CARISMA_WP1_TN

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CARISMA:
Aircraft Cabin and Cabin Systems Refurbishing,
Optimization of Technical Processes

Identification of the Process Chain for Cabin Conversion

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Technical Note

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19. Abstract This Technical Note is part of the cooperation project between ELAN GmbH and HAW Hamburg, having the purpose to preliminarily describe the set-up requirements for a Completion Center. Work Package 1, presented here, aims to identify and describe the necessary process steps in order to carry out an independent and successful cabin conversion, while fulfilling all the EASA requirements. It is found out that a company needs to apply for a Design Organization Approval (DOA) in order to prove that it can deliver an airworthy design. Parallel to the processes within the Completion Center, the processes for receiving the DOA are described. A way of representing the process chain is sought and the Design Structure Matrix approach is used for illustrating the relations between the processes and the direction of the information flow. Finally, the TN briefly presents a number of relevant instruments to be used for setting up the Completion Center, which can be further developed in the WP 3.		
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19. Kurzfassung
Diese Technische Niederschrift ist Teil des Kooperations Projektes CARISMA zwischen ELAN GmbH und HAW Hamburg. Aufgabe ist, den Weg in die Vision „Completion Center“ für die ELAN vorbereitend zu beschreiben. Arbeitspaket 1, das hier bearbeitet ist, versucht alle notwendigen Prozessschritte zu identifizieren, um eine eigenständige Kabinenumrüstung erfolgreich durchzuführen und dabei alle Anforderungen der EASA zu erfüllen. Es wurde festgestellt, dass Unternehmen, die zugelassene Entwürfe liefern wollen, ein Design Organization Approval (DOA) beantragen müssen. Parallel zu der Beschreibung der Prozesskette für die Kabinenumrüstungen, werden die Prozessschritte für DOA gezeigt. Als ein Darstellungsmodell für die Prozessschritte wird die Design Structure Matrix (DSM) ausgewählt. Die DSM zeigt effizient die Verknüpfungen zwischen den Prozessschritten. Die TN zeigt weiter relevante Instrumente für den Aufbau eines Completion Centers.

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DOA, Zertifizierung, Design Structure Matrix

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Abstract

The present economical context shows a growing market for cabin related activities. While OEM"s are increasing the pressure on subcontractors, by outsourcing larger work packages, the engineering offices, like ELAN GmbH, are seeking to further develop and increase their capabilities. In this context, WP 1 of the research project CARISMA, investigates the certification requirements with respect to cabin design and conversion. Background information for obtaining a Design Organization Approval from the responsible authority is presented here. The Completion Center concept is introduced and the process chain for cabin conversion is illustrated from the perspective of a medium sized engineering office. An investigation is conducted towards the available representation models used for the visualization and optimization of processes. After conducting this analysis, the Design Structure Matrix (DSM) representation is chosen. The process chain for a complete conversion can be divided into three parts. A: Offer, B: Conversion Processing, C: Hand Over. The complete process is (to make it simpler) illustrated with an example of a partial cabin conversion (modification). The investigation shows a high complexity of the task of cabin conversion. This complexity can only be mastered in an organization that controls itself rather independently from the surveillance of the Certification Agency. The present regulations pay more attention to the aircraft manufacturers than to subcontractors. This, however, will change soon: according to the European Aviation Safety Authority, the future will see the formation of specialized Centers of Excellence, formed by both manufacturers and engineering offices working on the certification of their products together.

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List of Abbreviations

AC	Advisory Circular
ADOA	Alternative Procedures to Design Organization Approval
AMC	Acceptable Means of Compliance
AP	Airbus Procedure
BPMN	Business Process Modeling Notation
CAS	Change Approval Sheet
CC	Completion Center
CCD	Catia Cadam Drafting
CCO	Cabin Conversion (Department at ELAN GmbH)
CDF	Concurrent Design Facility
CEF	Concurrent Engineering Facility

CP	Change Proposal
CS	Certification Specifications
CVE	Compliance Verification Engineer
DAS	Design Assurance System
DLR	Deutsches Zentrum für Luft- und Raumfahrt
DMS	Data Management System
DO	Design Organization
DOA	Design Organization Approval
DOM	Design Organization Manual
DSM	Design Structure Matrix
DT	Delegated Team
DTS	Documented Technical Solution
EADS	European Aeronautic Defense and Space Company
EASA	European Aviation Safety Agency
EDM	Engineering Data Management
EDS	Electronic Display System
EFW	Elbe Flugzeugwerke GmbH
EPC	Event-driven Process Chain
ESA	European Space Agency
ETSO	European Technical Standard Order
EU	European Union
EWIS	Electrical Wire Interconnection System
FAA	Federal Aviation Administration
FAL	Final Assembly Line
FAR	Federal Aviation Regulations
FM	Flight Manual
FMEA	Failure Mode and Effect Analysis
FMECA	Failure Mode and Effect Criticality Analysis
GM	Guidance Material
HTML	HyperText Markup Language
ICAO	International Civil Aviation Organization
ISO	International Standards Organization
JAA	Joint Aviation Authorities
JAR	Joint Aviation Requirements
MAS	Modification Approval Sheet
MCA	Major Component Assembly
MOC	Means of Compliance
OoA	Office of Airworthiness
PMM	Process Module Methodology
QFD	Quality Function Deployment
QM	Quality Management
RFC	Request for Change
RMO	Retrofit Modification Offer

RTC	Restricted Type Certificate
SADT	Structured Analysis and Design Technique
SB	Service Bulletin
STC	Supplemental Type Certificate
TC	Type Certificate
TI	Type Investigation
TRS	Technical Repercussion Sheet
UML	Unified Modeling Language
VIP	Very Important Person
XML	Extensible Markup Language
WBS	Work Breakdown Structure
WfMC	Workflow Management Coalition
WWW	World Wide Web

List of Terms and Definitions

Certification — Refers to any form of recognition that a product, part or appliance, organization or person complies with the applicable requirements including the provisions of this Regulation and its implementing rules, as well as the issuance of the relevant certificate attesting such compliance (**EASA 2009b**)

Concurrent Engineering — A work methodology for product development based on parallelization of tasks to reduce errors, time and to optimize the design (**Wikipedia 2009c**);

A systematic approach to integrated product development that emphasizes the response to customer expectations; it embodies team values of co-operation, trust and sharing in such a manner that decision making is by consensus, involving all perspectives in parallel, from the beginning of the product life cycle (**ESA 2009**);

Contract — Agreed requirements between a supplier and customer transmitted by any means (**EN 9100**)

Design Assurance System — Represents the means by which an organization demonstrates to EASA the capability to control and supervise the design or the changes to the design so as to comply with the applicable type certification basis and environmental protection standards (Article 21A.239, **EASA 2009b**)

Design Organization Manual	Is the handbook describing the organization, the relevant procedures and the products or changes to products to be designed by the design organization, according to the EASA Regulations (Article 21A.243, **EASA 2009b**)
European Commission	Officially: *Commission of the European Communities*, is the executive branch of the European Union. The body is responsible for proposing legislation, implementing decisions, upholding the Union's treaties and the general day