworthiness

Standard certificates of airworthiness are issued for aircraft for which a type certificate has been issued in accordance with JAR 21.

8.3.1.1 Issue of a certificate

1 Any owner (or the agent of the owner) may apply for a certificate of airworthiness.
2 A Standard certificate of airworthiness can be issued for new or used aircraft without prejudice to other provisions of national laws, applicable in the absence of a comprehensive set of JAA rules, upon presentation to the competent authority of the relevant documentation required by JAR 21.
3 In particular, for used aircraft, historical records to establish the production, modifications, and maintenance standards of the aircraft must be submitted.

The wording 'without prejudice … etc.' is used to take into account the fact that the JARs do not cover issues such as environmental certification procedures and others which may interfere with the certification procedures of JAR 21. This wording should not be interpreted as having the potential for additional requirements deviating from JARs, but only for additional national administrative requirements for subjects which are not otherwise addressed by the JARs.

As explained in Chapter 3, succeeding a joint type certification, the type certificate was issued by the national authorities on the basis of the JAA's recommendations.

The certificate of airworthiness was issued by the national authorities for aircraft which conform to a type design approved under a type certificate, and with the applicable national rules for operations and environmental protection.

8.3.2 Export Airworthiness Approval

8.3.2.1 Types of approval

1 Export Airworthiness Approval of complete aircraft issued in the form of **Export certificate of airworthiness**. Such certificates do not authorize the operation of the aircraft.
2 Export Airworthiness Approval of other products, parts (except standard parts), or appliances issued in the form of an **Authorized Release Certificate (JAA Form One)**, in accordance with applicable JARs.

8.3.2.2 Application for an Export certificate of airworthiness

The manufacturer or owner (or its agent) of a new aircraft, or the owner (or its agent) of a used aircraft may apply for an Export certificate of airworthiness upon presentation to the competent authority of the relevant documentation required by JAR 21.

In particular, for used aircraft, historical records to establish the production, modification, and maintenance standards of the aircraft must be submitted.

8.3.2.3 Issue of Export certificate of airworthiness

The certificate is issued if the applicant shows that:

1 The aircraft conforms to the type design acceptable to the importing country.[2]
2 New aircraft have been produced under Subpart F or G of JAR 21.[3]
3 Used aircraft possess or qualify for a valid certificate of airworthiness issued by the exporting authority.
4 The aircraft meets the additional requirements for import of the importing country.
5 All documents prescribed by JAR 21 have been submitted.

8.3.2.4 Export approval exceptions

Export approvals can be issued for aircraft or parts or appliances which do not meet all the requirements prescribed for the issue of an Export certificate of airworthiness or a JAA Form One, if the importing authority provides a written statement of acceptability.

In these cases, the requirements that are not met and the difference in configuration, if any, between the product, part, or appliance to be exported and the related type approved product, part, or appliance must be listed on the Export Airworthiness Approval as exceptions.

For example, it is possible to obtain Export certificates of airworthiness for damaged aircraft, or aircraft to be completed in the importing country, when the 'status' of the aircraft is clearly defined.

8.4 EASA Part 21 certificates of airworthiness

8.4.1 Certificates of airworthiness issued to aircraft in accordance with Part 21

8.4.1.1 Applicability

The certificates of airworthiness will be issued to aircraft which conform to a type certificate that has been issued in accordance with EASA Part 21.[4]

8.4.1.2 Application

Each application shall include:

1 For new aircraft, a statement of conformity issued by the manufacturer and validated by the competent authority,[5] a weight and balance report, and the flight manual.
2 For used aircraft originating from a Member State, airworthiness review certificate (EASA Form 15a).

3 For used aircraft originating from a non-Member State:
   (a) A statement by the competent authority of the state where the aircraft is, or was registered, reflecting the airworthiness status of the aircraft on its register at the time of transfer.
   (b) A weight and balance report.
   (c) The flight manual.
   (d) Historical records to establish the production, modification, and maintenance standards of the aircraft.
   (e) A recommendation for the issuance of a certificate of airworthiness and an airworthiness review certificate.

8.4.1.3 Issue of certificate of airworthiness

The competent authority of the state of registry shall issue a certificate of airworthiness for:

1 *New aircraft*, upon presentation of the documentation required by 21A.174(b)2, when the aircraft conforms to an approved design and is in condition for safe operations. This may include inspection by the competent authority of the Member State of registry.
2 *Used aircraft*, upon presentation of the documentation required by 21A.174(b)3 demonstrating that the aircraft conforms to a type design approved under a type certificate and any Supplemental type certificate, change or repair approved in accordance with EASA Part 21, and to applicable Airworthiness Directives, and the aircraft has been inspected in accordance with the applicable provision.

8.4.2 Restricted certificates of airworthiness

Restricted certificates of airworthiness shall be issued to aircraft which conform to a type certificate that has been issued in accordance with EASA Part 21, or which has been shown to the Agency to comply with specific certification specifications ensuring adequate safety.

8.4.2.1 Definition of a Restricted type certificate

For an aircraft that does not meet the provisions of 21A.21(c),[6] the applicant shall be entitled to have a Restricted type certificate issued by the Agency after:

1 Complying with the appropriate type certification basis established by the Agency ensuring adequate safety with regard to the intended use of the aircraft, and with the applicable environmental protection requirements.
2 Expressly stating that it is prepared to comply with 21A.44.[7]
3 Furthermore, the engine or propeller installed in the aircraft, or both, shall have a type certificate or have been shown to be in compliance with the certification specifications necessary to ensure safe flight of the aircraft.

8.4.2.2 Application

As per 'Standard' certificates.

8.4.2.3 Issue of Restricted certificate of airworthiness

The competent authority of the Member State of registry shall issue a Restricted certificate of airworthiness for:

1 *New aircraft*, upon presentation of the documentation required by 21A.174(b)2, demonstrating that the aircraft conforms to a design approved by the Agency under a Restricted type certificate or in accordance with specific certification specifications and in conditions of safe operation.
2 *Used aircraft*, upon presentation of the documentation required by 21A.174(b)3 demonstrating that the aircraft conforms to a design approved by the Agency under a Restricted type certificate or in accordance with certification specifications, and the applicable Airworthiness Directives have been complied with, and the aircraft has been inspected in accordance with the applicable provision.

8.4.3 Permits to fly

Permits to fly shall be issued to aircraft that do not meet, or have not been shown to meet, applicable certification specifications but are capable of safe flight under defined conditions.

8.4.3.1 Application

Each application for a permit to fly shall include:

1 The purpose of the flight(s).
2 The itineraries or airspace, or both, used for the flight.
3 Minimum flight crew and its qualification, required to operate the aircraft.
4 Restrictions for carriage of persons other than flight crew.
5 The ways in which the aircraft does not comply with the applicable certification specifications.
6 Any restriction considered necessary for safe operation of the aircraft.
7 Any other information considered necessary for the purpose of prescribing operating limitations.

8.4.3.2 Issue of permits to fly

The competent authority of the Member State of registry shall issue a permit to fly after the Agency has found that the aircraft and appropriate associated restriction compensating for departure from the essential requirements permit the aircraft to perform a basic flight safely.

For that purpose, the Agency may make or require the applicant to make appropriate inspection or tests necessary to ensure safety.

8.4.4 General remarks on EASA certificates of airworthiness

We previously mentioned that the issue of EASA certificates of airworthiness is made by the competent authority of the state of registry.

Referring again to the EASA classification of the certificates of airworthiness, the permits to fly have replaced all Special certificates (except the old Restricted ones).

Of course, the Special certificates already issued by the Member States will be maintained as they are for the time being.

We have to argue that this apparent 'simplification' is only a temporary arrangement pending a settlement of the matter.

In fact, we will describe how many types of special certificate prescribe the FAR 21; most of them are similar to the special certificates adopted a long time ago by many national authorities to solve the multitude of different problems linked with day-by-day operations, by means of different written rules established for different cases. These rules cannot be invented on a case-by-case basis, and this is why a record of cases is necessary.

8.5 FAR 21 airworthiness certificates

8.5.1 Standard airworthiness certificates

8.5.1.1 Applicability

Standard airworthiness certificates are airworthiness certificates issued for aircraft type certificated in one of the Normal, Utility, Acrobatic, Commuter, or Transport categories, and for manned free balloons, and for aircraft designated by the Administrator as special classes of aircraft.[8]

8.5.1.2 Issue of Standard airworthiness certificates

1 *New aircraft manufactured under a production certificate*. An applicant for a Standard airworthiness certificate for a new aircraft manufactured under a production certificate is entitled to a Standard airworthiness certificate without further showing, except that the Administrator may inspect the aircraft to determine conformity to the type design and condition for safe operation.
2 *New aircraft manufactured under type certificate only*. An applicant for a Standard airworthiness certificate for a new aircraft manufactured under a type certificate only is

entitled to a Standard airworthiness certificate upon presentation, by the holder or licensee of the type certificate, of the statement of conformity prescribed in paragraph 21.130 if the Administrator finds after inspection that the aircraft conforms to the type design and is in condition for safe operation.

3 *Import aircraft*. An applicant for a Standard airworthiness certificate for an import aircraft type certificated in accordance with paragraph 21.29[9] is entitled to an airworthiness certificate if the country in which the aircraft was manufactured certifies, and the Administrator finds, that the aircraft conforms to the type design and is in condition for safe operation.

Paragraph 21.183 also prescribes requirements for noise, passenger emergency exits, fuel venting, and exhaust emissions, when applicable.

8.5.2 Special airworthiness certificates

At first sight, we could question why the FAA has so many types of Special airworthiness certificates.

The answer, as already mentioned, is the necessity to solve the multitude of different problems linked with day-to-day operation, on the basis of different written rules established for the different cases.

It is essential to recall what was written at the beginning of this chapter about the content of this panoramic exposition of the rules governing the certificates of airworthiness; readers will not find a copy of FAR 21 paragraphs, but only the basics of these requirements used to explain their meaning. Therefore, readers are advised that, for practical applications of the requirements, they will have to refer to FAR 21, other FARs cited by the requirements, and finally, advisory material (ACs, Orders, etc.).

It is also important to know that most national authorities have had national regulations for aircraft certifications for a long time, based on the FAA's regulations, so that many of their certificates of airworthiness bear similarity with the corresponding FAA certificates. This implies that some considerations at the end of the description of the single certificate are not only applicable to US aircraft, but can assume more general value.

Another practical consideration: when a certificate of airworthiness for a type certificated aircraft is issued, safety is assured by the conformity of the single aircraft to the relevant type certificate and applicable operational requirements.

Because most of the Special certificates are not based on the existence of a type certificate, the issue of such a certificate of airworthiness should assure a 'sufficient level of safety'; this statement involves evaluations not only of the physical conditions of the single aircraft, but also of its design.

These types of evaluations normally require experience, skill, and common sense.

8.5.2.1 Special airworthiness certificate for Primary category aircraft

1. Definition of Primary category aircraft

An aircraft type certificated in the Primary category:

(a) Is unpowered or it is an airplane powered by a single, naturally aspirated engine with a 61-knot or less V_{so} stall speed as defined in paragraph 23.49, or a rotorcraft with a six pound per square foot main rotor disk loading limitation, under sea level standard day conditions.
(b) Weighs not more than 2700 lb or, for seaplanes, not more than 3375 lb.
(c) Has a maximum seating capacity of not more than four persons, including the pilot.
(d) Has an unpressurized cabin.

An applicant may include a special inspection and preventive maintenance program as part of the aircraft's type design or Supplemental type design.

2. Issue of an airworthiness certificate

(a) *New Primary category aircraft manufactured under a production certificate*. An applicant for an original, Special airworthiness certificate – Primary category for a new aircraft manufactured under a production certificate, including aircraft assembled by another person from a kit provided by the holder of the production certificate and under the supervision and quality control of that holder, is entitled to a Special airworthiness certificate without further documentation required, except that the Administrator may inspect the aircraft to determine conformity to the type design and condition for safe operation.
(b) *Imported aircraft.* An applicant for a Special airworthiness certificate – Primary category for an imported aircraft type certificated under paragraph 21.29[10] is entitled to a Special airworthiness certificate if the civil airworthiness authority of the country in which the aircraft was manufactured certifies, and the Administrator finds, after inspection, that the aircraft conforms to an approved type design that meets the applicable criteria.

3. General remarks

Aircraft in this category are of simple design and intended exclusively for recreation and personal use. Although these aircraft may be available for rental and flight instruction under certain conditions, the transport of persons or property for hire is prohibited.

One benefit of the certification in this category is the possibility for the pilot/owner to perform preventive maintenance beyond what is already allowed under Appendix A of FAR 43. Of course, there are rules that the pilot/owner has to follow in order to be considered properly qualified.

8.5.2.2 Special airworthiness certificates for Restricted category aircraft

1. Definition of Restricted category aircraft

An aircraft type certificated in the Restricted category for special purposes:

(a) Meets the airworthiness requirements of an aircraft category *except those requirements that the Administrator finds inappropriate* for the special purpose for which the aircraft is to be used.

(b) Is of a type that has been manufactured in accordance with the requirements of, and accepted for use by, an Armed Force of the United States and has been later modified for a special purpose.
(c) 'Special purpose operations' include:
  (i) Agricultural (spraying, dusting and seeding, and livestock and predatory animal control)
  (ii) Forest and wildlife conservation
  (iii) Aerial surveying (photography, mapping, and oil and mineral exploration)
  (iv) Patrolling (pipelines, power lines, and canals)
  (v) Weather control (cloud seeding)
  (vi) Aerial advertising (skywriting, banner towing, airborne signs, and public address systems)
  (vii) Any other operation specified by the Administrator.

2. Issue of an airworthiness certificate

(a) *Aircraft manufactured under a production certificate or type certificate only*. An applicant for the original issue of a Restricted category airworthiness certificate for an aircraft type certificated in the Restricted category, that was not previously type certificated in any other category, must comply with the appropriate provisions of paragraph 21.183.[11]
(b) *Other aircraft*. An applicant for a Restricted category airworthiness certificate for an aircraft type certificated in the Restricted category, that was either a surplus aircraft of the Armed Forces or previously type certificated in another category, is entitled to an airworthiness certificate if the aircraft has been inspected by the Administrator and found to be in a good state of preservation and repair and in a condition for safe operation.
(c) *Imported aircraft.* An applicant for the original issue of a Restricted category airworthiness certificate for an imported aircraft type certificated in the Restricted category only in accordance with FAR 21.29 is entitled to an airworthiness certificate if the country in which the aircraft was manufactured certifies, and the Administrator finds that the aircraft conforms to the type design and is in a condition for safe operation.

Paragraph 21.185 also prescribes requirements for noise, venting, and exhaust emissions, as applicable.

3. General remarks

To better understand the meaning of this special aircraft category, we will take one example of many.

An aeroplane, already type certificated according to FAR 23, is provided with an agricultural spraying installation. The certificate may tolerate an increase of the maximum take-off weight with consequent reduction of rate of climb (also under the minimum allowed by FAR 23) due to the higher weight, but also to the drag increase caused by the external installation. Obviously, it should be demonstrated that the aircraft's flight qualities are still acceptable: a quick drain to cope with emergencies may be installed; airspace restrictions could be enforced, etc. In other words, all the appropriate checks shall be carried out and limitations prescribed

to take into account deviations from essential requirements for airworthiness depicted in the basic regulations.

8.5.2.3 Special airworthiness certificate for Limited category aircraft

1. Definition of Limited category aircraft

A Limited category Special airworthiness certificate is issued to operate surplus military aircraft that have been converted to civilian use under the following conditions:

(a) The aircraft has a Limited type certificate.[12]
(b) The aircraft conforms to its type certificate.
(c) The FAA has determined that the aircraft is safe to operate.
(d) Operation may not include carrying passengers or cargo for hire. The FAA may prescribe additional limitations as necessary for safe operation.

2. Issue of an airworthiness certificate

An applicant for an airworthiness certificate for an aircraft in the Limited category is entitled to the certificate when:

(a) He or she can show that the aircraft has been previously issued a Limited category type certificate and that the aircraft conforms to that type certificate.
(b) The Administrator finds, after inspection (including a flight check by the applicant), that the aircraft is in a good state of preservation and repair, and is in a condition for safe operation.
(c) The Administrator prescribes limitations and conditions necessary for safe operation.

8.5.2.4 Special airworthiness certificate for a Light-Sport category aircraft

1. Definition

A **Light-Sport aircraft** is an aircraft, other than a helicopter or powered lift, that, since its original certification, has continued to meet the following criteria:

(a) A maximum take-off weight of not more than:
  (i) 660 lb (300 kg) for lighter-than-air aircraft
  (ii) 1320 lb (600 kg) for aircraft not intended for operation on water
  (iii) 1430 lb (650 kg) for an aircraft intended for operation on water.
(b) A maximum airspeed in level flight with maximum continuous power (V_H) of not more than 120 knots CAS under standard atmospheric conditions at sea level.
(c) A maximum never-exceed speed (V_{NE}) of not more than 120 knots CAS for a glider.
(d) A maximum stalling speed or minimum steady flight speed without the use of lift-enhancing devices (V_{S1}) of not more than 45 knots CAS at the aircraft's maximum certificated take-off weight and most critical center of gravity.
(e) A maximum seating capacity of no more than two persons, including the pilot.
(f) A single, reciprocating engine, if powered.
(g) A fixed or ground-adjustable propeller if a powered aircraft other than a powered glider.

(h) A fixed or auto-feathering propeller system if a powered glider.
(i) A fixed-pitch, semi-rigid, teetering, two-blade rotor system, if a gyroplane.
(j) A non-pressurized cabin, if equipped with a cabin.
(k) Fixed landing gear, except for an aircraft intended for operation on water or a glider.
(l) Fixed or repositionable landing gear, or a hull, for an aircraft intended for operation on water.
(m) Fixed or retractable landing gear for a glider.

2. Issue of an airworthiness certificate

(a) *Eligibility*. To be eligible for a Special airworthiness certificate in the Light-Sport category an applicant must provide the FAA with:
  (i) The aircraft's operating instructions
  (ii) The aircraft's maintenance and inspection procedures
  (iii) The manufacturer's statement of compliance as described in paragraph 21.190(c)
  (iv) The aircraft's flight training supplement.
  The aircraft must not have been previously issued a Standard, Primary, Restricted, Limited, or Provisional airworthiness certificate, or an equivalent airworthiness certificate issued by a foreign civil aviation authority.
  The aircraft must be inspected by the FAA and found to be in a condition for safe operation.

(b) *Manufacturer's statement of compliance for Light-Sport category aircraft.* The content of the manufacturer's statement to be provided is described in paragraph 21.190(c). In particular, the document shall state the compliance with the provisions of the **consensus standard**. **Consensus standard** means, for the purpose of certificating Light-Sport aircraft, an industry-developed consensus standard that applies to aircraft design, production, and airworthiness. It includes, but is not limited to, standards for aircraft design and performance, required equipment, manufacturer quality assurance systems, production acceptance test procedures, operating instructions, maintenance and inspection procedures, identification and recording of major repairs and major alterations, and continued airworthiness.

(c) *Light-Sport aircraft manufactured outside the United States*. For aircraft manufactured outside of the United States to be eligible for a Special airworthiness certificate in the Light-Sport category, an applicant must meet the requirements of eligibility and provide to the FAA evidence that:
  (i) The aircraft was manufactured in a country with which the United States has a Bilateral Airworthiness Agreement concerning airplanes or Bilateral Aviation Safety Agreement with associated Implementation Procedures for Airworthiness concerning airplanes, or an equivalent airworthiness agreement
  (ii) The aircraft is eligible for an airworthiness certificate, flight authorization, or other similar certification in its country of manufacture.

3. General remarks

The recent institution of this new category of aircraft in the United States, with special certification, could represent a revolution in the general aviation arena.

The boom of general aviation in the United States has been exhausted for a long time, mainly for economic reasons caused by many factors.

In order to create a revival in the field of the sport and recreational aviation, the FAA, after several years of study and discussions, issued on 1 September 2004 the new rules for the **Light-Sport aircraft (LSA)** relating to the certification of such aircraft, but also to the licenses to operate them.

These rules, recommended for some time by the Experimental Aircraft Association (EAA), aim to make it possible to fly a variety of machines characterized by a low cost of production and operation and with pilot's licenses obtainable in simplified manner. Significantly, it is possible to credit sport pilot flight time toward more advanced pilot ratings.

According to an FAA summary:

> *The intended effect of this action is to provide for the manufacture of safe and economical certificated aircraft that exceed the limits currently allowed by ultralight regulation, and to allow operation of these aircraft by certificated pilots for sport and recreation, to carry a passenger, and to conduct flight training and towing in a safe manner.*

A sport pilot may exercise flight privileges in one or more of the following aircraft categories:

(a) Aeroplane (single-engine only)
(b) Sailplane
(c) Lighter-than-air craft (airship or balloon)
(d) Rotorcraft (gyroplane only)
(e) Powered parachute
(f) Weight-shift control aircraft (e.g. trikes).

We mentioned the limitations stated by the rules in the definition.

The certification of these aircraft excludes a type certification. The FAA issues a Special airworthiness certificate for a Light-Sport category aircraft on the basis of a manufacturer's statement of compliance to an above-mentioned **consensus standard**. In particular, the airworthiness standard mentioned in the definition of consensus standard could be a new one or a standard already accepted by the FAA.

The statement of conformity to a consensus standard, which is accepted (but not approved) by the FAA, actually involves an autocertification. In any case, the FAA must be allowed by the manufacturer to have unrestricted access to its facilities, and perform a final inspection for the issue of the airworthiness certificate.

Other attractive privileges are the possibility of obtaining an **Experimental airworthiness certificate** for the operation of Light-Sport aircraft, if the aircraft was assembled from an eligible kit without the supervision and quality system of the manufacturer. In this case, the assemblage is without the burden of the 51 per cent imposed to the amateur-built aircraft.[13]

The aircraft can be used only for the purpose of sport and recreation and for flight training.

The continued airworthiness of Light-Sport aircraft issued Experimental certificates would follow the experience and precedent that has been established for the continued airworthiness of experimental amateur-built aircraft. The aircraft owner would be responsible for ensuring the continued airworthiness of the aircraft.

There is great expectation in the United States for the success of this initiative, which could really change general aviation. This could allow more people, who before would have considered it too costly or bureaucratic, to approach recreational flight.

The big FAA initiatives normally lead to fall-out in the rest of the world. For example, Transport Canada is looking at this new category of aircraft in order to revisit existing rules and regulations for adapting licensing regulations and certification procedures for light aircraft to the US model.

This kind of harmonization is likely to foster the establishment of a very large market in North America for Light-Sport aircraft.

What about Europe? The EASA, having (rightly) given priority to commercial aviation, does not seem so keen to change things in the field of sport in general aviation and is not likely to follow Transport Canada's example, at least for the time being.

As described before, dealing with 'EASA certification', aircraft excluded by Annex II are under the direct ruling of the Member States' authorities.

The rules and procedures adopted by the various Member State authorities for this type of aircraft have never been harmonized; a variety of behavior and some confusion can be found, for example, in the field of ultralights, which in many cases are no longer ultralights, but true aeroplanes.

The adoption of a regulation bearing similarity with the FAA Light-Sport aircraft could satisfy the exigencies of basic aviation, without the necessity of adopting special material and expensive techniques to stay within the weight limits of the current rules for ultralights, which may be adequate for *true* ultralights, but are too low for aeroplanes.

This could be realized by a *voluntary* initiative of some national authorities with the Agency's supervision, leading to an improvement of the safety and, finally, to the development of a large European market and possibilities of exchanges with the American market.

To simplify the task it could be possible, for instance, to begin with the aeroplanes that represent the most critical sector of light aircraft.

This approach might seem optimistic and utopian. Nevertheless, we must not forget that in the 1970s some national authorities began to co-operate *voluntarily* in order to set up common rules and procedures, leading the way to the JAA and finally to the EASA.

8.5.2.5 Experimental certificates of airworthiness

1. Definition

The Experimental certificates of airworthiness are issued for aircraft that are not type certificated, and to type certificated aircraft that embody non-approved changes or likely to exceed the approved limitations.

There are various types of Experimental certificates of airworthiness issued for different purposes. We will now list these certificates and then explain their utilization:

(a) Research and development
(b) Showing compliance with regulations
(c) Crew training
(d) Exhibition
(e) Air racing
(f) Market surveys
(g) Operating amateur-built aircraft
(h) Operating primary kit-built aircraft
(i) Operating a Light-Sport aircraft.

(a) Research and development

Testing new aircraft design concepts, new aircraft equipment, new aircraft installations, and new aircraft operating techniques or new uses for aircraft.

In order to better understand what we are referring to, we can take the example of a person who wants to test a new type of engine (even an engine of new conception) installed on a type certificated aircraft and, at least in the short term, who is not interested in achieving a type certificate (or Supplemental type certificate).

Flights carried out with such aircraft must not have consequences from a type certification point of view. The authority's intervention in such a case should be limited to general information about the activities to be performed by the applicant in order to establish some limitations which must essentially be of operative nature (i.e. areas over which the experiments will be conducted and how to reach such areas).[14] The authority will not perform flight tests for the issue of a certificate of airworthiness.

(b) Showing compliance with regulations

This pertains to conducting flight tests and other operations to show compliance with the airworthiness regulations, including flights to show compliance for issuance of type and Supplemental type certificates, flights to substantiate major design changes, and flights to show compliance with the function and reliability requirements of the regulations.

In this case the authority's involvement is quite different because the flight tests to be performed are inherent to the type certification. It is important to be aware of the aircraft's configuration and the state of demonstration of compliance already carried out.[15] The flight envelope cannot

be frozen because flight tests are carried out in order to gradually enlarge the same. Hence the applicant must agree with the authority about the criteria necessary to fix the limitations for each flight test and for gradual enlargement of the flight envelope.

(c) Crew training

Regarding training of the applicant's flight crews, the certificate of airworthiness is normally issued during the type certification process in order to train the applicant's crews for type certification or mass production test flights.

In this case also, the aircraft is involved in a type certification process. Then the remarks made in subsection (b) are still valid, with the exception of the authorized flight envelope, which should be well defined and explored.

(d) Exhibition

This refers to: exhibition of the aircraft's flight capabilities, performance, or unusual characteristics at air shows; motion pictures, television, and similar productions; and the maintenance of exhibition flight proficiency, including (for persons exhibiting aircraft) flying to and from such air shows and productions.

We will consider two cases:

(i) *Aircraft with type certification in process*. This case can be seen as an extension of the certificate of airworthiness for crew training. Sometimes, fortunately not often, an authorization is requested to perform maneuvers that should not be allowed even with a Standard certificate of airworthiness. The authority might allow such maneuvers (that must be well identified) if supported by serious justifications (structural analysis, flight tests, etc.).
(ii) *Other aircraft*. This case refers to 'non-type certificated aircraft' for which it is possible to express a judgement about a sufficient safety level for operations limited to those described in the certificate of airworthiness. This case is also interesting because of the possibility it offers in restoring historical or ex-military aircraft.

Note. It is worth remembering that aircraft certificated for exhibition are not allowed for indiscriminate tourist use, but only for the operations permitted by the certificate of airworthiness.

(e) Air racing

This refers to participation in air races, including (for such participants) practicing for such air races and flying to and from racing events. The description in subsection (d) is applicable, inclusive of the final note.

(f) Market surveys

Use of aircraft for purposes of conducting market surveys, sales demonstrations, and customer crew training:

(i) A manufacturer of aircraft within the United States may apply for an Experimental certificate for an aircraft that is to be used for market surveys, sales demonstrations, or customer crew training.

(ii) A manufacturer of aircraft engines who has altered a type certificated aircraft by installing different engines, manufactured by them within the United States, may apply for an Experimental certificate for that aircraft to be used for market surveys, sales demonstrations, or customer crew training if the basic aircraft, before alteration, was type certificated in one of the Normal, Acrobatic, Commuter, or Transport categories.
(iii) A private individual who has altered the design of a type certificated aircraft may apply for an experimental certificate for the altered aircraft to be used for market surveys, sales demonstrations, or customer crew training if the basic aircraft, before alteration, was type certificated in one of the Normal, Utility, Acrobatic, or Transport categories.

(g) Operating amateur-built aircraft

This refers to operating an aircraft in which the major part has been fabricated and assembled by persons who undertook the construction project solely for their own education or recreation.

For this type of aircraft, the demonstration of compliance to airworthiness standards is not required. Furthermore, the certification of the builder for design or production organization is not required.

The authority (or delegate organization) control of amateur-built aircraft is quite different from the control performed in other cases. The aim of these controls is to ascertain the technical skill of the applicant for building the aircraft, a sufficient qualitative level of construction and assembly, and flight behavior that obviously must not be perilous.

The authority does not have the responsibility of guaranteeing to third persons (customers, for example) the airworthiness of the aircraft; hence, formalities like material certificates of origin and standardized procedures can be avoided. It is important to investigate the means by which the amateur builder is able to guarantee him or herself (he or she is going to operate the aircraft) about the adequacy of materials and parts, technical processes, and checks. All this establishes a peculiar relationship between the authority and the applicant, and implies a great sensibility and experience of the professional controlling the construction, whose experience is sometimes integrated with the amateur builder's.[16]

We will consider two categories of amateur-built aircraft:

(i) Aircraft already certificated somewhere as amateur-built aircraft
(ii) Aircraft of a new design.

The first is a 'relaxed' case because, knowing that a certain type of aircraft is already flying (sometimes tens or even hundreds of units) allows the limitations of controls to a good realization of the design according to the drawings and instructions provided by the design holder, who sometimes supplies a kit of parts and materials.[17]

In the case of a new design, even if compliance to an airworthiness standard is not required, a design made by one or more competent persons should be presented. The authority does not require the design documentation, but it should be informed about the design criteria, the

tests to be performed, and the standards taken as reference (not necessarily the type certification standards required for similar aircraft).

Analogous remarks are valid for major changes in aircraft described in the former case.

Amateur-built aircraft must be provided with a flight manual and instructions for continued airworthiness. The amateur builder is responsible for the maintenance of the aircraft, which could be directly performed by him or her, if capable, or by maintenance organizations.

(h) Operating primary kit-built aircraft

This refers to operation of a Primary category aircraft that meets the criteria of paragraph 21.24(a)(1)[18] that was assembled by a person from a kit manufactured by the holder of a production certificate for that kit, without the supervision and quality control of the production certificate holder.

(i) Operating Light-Sport aircraft

Operating a Light-Sport aircraft that has been assembled:

(i) From an aircraft kit for which the applicant can provide the information required by paragraph 21.193(e),[19] and
(ii) In accordance with manufacturer's assembly instructions that meet an applicable consensus standard, or
(iii) It has been previously issued a Special airworthiness certificate in the Light-Sport category.

8.5.3 Special flight permits

8.5.3.1 Definition

A special flight permit may be issued for an aircraft that may not currently meet applicable airworthiness requirements but is capable of safe flight, for the following purposes:

1 Flying the aircraft to a base where repairs, alterations, or maintenance are to be performed, or to a point of storage.
2 Delivering or exporting the aircraft.
3 Production flight testing new production aircraft.
4 Evacuating aircraft from areas of impending danger.
5 Conducting customer demonstration flights in new production aircraft that have satisfactorily completed production flight tests.

A special flight permit may also be issued to authorize the operation of an aircraft at a *weight in excess* of its maximum certificated take-off weight for flight beyond the normal range over water, or over land areas where adequate landing facilities or appropriate fuel is not available. The excess weight that may be authorized is limited to the additional fuel, fuel-carrying facilities, and navigation equipment necessary for the flight.

Upon application, a special flight permit with a continuing authorization may be issued for aircraft that may not meet applicable airworthiness requirements but are capable of safe flight for the purpose of flying aircraft to a base where maintenance or alterations are to be performed.

8.5.3.2 Issue of special flight permits

In order to issue a special flight permit, the authority will gather all the necessary information for the purpose of prescribing operating limitations and may make, or require, the applicant to make appropriate inspections or tests necessary for safety.

8.5.4 Provisional airworthiness certificates

We will try to give a reasonable summary of this rather complex subject.

8.5.4.1 Definition

A Special airworthiness certificate in the Provisional category is issued to conduct *special purpose* operations[20] of aircraft with Provisional type certificates. The duration of this airworthiness certificate is limited to the duration of the provisional type certificate. Two classes of Provisional type certificates may be issued. Class I certificates may be issued for all categories and have a duration of 24 months. Class II certificates are issued for Transport category aircraft only and have a duration of 12 months.

Subpart C of FAR 21 contains procedural requirements for the issue of provisional type certificates, amendments to Provisional type certificates, and provisional amendments to type certificates, and rules governing the holders of those certificates.

8.5.4.2 Eligibility

As reported in FAR 21:

1 Any manufacturer of aircraft within the United States who is a United States citizen may apply for Class I or Class II Provisional type certificates, for amendments to Provisional type certificates they hold, and for provisional amendments to type certificates they hold.
2 Any manufacturer of aircraft in a foreign country with which the United States has an agreement for the acceptance of those aircraft for export and import may apply for a Class II Provisional type certificate, for amendments to Provisional type certificates they hold, and for provisional amendments to type certificates they hold.
3 An aircraft engine manufacturer who is a United States citizen and who has altered a type certificated aircraft by installing different type certificated aircraft engines manufactured by him within the United States may apply for a Class I Provisional type certificate for the aircraft and for amendments to Class I Provisional type certificates he holds, if the basic

aircraft, before alteration, was type certificated in one of the Normal, Utility, Acrobatic, Commuter, or Transport categories.

8.5.4.3 Requirements for issue and amendment of Class II Provisional airworthiness certificates

Subpart C prescribes requirements based on the compliance of the aircraft with certain applicable paragraphs of operational standards like FAR 91 and 121, compliance with the applicable type certification requirements of the basic aircraft, flight tests performed, inspection and maintenance programs, etc. and, of course, compliance with Subpart C of FAR 21.

Below is an FAA comment on these airworthiness certificates, in view of a revision of FAR 21:

Originally, the FAA viewed provisional TCs as a means to efficiently help incorporate early jet engine-equipped aircraft into the national airspace system. This need arose because airlines sought early delivery of these near-TC aircraft to facilitate flight crew training and route planning. This, however, is no longer the case for modern aircraft. The need for provisional TCs has become less clear.

For small aircraft, the FAA viewed provisional TCs as a means of addressing safety concerns by allowing operators to fly aircraft with experimental airworthiness certificates for market surveys and crew training only. Even though the FAA would authorize such flight operations, provisional TCs and airworthiness certificates were deemed to be a higher safety standard than experimental airworthiness certificates.

However, over the years, operators have shown they can safely fly aircraft that are issued experimental airworthiness certificates under 14 CFR paragraph 21.191, thereby eliminating the need for provisional TCs. We will explore this more as the 14 CFR Part 21 project advances.

8.5.5 Export Airworthiness Approvals

8.5.5.1 Types of approval

1 Export Airworthiness Approval of Class I products is issued in the form of **Export certificates of airworthiness**. Such a certificate does not authorize the operation of aircraft.
2 Export Airworthiness Approval of Class II and III products is issued in the form of **airworthiness approval tags**.

8.5.5.2 Definitions

1 A Class I product is a complete aircraft, aircraft engine, or propeller, which:
   (a) Has been type certificated in accordance with the applicable Federal Aviation Regulations and for which Federal Aviation Specifications or type certificate data sheets have been issued; or

(b) Is identical to a type certificated product in all respects except as is otherwise acceptable to the civil aviation authority of the importing state.

2 A Class II product is a major component of a Class I product (e.g. wings, fuselages, empennage assemblies, landing gears, power transmissions, control surfaces, etc.), the failure of which would jeopardize the safety of a Class I product; or any part, material, or appliance, approved and manufactured under the Technical Standard Order (TSO) system.

3 A Class III product is any part or component which is not a Class I or Class II product and includes standard parts, i.e. those designated as AN, NAS, SAE, etc.

4 The words 'newly overhauled' when used to describe a product mean that the product has not been operated or placed in service, except for functional testing, since having been overhauled, inspected, and approved for return to service in accordance with the applicable Federal Aviation Regulations.

8.5.5.3 Eligibility

1 Any exporter or their authorized representative may obtain an Export Airworthiness Approval for a Class I or Class II product.

2 Any manufacturer may obtain an Export Airworthiness Approval for a Class III product if the manufacturer has among their employees a designated representative of the Administrator who has been authorized to issue that approval, who holds for that product:
   (a) A production certificate
   (b) An approved Production Inspection System
   (c) An FAA Parts Manufacturer Approval (PMA), or
   (d) A Technical Standard Order authorization.

8.5.5.4 Issue of Export certificates of airworthiness for Class I products

An applicant is entitled to an Export certificate of airworthiness for a Class I product if that applicant shows at the time the product is submitted to the Administrator for Export Airworthiness Approval that it meets the following requirements, as applicable:

1 New or used aircraft manufactured in the United States must meet the airworthiness requirement for a standard US airworthiness certificate or meet the airworthiness certification requirements for a 'Restricted' airworthiness certificate.

2 New or used aircraft manufactured outside the United States must have a valid US Standard airworthiness certificate.

3 Used aircraft must have undergone an annual type inspection and be approved for return to service in accordance with the applicable requirements.

4 New engines and propellers must conform to the type design and must be in a condition for safe operation.

5 Used engines and propellers which are not being exported as part of a certificated aircraft must have been newly overhauled.

6 The special requirements of the importing country must have been met.

A product does not need to meet a requirement specified in the above-mentioned paragraphs, as applicable, if acceptable to the importing country and the importing country indicates that acceptability on the basis of a written statement; the requirements that are not met and the differences in configuration, if any, between the product to be exported and the related type certificated product are listed as exceptions on the Export Airworthiness Approval.

8.5.5.5 Issue of airworthiness approval tags for Class II products

An applicant is entitled to an Export Airworthiness Approval tag for Class II products if that applicant shows that:

1 The products are new or have been newly overhauled and conform to the approved design data.
2 The products are in a condition for safe operation.
3 The products are identified with at least the manufacturer's name, part number, model designation (when applicable), and serial number or equivalent.
4 The products meet the special requirements of the importing country.

A product does not need to meet a requirement specified in the above-mentioned paragraphs, as applicable, if acceptable to the importing country and the importing country indicates that acceptability on the basis of a written statement; the requirements that are not met and the differences in configuration, if any, between the product to be exported and the related type certificated product are listed as exceptions on the Export Airworthiness Approval.

8.5.5.6 Issue of Export Airworthiness Approval tags for Class III products

An applicant is entitled to an Export Airworthiness Approval tag for Class III products if that applicant shows that:

1 The products conform to the approved design data applicable to the Class I or Class II product of which they are a part.
2 The products are in a condition for safe operation.
3 The products comply with the special requirements of the importing country.

A product does not need to meet a requirement specified in the above-mentioned paragraphs, as applicable, if acceptable to the importing country and the importing country indicates that acceptability on the basis of a written statement; the requirements that are not met and the differences in configuration, if any, between the product to be exported and the related type certificated product are listed as exceptions on the Export Airworthiness Approval.

8.5.5.7 General remarks on Export Airworthiness Approvals

In Chapter 5, the section 'Type certification of imported products' relates to the validation of a type certificate by the authority of the importing country.

The Export certificate of airworthiness does not authorize flight operations; as previously mentioned, it is essentially a statement of conformity to the type certificate of the **importing** country, including additional requirements for import and a list of possible non-conformities accepted by the authority of the importing country.

Therefore, it is possible to issue an Export Airworthiness Approval for 'non-airworthy' aircraft as well.

8.6 Additional airworthiness requirements for operation

8.6.1 Introduction

The operational life of an aircraft begins with the issue of a certificate of airworthiness or equivalent document, as has been shown in this chapter.

We have described that such a certificate can be issued either because the aircraft has been found to comply with a type certificate or, having not met (or have not been shown to meet) applicable certification specifications, it has been found to be capable of safe flight under defined conditions.

Because the same aircraft can be used in different kinds of operations, besides the basic certification requirements the aircraft also has to satisfy the requirements issued by the authority for each particular kind of operation.

For example, a single-engine FAR 23 airplane can be operated for personal use or for compensation or hire (aerotaxi, aerial working, etc.), but also according to different flight rules (VFR, IFR, etc.). Depending on the particular type of operation allowed, additional airworthiness requirements, which influence the airplane's configuration, shall be complied with (equipment, instruments, etc.).

To better illustrate the above remarks, Figure 8.1 presents a summary of the certification of an aircraft from design to operation.

Starting from the airworthiness and environmental standards (1), through the type certification process (2), a type certificate is issued (3). In order to obtain a certificate of airworthiness (6), it is necessary to take into consideration the additional requirements for operation (4) and carry out a demonstration of compliance for the relevant kinds of operation to be authorized (5) (if not already incorporated in the type certificate).

Figure 8.1 also considers the case of aircraft that, having not met (or having not been shown to meet) applicable certification specifications (according to Subpart H of FAR 21/EASA Part 21) (7), have been found to be capable of safe flight under defined conditions (8); they must be demonstrated to comply with additional airworthiness requirements for operations, if applicable (5), in order to obtain a certificate of airworthiness or a permit to fly (9).

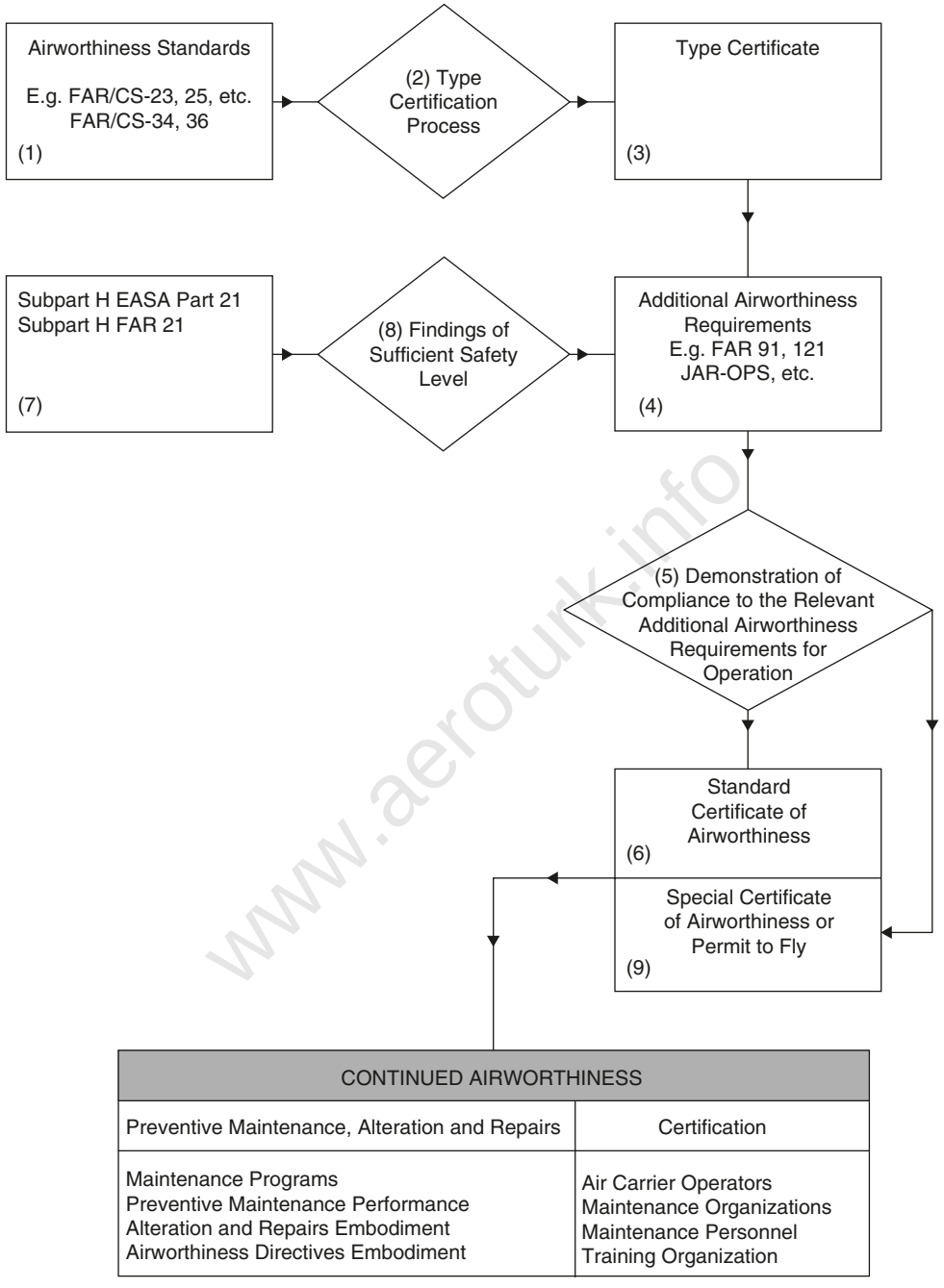


Figure 8.1 *Summary of the certification of an aircraft from design to operation*

It is correct to recognize that Figure 8.1 is a schematic simplification, because in many cases aircraft are type certificated in consideration of operating rules, then with operational requirements already incorporated in the type certification basis: this is quite normal for Large Transport category aircraft.

8.6.2 Operational standards

Operational standards prescribe requirements for the operation of aircraft, including prescriptions for the certification of operators, and in particular their organization, procedures, manuals, crew employment and training, equipment, aircraft adequacy and maintenance, transport of dangerous goods, and protection against acts of unlawful interference.

This means that these operational standards, already listed in Chapter 4,[21] are complex and lengthy documents, which we will attempt to summarize. We will also mention their 'applicability' and *partially* report some significant paragraphs or titles – significant for the scope of this book – related to additional airworthiness requirements.

We will consider:

1 The FAA standards FAR 91, 121, 125, 129, 135, and 137.
2 The EASA/JAA standards JAR-OPS 1, JAR-OPS 3, and CS-AWO.

8.6.2.1 Definitions

We will list some definitions in order to better understand the content of the above-mentioned operational standards.

Air carrier means a person who undertakes directly by lease, or other arrangement, to engage in air transportation.

Air commerce means interstate, overseas, or foreign air commerce or the transportation of mail by aircraft or any operation or navigation of aircraft within the limits of any Federal airway or any operation or navigation of aircraft which directly affects, or which may endanger safety in, interstate, overseas, or foreign air commerce.

Category II operation, with respect to the operation of aircraft, means a straight-in ILS approach to the runway of an airport under a Category II ILS instrument approach procedure issued by the Administrator or other appropriate authority.

Category III operation, with respect to the operation of aircraft, means an ILS approach to, and landing on, the runway of an airport using a Category III ILS instrument approach procedure issued by the Administrator or other appropriate authority.

Commercial operator means a person who, for compensation or hire, engages in the carriage by aircraft in air commerce of persons or property, other than as an air carrier or foreign air carrier or under the authority of FAR 375. Where it is doubtful that an operation is for 'compensation or hire', the test applied is whether the carriage by air is merely incidental to the person's other business or is, in itself, a major enterprise for profit.

Commuter operation means any scheduled operation conducted by any person operating one of the following types of aircraft with a frequency of operations of at least five round trips per week on at

least one route between two or more points according to the published flight schedules: (1) airplanes, other than turbojet-powered airplanes, having a maximum passenger-seat configuration of nine seats or less, excluding each crew member seat, and a maximum payload capacity of 7500 lb or less; or (2) rotorcraft.

Domestic operation means any scheduled operation conducted by any person operating any airplane described in paragraph (1) of this definition at locations described in paragraph (2) of this definition:

(1) Airplanes – (i) turbojet-powered airplanes; (ii) airplanes having a passenger-seat configuration of more than nine passenger seats, excluding each crewmember seat; or (iii) airplanes having a payload capacity of more than 7500 lb.

(2) Locations – (i) between any points within the 48 contiguous States of the United States or the District of Columbia; or (ii) operations solely within the 48 contiguous States of the United States or the District of Columbia; or (iii) operations entirely within any State, territory, or possession of the United States.

Flag operation means any scheduled operation conducted by any person operating any airplane described in paragraph (1) of this definition at the locations described in paragraph (2) of this definition:

(1) Airplanes – (i) turbojet-powered airplanes; (ii) airplanes having a passenger-seat configuration of more than nine passenger seats, excluding each crew member seat; or (iii) airplanes having a payload capacity of more than 7500 lb.

(2) Locations – (i) between any point within the State of Alaska; or (ii) between any point within the 48 contiguous States of the United States or the District of Columbia and any point outside the 48 contiguous States of the United States and the District of Columbia; (iii) between any point outside the USA and another point outside the USA.

Foreign air carrier means any person other than a citizen of the United States, who undertakes directly, by lease or other arrangement, to engage in air transportation.

Foreign air commerce means the carriage by aircraft of persons or property for compensation or hire, or the carriage of mail by aircraft, or the operation or navigation of aircraft in the conduct or furtherance of a business or vocation, in commerce between a place in the United States and any place outside thereof, whether such commerce moves wholly by aircraft or partly by aircraft and partly by other forms of transportation.

Foreign air transportation means the carriage by aircraft of persons or property as a common carrier for compensation or hire, or the carriage of mail by aircraft, in commerce between a place in the United States and any place outside of the United States, whether that commerce moves wholly by aircraft or partly by aircraft and partly by other forms of transportation.

Interstate air commerce means the carriage by aircraft of persons or property for compensation or hire, or the carriage of mail by aircraft, or the operation or navigation of aircraft in the conduct or furtherance of a business or vocation, in commerce between a place in any State of the United States, or the District of Columbia, and a place in any other State of the United States.

Interstate air transportation means the carriage by aircraft of persons or property as a common carrier for compensation or hire, or the carriage of mail by aircraft in commerce: between a place in a State or the District of Columbia and another place in another State.

Kind of operation means one of the various operations a certificate holder is authorized to conduct, as specified in its operations specifications, i.e. domestic, flag, supplemental, commuter, or on-demand operations.

Non-common carriage means an aircraft operation for compensation or hire that does not involve holding out to others.

On-demand operation means any operation for compensation or hire that is one of the following:

(1) Passenger-carrying operations conducted as a public charter … that are any of the following types of operations: (i) common carriage operations conducted with airplanes, including turbo-jet-powered airplanes, having a passenger-seat configuration of 30 seats or fewer, excluding each crew member seat, and a payload capacity of 7500 lb or less; (ii) non-common or private carriage operations conducted with airplanes having a passenger-seat configuration of less than 20 seats, excluding each crew member seat, and a payload capacity of less than 6000 lb; or (iii) any rotorcraft operation.

(2) Scheduled passenger-carrying operations conducted with one of the following types of aircraft with a frequency of operations of less than five round trips per week on at least one route between two or more points according to the published flight schedules: (i) airplanes, other than turbojet-powered airplanes, having a maximum passenger-seat configuration of nine seats or less, excluding each crew member seat, and a maximum payload capacity of 7500 lb or less; or (ii) rotorcraft.

(3) All-cargo operations conducted with airplanes having a payload capacity of 7500 lb or less, or with rotorcraft.

Overseas air commerce means the carriage by aircraft of persons or property for compensation or hire, or the carriage of mail by aircraft, or the operation or navigation of aircraft in the conduct or furtherance of a business or vocation, in commerce between a place in any State of the United States, or the District of Columbia, and any place in a territory or possession of the United States; or between a place in a territory or possession of the United States and a place in any other territory or possession of the United States.

Rating means a statement that, as a part of a certificate, sets forth special conditions, privileges, or limitations.

Supplemental operation means any common carriage operation for compensation or hire conducted with any airplane described in paragraph (1) of this definition that is a type of operation described in paragraph (2) of this definition:

(1) Airplanes: (i) airplanes having a passenger-seat configuration of more than 30 seats, excluding each crew member seat; (ii) airplanes having a payload capacity of more than 7500 lb; or (iii) each propeller-powered airplane having a passenger-seat configuration of more

than nine and less than 31 seats, excluding each crew member seat, that is also used in domestic or flag operations and that is so listed in the operations specifications as required by paragraph 119.49(a)(4) for those operations; or (iv) each turbojet-powered airplane having a passenger seat configuration of one or more and less than 31 seats, excluding each crew member seat, that is also used in domestic or flag operations and that is so listed in the operations specifications as required by paragraph 119.49(a)(4) for those operations.

(2) Types of operation: (i) operations for which the departure time, departure location, and arrival location are specifically negotiated with the customer or the customer's representative; (ii) all-cargo operations; or (iii) passenger-carrying public charter operations conducted under Part 380 of this title.

When 'common carriage is not involved' or 'operations not involving common carriage' means any of the following:

(1) Non-common carriage. (2) Operations in which persons or cargo are transported without compensation or hire. (3) Operations not involving the transportation of persons or cargo. (4) Private carriage.

Wet lease means any leasing arrangement whereby a person agrees to provide an entire aircraft and at least one crew member. A wet lease does not include a code-sharing arrangement.

8.7 FAA operational standards (additional airworthiness requirements)

8.7.1 FAR 91. General Operating and Flight Rules

Subpart A: General

91.1 Applicability

(a) Except as provided in paragraphs (b) and (c) of this section and FAR 91.701 and 91.703,[22] this part prescribes rules governing the operation of aircraft (other than moored balloons, kites, unmanned rockets, and unmanned free balloons, which are governed by FAR 101, and ultralight vehicles operated in accordance with FAR 103) within the United States, including the waters within three nautical miles of the US coast.

(b) Each person operating an aircraft in the airspace overlying the waters between three and 12 nautical miles from the coast of the United States must comply with FAR 91.1 through 91.21…

Subpart C: Equipment, Instrument, and Certificate Requirements

91.203 Civil aircraft: certifications required

(a) Except as provided in FAR 91.715,[23] no person may operate a civil aircraft unless it has within it the following: (1) an appropriate and current airworthiness certificate … .

(c) No person may operate an aircraft with a fuel tank installed within the passenger compartment or a baggage compartment unless the installation was accomplished pursuant to FAR 43, and a copy of FAA Form 337 authorizing that installation is on board the aircraft.

(d) No person may operate a civil airplane (domestic or foreign) into or out of an airport in the United States unless it complies with the fuel venting and exhaust emissions requirements of FAR 34.

91.205 Powered civil aircraft with Standard category US airworthiness certificates: instrument and equipment requirements

(a) *General.* Except as provided in paragraphs (c)(3) and (e) of this section, no person may operate a powered civil aircraft with a Standard category US airworthiness certificate in any operation described in paragraphs (b) through (f) of this section unless that aircraft contains the instruments and equipment specified in those paragraphs (or FAA-approved equivalents) for that type of operation, and those instruments and items of equipment are in operable condition.

(b) *Visual-flight rules (day).* For VFR flight during the day, the following instruments and equipment are required:

(1) Airspeed indicator. (2) Altimeter. (3) Magnetic direction indicator. (4) Tachometer for each engine. (5) Oil pressure gauge for each engine using pressure system. (6) Temperature gauge for each liquid-cooled engine. (7) Oil temperature gauge for each air-cooled engine … .

(c) *Visual flight rules (night).* For VFR flight at night, the following instruments and equipment are required:

(1) Instruments and equipment specified in paragraph (b) of this section. (2) Approved position lights. (3) An approved aviation red or aviation white anticollision light system on all US-registered civil aircraft. (4) If the aircraft is operated for hire, one electric landing light … .

(d) *Instrument flight rules.* For IFR flight, the following instruments and equipment are required:

(1) Instruments and equipment specified in paragraph (b) of this section, and, for night flight, instruments and equipment specified in paragraph (c) of this section. (2) Two-way radio communications system and navigational equipment appropriate to the ground facilities to be used. (3) Gyroscopic rate-of-turn indicator, except on the following aircraft: … .

(f) *Category II operations.*[24] The requirements for Category II operations are the instruments and equipment specified in: (1) paragraph (d) of this section; and (2) Appendix A to this FAR.

(g) *Category III operations.*[25] The instruments and equipment required for Category III operations are specified in paragraph (d) of this section.

(h) *Exclusions.* Paragraphs (f) and (g) of this section do not apply to operations conducted by a holder of a certificate issued under FAR 121 or FAR 135.

91.211 Supplemental oxygen

(a) *General.* No person may operate a civil aircraft of US registry:

(1) At cabin pressure altitudes above 12 500 feet (MSL) up to and including 14 000 feet (MSL) unless the required minimum flight crew is provided with and uses supplemental oxygen for that

part of the flight at those altitudes that is of more than 30 minutes duration. (2) At cabin pressure altitudes … .

(b) *Pressurized cabin aircraft.* (1) No person may operate a civil aircraft of US registry with a pressurized cabin:

(i) At flight altitudes above flight level 250 unless at least a 10-minute supply of supplemental oxygen, in addition to any oxygen required to satisfy paragraph (a) of this section, is available for each occupant of the aircraft for use in the event that a descent is necessitated by loss of cabin pressurization; and (ii) at flight altitudes above … .

91.213 Inoperative instruments and equipment

(a) Except as provided in paragraph (d) of this section, no person may take off an aircraft with inoperative instruments or equipment installed unless the following conditions are met:

(1) An approved minimum equipment list exists for that aircraft. (2) The aircraft has within it a letter of authorization, issued by the FAA Flight Standards district office… . (3) The approved minimum equipment list must (i) be prepared in accordance with the limitations specified in paragraph (b) of this section … .

(b) The following instruments and equipment may not be included in a minimum equipment list:

(1) Instruments and equipment that are either specifically or otherwise required by the airworthiness requirements under which the aircraft is type certificated and which are essential for safe operations under all operating conditions. (2) Instruments and equipment required by an Airworthiness Directive to be in operable condition unless the Airworthiness Directive provides otherwise. (3) Instruments and equipment required for specific operations by this FAR.

(c) A person authorized to use an approved minimum equipment list issued for a specific aircraft under Subpart K of this FAR 91, FAR 121, 125, or 135 must use that minimum equipment list to comply with the requirements in this section.

(d) Except for operations conducted in accordance with paragraph (a) or (c) of this section, a person may take off an aircraft in operations conducted under this part with inoperative instruments and equipment without an approved minimum equipment list provided:

(1) The flight operation is conducted in a (i) rotorcraft, non-turbine-powered airplane, glider, lighter-than-air aircraft, powered parachute, or weight-shift-control aircraft, for which a master minimum equipment list has not been developed … .

(e) Notwithstanding any other provision of this section, an aircraft with inoperable instruments or equipment may be operated under a special flight permit issued in accordance with FAR 21.197 and 21.199 of FAR 91.

The titles of the other paragraphs of Subpart C are:

91.215 ATC transponder and altitude reporting equipment and use
91.219 Altitude alerting system or device: turbojet-powered civil airplanes
91.223 Terrain awareness and warning system

Subpart D: Special Flight Operations

91.309 Towing: gliders and unpowered ultralight vehicles

(a) No person may operate a civil aircraft towing a glider or unpowered ultralight vehicle unless:

…

(2) The towing aircraft is equipped with a tow-hitch of a kind, and installed in a manner that is approved by the Administrator. (3) The towline used has breaking strength not less than 80 per cent of the maximum certificated operating weight of the glider. …

(i) A safety link is installed at the point of attachment of the towline to the glider … . (ii) A safety link is installed at the point of attachment of the towline to the towing aircraft. …

Subpart G: Additional Equipment and Operating Requirements for Large and Transport Category Aircraft

91.601 Applicability

This subpart applies to operation of Large and Transport category US-registered civil aircraft.

91.603 Aural speed warning device

No person may operate a Transport category airplane in air commerce unless that airplane is equipped with an aural speed warning device that complies with FAR 25.1303(c)(1).

91.609 Flight recorders and cockpit voice recorders

(a) No holder of an air carrier operating certificate or an operating certificate may conduct any operation under this part with an aircraft listed in the holder's operations specifications or current list of aircraft used in air transportation unless that aircraft complies with any applicable flight recorder and cockpit voice recorder requirements.

…

(f) In complying with this section, an approved cockpit voice recorder having an erasure feature may be used, so that at any time during the operation of the recorder, information recorded more than 15 minutes earlier may be erased or otherwise obliterated.

Subpart H: Foreign Aircraft Operations and Operations of U.S.-Registered Civil Aircraft Outside of the United States; and Rules Governing Persons on Board Such Aircraft

91.701 Applicability

(a) This subpart applies to the operations of civil aircraft of US registry outside of the United States and the operations of foreign civil aircraft within the United States.

(b) Section 91.702 of this subpart also applies to each person on board an aircraft operated as follows:

(1) A US registered civil aircraft operated outside the United States. (2) Any aircraft operated outside the United States … .

91.711 Special rules for foreign civil aircraft

(a) *General.* In addition to the other applicable regulations of this part, each person operating a foreign civil aircraft within the United States shall comply with this section. …

(c) *IFR.* No person may operate a foreign civil aircraft under IFR unless (1) that aircraft is equipped with:

(i) Radio equipment allowing two-way radio communication with ATC when it is operated in controlled airspace; and (ii) radio navigational equipment appropriate to the navigational facilities to be used; … .

(e) *Flight at and above FL 240.* If VOR navigational equipment is required under paragraph (c)(1)(ii) of this section, no person may operate a foreign civil aircraft within the 50 States and the District of Columbia at or above FL 240, unless the aircraft is equipped with distance measuring equipment (DME) capable of receiving and indicating distance information from the VORTAC facilities to be used … .

However, paragraph (e) of this section does not apply to foreign civil aircraft that are not equipped with DME when operated for the following purposes and if ATC is notified prior to each take off: (1) Ferry flights to and from a place in the United States where repairs or alterations are to be made … .

Subpart I: Operating Noise Limits

91.801 Applicability: in relation to FAR 36

(a) This subpart prescribes operating noise limits and related requirements that apply, as follows, to the operation of civil aircraft in the United States:

(1) Sections 91.803, 91.805, 91.807, 91.809, and 91.811 apply to civil subsonic jet (turbojet) airplanes with maximum weights of more than 75 000 lb. …

91.815 Agricultural and fire-fighting airplanes: noise operating limitations

(a) This section applies to propeller-driven, small airplanes having Standard airworthiness certificates that are designed for 'agricultural aircraft operations' (as defined in FAR 137.3 of this FAR 91, as effective on 1 January 1966) or for dispensing fire-fighting materials. …

91.817 Civil aircraft sonic boom

(a) No person may operate a civil aircraft in the United States at a true flight Mach number greater than 1 except in compliance with conditions and limitations in an authorization to exceed Mach 1 issued to the operator under Appendix B of this FAR.

(b) In addition, no person may operate a civil aircraft for which the maximum operating limit speed M_{M0} exceeds a Mach number of 1, to or from an airport in the United States, unless:

(1) Information available to the flight crew includes flight limitations that ensure that flights entering or leaving the United States will not cause a sonic boom to reach the surface within the United States.

(2) The operator complies with the flight limitations prescribed in paragraph (b)(1) of this section or complies with conditions and limitations in an authorization to exceed Mach 1 issued under Appendix B of this FAR 91.

8.7.2 FAR 121. Operating Requirements: Domestic, flag, and supplemental operations

Subpart A: General

121.1 Applicability

This part prescribes rules governing:

(a) The domestic, flag, and supplemental operations of each person who holds or is required to hold an Air Carrier Certificate or Operating Certificate under FAR 119.
(b) Each person employed or used by a certificate holder conducting operations under this part, including maintenance, preventive maintenance, and alteration of aircraft.
(c) Each person who applies for provisional approval … .
(d) Non-stop sightseeing flights conducted with airplanes having a passenger-seat configuration of 30 seats or fewer and a maximum payload capacity of 7500 lb or less that begin and end at the same airport … .

Subpart G: Manual Requirements

121.131 Applicability

This subpart prescribes requirements to prepare and maintain manuals by all certificate holders.

121.141 Airplane flight manual

(a) Each certificate holder shall keep a current approved airplane flight manual for each type of airplane that it operates … .

121.159 Single-engine airplanes prohibited

No certificate holder may operate a single-engine airplane under this part.

Subpart I: Airplane Performance Operating Limitations

121.171 Applicability

(a) This subpart prescribes airplane performance operating limitations for all certificate holders … .

121.173 General

(a) Except as provided in paragraph (c) of this section, each certificate holder operating a reciprocating engine-powered airplane shall comply with paragraphs 121.175 through 121.187.
(b) Except as provided in paragraph (c) of this section, each certificate holder operating a turbine engine-powered airplane shall comply with the applicable provisions of paragraphs 121.189 through 121.197, except when it operates:

(1) A turbo-propeller-powered airplane …

The titles of other paragraphs of this subpart are:

121.181 Airplanes: Reciprocating engine-powered – En route limitations – One engine inoperative
121.185 Airplanes: Reciprocating engine-powered – Landing limitations – Destination airport
121.187 Airplanes: Reciprocating engine-powered – Landing limitations – Alternate airport
121.189 Airplanes: Turbine engine powered – Take-off limitations
121.191 Airplanes: Turbine engine powered – En route limitations – One engine inoperative
121.193 Airplanes: Turbine engine powered – En route limitations – Two engines inoperative
121.195 Airplanes: Turbine engine powered – Landing limitations – Destination airports
121.197 Airplanes: Turbine engine powered – Landing limitations – Alternate airports
121.198 Cargo service airplanes: Increased zero fuel and landing weights
121.199 Non-transport category airplanes: Take-off limitations
121.201 Non-transport category airplanes: En route limitations – One engine inoperative
121.203 Non-transport category airplanes: Landing limitations – Destination airport
121.205 Non-transport category airplanes: Landing limitations – Alternate airport
121.207 Provisionally certificated airplanes: Operating limitations

Subpart J: Special Airworthiness Requirements

121.211 *Applicability*

(a) This subpart prescribes special airworthiness requirements applicable to certificate holders as stated in paragraphs (b) through (e) of this section … .

The titles of the paragraphs of this subpart are:

121.215 Cabin interiors
121.217 Internal doors
121.219 Ventilation
121.221 Fire precautions
121.223 Proof of compliance with paragraph 121.221
121.225 Propeller deicing fluid
121.227 Pressure cross-feed arrangements
121.229 Location of fuel tanks
121.231 Fuel system lines and fittings
121.233 Fuel lines and fittings in designated fire zones
121.235 Fuel valves
121.237 Oil lines and fittings in designated fire zones
121.239 Oil valves
121.241 Oil system drains
121.243 Engine breather lines
121.245 Firewalls
121.247 Firewall construction
121.249 Cowling
121.251 Engine accessory section diaphragm
121.253 Power plant fire protection
121.255 Flammable fluids
121.257 Shut-off means
121.259 Lines and fittings

121.261 Vent and drain lines
121.263 Fire-extinguishing systems
121.265 Fire-extinguishing agents
121.267 Extinguishing agent container pressure relief
121.269 Extinguishing agent container compartment temperature
121.271 Fire-extinguishing system materials
121.273 Fire-detector systems
121.275 Fire detectors
121.277 Protection of other airplane components against fire
121.279 Control of engine rotation
121.281 Fuel system independence
121.283 Induction system ice prevention
121.285 Carriage of cargo in passenger compartments
121.287 Carriage of cargo in cargo compartments
121.289 Landing gear: Aural warning device
121.291 Demonstration of emergency evacuation procedures
121.293 Special airworthiness requirements for non-transport category airplanes type certificated after 31 December 1964

Subpart K: Instrument and Equipment Requirements

121.301 Applicability

This subpart prescribes instrument and equipment requirements for all certificate holders.

The titles of paragraphs of this subpart are:

121.303 Airplane instruments and equipment
121.305 Flight and navigational equipment
121.306 Portable electronic devices
121.307 Engine instruments
121.308 Lavatory fire protection
121.309 Emergency equipment
121.310 Additional emergency equipment
121.311 Seats, safety belts, and shoulder harnesses
121.312 Materials for compartment interiors
121.313 Miscellaneous equipment
121.314 Cargo and baggage compartments
121.315 Cockpit check procedure
121.316 Fuel tanks
121.317 Passenger information requirements, smoking prohibitions, and additional seat belt requirements
121.318 Public address system
121.319 Crew member interphone system
121.321 [Reserved]
121.323 Instruments and equipment for operations at night
121.325 Instruments and equipment for operations under IFR or over-the-top

121.327 Supplemental oxygen: Reciprocating engine-powered airplanes
121.329 Supplemental oxygen for sustenance: Turbine engine-powered airplanes
121.331 Supplemental oxygen requirements for pressurized cabin airplanes: Reciprocating engine-powered airplanes
121.333 Supplemental oxygen for emergency descent and for first aid: Turbine engine-powered airplanes with pressurized cabins
121.335 Equipment standards
121.337 Protective breathing equipment
121.339 Emergency equipment for extended over-water operations
121.340 Emergency flotation means
121.341 Equipment for operations in icing conditions
121.342 Pitot heat indication systems
121.343 Flight recorders
121.344 Digital flight data recorders for Transport category airplanes
121.344a Digital flight data recorders for 10–19 seat airplanes
121.345 Radio equipment
121.347 Radio equipment for operations under VFR over routes navigated by pilotage
121.349 Radio equipment for operations under VFR over routes not navigated by pilotage or for operations under IFR or over-the-top
121.351 Radio equipment for extended over-water operations and for certain other operations
121.353 Emergency equipment for operations over uninhabited terrain areas: Flag, supplemental, and certain domestic operations
121.354 Terrain awareness and warning system
121.355 Equipment for operations on which specialized means of navigation are used
121.356 Collision avoidance system
121.357 Airborne weather radar equipment requirements
121.358 Low-altitude windshear system equipment requirements
121.359 Cockpit voice recorders
121.360 Ground proximity warning-glide slope deviation alerting system

8.7.3 FAR 125. Certification and Operations: Airplanes having a seating capacity of 20 or more passengers or a maximum payload capacity of 6000 lb or more; and rules governing persons on board such aircraft

Subpart A: General

125.1 Applicability

(a) Except as provided in paragraphs (b), (c), and (d) of this section, this part prescribes rules governing the operations of US-registered civil airplanes which have a seating configuration of 20 or more passengers or a maximum payload capacity of 6000 lb or more when common carriage is not involved.

(b) The rules of this part do not apply to the operations of airplanes specified in paragraph (a) of this section, when:

(1) They are required to be operated under Part 121, 129, 135, or 137 of this chapter. (2) They have been issued Restricted, Limited, or Provisional airworthiness certificates, special flight

permits, or Experimental certificates. (3) They are being operated by a Part 125 certificate holder without carrying passengers or cargo under Part 91 for training, ferrying, positioning, or maintenance purposes … .

(c) The rules of this FAR, except paragraph 125.247, do not apply to the operation of airplanes specified in paragraph (a) when they are operated outside the United States by a person who is not a citizen of the United States … .

Subpart E: Special Airworthiness Requirements

125.111 General

(a) Except as provided in paragraph (b) of this section, no certificate holder may use an airplane powered by airplane engines rated at more than 600 horsepower each for maximum continuous operation unless that airplane meets the requirements of paragraphs 125.113 through 125.181.
(b) If the Administrator determines that, for a particular model of airplane used in cargo service, literal compliance with any requirement under paragraph (a) of this section would be extremely difficult and that compliance would not contribute materially to the objective sought, the Administrator may require compliance with only those requirements that are necessary to accomplish the basic objectives of this part.
(c) This section does not apply to any airplane certificated under:

(1) CAR 4b in effect after 31 October 1946; (2) FAR 25; or (3) Special Civil Air Regulation 422, 422A, or 422B.

125.113 Cabin interiors

(a) Upon the first major overhaul of an airplane cabin or refurbishing of the cabin interior, all materials in each compartment used by the crew or passengers that do not meet the following requirements must be replaced with materials that meet these requirements … .
(b) Except as provided in paragraph (a) of this section, each compartment used by the crew or passengers must meet the following requirements:

(1) Materials must be at least flash resistant. (2) The wall and ceiling linings and the covering of upholstering, floors, and furnishings must be flame resistant. (3) Each compartment where smoking is to be allowed must be equipped … .

(c) Thermal/acoustic insulation materials … .

125.117 Ventilation

Each passenger or crew compartment must be suitably ventilated. Carbon monoxide concentration may not be more than one part in 20 000 parts of air, and fuel fumes may not be present … .

125.119 Fire precautions

(a) Each compartment must be designed so that, when used for storing cargo or baggage, it meets the following requirements … .

(b) *Class A*. Cargo and baggage compartments are classified in the 'A' category if a fire therein would be readily discernible to a member of the crew while at that crew member's station, and all parts of the compartment are easily accessible in flight. There must be a hand fire extinguisher available for each Class A compartment.
(c) *Class B*. Cargo and baggage compartments are classified in the 'B' category if enough access is provided while in flight to enable a member of the crew to effectively reach all of the compartment and its contents with a hand fire extinguisher and the compartment is so designed that, when the access provisions are being used, no hazardous amount of smoke, flames, or extinguishing agent enters any compartment occupied by the crew or passengers … .
(d) *Class C*. Cargo and baggage compartments are classified in the 'C' category if they do not conform to the requirements for the 'A', 'B', 'D', or 'E' categories … .
(e) *Class D*. Cargo and baggage compartments are classified in the 'D' category if they are so designed and constructed that a fire occurring therein will be completely confined without endangering the safety of the airplane or the occupants … .
(f) *Class E*. On airplanes used for the carriage of cargo only, the cabin area may be classified as a Class 'E' compartment … .

(1) It must be completely lined with fire-resistant material. (2) It must have a separate system of an approved type smoke or fire detector to give warning at the pilot or flight engineer station. (3) It must have a means to shut off the ventilating air flow … .

125.121 Proof of compliance with paragraph 125.119

Compliance with those provisions of paragraph 125.119 that refer to compartment accessibility, the entry of hazardous quantities of smoke or extinguishing agent into compartment occupied by the crew or passengers, and the dissipation of the extinguishing agent in Class 'C' compartments must be shown by tests in flight … .

125.121 Propeller deicing fluid

If combustible fluid is used for propeller deicing, the certificate holder must comply with paragraph 125.153.

The titles of the remaining paragraphs of this subpart are:

125.125 Pressure cross-feed arrangements
125.127 Location of fuel tanks
125.129 Fuel system lines and fittings
125.131 Fuel lines and fittings in designated fire zones
125.133 Fuel valves
125.135 Oil lines and fittings in designated fire zones
125.137 Oil valves
125.139 Oil system drains
125.141 Engine breather lines
125.143 Firewalls
125.145 Firewall construction

125.147 Cowling
125.149 Engine accessory section diaphragm
125.151 Power plant fire protection
125.153 Flammable fluids
125.155 Shut-off means
125.157 Lines and fittings
125.159 Vent and drain lines
125.161 Fire-extinguishing systems
125.163 Fire-extinguishing agents
125.165 Extinguishing agent container pressure relief
125.167 Extinguishing agent container compartment temperature
125.169 Fire-extinguishing system materials
125.171 Fire-detector systems
125.173 Fire detectors
125.175 Protection of other airplane components against fire
125.177 Control of engine rotation
125.179 Fuel system independence
125.181 Induction system ice prevention
125.183 Carriage of cargo in passenger compartments
125.185 Carriage of cargo in cargo compartments
125.187 Landing gear: Aural warning device
125.189 Demonstration of emergency evacuation procedures

Subpart F: Instrument and Equipment Requirements

125.201 Inoperable instruments and equipment

(a) No person may take off an airplane with inoperable instruments or equipment installed unless the following conditions are met:

(1) An approved minimum equipment list exists for that airplane … .

The titles of the remaining paragraphs of this subpart are:

125.201 Inoperable instruments and equipment
125.203 Radio and navigational equipment
125.204 Portable electronic devices
125.205 Equipment requirements: Airplanes under IFR
125.206 Pitot heat indication systems
125.207 Emergency equipment requirements
125.209 Emergency equipment: Extended over-water operations
125.211 Seat and safety belts
125.213 Miscellaneous equipment
125.215 Operating information required
125.217 Passenger information
125.219 Oxygen for medical use by passengers
125.221 Icing conditions: Operating limitations
125.223 Airborne weather radar equipment requirements

125.224 Collision avoidance system
125.225 Flight recorders
125.226 Digital flight data recorders
125.227 Cockpit voice recorders

8.7.4 FAR 129. Operations: Foreign air carriers and foreign operators of US-registered aircraft engaged in common carriage

129.1 Applicability and definitions

(a) *Foreign air carrier operations in the United States*. This part prescribes rules governing the operation within the United States of each foreign air carrier holding the following:

(1) A permit issued by the Civil Aeronautics Board or the US Department of Transportation under 49 USC 41301 through 41306 (formerly section 402 of the Federal Aviation Act of 1958, as amended), or (2) other appropriate economic or exemption authority issued by the Civil Aeronautics Board or the US Department of Transportation.

(b) *Operations of US-registered aircraft solely outside the United States*. In addition to the operations specified under paragraph (a) of this section, paragraphs 129.14, 129.16, 129.20, 129.32, and 129.33 also apply to US-registered aircraft operated solely outside the United States in common carriage by a foreign person or foreign air carrier.

(c) *Definitions*. For the purpose of this part:

(1) *Foreign person* means any person who is not a citizen of the United States and who operates a US-registered aircraft in common carriage solely outside the United States. (2) *Years in service* means the calendar time elapsed since an aircraft was issued its first US or first foreign airworthiness certificate.

129.13 Airworthiness and registration certificates

(a) Except as provided in paragraph 129.28(b) of this part, no foreign air carrier may operate any aircraft within the United States unless that aircraft carries current registration and airworthiness certificates issued or validated by the country of registry and displays the nationality and registration markings of that country.

(b) No foreign air carrier may operate a foreign aircraft within the United States except in accordance with the limitations on maximum certificated weights prescribed for that aircraft and that operation by the country of manufacture of the aircraft.

129.17 Radio equipment

(a) Subject to the applicable laws and regulations governing ownership and operation of radio equipment, each foreign air carrier shall equip its aircraft with such radio equipment as is necessary to properly use the air navigation facilities, and to maintain communications with ground stations, along or adjacent to their routes in the United States.

(b) Whenever VOR navigational equipment is required by paragraph (a) of this section, at least one distance measuring equipment unit (DME), capable of receiving and indicating distance information from the VORTAC facilities … .

129.18 Collision avoidance system

Effective 1 January 2005, any airplane you, as a foreign air carrier, operate under Part 129 must be equipped and operated according to the following table: …

129.19 Digital flight data recorders

No person may operate an aircraft under this part that is registered in the United States unless it is equipped with one or more approved flight recorders that use a digital method of recording and storing data … .

8.7.5 FAR 135. Operating Requirements: Commuter and on-demand operations and rules governing persons on board such aircraft

Subpart A: General

135.1 Applicability

(a) This part prescribes rules governing:

(1) The commuter or on-demand operations of each person who holds or is required to hold an Air Carrier Certificate or Operating Certificate under FAR 119.
(2) Each person employed or used by a certificate holder conducting operations under this part, including the maintenance, preventative maintenance, and alteration of an aircraft.
(3) The transportation of mail by aircraft conducted under a postal service contract … .
(4) Each person who applies for provisional approval of an Advanced Qualification Program curriculum, curriculum segment … .
(5) Non-stop sightseeing flights for compensation or hire that begin and end at the same airport, and are conducted within a 25 statute mile radius of that airport.
(6) Each person who is on board an aircraft being operated under this FAR.
(7) Each person who is an applicant for an Air Carrier Certificate or an Operating Certificate under FAR 119, when conducting proving tests.

135.25 Aircraft requirements

…

(d) A certificate holder may operate in common carriage, and for the carriage of mail, a civil aircraft which is leased or chartered to it without crew and is registered in a country which is a party to the Convention on International Civil Aviation if:

(1) The aircraft carries an appropriate airworthiness certificate issued by the country of registration and meets the registration and identification requirements of that country. (2) The aircraft is of a type design which is approved under a US type certificate and complies with all of the requirements of this chapter (14 CFR chapter I) that would be applicable to that aircraft were it registered in the United States, including the requirements which must be met for issuance of a US standard airworthiness certificate (including type design conformity, condition for safe operation, and the noise, fuel venting, and engine emission requirements of this chapter), except that a US registration certificate and a US standard airworthiness certificate will not be issued for the aircraft. …

8.7.6 FAR 137. Agricultural Aircraft Operations

Subpart A: General

137.1 Applicability

(a) This part prescribes rules governing:

(1) Agricultural aircraft operations within the United States; and
(2) The issue of commercial and private agricultural aircraft operator certificates for those operations.

(b) In a public emergency, a person conducting agricultural aircraft operations under this part may, to the extent necessary, deviate from the operating rules of this part for relief and welfare activities approved by an agency of the United States or of a State or local government.
(c) Each person who, under the authority of this section, deviates from a rule of this part. …

Subpart B: Certification Rules

137.11 Certificate required

(a) Except as provided in paragraphs (c) and (d) of this section, no person may conduct agricultural aircraft operations without, or in violation of, an agricultural aircraft operator certificate issued under this part.
(b) Notwithstanding FAR, an operator may, if he complies with this part, conduct agricultural aircraft operations with a rotorcraft with external dispensing equipment in place without a rotorcraft external-load operator certificate.
(c) A Federal, State, or local government conducting agricultural aircraft operations with public aircraft need not comply with this subpart.
(d) The holder of a rotorcraft external-load operator certificate under FAR 133 conducting an agricultural aircraft operation, involving only the dispensing of water on forest fires by rotorcraft external-load means, need not comply with this subpart.

Subpart C: Operating Rules

137.31 Aircraft requirements

No person may operate an aircraft unless that aircraft:

(a) Meets the requirements of paragraph 137.19(d);[26] and
(b) Is equipped with a suitable and properly installed shoulder harness for use by each pilot.

8.8 JAA/EASA operational standards (additional airworthiness requirements)

8.8.1 JAR-OPS 1. Commercial Air Transportation (Aeroplanes)

Subpart A: Applicability

JAR-OPS 1.001 Applicability

(a) JAR-OPS Part 1 prescribes requirements applicable to the operation of any civil aeroplane for the purpose of commercial air transportation by any operator whose principal

place of business and [if any, its registered office] is in a JAA Member State. JAR-OPS 1 does not apply:

(1) to aeroplanes when used in military, customs, and police services; nor (2) to parachute dropping and fire-fighting flights, and to associated positioning and return flights in which the persons carried are those who would normally be carried on parachute dropping or fire-fighting; nor (3) to flights immediately before, during, or immediately after an aerial work activity provided these flights are connected with that aerial work activity and in which, excluding crew members, no more than six persons indispensable to the aerial work activity are carried. …

Subpart B: General

JAR-OPS 1.030 Minimum equipment lists – Operator's responsibilities

(a) An operator shall establish, for each aeroplane, a minimum equipment list (MEL) approved by the authority. …

(b) An operator shall not operate an aeroplane other than in accordance with the MEL unless permitted by the authority. Any such permission will in no circumstances permit operation outside the constraints of the MMEL.

JAR-OPS 1.060 Ditching

An operator shall not operate an aeroplane with an approved passenger seating configuration of more than 30 passengers on over-water flights at a distance from land suitable for making an emergency landing, greater than 120 minutes at cruising speed, or 400 nautical miles, whichever is the lesser, unless the aeroplane complies with the ditching requirements prescribed in the applicable airworthiness code.

Subpart F: Performance General

JAR-OPS 1.470 Applicability

(a) An operator shall ensure that multi-engine aeroplanes powered by turbopropeller engines with a maximum approved passenger seating configuration of more than nine or a maximum take-off mass exceeding 5700 kg, and all multi-engine turbojet-powered aeroplanes are operated in accordance with Subpart G (Performance Class A).

(b) An operator shall ensure that propeller-driven aeroplanes with a maximum approved passenger seating configuration of nine or less, and a maximum take-off mass of 5700 kg or less are operated in accordance with Subpart H (Performance Class B).

(c) An operator shall ensure that aeroplanes powered by reciprocating engines with a maximum approved passenger seating configuration of more than nine or a maximum take-off mass exceeding 5700 kg are operated in accordance with Subpart I (Performance Class C).

(d) Where full compliance with the requirements of the appropriate Subpart cannot be shown due to specific design characteristics (e.g. supersonic aeroplanes or seaplanes), the operator shall apply approved performance standards that ensure a level of safety equivalent to that of the appropriate Subpart.

Subpart G: Performance Class A

JAR-OPS 1.485 General

(a) An operator shall ensure that, for determining compliance with the requirements of this Subpart, the approved performance data in the aeroplane flight manual is supplemented as necessary with other data acceptable to the authority if the approved performance data in the aeroplane flight manual is insufficient in respect of items such as:

(1) Accounting for reasonably expected adverse operating conditions such as take-off and landing on contaminated runways; and (2) consideration of engine failure in all flight phases.

(b) An operator shall ensure that, for the wet and contaminated runway case, performance data determined in accordance with JAR 25X1591 or equivalent acceptable to the authority is used.

The titles of the other Subpart G paragraphs are:

JAR-OPS 1.490 Take-off
JAR-OPS 1.495 Take-off obstacle clearance
JAR-OPS 1.500 En route – One engine inoperative
JAR-OPS 1.505 En route – Aeroplanes with three or more engines, two engines inoperative
JAR-OPS 1.510 Landing – Destination and alternate aerodromes
JAR-OPS 1.515 Landing – Dry runways
JAR-OPS 1.520 Landing – Wet and contaminated runways

Subpart H: Performance Class B

JAR-OPS 1.525 General

(a) An operator shall not operate a single-engine aeroplane:

(1) At night; or (2) in Instrument Meteorological Conditions except under Special Visual Flight Rules.

(b) An operator shall treat two-engine aeroplanes which do not meet the climb requirements of Appendix 1 to JAR-OPS 1.525(b) as single-engine aeroplanes.

The titles of the other paragraphs of Subpart H are:

JAR-OPS 1.530 Take-off
JAR-OPS 1.535 Take-off obstacle clearance – Multi-engine aeroplanes
JAR-OPS 1.540 En route – Multi-engine aeroplanes
JAR-OPS 1.542 En route – Single-engine aeroplanes
JAR-OPS 1.545 Landing – Destination and alternate aerodromes
JAR-OPS 1.550 Landing – Dry runway
JAR-OPS 1.555 Landing – Wet and contaminated runways

Subpart I: Performance Class C

JAR-OPS 1.560 General

An operator shall ensure that, for determining compliance with the requirements of this Subpart, the approved performance data in the aeroplane flight manual is supplemented, as necessary, with other data acceptable to the authority if the approved performance data in the aeroplane flight manual is insufficient.

The titles of the other Subpart I paragraphs are:

JAR-OPS 1.565 Take-off
JAR-OPS 1.570 Take-off obstacle clearance
JAR-OPS 1.575 En route – All engines operating
JAR-OPS 1.580 En route – One engine inoperative
JAR-OPS 1.585 En route – Aeroplanes with three or more engines, two engines inoperative

Subpart K: Instruments and Equipment

JAR-OPS 1.630 General introduction

(a) An operator shall ensure that a flight does not commence unless the instruments and equipment required under this Subpart are:

(1) Approved, except as specified in subparagraph (c), and installed in accordance with the requirements applicable to them, including the minimum performance standard and the operational and airworthiness requirements; and (2) in operable condition for the kind of operation being conducted except as provided in the MEL (JAR-OPS 1.030 refers).

(b) Instruments and equipment minimum performance standards are those prescribed in the applicable Joint Technical Standard Orders (JTSO) as listed in JAR-TSO, unless different performance standards are prescribed in the operational or airworthiness codes. …

(c) The following items shall not be required to have an equipment approval:

(1) Fuses referred to in JAR-OPS 1.635; (2) electric torches referred to in JAR-OPS 1.640(a)(4); (3) an accurate timepiece referred to in JAR-OPS 1.650(b) and 1.652(b); (4) chart holder referred to in JAR-OPS 1.652(n); (5) first-aid kits referred to in JAR-OPS 1.745. …

(d) If equipment is to be used by one flight crew member at his station during flight, it must be readily operable from his station. When a single item of equipment is required to be operated by more than one flight crew member it must be installed so that the equipment is readily operable from any station at which the equipment is required to be operated.

(e) Those instruments that are used by any one flight crew member shall be so arranged as to permit the flight crew member to see the indications readily from his station, with the minimum practicable deviation from the position and line of vision which he normally assumes when looking forward along the flight path. Whenever a single instrument is

required in an aeroplane operated by more than one flight crew member it must be installed so that the instrument is visible from each applicable flight crew station.

JAR-OPS 1.635 Circuit protection devices

An operator shall not operate an aeroplane in which fuses are used unless …

JAR-OPS 1.640 Aeroplane operating lights

An operator shall not operate an aeroplane unless it is equipped with:

(a) For flight by day:

(1) Anti-collision light system; (2) lighting supplied from the aeroplane's electrical system to provide adequate illumination for all instruments and equipment essential to the safe operation of the aeroplane; (3) lighting supplied from the aeroplane's electrical system to provide illumination in all passenger compartments; and (4) an electric torch for each required crew member readily accessible to crew members when seated at their designated station.

(b) For flight by night, in addition to equipment specified in paragraph (a) above:

(1) Navigation/position lights; and (2) two landing lights or a single light having two separately energized filaments; and (3) lights to conform to the international regulations for preventing collisions at sea if the aeroplane is a seaplane or an amphibian.

JAR-OPS 1.645 Windshield wipers

An operator shall not operate an aeroplane with a maximum certificated take-off mass of more than 5700 kg unless it is equipped at each pilot station with a windshield wiper or equivalent means to maintain a clear portion of the windshield during precipitation.

JAR-OPS 1.650 Day VFR operations: Flight and navigational instruments and associated equipment

An operator shall not operate an aeroplane by day in accordance with Visual Flight Rules (VFR) unless it is equipped with the flight and navigational instruments and associated equipment and, where applicable, under the conditions stated in the following subparagraphs:

(a) A magnetic compass.
(b) An accurate timepiece showing the time in hours, minutes, and seconds.
(c) A sensitive pressure altimeter calibrated in feet with a sub-scale setting, calibrated in hectopascals/millibars, adjustable for any barometric pressure likely to be set during flight.
(d) An airspeed indicator calibrated in knots.
(e) A vertical speed indicator.
(f) A turn and slip indicator, or a turn co-ordinator incorporating a slip indicator.
(g) An attitude indicator … .

JAR-OPS 1.652 IFR or night operations: Flight and navigational instruments and associated equipment

An operator shall not operate an aeroplane in accordance with Instrument Flight Rules (IFR) or by night in accordance with Visual Flight Rules (VFR) unless it is equipped with the flight and navigational instruments and associated equipment and, where applicable, under the conditions stated in the following subparagraphs:

(a) A magnetic compass.
(b) An accurate timepiece showing the time in hours, minutes, and seconds.
(c) Two sensitive pressure altimeters calibrated in feet with sub-scale settings, calibrated in hectopascals/millibars, adjustable for any barometric pressure likely to be set during flight. …
(d) An airspeed indicating system with heated pitot tube or equivalent means for preventing malfunctioning due to either condensation or icing, including a warning indication of pitot heater failure. …
(e) A vertical speed indicator.
(f) A turn and slip indicator.
(g) An attitude indicator. …

JAR-OPS 1.655 Additional equipment for single pilot operation under IFR

An operator shall not conduct single pilot IFR operations unless the aeroplane is equipped with an autopilot with at least altitude hold and heading mode.

JAR-OPS 1.660 Altitude alerting system

(a) An operator shall not operate a turbine propeller-powered aeroplane with a maximum certificated take-off mass in excess of 5700 kg or having a maximum approved passenger seating configuration of more than nine seats or a turbojet-powered aeroplane unless it is equipped with an altitude alerting system capable of:

(1) Alerting the flight crew upon approaching a preselected altitude; and (2) alerting the flight crew by at least an aural signal, when deviating from a preselected altitude, except for aeroplanes with a maximum certificated take-off mass of 5700 kg or less having a maximum approved passenger seating configuration of more than nine and first issued with an individual certificate of airworthiness in a JAA Member State before 1 April 1972 and already registered in a JAA Member State on 1 April 1995.

The titles of the other Subpart K paragraphs are:

JAR-OPS 1.665 Ground proximity warning system and terrain awareness warning system
JAR-OPS 1.668 Airborne collision avoidance system
JAR-OPS 1.670 Airborne weather radar equipment
JAR-OPS 1.675 Equipment for operations in icing conditions
JAR-OPS 1.680 Cosmic radiation detection equipment
JAR-OPS 1.685 Flight crew interphone system
JAR-OPS 1.690 Crew member interphone system

JAR-OPS 1.695 Public address system
JAR-OPS 1.700 Cockpit voice recorders
JAR-OPS 1.705 Cockpit voice recorders
JAR-OPS 1.710 Cockpit voice recorders
JAR-OPS 1.715 Flight data recorders
JAR-OPS 1.720 Flight data recorders
JAR-OPS 1.725 Flight data recorders
JAR-OPS 1.727 Combination recorder
JAR-OPS 1.730 Seats, seat safety belts, harnesses, and child restraint devices
JAR-OPS 1.731 Fasten Seat Belt and No Smoking signs
JAR-OPS 1.735 Internal doors and curtains
JAR-OPS 1.745 First-aid kits
JAR-OPS 1.750 Intentionally blank
JAR-OPS 1.755 Emergency medical kit
JAR-OPS 1.760 First-aid oxygen
JAR-OPS 1.765 Intentionally blank
JAR-OPS 1.770 Supplemental oxygen – Pressurized aeroplanes
JAR-OPS 1.775 Supplemental oxygen – Non-pressurized aeroplanes
JAR-OPS 1.780 Crew protective breathing equipment
JAR-OPS 1.785 Intentionally blank
JAR-OPS 1.790 Hand fire extinguishers
JAR-OPS 1.795 Crash axes and crowbars
JAR-OPS 1.800 Marking of break-in points
JAR-OPS 1.805 Means for emergency evacuation
JAR-OPS 1.810 Megaphones
JAR-OPS 1.815 Emergency lighting
JAR-OPS 1.820 Emergency locator transmitter
JAR-OPS 1.825 Life jackets
JAR-OPS 1.830 Life-rafts and survival ELTs for extended over-water flights
JAR-OPS 1.835 Survival equipment
JAR-OPS 1.840 Seaplanes and amphibians – Miscellaneous equipment

Subpart L: Communication and Navigation Equipment

The titles of the Subpart L paragraphs are:

JAR-OPS 1.845 General introduction
JAR-OPS 1.850 Radio equipment
JAR-OPS 1.855 Audio selector panel
JAR-OPS 1.860 Radio equipment for operations under VFR over routes navigated by reference to visual landmarks
JAR-OPS 1.865 Communication and navigation equipment for operations under IFR, or under VFR over routes not navigated by reference to visual landmarks
JAR-OPS 1.866 Transponder equipment
JAR-OPS 1.870 Additional navigation equipment for operations in MNPS airspace
JAR-OPS 1.872 Equipment for operation in defined airspace with reduced vertical separation minima (RVSM)

8.8.2 JAR-OPS 3. Commercial Air Transportation (Helicopters)

Subpart A: Applicability

JAR-OPS 3.001 Applicability

(a) JAR-OPS Part 3 prescribes requirements applicable to the operation of any civil helicopter for the purpose of commercial air transportation by any operator whose principal place of business is in a JAA Member State. JAR-OPS Part 3 does not apply:

(1) To helicopters when used in military, customs, police services, and SAR; nor
(2) To parachute dropping and fire-fighting flights, and to associated positioning and return flights in which the only persons carried are those who would normally be carried on parachute dropping or fire-fighting flights; nor
(3) To flights immediately before, during, or immediately after an aerial work activity provided these flights are connected with that aerial work activity and in which, excluding crew members, no more than six persons indispensable to the aerial work activity are carried. …

The scheme of JAR-OPS 3 is similar to JAR-OPS 1. The additional airworthiness requirements can be found in the corresponding paragraphs quoted for JAR-OPS 1.

The general layout of the document is:

JAR-OPS 3 Commercial Air Transportation (Helicopters)

Checklist of pages

Preamble

Section 1 – Requirements
Subpart A: Applicability
Subpart B: General
Subpart C: Operator Certification and Supervision
Subpart D: Operational Procedures
Subpart E: All Weather Operations
Subpart F: Performance General
Subpart G: Performance Class 1
Subpart H: Performance Class 2
Subpart I: Performance Class 3
Subpart J: Mass and Balance
Subpart K: Instruments and Equipment
Subpart L: Communication and Navigation Equipment
Subpart M: Helicopter Maintenance
Subpart N: Flight Crew
Subpart O: Crew Members other than Flight Crew
Subpart P: Manuals, Logs, and Records
Subpart Q: Flight and Duty Time Limitations and Rest Requirements
Subpart R: Transport of Dangerous Goods by Air

Subpart S: Security
Section 2 – Acceptable Means of Compliance (AMC)/Interpretative and Explanatory Material (IEM)

8.8.3 CS-AWO Certification Specification for All Weather Operations

The general layout of the document is reported here.

8.8.3.1 Book 1: Airworthiness Code

Subpart 1: Automatic Landing Systems
Subpart 2: Airworthiness Certification of Aeroplanes for Operations with Decision Heights Below 60 m (200 ft) Down to 30 m (100 ft) – Category 2 Operations
Subpart 3: Airworthiness Certification of Aeroplanes for Operations with Decision Heights Below 30 m (100 ft) or No Decision Height – Category 3 Operations
Subpart 4: Directional Guidance for Take-Off in Low Visibility

8.8.3.2 Book 2: Acceptable Means of Compliance

The following paragraphs report the applicability of the four Subparts.

Subpart 1. Automatic Landing Systems
General: CS-AWO 100 applicability and terminology

(a) Subpart 1 of this airworthiness code is applicable to aeroplanes which are capable of automatic landing carried out in association with an Instrument Landing System (ILS), a Microwave Landing System (MLS), or both. In addition, the automatic landing system must meet the requirements of CS-25.1329.
(b) The term 'automatic landing system' in this CS-AWO refers to the airborne equipment, which provides automatic control of the aeroplane during the approach and landing. It includes all of the sensors, computers, actuators, and power supplies necessary to control the aeroplane to touchdown. It also includes provisions to control the aeroplane along the runway during the landing rollout. In addition, it includes the indications and control necessary for its management and supervision by the pilot.

Subpart 2. Airworthiness Certification of Aeroplanes for Operations with Decision Heights Below 60 m (200 ft) and Down to 30 m (100 ft) – Category 2 Operations
General: CS-AWO 200 applicability and terminology

(a) Subpart 2 of this airworthiness code is applicable to aeroplanes for which certification is sought to allow the performance of approaches with decision heights below 60 m (200 ft) down to 30 m (100 ft) – Category 2 operations, using a precision approach system as defined in Annex 10 of the Chicago Convention, i.e. an Instrument Landing System (ILS), or a Microwave Landing System (MLS) which has outputs indicating the magnitude and sense of deviation from a preset azimuth and elevation angle giving equivalent operational characteristics to that of a conventional ILS.

(b) Terminology:

(1) The term 'approach system' used here refers only to the airborne system. It includes the equipment listed in CS-AWO 221 and all related sensors, instruments, and power supplies.
(2) 'Decision height' is the wheel height above the runway elevation by which a go-around must be initiated unless adequate visual reference has been established and the aircraft position and approach path have been visually assessed as satisfactory to continue the approach and landing in safety. Where it is used in this Subpart 2 it means the minimum decision height at which compliance with the requirements of this Subpart 2 have been demonstrated.
(3) A go-around is the transition from an approach to a stabilized climb.
(4) 'Failure condition' and terms describing the probabilities and effects of failure …

Subpart 3. Airworthiness Certification of Aeroplanes for Operations with Decision Height Below 30 m (100 ft) – Category 3 Operations

General: CS-AWO 300 applicability and terminology

(a) Subpart 3 of this airworthiness code is applicable to aeroplanes for which certification is sought to allow the performance of approaches with decision heights below 30 m (100 ft) or with no decision height – Category 3 operations, using a precision approach system as defined in Annex 10 of the Chicago Convention, i.e. an Instrument Landing System (ILS), or a Microwave Landing System (MLS) which has outputs indicating the magnitude and sense of deviation from a preset azimuth and elevation angle giving equivalent operational characteristics to that of a conventional ILS. The criteria are divided, where necessary, into those applicable to the following types of operation:

(1) Decision heights below 30 m (100 ft) but not less than 15 m (50 ft).
(2) Decision heights below 15 m (50 ft).
(3) No decision height.

(b) Terminology:

(1) The term 'landing system' used here refers only to the airborne system. It includes the equipment listed in JAR-AWO 321 and also all related sensors, instruments and power supplies.
(2) Automatic landing system: the airborne equipment which provides automatic control of the aeroplane during the approach and landing.
(3) Fail-passive automatic landing system: an automatic landing system is fail passive if, in the event of a failure, there is no significant out-of-trim condition or deviation of flight path or attitude but the landing is not completed automatically. For a fail-passive automatic landing system the pilot assumes control of the aircraft after a failure. …

Subpart 4. Directional Guidance for Take-Off in Low Visibility

CS-AWO 400 applicability and terminology

(a) Subpart 4 of this airworthiness code is applicable to aeroplanes for which certification is sought to allow the performance of take-off in lower visibilities than those which are sufficient to ensure that the pilot will at all times have sufficient visibility to complete or abandon the take-off safely. It is only concerned with directional guidance during the

ground-borne portion of the take-off (i.e. from start to main wheel lift-off, or standstill in the event of abandoned take-off).

(b) Take-off guidance system: a take-off guidance system provides directional guidance information to the pilot during the take-off or abandoned take-off. It includes all the airborne sensors, computers, controllers, and indicators necessary for the display of such guidance. Guidance normally takes the form of command information, but it may alternatively be situation (or deviation) information.

Notes

1 Special classes of aircraft: see 'FAR 21 Standard airworthiness certificates' section in this chapter.
2 For many years this concept has often been misleading. In fact, some authorities used to *require* a statement of conformity to **their own** type certificate for imported aircraft, and to *issue* a statement of conformity (also) to **their own** type certificate for exported aircraft, creating an unbalanced situation. The latest bilateral agreements have solved this problem.
3 See Chapter 7.
4 The definition is equivalent to the definition of the Standard certificate of airworthiness (JAR 21) or the Standard airworthiness certificate (FAR 21).
5 The modalities of this statement are prescribed in paragraph 21A.174.
6 'Standard' type certificate.
7 Obligations of the holder.
8 Special classes of aircraft include gliders (sailplanes for the Europeans) and powered gliders, airships, and other kinds of aircraft, which would be eligible for a Standard airworthiness certificate, but for which no FAA airworthiness standards have yet been established.
9 21.29 Issue of type certificate for import products manufactured in a foreign country with which the United States has an agreement for the acceptance of these products for export and import.
10 21.29 Issue of type certificate: import products.
11 21.183 Issue of standard airworthiness certificates for Normal, Utility, Acrobatic, Commuter, and Transport category aircraft, manned free balloons, and special classes of aircraft.
12 FAA Order 8130.2, 'Airworthiness Certification of Aircraft and Related Products', contains a list of aircraft models that have been issued Limited category type certificates.
13 As explained in the 'Operating amateur-built aircraft' section in this chapter, the main portion of the aircraft must be fabricated and assembled by persons who undertook the construction.
14 Normally the applicant has to produce a program of the experimentation and the number of flights he reckons as necessary.
15 For example, static tests, system and equipment assessments, etc.
16 It is worth mentioning that the authority does not have the task of teaching how to build an aircraft. Amateur builder associations, normally of a national nature, provide a valuable advisory activity.
17 In these cases the authority checks that the prefabricated parts are no more than 50 per cent (in terms of working hours) of the total. This (not always easy) evaluation has to be performed before the beginning of the construction.
18 For a Primary category aircraft type certificate.
19 Requirements for Light-Sport aircraft assembled from a kit.

20 The special purpose operations for which provisionally certificated aircraft may be operated are contained in FAR 91.317 and include: Training flight crews, including simulated air carrier operations; Demonstration flights by the manufacturer for prospective purchasers; Market surveys by the manufacturer; Flight checking of instruments, accessories, and equipment that does not affect the basic airworthiness of the aircraft; Service testing of aircraft.

21 The brief description of the standards in Chapter 4 gives a broad outline of their content, which does not appear so immediate from their 'applicability' paragraphs.

22 Paragraphs 701 and 703 belong to Subpart H of FAR 91, which applies to the operations of civil aircraft of US registry outside of the United States and the operations of foreign civil aircraft within the United States.

23 91.715 Special flight authorizations for foreign civil aircraft. Foreign civil aircraft may be operated without airworthiness certificates required under paragraph 91.203 if a special flight authorization for that operation is issued under this section.

24 *Category II operations*, with respect to the operation of aircraft, means a straight-in ILS approach to the runway of an airport under a Category II ILS instrument approach procedure issued by the Administrator or other appropriate authority.

25 *Category III operations*, with respect to the operation of aircraft, means an ILS approach to, and landing on, the runway of an airport using a Category III ILS instrument approach procedure issued by the Administrator or other appropriate authority.

26 137(d) *Aircraft.* The applicant must have at least one certificated and airworthy aircraft, equipped for agricultural operation.

Chapter 9

Flight Operation – Continued Airworthiness

9.1 Continued airworthiness

Safety must be ensured for all flight operations and aircraft must constantly be maintained in an airworthy state. This means that all maintenance operations listed in the relevant manuals and Airworthiness Directives[1] must be performed.

Continued airworthiness also depends on the particular organizations of operators and maintenance.

Therefore, in extreme synthesis, continued airworthiness is made by:

1 Maintenance
2 In a more general sense, certification of operators.[2]

9.1.1 Maintenance

From an airworthiness point of view, there is no such concept as an 'old'[3] aircraft: the term applied is 'used' aircraft. This means that the aircraft's age could influence its commercial value, but not its airworthiness conditions.

Typically, and this also applies to maintenance, we need to know:

1 **What** to do
2 **How** to do it
3 **Where** to do it
4 **Who** does it.

These points will now be expanded upon below.

1. The term 'maintenance' refers to preventive maintenance, alterations and repairs, and introduction of Airworthiness Directives. Airworthiness should depend on the maintenance programs, which also establish the replacement of time change items, the overhaul of engines, propellers, and various parts and appliances.

In Chapter 5 we illustrated that the JAR/FAR 21/EASA Part 21 require Instructions for Continued Airworthiness as a part of the product type certification, but also for the issue of Supplemental type certificates, for approval of changes to type design and major repairs.

Therefore, those instructions become the basic tool for the maintenance of the aircraft because they establish the basic maintenance program.

However, as for the aircraft configuration and the additional airworthiness requirements for operation, maintenance programs must also conform with the requirements of what we have called the 'operational standards' and other maintenance standards (like FAR 43 and EASA Part M). This will now be explained in more detail.

2. The above-mentioned Instructions for Continued Airworthiness, alongside the preventive maintenance programs, also contain the necessary instructions for this activity.[4] For extraordinary maintenance, like repairs, we have also seen that repair manuals are normally provided and, if not available or not covering the particular repair case, a repair design has to be approved.

The operational standards and other maintenance standards (like FAR 43 and EASA Part M) also establish the rules to be complied with for maintenance in relation to the type of aircraft and the kind of operation involved.

3. Apart from those particular cases, discussed in Chapter 8, of special certifications allowing the aircraft owner to perform the maintenance him or herself, the authorities issue requirements for aircraft operators with particular attention to the maintenance organizations. This will now be discussed further.

4. Associated with the certification of maintenance organization is the certification and training of personnel authorized to perform maintenance operation and issue certificates to release to service the authorized operation.

9.1.2 EASA continued airworthiness/maintenance

The EU Commission has approved EC Regulation No. 2042/2003 'On the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organizations and personnel involved in these tasks'.

An excerpt of this Regulation is given below.

Objective and scope

1 This Regulation establishes common technical requirements and administrative procedures for ensuring the continuing airworthiness of aircraft, including any component for installation thereto, which are:
   (a) Registered in a Member State, or
   (b) Registered in a third country and used by an operator for which a Member State ensures oversight of operations.
2 Paragraph 1 shall not apply to aircraft the regulatory safety oversight of which has been transferred to a third country and which are not used by a Community operator, or to aircraft referred to in Annex II to the basic Regulation.
3 The provisions of this Regulation related to commercial air transport are applicable to licensed air carriers as defined by Community law.

Continuing airworthiness requirements

1 The continuing airworthiness of aircraft and components shall be ensured in accordance with the provisions of **Annex I (Part M)**.
2 Organizations and personnel involved in the continuing airworthiness of aircraft and components, including maintenance, shall comply with the provisions of Annex I and where appropriate those specified in Articles 4 and 5.
3 By derogation from paragraph 1, the continuing airworthiness of aircraft holding a permit to fly shall, without prejudice to Community law, be ensured on the basis of the national regulations of the state of registry.

Maintenance organization approvals (Article 4)

Organizations involved in the maintenance of large aircraft or of aircraft used for commercial air transport, and components intended for fitment thereto, shall be approved in accordance with the provisions of **Annex II (Part 145)** …

Certifying staff (Article 5)[5]

Certifying staff shall be qualified in accordance with the provisions of **Annex III (Part 66)** …

Training organization requirements (Article 6)

Organizations involved in the training of personnel referred to in Article 5 shall be approved in accordance with **Annex IV (Part 147)** …

We will now consider some extracts of the above-mentioned Annexes which are all provided with Acceptable Means of Compliance.

9.1.2.1 Annex I, Part M

1. Section A – Technical Requirements

Subpart A: General

M.A.101 Scope

This Section establishes the measures to be taken to ensure that airworthiness is maintained, including maintenance. It also specifies the conditions to be met by the individuals or organizations involved in such continuing airworthiness management.

Subpart B: Accountability

M.A.201 Responsibilities

(a) The owner is responsible for the continuing airworthiness of an aircraft and shall ensure that no flight takes place unless:

1. The aircraft is maintained in an airworthy condition, and
2. Any operational and emergency equipment fitted is correctly installed and serviceable or clearly identified as unserviceable, and
3. The airworthiness certificate remains valid, and
4. The maintenance of the aircraft is performed in accordance with the approved maintenance program as specified in M.A.302.

…

(g) Maintenance of large aircraft, aircraft used for commercial air transport and components thereof shall be carried out by a Part 145 approved maintenance organization.

(h) In the case of commercial air transport the operator is responsible for the continuing airworthiness of the aircraft it operates and shall:

1. Be approved, as part of the air operator certificate issued by the competent authority, pursuant to M.A. Subpart G for the aircraft it operates; and
2. Be approved in accordance with Part 145 or contract such an organization; and
3. Ensure that paragraph (a) is satisfied.

(i) When an operator is requested by a Member State to hold a certificate for its operational activities, other than for commercial air transport, it shall:

1. Be appropriately approved, pursuant to M.A. Subpart G, for the management of the continuing airworthiness of the aircraft it operates or contract such an organization; and
2. Be appropriately approved in accordance with M.A. Subpart F or Part 145, or contract such organizations; and
3. Ensure that paragraph (a) is satisfied.

Subpart C: Continuing Airworthiness

M.A.302 Maintenance program

(a) Every aircraft shall be maintained in accordance with a maintenance program approved by the competent authority, which shall be periodically reviewed and amended accordingly.

(b) The maintenance program and any subsequent amendments shall be approved by the competent authority.

(c) The maintenance program must establish compliance with:

1. Instructions for continuing airworthiness issued by type certificate and Supplementary type certificate holders and any other organization that publishes such data in accordance with Part 21; or
2. Instructions issued by the competent authority, if they differ from subparagraph 1 or in the absence of specific recommendations; or
3. Instructions defined by the owner or the operator and approved by the competent authority if they differ from subparagraphs 1 and 2.

(d) The maintenance program shall contain details, including frequency, of all maintenance to be carried out, including any specific tasks linked to specific operations. …

M.A.303 Airworthiness Directives

Any applicable Airworthiness Directive must be carried out within the requirements of that Airworthiness Directive, unless otherwise specified by the Agency.

Subpart F: Maintenance Organization

M.A.601 Scope

This Subpart establishes the requirements to be met by an organization to qualify for the issue or continuation of an approval for the maintenance of aircraft and components not listed in M.A.201(f) and (g) (large aircraft).

Subpart G: Continuing Airworthiness Management Organization

M.A.701 Scope

This Subpart establishes the requirements to be met by an organization to qualify for the issue or continuation of an approval for the management of continuing aircraft airworthiness.

M.A.712 Quality system

(a) To ensure that the approved continuing airworthiness management organization continues to meet the requirements of this Subpart, it shall establish a **Quality System** and designate a **Quality Manager** to monitor compliance with, and the adequacy of, procedures required to ensure airworthy aircraft. Compliance monitoring shall include a feedback system to the accountable manager to ensure corrective action as necessary.

Subpart H: Certificate of Release to Service (CRS)

M.A.801 Aircraft certificate of release to service

(a) Except for aircraft released to service by a Part 145 organization, the certificate of release to service shall be issued according to this Subpart.

(b) A certificate of release to service shall be issued before flight at the completion of any maintenance. When satisfied that all maintenance required has been properly carried out, a certificate of release to service shall be issued:

1. By appropriate certifying staff on behalf of the M.A. Subpart F approved maintenance organization; or

2. Except for complex maintenance tasks listed in Appendix VII, by certifying staff in compliance with the requirements of Part 66; or
3. By the M.A.803 pilot-owner. …

M.A.803 Pilot-owner authorization

(a) The pilot-owner is the person who owns or jointly owns the aircraft being maintained and holds a valid pilot license with the appropriate type or class rating.
(b) For any privately operated aircraft of simple design with a maximum take-off mass of less than 2730 kg, glider and balloon, the pilot-owner may issue the certificate of release to service after limited pilot owner maintenance listed in Appendix VIII.
(c) Limited pilot-owner maintenance shall be defined in the M.A.302 aircraft maintenance program. …

2. Section B – Procedure for Competent Authorities

Subpart A: General

M.B.101 Scope

This Section establishes the administrative requirements to be followed by the competent authorities in charge of the application and the enforcement of Section A of this Part.

M.B.102 Competent authority

(a) *General*. A Member State shall designate a competent authority with allocated responsibilities for the issuance, continuation, change, suspension, or revocation of certificates and for the oversight of continuing airworthiness. This competent authority shall establish documented procedures and an organizational structure. …

Subpart F: Maintenance Organization

M.B.603 Issue of approval

(a) The competent authority shall issue to the applicant an **EASA Form 3 Approval Certificate** (Appendix V – *Approval Certificate, Part M, Section A, Subpart F: Maintenance Organization*), which includes the extent of approval, when the maintenance organization is in compliance with the applicable paragraphs of this Part. …

Subpart G: Continuing Airworthiness Management Organization

M.B.703 Issue of approval

(a) The competent authority shall issue to the applicant **an EASA Form 14 Approval Certificate** (Appendix VI – *Approval Certificate, Part M, Section A, Subpart G: Continuing Airworthiness Management Organization*), which includes the extent of approval, when the continuing airworthiness management organization is in compliance with M.A. Subpart G. …

9.1.2.2 Annex II, Part 145

1. Section A

145.A.10 Scope

This Section establishes the requirements to be met by an organization to qualify for the issue or continuation of an approval for the maintenance of aircraft and components.

145.A.20 Terms of approval

The organization shall specify the scope of work deemed to constitute approval in its exposition (Appendix II to this Part contains a table of all classes and ratings).

145.A.25 Facility requirements

The organization shall ensure that:

(a) Facilities are provided appropriate for all planned work, ensuring in particular, protection from the weather elements. Specialized workshops and bays are segregated as appropriate. …

145.A.30 Personnel requirements

(a) The organization shall appoint an accountable manager who has corporate authority for ensuring that all maintenance required by the customer can be financed and carried out to the standard required by this Part. …

(b) The organization shall nominate a person or group of persons, whose responsibilities include ensuring that the organization complies with this Part. Such person(s) shall ultimately be responsible to the accountable manager. …

145.A.40 Equipment, tools, and material

(a) The organization shall have available and use the necessary equipment, tools, and material to perform the approved scope of work. …

145.A.45 Maintenance data

(a) The organization shall hold and use applicable current maintenance data in the performance of maintenance, including modifications and repairs. 'Applicable' means relevant to any aircraft, component, or process specified in the organization's approval class rating schedule and in any associated capability list. …

145.A.50 Certification of maintenance

(a) A certificate of release to service shall be issued by appropriately authorized certifying staff on behalf of the organization when it has been verified that all maintenance ordered has been properly carried out by the organization in accordance with the procedures specified in 145.A.70, taking into account the availability and use of the maintenance data specified in 145.A.45 and that there are no non-compliances which are known that hazard seriously the flight safety. …

145.A.70 Maintenance organization exposition

(a) '**Maintenance organization exposition**' means the document or documents that contain the material specifying the scope of work deemed to constitute approval and showing how the organization intends to comply with this Part. The organization shall provide the competent authority with a maintenance organization exposition, containing the following information: …

145.A.75 Privileges of the organization

In accordance with the exposition, the organization shall be entitled to carry out the following tasks:

(a) Maintain any aircraft and/or component for which it is approved at the locations identified in the approval certificate and in the exposition.
(b) Arrange for maintenance of any aircraft or component for which it is approved at another organization that is working under the quality system of the organization. This refers to work being carried out by an organization not itself appropriately approved to carry out such maintenance under this Part and is limited to the work scope permitted under 145.A.65(b) procedures. This work scope shall not include a base maintenance check of an aircraft or a complete workshop maintenance check or overhaul of an engine or engine module.
(c) Maintain any aircraft or any component for which it is approved at any location subject to the need for such maintenance arising either from the unserviceability of the aircraft or from the necessity of supporting occasional line maintenance, subject to the conditions specified in the exposition.
(d) Maintain any aircraft and/or component for which it is approved at a location identified as a line maintenance location capable of supporting minor maintenance and only if the organization exposition both permits such activity and lists such locations.
(e) Issue certificates of release to service in respect of completion of maintenance in accordance with 145.A.50.

145.A.80 Limitations on the organization

The organization shall only maintain an aircraft or component for which it is approved when all the necessary facilities, equipment, tooling, material, maintenance data, and certifying staff are available.

2. General remarks

An important privilege of a Part 145 certification is the possibility of servicing aircraft registered abroad as well, with recognition from the relevant (JAA/EASA) authority without further documentation required.

All this emphasizes the importance for the enterprise of relying upon an independent quality system to ensure good maintenance practices and compliance with all relevant requirements.

As we explained previously, maintenance outside JAR-OPS certification has to be performed according to the relevant prescriptions applicable in each single state. Also, in these cases, the operators have to declare the kind and level of maintenance they want to perform, and/or the maintenance organizations they choose.

3. Section B: Procedure for Competent Authorities

145.B.01 Scope

This section establishes the administrative procedures which the competent authority shall follow when exercising its tasks and responsibilities regarding issuance, continuation, change, suspension, or revocation of Part 145 maintenance organization approvals. …

145.B.25 Issue of approval

1 The competent authority shall formally approve the exposition and issue to the applicant a Form 3 **Approval Certificate**, which includes the approval ratings. The competent authority shall only issue a certificate when the organization is in compliance with Part 145.
2 The competent authority shall indicate the conditions of the approval on the Form 3 Approval Certificate.
3 The reference number shall be included on the Form 3 Approval Certificate in a manner specified by the Agency.

9.1.2.3 Annex III, Part 66

1. Section A

Subpart A: Aircraft Maintenance License Aeroplanes and Helicopters

66.A.1 Scope

(a) This section establishes the requirements for the issue of an aircraft maintenance license and conditions of its validity and use, for aeroplanes and helicopters of the following categories: A, B1, B2, and C.
(b) Categories A and B1 are subdivided into subcategories relative to combinations of aeroplanes, helicopters, turbine, and piston engines. The subcategories are: A1 and B1.1 Aeroplanes Turbine; A2 and B1.2 Aeroplanes Piston; A3 and B1.3 Helicopters Turbine; A4 and B1.4 Helicopters Piston.

66.A.20 Privileges

(a) Subject to compliance with paragraph (b), the following privileges shall apply:

1. A category A aircraft maintenance license permits the holder to issue certificates of release to service following minor scheduled line maintenance and simple defect rectification within the limits of tasks specifically endorsed on the authorization. The certification privileges shall be restricted to work that the license holder has personally performed in a Part 145 organization.
2. A category B1 aircraft maintenance license shall permit the holder to issue certificates of release to service following maintenance, including aircraft structure, power plant, and mechanical and electrical systems. Replacement of avionic line replaceable units, requiring simple tests to prove their serviceability, shall also be included in the privileges. Category B1 shall automatically include the appropriate A subcategory.
3. A category B2 aircraft maintenance license shall permit the holder to issue certificates of release to service following maintenance on avionic and electrical systems.
4. A category C aircraft maintenance license shall permit the holder to issue certificates of release to service following base maintenance on aircraft. The privileges apply to the aircraft in its entirety in a Part 145 organization.

(b) The holder of an aircraft maintenance license may not exercise certification privileges unless:

1. In compliance with the applicable requirements of Part M and/or Part 145.

2. In the preceding two-year period he/she has either had six months of maintenance experience in accordance with the privileges granted by the aircraft maintenance license, or met the provision for the issue of the appropriate privileges.
3. He/she is able to read, write, and communicate to an understandable level in the language(s) in which the technical documentation and procedures necessary to support the issue of the certificate of release to service are written.

66.A.30 Experience requirements

(a) An applicant for an aircraft maintenance license shall have acquired:

1. For category A and subcategories B1.2 and B1.4: (i) three years of practical maintenance experience on operating aircraft, if the applicant has no previous relevant technical training; or (ii) two years of practical maintenance experience on operating aircraft and completion of training considered relevant by the competent authority as a skilled worker, in a technical trade; or (iii) one year of practical maintenance experience on operating aircraft and completion of a Part 147 approved basic training course. …

2.Section B – Procedure for Competent Authorities

Subpart A: General

66.B.05 Scope

This Section establishes the administrative requirements to be followed by the competent authorities in charge of the application and the enforcement of Section A of this Part.

Subpart B: Issue of an Aircraft Maintenance License

This Subpart provides the procedures to be followed by the competent authority to issue or vary or to permit continuity of the aircraft maintenance license.

66.B.100 Procedure for the issue of an aircraft maintenance license by the competent authority

(a) On receipt of EASA Form 19 and any supporting documentation, the competent authority shall verify EASA Form 19 for completeness and ensure that the experience claimed meets the requirement of this Part.
(b) The competent authority shall verify an applicant's examination status and/or confirm the validity of any credits to ensure that all required modules of Appendix 1 have been met as required by this Part B. …

9.1.2.4 Annex IV, Part 147

1. Section A

Subpart A: General

147.A.05 Scope

This Section establishes the requirements to be met by organizations seeking approval to conduct training and examination as specified in Part 66.

147.A.10 General

A training organization shall be an organization or part of an organization registered as a legal entity.

Subpart B: Organization Requirements

147.A.100 Facility requirements

(a) The size and structure of facilities shall ensure protection from the prevailing weather elements and proper operation of all planned training and examination on any particular day.

(b) Fully enclosed appropriate accommodation separate from other facilities shall be provided for the instruction of theory and the conduct of knowledge examinations. …

147.A.105 Personnel requirements

(a) The organization shall appoint an accountable manager who has corporate authority for ensuring that all training commitments can be financed and carried out to the standard required by this Part.

(b) A person or group of persons, whose responsibilities include ensuring that the maintenance training organization is in compliance with the requirements of this Part, shall be nominated. Such person(s) must be responsible to the accountable manager. The senior person or one person from the group of persons may also be the accountable manager subject to meeting the requirements for the accountable manager as defined in paragraph (a). …

147.A.115 Instructional equipment

(a) Each classroom shall have appropriate presentation equipment of a standard that ensures students can easily read presentation text/drawings/diagrams and figures from any position in the classroom.

Presentation equipment shall include representative synthetic training devices to assist students in their understanding of the particular subject matter where such devices are considered beneficial for such purposes. …

147.A.140 Maintenance training organization exposition

(a) The organization shall provide an exposition for use by the organization describing the organization and its procedures and containing the following information:

1. A statement signed by the accountable manager confirming that the maintenance training organization exposition and any associated manuals define the maintenance training organization's compliance with this Part and shall be complied with at all times. …

147.A.145 Privileges of the maintenance training organization

(a) The maintenance training organization may carry out the following as permitted by and in accordance with the maintenance training organization exposition:

1. Basic training courses to the Part 66 syllabus, or part thereof.
2. Aircraft type/task training courses in accordance with Part 66.

3. The examinations on behalf of the competent authority, including the examination of students who did not attend the basic or aircraft type training course at the maintenance training organization.
4. The issue of certificates in accordance with Appendix III following successful completion of the approved basic or aircraft type training courses and examinations specified in subparagraphs (a)(1), (a)(2), and (a)(3), as applicable. …

2. Section B – Procedure for Competent Authorities

Subpart A: General

147.B.05 Scope

This Section establishes the administrative requirements to be followed by the competent authorities in charge of the application and the enforcement of Section A of this Part.

Subpart B: Issue of an Approval

This Subpart provides the requirements to issue or vary the maintenance training organization approval.

147.B.100 General

(a) An application for maintenance training organization initial approval or variation of a maintenance training organization approval shall be made on a form and in a manner established by the competent authority.
(b) The maintenance training organization approval shall be granted to the organization by the competent authority. …

9.1.3 EASA JAR-OPS 1 and JAR-OPS 3 requirements for maintenance

The EASA operational standards prescribe maintenance requirements for operators subject to these standards.

The titles of Subpart M of JAR-OPS 1 are reported here.

Subpart M of JAR-OPS 3 presents the same titles for the corresponding paragraphs.

9.1.3.1 JAR-OPS 1 Subpart M: Aeroplane Maintenance

JAR-OPS 1.875	General 1
JAR-OPS 1.880	Terminology
JAR-OPS 1.885	Application for and approval of the operator's maintenance system
JAR-OPS 1.890	Maintenance responsibility
JAR-OPS 1.895	Maintenance management
JAR-OPS 1.900	Quality system
JAR-OPS 1.905	Operator's maintenance management exposition
JAR-OPS 1.910	Operator's aeroplane maintenance program
JAR-OPS 1.915	Operator's aeroplane technical log

JAR-OPS 1.920	Maintenance records
JAR-OPS 1.930	Continued validity of the air operator certificate in respect of the maintenance system
JAR-OPS 1.935	Equivalent safety case

In particular, we report paragraph 1.905.

JAR-OPS 1.905 Operator's maintenance management exposition

(a) An operator must provide an operator's maintenance management exposition containing details of the organization structure, including:

(1) The nominated postholder responsible for the maintenance system required by JAR-OPS 1.175(i) and the person, or group of persons, referred to in JAR-OPS 1.895(b).
(2) The procedures that must be followed to satisfy the maintenance responsibility of JAR-OPS 1.890 and the quality functions of JAR-OPS 1.900, except that where the operator is appropriately approved as a maintenance organization in accordance with JAR 145, such details may be included in the JAR 145 exposition.

(b) An operator's maintenance management exposition and any subsequent amendment must be approved by the authority.

9.1.4 EASA certification of operators

In the 'applicability' of JAR-OPS 1 and 3, we explained that these standards are applicable to any civil aeroplane and helicopter aeroplane for the purpose of commercial air transportation by any operator whose principal location of business is in a JAA Member State.

We similarly discussed the content of these standards from the point of view of additional requirements for airworthiness and maintenance.

All the requirements of these standards lead to the issue of an **Air Operator Certificate**, according to Subpart C.

The JAR-OPS contain, or will soon contain, the prescription for the certification of operators, and in particular their organization, procedures, manuals, crew employment and training, equipments, aircraft adequacy and maintenance, transport of dangerous goods, and protection against acts of unlawful interference. The operator is required to establish a Quality System to monitor compliance with, and the adequacy of, procedures to ensure safe operational practices and airworthy aircraft.

The application of these requirements is going through a development phase in Europe. **JAR-OPS 1 'Commercial Air Transportation – Aeroplanes'**, and the **JAR-OPS 3 'Commercial Air Transportation – Helicopters'** have been adopted step by step in the various states of Europe, with enforcement modalities, which may be different.

JAR-OPS 2 'General Aviation' is still in a maturing phase. That means that the national authorities approve operator's organizations for which JAR-OPS are still not applicable with the prescriptions applicable in each single state. Examples of these operators are 'aerial working' and 'flight schools'.

In the specific case of maintenance, the operators certificated according to the JAR-OPS must rely on a maintenance organization approved according to **EASA Part 145 'Approved Maintenance Organization'**.

The operator is not obliged to perform all the maintenance operations inside his own organization; the company can collaborate with other (Part 145) approved organizations. Of course, this has to be clearly established in the operator's procedures.

An excerpt of Subpart C of JAR-OPS 1 (JAR-OPS 3 is equivalent) is given below.

Subpart C: Operator Certificate and Supervision

JAR-OPS 1.180 Issue, variation, and continued validity of an AOC

(a) An operator will not be granted an AOC, or a variation to an AOC, and that AOC will not remain valid unless:

(1) Aeroplanes operated have a Standard certificate of airworthiness issued in accordance with ICAO Annex 8 by a JAA Member State. Standard certificates of airworthiness issued by a JAA Member State other than the State responsible for issuing the AOC will be accepted without further showing when issued in accordance with JAR 21.
(2) The maintenance system has been approved by the authority in accordance with Subpart M.
(3) He has satisfied the authority that he has the ability to: (i) establish and maintain an adequate organization; (ii) establish and maintain a quality system in accordance with JAR-OPS 1.035; (iii) comply with required training programs; (iv) comply with maintenance requirements, consistent with the nature and extent of the operations specified, including the relevant items prescribed in JAR-OPS 1.175(g) to (o); and (v) comply with JAR-OPS 1.175.[6] …

9.1.5 FAA continued airworthiness/maintenance

The requirements for FAA continued airworthiness are much more articulated than the corresponding EASA documents. In comparing them with the standards listed for EASA continued airworthiness, we find the following correspondences:

1 General rules for maintenance, including organizations and personnel, involved in continuing airworthiness can be found in FAR 43.
2 Approval of organizations involved in maintenance can be found in FAR 145.
3 The certification of personnel involved in maintenance operation is regulated by FAR 65.
4 The certification of an organization seeking approval to conduct training of personnel is regulated by FAR 147.

Furthermore, some of the 'operational standards' we considered in the section 'FAA operational standards (additional airworthiness requirements)' at the beginning of this chapter prescribe maintenance requirements for the operators subject to these standards. We can quote the following: FAR 91, FAR 121, FAR 125, FAR 129, and FAR 135. The 'applicability' of these standards can be found in the above-mentioned section.

It is worth remembering that there are plenty of Advisory Circulars and FAA Orders to provide guidance on these standards.

Extracts of the above-mentioned standards are given below.

9.1.5.1 FAR 43. Maintenance, Preventive Maintenance, Rebuilding, and Alteration

43.1 Applicability

(a) Except as provided in paragraphs (b) and (d) of this section, this part prescribes rules governing the maintenance, preventive maintenance, rebuilding, and alteration of any:

(1) Aircraft having a US airworthiness certificate
(2) Foreign-registered civil aircraft used in common carriage or carriage of mail under the provisions of Part 121 or 135 of this chapter, and
(3) Airframe, aircraft engines, propellers, appliances, and component parts of such aircraft.

(b) This part does not apply to any aircraft for which the FAA has issued an Experimental certificate, unless the FAA has previously issued a different kind of airworthiness certificate for that aircraft.
(c) This part applies to all life-limited parts that are removed from a type certificated product, segregated, or controlled as provided in paragraph 43.10.
(d) This part applies to any aircraft issued a Special airworthiness certificate in the Light-Sport category except: …

The content of this standard is as follows:

43.12 Maintenance records: Falsification, reproduction, or alteration
43.13 Performance rules (general)
43.15 Additional performance rules for inspections
43.16 Airworthiness limitations
43.17 Maintenance, preventive maintenance, and alterations performed on US aeronautical products by certain Canadian persons
Appendix A to FAR 43 – Major alterations, major repairs, and preventive maintenance
Appendix B to FAR 43 – Recording of major repairs and major alterations
Appendix C to FAR 43 [Reserved]
Appendix D to FAR 43 – Scope and detail of items (as applicable to the particular aircraft) to be included in annual and 100-hour inspections
Appendix E to FAR 43 – Altimeter system test and inspection
Appendix F to FAR 43 – ATC transponder tests and inspections

Appendix A is of particular interest and an excerpt is given below.[7]

Appendix A to Part 43: Major alterations, major repairs, and preventive maintenance

(a) *Major alterations*:

(1) *Airframe major alterations*. Alterations of the following parts and alterations of the following types, when not listed in the aircraft specifications issued by the FAA, are airframe major alterations: (i) Wings. (ii) Tail surfaces. (iii) Fuselage. (iv) Engine mounts. (v) Control system. (vi) Landing gear. … (xiii) Changes to the wing or to fixed or movable control surfaces which affect flutter and vibration characteristics.

(2) *Power plant major alterations*. The following alterations of a power plant when not listed in the engine specifications issued by the FAA are power plant major alterations. (i) Conversion of an aircraft engine from one approved model to another, involving any changes in compression ratio, propeller reduction gear, impeller gear ratios, or the substitution of major engine parts which requires extensive rework and testing of the engine. (ii) Changes to the engine by replacing aircraft engine structural parts with parts not supplied by the original manufacturer or parts not specifically approved by the Administrator. … (vi) Conversions of any sort for the purpose of using fuel of a rating or grade other than that listed in the engine specifications.

(3) *Propeller major alterations*. The following alterations of a propeller when not authorized in the propeller specifications issued by the FAA are propeller major alterations: (i) Changes in blade design. (ii) Changes in hub design. (iii) Changes in the governor or control design. (iv) Installation of a propeller governor or feathering system. (v) Installation of propeller de-icing system. (vi) Installation of parts not approved for the propeller.

(4) *Appliance major alterations*. Alterations of the basic design not made in accordance with recommendations of the appliance manufacturer or in accordance with an FAA Airworthiness Directive are appliance major alterations. In addition, changes in the basic design of radio communication and navigation equipment approved under type certification or a Technical Standard Order that have an effect on frequency stability, noise level, sensitivity, selectivity, distortion, spurious radiation, AVC characteristics, or ability to meet environmental test conditions and other changes that have an effect on the performance of the equipment are also major alterations.

9.1.5.2 FAR 145. Repair Stations

Subpart A: General

145.1 Applicability

This part describes how to obtain a repair station certificate. This part also contains the rules a certificated repair station must follow related to its performance of maintenance, preventive maintenance, or alterations of an aircraft, airframe, aircraft engine, propeller, appliance, or component part to which Part 43 applies. It also applies to any person who holds, or is required to hold, a repair station certificate issued under this part.

Subpart B: Certification

145.53 Issue of certificate

(a) Except as provided in paragraph (b) of this section, a person who meets the requirements of this part is entitled to a repair station certificate with appropriate ratings prescribing such operations specifications and limitations as are necessary in the interest of safety.

(b) If the person is located in a country with which the United States has a bilateral aviation safety agreement, the FAA may find that the person meets the requirements of this part based on a certification from the civil aviation authority of that country. This certification must be made in accordance with implementation procedures signed by the Administrator or the Administrator's designee.

Subpart E: Operating Rules

145.201 Privileges and limitations of certificate

(a) A certificated repair station may:

(1) Perform maintenance, preventive maintenance, or alterations in accordance with FAR 43 on any article for which it is rated and within the limitations in its operations specifications.

(2) Arrange for another person to perform the maintenance, preventive maintenance, or alterations of any article for which the certificated repair station is rated. If that person is not certificated under FAR 145, the certificated repair station must ensure that the non-certificated person follows a quality control system equivalent to the system followed by the certificated repair station.

(3) Approve for return to service any article for which it is rated after it has performed maintenance, preventive maintenance, or an alteration in accordance with FAR 43.

(b) A certificated repair station may not maintain or alter any article for which it is not rated, and may not maintain or alter any article for which it is rated if it requires special technical data, equipment, or facilities that are not available to it.

(c) A certificated repair station may not approve for return to service:

(1) Any article unless the maintenance, preventive maintenance, or alteration was performed in accordance with the applicable approved technical data or data acceptable to the FAA.

(2) Any article after a major repair or major alteration unless the major repair or major alteration was performed in accordance with applicable approved technical data, and

(3) Any experimental aircraft after a major repair or major alteration performed under paragraph 43.1(b) unless the major repair or major alteration was performed in accordance with methods and applicable technical data acceptable to the FAA.

9.1.5.3 FAR 65. Certification: Airmen Other Than Crew Members

Subpart A: General

65.1 Applicability

This part prescribes the requirements for issuing the following certificates and associated ratings and the general operating rules for the holders of those certificates and ratings:

(a) Air traffic control-tower operators.
(b) Aircraft dispatchers.
(c) Mechanics.
(d) Repairmen.
(e) Parachute riggers.

Subpart D: Mechanics

65.95 Inspection authorization: Privileges and limitations

(a) The holder of an inspection authorization may:

(1) Inspect and approve for return to service any aircraft or related part or appliance (except any aircraft maintained in accordance with a continuous airworthiness program under FAR 121r) after a major repair or major alteration to it in accordance with FAR 43 [New], if the work was done in accordance with technical data approved by the Administrator; and
(2) Perform an annual, or perform or supervise a progressive, inspection according to FAR 43.13 and 43.15. …

9.1.5.4 FAR 147. Aviation Maintenance Technician Schools

Subpart A: General

147.1 Applicability

This part prescribes the requirements for issuing **aviation maintenance technician school certificates** and associated ratings and the general operating rules for the holders of those certificates and ratings.

Subpart B: Certification Requirements

147.11 Ratings

The following ratings are issued under this part:

(a) Airframe.
(b) Power plant.
(c) Airframe and power plant.

9.1.6 FAA operational standards (requirements for maintenance)

An excerpt of these requirements is reported here.

9.1.6.1 FAR 91

Subpart E: Maintenance, Preventive Maintenance, and Alterations

91.401 Applicability

(a) This subpart prescribes rules governing the maintenance, preventive maintenance, and alterations of US-registered civil aircraft operating within or outside of the United States.
(b) Sections 91.405, 91.409, 91.411, 91.417, and 91.419 of this subpart do not apply to an aircraft maintained in accordance with a continuous airworthiness maintenance program as provided in FAR 121, 129, or paragraphs 91.1411 or 135.411(a)(2).
(c) Sections 91.405 and 91.409 of this part do not apply to an airplane inspected in accordance with FAR 125.

91.403 General

(a) The owner or operator of an aircraft is primarily responsible for maintaining that aircraft in an airworthy condition, including compliance with FAR 39.[8]
(b) No person may perform maintenance, preventive maintenance, or alterations on an aircraft other than as prescribed in this subpart and other applicable regulations, including FAR 43.[9]
(c) No person may operate an aircraft for which a manufacturer's maintenance manual or instructions for continued airworthiness has been issued that contains an airworthiness limitations section unless the mandatory replacement times, inspection intervals, and related procedures specified in that section or alternative inspection intervals and related procedures set forth in an operations specification approved by the Administrator under FAR 121 or 135 or in accordance with an inspection program approved under paragraph 91.409(e) have been complied with.

91.405 Maintenance required

Each owner or operator of an aircraft:

(a) Shall have that aircraft inspected as prescribed in Subpart E of this part and shall between required inspections, except as provided in paragraph (c) of this section, have discrepancies repaired as prescribed in FAR 43 of this chapter.
(b) Shall ensure that maintenance personnel make appropriate entries in the aircraft maintenance records indicating the aircraft has been approved for return to service.
(c) Shall have any inoperative instrument or item of equipment, permitted to be inoperative by FAR 91.213(d)(2), repaired, replaced, removed, or inspected at the next required inspection.
(d) When listed discrepancies include inoperative instruments or equipment, shall ensure that a placard has been installed as required by FAR 43.11.

91.407 Operation after maintenance, preventive maintenance, rebuilding, or alteration

(a) No person may operate any aircraft that has undergone maintenance, preventive maintenance, rebuilding, or alteration unless:

(1) It has been approved for return to service by a person authorized under FAR 43.7. …

91.409 Inspections

(a) Except as provided in paragraph (c) of this section, no person may operate an aircraft unless, within the preceding 12 calendar months, it has had:

(1) An annual inspection in accordance with FAR 43 and has been approved for return to service by a person authorized by FAR 43.7; or
(2) An inspection for the issuance of an airworthiness certificate in accordance with FAR 21. …

(b) Except as provided in paragraph (c) of this section, no person may operate an aircraft carrying any person (other than a crew member) for hire, and no person may give flight instruction for hire in an aircraft which that person provides, unless within the preceding 100 hours of time in service the aircraft has received an annual or 100-hour inspection and been approved for return to service.

(c) Paragraphs (a) and (b) of this section do not apply to:

(1) An aircraft that carries a special flight permit, a current Experimental certificate, or a Light-Sport or Provisional airworthiness certificate. …

(d) *Progressive inspection*. Each registered owner or operator of an aircraft desiring to use a progressive inspection program must submit a written request to the FAA Flight Standards district office having jurisdiction over the area in which the applicant is located, and shall provide. …

(e) Large airplanes (to which FAR 125 is not applicable), turbojet multi-engine airplanes, turbopropeller-powered multi-engine airplanes, and turbine-powered rotorcraft. No person may operate a large airplane, turbojet multi-engine airplane, turbopropeller-powered multi-engine airplane, or turbine-powered rotorcraft unless the replacement times for life-limited parts specified in the aircraft specifications, type data sheets …

(g) *Inspection program approved under paragraph (e) of this section*. Each operator of an airplane or turbine-powered rotorcraft desiring to establish or change an approved inspection program under paragraph (f)(4) of this section must submit the program for approval. …

91.410 Special maintenance program requirements

(a) No person may operate an Airbus Model A300 (excluding the 600 series), British Aerospace Model BAC 1-11, Boeing Model, 707, 720, 727, 737 or 747, McDonnell Douglas Model DC-8, DC-9/MD-80 or DC-10, Fokker Model F28, or Lockheed Model L-1011 airplane beyond applicable flight cycle implementation time specified below. …

91.411 Altimeter system and altitude reporting equipment tests and inspections

No person may operate an airplane, or helicopter, in controlled airspace under IFR unless:

(1) Within the preceding 24 calendar months, each static pressure system, each altimeter instrument, and each automatic pressure altitude reporting system has been tested and inspected. …

91.413 ATC transponder tests and inspections

(a) No persons may use an ATC transponder that is specified in FAR 91.215(a), FAR 121.345(c), or FAR 135.143(c) unless, within the preceding 24 calendar months, the ATC transponder has been tested and inspected …

9.1.6.2 FAR 121

Subpart L: Maintenance, Preventive Maintenance, and Alterations

121.361 Applicability

(a) Except as provided by paragraph (b) of this section, this subpart prescribes requirements for maintenance, preventive maintenance, and alterations for all certificate holders. …

121.367 Maintenance, preventive maintenance, and alterations programs

Each certificate holder shall have an inspection program and a program covering other maintenance, preventive maintenance, and alterations that ensures that:

(a) Maintenance, preventive maintenance, and alterations performed by it, or by other persons, are performed in accordance with the certificate holder's manual. …

121.368 Aging airplane inspections and records reviews

…

(b) *Operation after inspection and records review.* After the dates specified in this paragraph, a certificate holder may not operate an airplane under this part unless the Administrator has notified the certificate holder that the Administrator has completed the aging airplane inspection and records review required by this section. During the inspection and records review, the certificate holder must demonstrate to the Administrator that the maintenance of age-sensitive parts and components of the airplane has been adequate and timely enough to ensure the highest degree of safety. …

121.370 Special maintenance program requirements

(a) No certificate holder may operate an Airbus Model A300 (excluding the 600 series), British Aerospace Model BAC 1-11, Boeing Model 707, 720, 727, 737, or 747, McDonnell Douglas Model DC-8, DC-9/MD-80 or DC-10, Fokker Model F28, or Lockheed Model L-1011 airplane beyond the applicable flight cycle implementation time specified below. …

9.1.6.3 FAR 125

Subpart G: Maintenance

125.241 Applicability

This subpart prescribes rules, in addition to those prescribed in other parts of this chapter, for the maintenance of airplanes, airframes, aircraft engines, propellers, appliances, each item of survival and emergency equipment, and their component parts operated under this part.

125.247 Inspection programs and maintenance

(a) No person may operate an airplane subject to this FAR unless:

(1) The replacement times for life-limited parts specified in the aircraft type certificate data sheets, or other documents approved by the Administrator, are complied with; (2) defects disclosed between inspections, or as a result of inspection, have been corrected in accordance with FAR 43; and (3) the airplane, including airframe, aircraft engines, propellers, appliances, and survival and emergency equipment, and their component parts, is inspected in accordance with an inspection program approved by the Administrator.

(b) The inspection program specified in paragraph (a)(3) of this section must include at least the following …

125.248 Special maintenance program requirements

(a) No person may operate an Airbus Model A300 (excluding the 600 series), British Aerospace Model BAC 1-11, Boeing Model 707, 720, 727, 737 or 747, McDonnell Douglas Model DC-8, DC-9/MD-80 or DC-10, Fokker Model F28, or Lockheed Model L-1011 beyond the applicable flight cycle implementation time specified below …

9.1.6.4 FAR 129

129.14 Maintenance program and minimum equipment list requirements for US-registered aircraft

(a) Each foreign air carrier and each foreign person operating a US-registered aircraft within or outside the United States in common carriage shall ensure that each aircraft is maintained in accordance with a program approved by the Administrator. …

129.32 Special maintenance program requirements

(a) No foreign air carrier or foreign persons operating a US-registered airplane may operate an Airbus Model A300 (excluding 600 series), British Aerospace Model BAC 1-11, Boeing Model 707, 720, 727, 737 or 747, McDonnell Douglas Model DC-8, DC-9/MD-80 or DC-10, Fokker Model F28, or Lockheed Model L-1011 beyond the applicable flight cycle implementation time specified below …

9.1.6.5 FAR 135

Subpart J: Maintenance, Preventive Maintenance, and Alterations

135.411 Applicability

(a) This subpart prescribes rules in addition to those in other parts of this chapter for the maintenance, preventive maintenance, and alterations for each certificate holder as follows:

(1) Aircraft that are type certificated for a passenger seating configuration, excluding any pilot seat, of nine seats or less, shall be maintained under FAR 91 and 43, and FAR 135.415, 135.416, 135.417, 135.421, and 135.422. An approved aircraft inspection program may be

used under FAR 135.419. (2) Aircraft that are type certificated for a passenger seating configuration, excluding any pilot seat, of 10 seats or more, shall be maintained under a maintenance program in FAR 135.415, 135.416, 135.417, and 135.423 through 135.443.

(b) A certificate holder who is not otherwise required may elect to maintain its aircraft under paragraph (a)(2) of this section.
(c) Single-engine aircraft used in passenger-carrying IFR operations shall also be maintained in accordance with paragraphs 135.421(c), (d), and (e).

135.419 Approved aircraft inspection program

(a) Whenever the Administrator finds that the aircraft inspections required or allowed under FAR 91 of this chapter are not adequate to meet this part, or upon application by a certificate holder, the Administrator may amend the certificate holder's operations specifications under paragraph 135.17 …

135.421 Additional maintenance requirements

(a) Each certificate holder who operates an aircraft type certificated for a passenger seating configuration, excluding any pilot seat, of nine seats or less, must comply with the manufacturer's recommended maintenance programs, or a program approved by the Administrator, for each aircraft engine, propeller, rotor, and each item of emergency equipment required by this chapter.
(c) For each single-engine aircraft to be used in passenger-carrying IFR operations, …
(e) No certificate holder may operate a single-engine aircraft under IFR, carrying passengers, unless the certificate holder records and maintains in the engine maintenance records the results of each test, observation, and inspection required by the applicable engine trend monitoring program specified in (c)(1) and (2) of this section.

135.422 Aging airplane inspections and records reviews for multi-engine airplanes certificated with nine or fewer passenger seats

(a) *Applicability*. This section applies to multi-engine airplanes certificated with nine or fewer passenger seats, operated by a certificate holder in a scheduled operation under this part, …
(b) *Operation after inspections and records review*. After the dates specified in this paragraph, a certificate holder may not operate a multi-engine airplane in a scheduled operation under this part unless the Administrator has notified the certificate holder that the Administrator has completed the aging airplane inspection and records review required by this section. …

135.425 Maintenance, preventive maintenance, and alteration programs

Each certificate holder shall have an inspection program and a program covering other maintenance, preventive maintenance, and alterations, that ensures that:

(a) Maintenance, preventive maintenance, and alterations performed by it, or by other persons, are performed under the certificate holder's manual …

(b) Competent personnel and adequate facilities and equipment are provided for the proper performance of maintenance, preventive maintenance, and alterations; and
(c) Each aircraft released to service is airworthy and has been properly maintained for operation under this part.

9.1.7 FAA certification of operators

Besides the air carrier operators that we will describe in more detail, there are various types of operators that have to be certificated in order to carry out their tasks. The list includes, for example, 'agricultural aircraft operators', 'rotorcraft external-load operators', 'pilot schools', etc. The FAA provides Advisory Circulars to assist individuals in obtaining a relevant certificate.

FAR 119 prescribes requirements for the certification of operators subject to FAR 121, FAR 125, and FAR 135.

We will now report the general content and an excerpt of the most relevant paragraphs.

9.1.7.1 FAR 119. Certification: Air carriers and commercial operators

Subpart A: General

119.1 Applicability
119.3 Definitions
119.5 Certifications, authorizations, and prohibitions
119.7 Operations specifications
119.9 Use of business names

119.1 Applicability

(a) This part applies to each person operating or intending to operate civil aircraft:

(1) As an air carrier or commercial operator, or both, in air commerce; or
(2) When common carriage is not involved, in operations of US-registered civil airplanes with a seat configuration of 20 or more passengers, or a maximum payload capacity of 6000 lb or more.

(b) This part prescribes:

(1) The types of **air operator certificates** issued by the Federal Aviation Administration, including **air carrier certificates** and **operating certificates**.
(2) The certification requirements an operator must meet in order to obtain and hold a certificate authorizing operations under FAR 121, 125, or/and operations specifications for each kind of operation to be conducted and each class and size of aircraft to be operated under FAR 121 or 135.
(3) The requirements an operator must meet to conduct operations under FAR 121, 125, or 135 and in operating each class and size of aircraft authorized in its operations specifications.

(4) Requirements affecting wet leasing of aircraft and other arrangements for transportation by air.
(5) Requirements for obtaining deviation authority to perform operations under a military contract and obtaining deviation authority to perform an emergency operation.
(6) Requirements for management personnel for operations conducted under FAR 121 or FAR 135.

(c) Persons subject to this part must comply with the other requirements of this chapter, except where those requirements are modified by or where additional requirements are imposed by FAR 119, 121, 125, or 135.
(d) This FAR does not govern operations conducted under FAR 91, Subpart K (when common carriage is not involved) nor does it govern operations conducted under FAR 129, 133, 137, or 139.
(e) Except for operations when common carriage is not involved conducted with airplanes having a passenger-seat configuration of 20 seats or more, excluding any required crew member seat, or a payload capacity of 6000 lb or more, this part does not apply to:

(1) Student instruction.
(2) Non-stop sightseeing flights conducted with aircraft having a passenger seat configuration of 30 or fewer, excluding each crew member seat, and a payload capacity of 7500 lb or less, that begin and end at the same airport, and are conducted within a 25 statute mile radius of that airport. …
(3) Ferry or training flights.
(4) Aerial work operations. …

119.5 Certifications, authorizations, and prohibitions

(a) A person authorized by the Administrator to conduct operations as a direct air carrier will be issued an **Air Carrier Certificate**.
(b) A person who is not authorized to conduct direct air carrier operations, but who is authorized by the Administrator to conduct operations as a US commercial operator, will be issued an **Operating Certificate**.
(c) A person who is not authorized to conduct direct air carrier operations, but who is authorized by the Administrator to conduct operations when common carriage is not involved as an operator of US-registered civil airplanes with a seat configuration of 20 or more passengers, or a maximum payload capacity of 6000 lb or more, will be issued an **Operating Certificate**. …

Subpart B: Applicability of Operating Requirements to Different Kinds of Operations Under FAR 121, 125, and 135

119.21 Commercial operators engaged in intrastate common carriage and direct air carriers
119.23 Operators engaged in passenger-carrying operations, cargo operations, or both with airplanes when common carriage is not involved
119.25 Rotorcraft operations: Direct air carriers and commercial operators

Subpart C: Certification, Operations Specifications, and Certain Other Requirements for Operations Conducted Under FAR 121 or FAR 135

119.31 Applicability
119.33 General requirements
119.35 Certificate application requirements for all operators
119.36 Additional certificate application requirements for commercial operators
119.37 Contents of an Air Carrier Certificate or Operating Certificate
119.39 Issuing or denying a certificate
119.41 Amending a certificate
119.43 Certificate holder's duty to maintain operations specifications
119.45 [Reserved]
119.47 Maintaining a principal base of operations, main operations base, and main maintenance base; change of address
119.49 Contents of operations specifications
119.51 Amending operations specifications
119.53 Wet leasing of aircraft and other arrangements for transportation by air
119.55 Obtaining deviation authority to perform operations under a US military contract
119.57 Obtaining deviation authority to perform an emergency operation
119.59 Conducting tests and inspections
119.61 Duration and surrender of certificate and operations specifications
119.63 Recency of operation
119.65 Management personnel required for operations conducted under FAR 121
119.67 Management personnel: Qualifications for operations conducted under FAR 121
119.69 Management personnel required for operations conducted under FAR 135
119.71 Management personnel: Qualifications for operations conducted under FAR 135

9.2 Airworthiness Directives

Besides the ordinary actions aimed at maintaining the continued airworthiness of a product, sometimes it is also essential to intervene with extraordinary measures.

If the authority reveals an unsafe condition in an aircraft, such as a deficiency of an engine, propeller, part, or appliance installed on this aircraft, that exists or has the potential to develop on similar types of aircraft, then the authority issues an **Airworthiness Directive**.

This is a document which mandates actions to be performed on an aircraft to restore an acceptable level of safety.

9.2.1 EASA Airworthiness Directives

According to its statute, the Agency is responsible for the design of products, parts, and appliances designed, manufactured, or used under the regulatory oversight of the EU Member States. In that context it will issue Airworthiness Directives to ensure the continuing airworthiness of such products, parts, and appliances. In doing so, the Agency only exercises the

responsibilities of a state of design or those related to the design of such products, parts, and appliances of a state of registry. Airworthiness Directives are therefore addressed to the holders of the design approvals affected by such Airworthiness Directives.

The dissemination of Airworthiness Directives to aircraft owners is a responsibility of the state of registry and does not belong to the Agency.

In the case of products, parts, and appliances, for which the Agency only exercises the design responsibilities of the state of registry, its policy is to endorse automatically the Airworthiness Directives issued by the state of design. This does not apply if the Agency itself issues a different Airworthiness Directive before the date at which it comes into effect of the state of design Airworthiness Directive.

It is common practice for imported products, parts, and appliances to rely on the state of design to first detect whether unsafe conditions require the issuing of an Airworthiness Directive.

Only those Airworthiness Directives issued by the Agency itself are published.

9.2.2 FAA Airworthiness Directives

The FAA issues three types of ADs:

1 Notice of Proposed Rulemaking (NPRM), followed by a Final Rule.
2 Final Rule with request for comments.
3 Emergency ADs.

1. A standard AD process is to issue an NPRM followed by a Final Rule. After an unsafe condition is discovered, a proposed solution is published as an NPRM, which solicits public comment on the proposed action. After the comment period closes, the final rule is prepared, taking into account all the comments received, with the rule perhaps being changed as warranted by the comments. The preamble to the Final Rule AD will state if no changes were made, or if there were no comments received.

2. Final Rule with request for comments. In certain cases, the critical nature of an unsafe condition may warrant the immediate adoption of a rule without prior notice and solicitation of comments. This is an exception to the standard process. If the time by which the terminating action must be accomplished is too short to allow a public comment (that is, less than 60 days), then a finding of impracticability is justified for the terminating of the action, and this can be issued as an immediately adopted rule. The immediately adopted rule is then published in the Federal Register with a request for comments. The Final Rule AD may be changed later if substantive comments are received.

3. An Emergency AD is issued when an unsafe condition exists that requires immediate action by an owner/operator. The intent of an Emergency AD is to rapidly correct an urgent safety of flight situation. An Emergency AD may be distributed by Fax, letter, or other methods.

An AD is considered to be no longer in effect when it is superseded by a new AD. The superseding AD identifies the AD that is no longer in effect. There are no compliance requirements for an AD that has been superseded.

9.3 Older aircraft

Older aircraft are also known as 'aging aircraft'.

Aircraft are designed and built to provide for many years of service. If an aircraft is to remain airworthy and safe operating throughout a long in-service life, it must be operated in accordance with the recommendations of the manufacturer and cared for with sound inspection and maintenance practices.

We will ultimately consider transport aeroplanes, on the whole the most long-lived aircraft.[10]

Service experience has revealed that aging aeroplanes need more care and special attention during the maintenance processes and, at times, more frequent inspection of structural components are required for damage due to environmental deterioration, accidental damage, and fatigue. Hence, manufacturers have to provide operators with programs of continued airworthiness where virtually every component of an aeroplane is involved in some form of preservation, inspection, maintenance, preventive maintenance, overhaul, repair, and/or replacement activity.

Safety of operation through continued airworthiness demands increasing vigilance as an aeroplane ages.

Maintenance information needs to be continually updated. Open communication should exist between the **owner/operator**, who should notify the **manufacturer** as soon as a new situation arises, and the **authority**. Such communication and co-operation will facilitate the maintenance of an entire fleet in a constant airworthy condition.

Thus, the manufacturer should prepare and distribute recommendations on the need for increased inspection vigilance, updating programs of continued airworthiness, while the authority will review and approve such programs eventually issuing Airworthiness Directives in order to enforce them.

It is also important to consider the possibility that the aeroplane could be used in a manner significantly different from the original intended mission profile. Low-altitude operation, such

as pipeline patrol and training operations, will subject the airplanes to more fatigue damage than high-altitude cruise. Furthermore, airplane operations on distances shorter than those immediately foreseen by the manufacturer lead to an increase of the cycle/flight hours rate, with consequent alteration of the structure fatigue life.

Background. To address aging aircraft concerns, in October 1991 the US Congress enacted Title IV of Public Law 102-143, known as the 'Aging Aircraft Safety Act of 1991'. The law instructed the Administrator to prescribe regulations that would ensure the continuing airworthiness of aging aircraft. The law also instructed the Administrator to conduct inspections and review the maintenance and other records of each aircraft an air carrier uses to provide air transportation. These inspections and records reviews were intended to enable the Administrator to decide whether aging aircraft are in a safe condition and properly maintained for air transportation operation. The law also required the Administrator to establish procedures to be followed to perform such inspections.

In addition to imposing obligations on the Administrator, the law stated that air carriers must demonstrate that the maintenance of their aircraft's age-sensitive parts and components has been adequate and well timed, and operators must make their aircraft and books available for inspection.

As a result of these statutory requirements, the FAA published a final rule titled 'Aging Airplane Safety' that specifies mandatory aging aircraft inspections for certain airplanes according to their time-in-service, as well as requirements for damage-tolerance-based inspections and procedures to be included in the maintenance or inspection programs of certain airplanes. The rule also prohibits operation of those airplanes after specified deadlines unless damage-tolerance-based inspections and procedures are included in the maintenance or inspection programs under which the airplanes are maintained. This requirement was implemented to ensure the continuing airworthiness of aging airplanes operated in air transportation by assessing the damage tolerance of older airplane structures.

The 'Aging Airplane Safety' rule requires all airplanes operated under FAR 121 of all US-registered multi-engine airplanes operated under FAR 129, and all multi-engine airplanes used in scheduled operations under FAR 135, to undergo records review and inspections by the Administrator after their 14th year in service, to ensure that the maintenance of their age-sensitive parts and components has been adequate and well timed.

Subsequently, the FAA issued AC 91-56A, 'Continuing Structural Integrity Program for Large Transport Category Airplanes' applicable to aeroplanes which have a gross weight greater than 75 000 lb and certificated under fail-safe and fatigue requirements *prior to Amendment 25-45 of FAR 25*.

This AC provides guidance material to manufacturers and operators of transport category airplanes for use in developing a continuing structural integrity program to ensure safe operation of older airplanes throughout their operational life.

The procedures set forth by this AC are applicable to the Large Transport category airplanes operated under Subpart D of FAR 91 and FAR 121 and 125.

Actually, an interesting aspect of these procedures is that aeroplanes certificated before the 1970s had to comply with less stringent fatigue requirements[11] than those contained nowadays in JAR/FAR 25/EASA CS-25 and relevant advisory material of ACJs and ACs.

This AC, besides the usual recommendation for an exchange of field service information between operators, manufacturers, and the FAA, deals with the development of a **Supplemental Structural Inspection Program** to be implemented before analysis, tests, and/or service experience, indicating that a significant increase in inspection and/or modification is necessary to maintain the structural integrity of the aeroplane. In the absence of other data as a guideline, the program should be initiated not later than when the high-time or high-cycle aeroplane in the fleet reaches one-half its design service goal.

Then, a **Supplemental Inspection Document (SID)** should be developed for FAA review and approval. The manufacturer should revise the SID whenever additional information shows a specific need for it.

The program of the SID for the structures to be evaluated, the type of damage considered (fatigue, corrosion, service, and production damage), and the inspection and/or modification criteria should, to the extent practicable, be in accordance with the damage-tolerance principles of the current FAR 25 standards.

The above-mentioned AC provides guidelines for development of the SID.

9.3.1 Older small transport and commuter airplanes

For these aircraft, the FAA AC 91-MA provides information and guidance material to manufacturers and operators for use in developing continued structural integrity programs to ensure the safe operation of small transport and commuter airplanes throughout their operational life.

The procedures set forth by this AC are applicable to multi-engine airplanes that are required to have damage-tolerance-based inspections and procedures included in their maintenance or inspections programs in accordance with FAR 121, 129, and 135.

9.3.2 JAA guidance material

A JAA Administrative Guidance Material on 'Continued Airworthiness of Aging Aircraft Structures' was issued on 6 December 2002. This document provides guidelines for JAA Member States recommending a common approach for continued airworthiness of aging aircraft structures in advance of rule publication to ensure a safe operation of older aeroplanes throughout their operational life. The document has been drafted by a JAA Study Group

(European Aging Aircraft Working Group – EAAWG), and reviews the existing published material co-operating with the FAA, with the aim to ensure a consistent transatlantic approach for all Transport category aircraft.

Subsequently, the JAA issued NPA 20-10. This NPA is based on the technical agreement reached by EAAWG. The related issues of the FAA (draft) NPRMs were last revised at various dates between 1999 and 2002.

The proposals contained in this NPA are intended to achieve a common approach to the continued airworthiness of (aging) aircraft structure requirements of JAR and FAR to maintain the safety provided by the regulations, without reducing it below a level that is acceptable to both authorities and industry.

The harmonization of JAR 25 and FAR 25 and the adoption of a common approach to operational maintenance would generate cost savings by minimizing any duplication of certification and maintenance activities.

9.4 Extended range operation for two-engine airplanes (ETOPS)

9.4.1 FAA ETOPS

We have previously described additional airworthiness requirements for operation, i.e. requirements to be complied with in order to obtain a certificate of airworthiness allowing certain kinds of operation. Very often these requirements are likely to alter a type design after the type certification.

We will now consider the case in which this is likely to be taken into account from the beginning of the design, because the aeroplane is designed for that particular type of operation.

We will specifically deal with the 'extended range operation for two-engine airplanes' (ETOPS).

It is quite normal to notice different types of twin-engine aeroplanes in fleets used for long-range operations such as crossing the Atlantic or Pacific Oceans.

At present, one of the most tenacious competitions between Airbus and Boeing is about the new generation of long-range, twin-engine aeroplanes, the A350 and the B787.

Two engines are statistically much better then one, but are they really also safer?

This question is at the foundation of the requirements for 'extended range operation' (ETOPS). As mentioned in the previous chapters, for the main purpose of this book we will limit our considerations to the basic concepts. We will therefore explain this concept quoting FAA AC

120-42A, of which we will report some excerpts (we will identify the following sections with the corresponding AC paragraph numbers).

We will first consider subparagraph (a) of FAR 121.161.

121.161 Airplane limitations: Type of route

(a) *Unless authorized by the Administrator*, based on the character of the terrain, the kind of operation, or the performance of the airplane to be used, no certificate holder may operate two-engine or three-engine airplanes (except a three-engine turbine-powered airplane) over a route that contains a point further than one hour flying time (in still air at normal cruising speed with one engine inoperative) from an adequate airport.

Extended range operations

For the purpose of the AC, extended range operations are those flights conducted over a route that contain a point *further* than one hour flying time at the approved one-engine inoperative cruise speed (under standard conditions in still air) from an adequate airport.[12]

5. Discussion

To be eligible for extended range operations, the specified airframe–engine combination should have been certificated to the airworthiness standards of Transport category airplanes and should be evaluated considering the concepts in Paragraph 7, evaluated considering the type design considerations in Paragraph 8, evaluated considering in-service experience discussed in Paragraph 9, and evaluated considering the continuing airworthiness and operational concepts outlined in Paragraph 10.

6. Background

Some[13] *of the new generation airplanes have a range/payload capability equivalent to many previous generation three- and four-engine airplanes*. The demonstrated range/payload capabilities of the new generation airplanes, including their provisions for achieving a higher degree of reliability, clearly indicate there is a need to recognize the capabilities of these airplanes and to establish the conditions under which extended range operations with these airplanes can be safely conducted, over oceanic and/or desolate land areas.

Since Large Transport category airplanes are certificated in consideration of the operating rule, FAR Section 121.161, any consideration for deviation from this operating rule for two-engine airplanes necessitates an evaluation of the type design to determine suitability of that particular *airframe–engine combination* for the intended operation.

7. Concepts

Although it is self-evident that the overall safety of an extended range operation cannot be better than that provided by the reliability of the propulsion systems, some of the factors related to extended range operations are not necessarily obvious.

For example, cargo compartment fire suppression/containment capability could be a significant factor or operational/maintenance practices may invalidate certain determinations made during the airplane type design certification, or the probability of system failures could be a more significant problem than the probability of propulsion system failures.

Although engine reliability is a critical factor, *it is not the only factor which should be seriously considered* in evaluating extended range operations. Any decision relating to extended range operation with two-engine airplanes should also consider the probability of occurrence of any condition which would reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions.

The following is provided to define the concepts for evaluating extended range operations with two-engine airplanes. This approach ensures that two-engine airplanes are consistent with the level of safety required for current extended range operations with three- and four-engine turbine-powered airplanes without unnecessarily restricting operation.

(a) Airframe system

A number of airframe systems have an effect on the safety of extended range operations; therefore, the type design certification of the airplane should be reviewed to ensure that the design of these systems is acceptable for the safe conduct of the intended operation.

(b) Propulsion system

A review of the historical data (1978–1988) for transport aviation two-engine turbofan-powered large commercial airplanes indicates that the current safety record, as exemplified by the world accident rate (airworthiness causes) is sustained *in part* by a propulsion system IFSD[14] rate of only about 0.02/1000 hours. Although the quality of this safety record is not wholly attributable to the IFSD rate, it is believed that maintaining an IFSD rate of that order is necessary to not adversely impact the world accident rate from airworthiness causes.

Upon further review of the historical database and in consideration of the required safety of extended range operation, it is necessary that the achieved performance and reliability of the airplane should be shown to be sufficiently high. When considering the impact of increasing diversion time, it must be shown that the operation can be conducted at a level of reliability resulting in no adverse change in risk.

(c) Maintenance reliability program definition

Since the quality of maintenance and reliability programs can have an appreciable effect on the reliability of the propulsion system and the airframe systems required for extended range operation, an assessment should be made of the proposed maintenance and reliability program's ability to maintain a satisfactory level of airplane systems reliability for *the particular airframe–engine combination*.

(d) Maintenance and reliability program implementation

Following a determination that the airframe systems and propulsion systems are designed to be suitable for extended range operations, an in-depth review of the applicant's training

programs, operations, and maintenance and reliability programs should be accomplished to show the ability to achieve and maintain an acceptable level of systems reliability to safely conduct these operations.

(e) Human factors

System failures or malfunctions occurring during extended range operations could affect flight crew workload and procedures. Although the demands on the flight crew may increase, an assessment should be made to ensure that exceptional piloting skills or crew co-ordination are not required.

(f) Approval basis

Each applicant (manufacturer or operator as appropriate) for extended range approval should show that the particular airframe–engine combination is sufficiently reliable. …

8. Type design approval consideration

When a two-engine type design airplane is intended to be used in extended range operations, a determination should be made that the design features are suitable for the intended operation. In some cases modifications to systems may be necessary to achieve the desired reliability. The essential airframe systems and the propulsion system for the particular airframe–engine combination should be shown to be designed to fail-safe criteria and through service experience it must be determined that it can achieve a level of reliability suitable for the intended operation. …

(b) Criteria

The applicant should conduct an evaluation of failures and failure combinations based on engineering and operational considerations, as well as acceptable fail-safe methodology. The analysis should consider effects of operations with a single engine, including allowance for additional stress that could result from failure of the first engine. Unless it can be shown that equivalent safety levels are provided or the effects of failure are minor, failure and reliability analysis should be used as guidance in verifying that the proper level of fail-safe design has been provided. The following criteria are applicable to the extended range operation of airplanes with two engines. …

The AC provide criteria based on system safety assessment, fuel management, assessment of additional engine loading during the one-engine phase, APU reliability if required in that phase, skill of pilots necessary to cope with the situation, electrical power assessment, etc.

(c) Analysis of failure effects and reliability

(1) *General*. The analysis and demonstration of airframe and propulsion system failure effects and reliability provided by the applicant should be based on in-service experience as required by Paragraph 9, and the expected longest diversion time for extended range routes likely to be flown with the airplane. If it is necessary in certain failure scenarios to consider less time due to time-limited systems, the next lower time of 75 or 120 minutes will be established as the approved diversion time.

The AC provides criteria on reliability assessments to be carried out on:

1 Propulsion systems
2 Hydraulic power and flight control
3 Electrical power
4 Equipment cooling
5 Cargo compartment
6 Communication, navigation, and basic flight
7 Cabin pressurization
8 Cockpit and cabin environment.

(d) Assessment of failure conditions

In assessing the fail-safe features and effects of failure conditions, account should be taken of:

(1) The variations in the performance of the system …
(2) Factors alleviating or aggravating the direct effects of the initial failure condition …
(3) A flight test should be conducted by the manufacturer and witnessed by the FAA type certificate holding office to validate expected airplane flying qualities and performance considering engine failure, electrical power losses, etc. …

(e) FAA Airplane Assessment Report

The assessment of the reliability of propulsion and airframe systems for a particular airframe–engine combination will be contained in an FAA Airplane Assessment Report. …

(f) ETOPS type design approval

Upon satisfactory completion of the airplane evaluation through an engineering inspection and test program consistent with the type certification procedures of FAR 21 and sufficient in-service experience data:

(1) The type design approval will be reflected in the FAA approved AFM or supplement, and type certification data sheet or Supplemental type certificate which contain directly or by reference the following pertinent information, as applicable …

(g) Type design change process

The FAA directorate responsible for the certification of the type design will include the consideration of extended range operation in its normal monitoring and design change approval functions. Any significant problems which adversely affect extended range operation will be corrected. Modifications or maintenance actions to achieve or maintain the reliability objective of extended range operations will be incorporated into the type design CMP (configuration and maintenance procedures) standard document. …

(h) Continued airworthiness

The type design CMP standard which establishes the suitability of an airplane for extended range operations defines the minimum standards for the operation. Incorporation of additional

modifications or maintenance actions generated by an operator or manufacturer to enhance or maintain the continued airworthiness of the airplane may be made through the normal approval process. The operator or manufacturer (as appropriate) should thoroughly evaluate such changes to ensure that they do not adversely affect reliability or conflict with requirements for extended range approval.

9. In-service experience

In establishing the suitability of type design in accordance with Paragraph 8 of this AC and as a prerequisite to obtaining any operational approval, in accordance with the criteria of Paragraph 10 of this AC, it should be shown that an acceptable level of propulsion system reliability has been achieved in service by the world fleet for that particular airframe–engine combination. The candidate operator also needs to obtain sufficient maintenance and operation familiarity with the particular airframe–engine combination in question. …

Any reduction or increase in 'in-service' experience guidelines will be based on an evaluation of the operator's ability and competence to achieve the necessary reliability for the particular airframe–engine combination in extended range operations. For example, a reduction of in-service experience may be considered for an operator who can show extensive in-service experience with a related engine on another airplane which has achieved acceptable reliability. In contrast, an increase of in-service experience may be considered for those cases where heavy maintenance has yet to occur and/or an abnormally low number of take-offs have occurred.

(1) **75-minute operation.** Consideration may be given to the approval of 75-minute extended range operations for operators with minimal or no in-service experience with the airframe–engine combination. This determination considers such factors as the proposed area of operations, the operator's demonstrated ability to successfully introduce airplanes into operations, and the quality of the proposed maintenance and operations programs.
(2) **120-minute operation.** Each operator requesting approval to conduct extended range operations with a maximum diversion time of 120 minutes (in still air) should have 12 consecutive months of operational in-service experience with the specified airframe–engine combination. In-service experience guidelines may be increased or decreased by the Director, Flight Standards Service.
(3) **180-minute operation.** Each operator requesting approval to conduct extended range operations with a maximum diversion time of 180 minutes (in still air) should have previously gained 12 consecutive months of operational in-service experience with the specified airframe–engine combination in conducting 120-minute extended range operations. In-service experience guidelines may be reduced or increased by the Director, Flight Standards Service. …

Paragraph 10 contains considerations for operational approval and continued airworthiness.

The AC also presents some addenda providing advisory material for the ETOPS certification.

9.4.2 JAR-OPS ETOPS

To conclude this analysis of ETOPS, we will report an extract of the JAR-OPS 1 requirements.

JAR-OPS 1.246 Extended range operations with two-engined aeroplanes (ETOPS)

(a) An operator shall not conduct operations beyond the threshold distance determined in accordance with JAR-OPS 1.245 unless approved to do so by the authority.

(b) Prior to conducting an ETOPS flight, an operator shall ensure that a suitable ETOPS en route alternate is available, within either the approved diversion time or a diversion time based on the MEL generated serviceability status of the aeroplane, whichever is shorter (see also JAR-OPS 1.297(d)).

JAR-OPS 1.245 Maximum distance from an adequate aerodrome for two-engine aeroplanes without ETOPS approval

(a) Unless specifically approved by the authority in accordance with JAR-OPS 1.246(a) (ETOPS approval), an operator shall not operate a two-engined aeroplane over a route which contains a point further from an adequate aerodrome. …

The paragraph prescribes the maximum distances flown in 60/120/180 minutes with one engine inoperative for aeroplanes of various performance classes, maximum weight and number of passengers, as summarized in IEM-OPS 1.245(a). See Figure 9.1.

JAR-OPS 1.297 Planning minima for IFR flights

…

(d) *Planning minima for an ETOPS en route alternate*. An operator shall not select an aerodrome as an ETOPS en route alternate aerodrome unless the appropriate weather

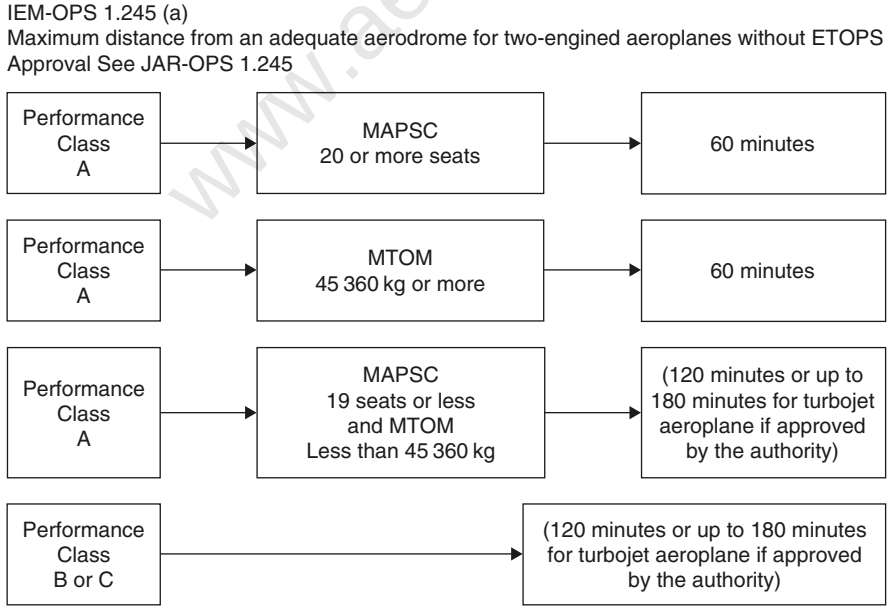


Figure 9.1 *Summary of IEM-OPS 1.245(a)*

reports or forecasts, or any combination thereof, indicate that, during a period commencing one hour before and ending one hour after the expected time of arrival at the aerodrome, the weather conditions will be at or above the planning minima prescribed in Table 2 below, and in accordance with the operator's ETOPS approval. …

9.5 Safety assessment of foreign aircraft

In this chapter we have considered a summary of the requirements prescribed by the EASA and FAA for the safety of flight operation, with particular reference to the air carrier operators.

The rapid growth of civil air traffic all round the world and the proliferation of operators of airlines put the authorities in a position of tightening controls not only on their own operators, but also on foreign aircraft operating in their territory.

Under the International Convention on Civil Aviation (Chicago Convention) each country is responsible for the safety oversight of its own air carriers. Other countries can only conduct specific surveillance activities, principally involving inspection of required documents and the physical condition of the aircraft.

Similar initiatives have been taken for long time by the various authorities. To explain this concept, we will report an extract from the JAA 'Safety Assessment of Foreign Aircraft (SAFA)'.

9.5.1 Safety Assessment of Foreign Aircraft (SAFA)

This section explains the Safety Assessment of Foreign Aircraft (SAFA) program established by the European Civil Aviation Conference (ECAC)[15] and the role played by the Central JAA.

9.5.1.1 International requirements

The international civil aviation is governed by the Convention on International Civil Aviation (commonly known as the Chicago Convention). Under this Convention, the International Civil Aviation Organization (ICAO), a specialized agency of the United Nations, sets the minimum Standards and Recommended Practices for international civil aviation. These standards are contained in 18 Annexes to the Convention. The Individual States remain responsible for regulating their aviation industries but have to take into account the requirements of the Convention and the minimum standards established by the ICAO.

The main standards that apply to airlines are in three of the 18 Annexes.

- Annex 1 deals with personnel licensing including flight crew
- Annex 6 deals with the operation of aircraft
- Annex 8 deals with airworthiness.

The responsibility for implementing Annexes 1 and 8 rests with the State of Registry – that is, the State in which the aircraft is registered. The responsibility for implementing Annex 6 rests with the State of Operator – the State in which the airline is based. Often, the State of Operator and the State of Registry are the same, as airlines tend to operate aircraft registered in the State in which they are based.

Significant increases in the volume of air travel over the last 10 years or so have made it more of a burden for many States to oversee their airlines in compliance with the Chicago Universal Safety Oversight Audit Program (USOAP) published in 1996, which is worldwide, transparent, and mandatory. It concentrates on auditing how oversight mechanisms work in ICAO Contracting States. The ICAO makes the main conclusions of its safety audits available to other Contracting States. The ECAC's Safety Assessment of Foreign Aircraft program complements the USOAP in Europe by concentrating on actual aircraft checks at airports.

The principles of the SAFA program are simple: in each ECAC State, all foreign aircraft (ECAC or non-ECAC) can be inspected. These inspections follow a procedure common to all ECAC Member States and are then reported on using a common format. If an inspection identifies significant irregularities, these will be taken up with the operator and the oversight authority. Where irregularities have an immediate impact on safety, inspectors can demand corrective action before they allow the aircraft to fly again.

All report data is centralized in a computerized database set up by the Joint Aviation Authorities (JAA), the associated body of the ECAC. The database also holds supplementary information, such as lists of actions carried out following inspections. The information on the database is reviewed by the JAA on a regular basis to identify any areas of concern.

It has to be stressed that SAFA inspections are limited to on-the-spot assessments and cannot substitute for proper regulatory oversight. Ramp inspections serve as pointers, but they cannot guarantee the airworthiness of a particular aircraft.

9.5.1.2 Aircraft and operators checked

Oversight authorities of ECAC Member States choose which aircraft to inspect. Some authorities carry out random inspections while others try to target aircraft or airlines that they suspect may not comply with ICAO standards. In either case, only a very small proportion of foreign aircraft operating into each State are inspected.

Depending on the volume of foreign flights and the availability of inspectors in each ECAC Member State, the number of inspections may vary from relatively few to several hundred each year.

Checks may include:

1 Pilots' licenses
2 Procedures and manuals that should be carried in the cockpit

3 Compliance with these procedures by flight and cabin crew safety equipment in cockpit and cabin
4 Cargo carried in the aircraft
5 The apparent condition of the aircraft.

A checklist of 54 inspection items is used during a ramp check. As the time between arrival and departure (the turnaround time) may not be sufficient to go through the full checklist, only some items may be inspected. It is SAFA policy not to delay an aircraft except for safety reasons.

Since the program began in 1996, ECAC States have performed more than 24 000 SAFA inspections (March 2005).

9.5.1.3 Results

Obviously, any major findings will immediately be communicated to all concerned parties. In the case of more serious findings, the oversight authority of the ECAC Member State that performed the ramp check will contact its counterpart in the State responsible for the airline, passing on its findings and asking for any necessary corrective actions. The oversight authority will also inform the aircraft's captain and the headquarters of the airline.

When findings directly affect the safety of the aircraft, its crew and passengers, inspectors may request immediate corrective action before the aircraft can fly again. If rectification requires more time or needs to be performed at another airport, inspectors may decide to authorize a positioning flight (a flight to a specific destination without passengers or cargo onboard).

9.5.1.4 Further information

Each year an (annual) SAFA report is produced containing an overview of the major milestones of the program.

Having examined the situation in Europe, let us see how this problem is faced on the other side of the Atlantic. For this purpose, we include an extract of the FAA International Aviation Safety Assessment (IASA).

9.5.2 International Aviation Safety Assessment (IASA)

The United States Federal Aviation Administration (FAA) established the IASA program through public policy in August of 1992. The FAA's foreign assessment program focuses *on a country's ability, not the individual air carrier*, to adhere to international standards and recommended practices for aircraft operations and maintenance established by the United Nation's technical agency for aviation, the International Civil Aviation Organization (ICAO).

9.5.2.1 IASA program overview

In mid-1991, the FAA began to formulate a program to address these concerns. This program included visits to 12 countries with airlines seeking authority to operate to and from the United States. After a trial period our findings convinced us of the need to formally establish the IASA program. The purpose of the IASA is to ensure that all foreign air carriers that operate to or from the United States are properly licensed and with safety oversight provided by a competent Civil Aviation Authority (CAA) in accordance with ICAO standards.

9.5.2.2 IASA process overview

A foreign air carrier of a sovereign state desiring to conduct foreign air transportation operations into the United States files an application with the DOT for a foreign air carrier permit under the Federal Aviation Act ….

Consistent with international law, certain safety requirements for operations into the United States are prescribed by FAR 129. FAR 129 specifies that the carrier must meet the safety standards contained in Part 1 (International Commercial Air Transport) of Annex 6 (Operations of Aircraft) to the Convention on International Civil Aviation (Chicago Convention). Before the Department of Transport (DOT) issues a foreign air carrier permit, it notifies the FAA of the application and requests the FAA's evaluation of the respective CAA's capability for providing safety certification and continuing oversight for its international carriers.

If the CAA meets the standards, the FAA gives that authority a Category 1 rating.[16] Upon DOT notification of a pending foreign air carrier application, if the FAA has not made a positive assessment of those countries' safety oversight capabilities, the FAA Flight Standards Service will direct its appropriate international field office to schedule an FAA assessment visit to the CAA of the applicant's country.

Once the assessment visits have been completed, the FAA assessment team will return to the United States to compile the findings. Appropriate notifications to the CAA and other US Government officials of the results of the assessments will be made from the Washington, DC headquarters as soon as possible.

If a CAA is found to be meeting its minimum safety obligations under the Chicago Convention, the FAA will forward a positive recommendation to the DOT. If there is a pending foreign carrier application, the DOT will issue the requested economic authority and the FAA will issue operations specifications to permit the carrier to begin operations to or from the United States.

When CAAs of countries with existing air carrier service to the USA are found not to meet ICAO standards, the FAA formally requests consultations with the CAA. The purpose of these consultations is to discuss our findings in some detail and explore means to quickly rectify shortcomings found with regard to ICAO annexes, to enable its air carriers to continue service to the United States. During the consultation phase, foreign air carrier operations from that country into the United States will be frozen at existing levels.

The FAA may also intensify its surveillance inspections (ramp checks) on these carriers while they are in the United States. If the deficiencies noted during consultations cannot be successfully corrected within a reasonable period of time, the FAA will notify the DOT that carriers from that country do not have an acceptable level of safety oversight and will recommend that the DOT revoke or suspend their economic operating authority.

After the assessment visit, consultations (if necessary), and notifications are completed, the FAA will publicly release the results of these assessments.

We determined that the findings in our IASA program *regarding safety oversight shortcomings must be provided to all US citizens so they can make informed choices in their international flights*.

The FAA plans to periodically revisit CAAs of countries with air carriers operating in the United States to maintain full familiarity with the methods of those countries' continued compliance with ICAO provisions. The FAA may also find it necessary to reassess a CAA at any time if it has reason to believe that the minimum ICAO standards are not being met.

At present, there are almost 600 foreign air carriers operating in the United States. There are approximately 103 countries or regional country alliances with oversight responsibilities for air carriers that are either currently operating in the United States or that have planned and applied to do so in the future.

The initial findings have shown that two-thirds of these countries were not fully complying with ICAO standards. Deficiencies found in FAA assessments typically fall into major categories. These categories are almost identical to the deficiencies found by the ICAO in 1993, in its safety surveillance project surveying six Asian countries. These deficiencies included:

(a) Inadequate and in some cases non-existent regulatory legislation.
(b) Lack of advisory documentation.
(c) Shortage of experienced airworthiness staff.
(d) Lack of control on important airworthiness-related items such as issuance and enforcement of Airworthiness Directives, minimum equipment lists, investigation of Service Difficulty Reports, etc.
(e) Lack of adequate technical data.
(f) Absence of Air Operator Certification (AOC) systems.
(g) Non-conformance to the requirements of the AOC system.
(h) Lack or shortage of adequately trained flight operations inspectors, including a lack of type ratings.
(i) Lack of updated company manuals for use by airmen.
(j) Inadequate proficiency check procedures.
(k) Inadequately trained cabin attendants.

Some of the same items are also being found on FAA ramp checks of foreign carriers while in this country. This list is long but by no means exhaustive and points out a permanent safety

oversight problem that several ICAO Member States need to address within their own CAA. These are also problems that must be corrected before carriers from those CAAs can operate on a regularly scheduled basis to and from the United States.

Desired outcome. The FAA is working to determine that each country meets its obligations under the ICAO and to provide proper oversight to each air carrier operating into the USA. The continued application of this program will result in a lower number of safety-related problems, including accidents, incidents, and an improved level of safety to the public.

9.5.3 General remarks

We have seen two different ways of facing the same problem in Europe and in the USA. The European SAFA is certainly useful, but cannot be the solution to the safety problem. The JAA honestly declares in its explanation that 'ramp inspections cannot guarantee the airworthiness of a particular aircraft'.

Indeed, try to picture an inspection made at night on an eastern aircraft with documents written in Russian (and tomorrow in Chinese) in a limited space of time because 'it is SAFA policy not to delay an aircraft except for safety reasons'.

The FAA's approach is (at least philosophically) much more consistent.

At the root of flight safety is compliance to the 'safety minima' known as ICAO Standards and Recommended Practices (SARPs). This compliance has to be demonstrated through the certification and oversight of an airline operator carried out by the state's aviation authority (provided it has the necessary capability and organization).

The capability and organization of this authority is the key to the problem of having air carriers acting according to the rules of the ICAO.

This is why the FAA (also on the basis of the rules of the ICAO) assesses the authorities' capability rather than the organization of the air carriers on the basis of a powerful organization that, at least at the time of writing, the EASA/ECAC do not have, although they could rely on a considerable number of national authorities capable of performing something similar to the IASA, if properly co-ordinated.

The FAA also gives support to countries that are poorly organized from an airworthiness point of view but, of course, only for countries with airlines seeking permission to operate to and from the United States.

However, the high number of commercial aircraft accidents in 2005 makes the problem increasingly urgent and this crisis concerns not only Europe and the United States, but the entire world.

We must point out that, currently, it is relatively easier – having adequate capital – to set up an airline in any country of the world than to 'invent' an effective aviation authority in the same country. Such authorities require several years of grounding and sometimes need external support to reach the necessary expertise; this is something that developing countries in particular are not always capable of achieving. In these cases, it is pointless to blame the authorities of those countries while their aircraft carry on flying around the world.

If the relevant aviation authority is not able to carry out its job, it should delegate its functions to an external competent aviation authority or, according to an ICAO initiative, to a Safety Oversight Group, pooling its resources among groups of nations.

From this perspective, no airline operator should be allowed to operate without certification and oversight made by a competent aviation authority. Of course, that should be co-ordinated by the ICAO, which would certainly be able to find the appropriate legal enforcement.

Notes

1 See the 'Airworthiness Directives' section in this chapter.
2 See the 'EASA certification of operators' and 'FAA certification of operators' sections in this chapter.
3 We will see an exception in the case of 'older airplanes', related to maintenance procedures only, without any decrease in safety.
4 In Chapter 5, the 'Instructions for Continued Airworthiness' section contains an example of what kind of instruction must be produced.
5 'Certifying staff' means personnel responsible for the release of an aircraft or a component after maintenance.
6 JAR-OPS 1.175 General rules for Air Operator Certification.
7 Subparagraph (b) dealing with repairs has been considered in Chapter 5, 'FAA repairs'.
8 Airworthiness Directives.
9 Maintenance, Preventive Maintenance, Rebuilding, and Alteration.
10 It is not rare to see aeroplanes having totaled 80 000–100 000 flight cycles.
11 See Chapter 4, 'Fatigue strength'.
12 Certificated (or equivalent to) of a FAR 139 airport.
13 The AC is dated December 1988.
14 In-flight shutdown (IFSD).
15 See note 1 in Chapter 3.
16 Category 1 means the air carriers from the assessed state may initiate or continue service to the United States in a normal manner and take part in reciprocal code-share arrangements with US carriers.

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Internet resources

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FAA: www.faa.gov
ICAO: www.icao.int
JAA: www.jaa.nl

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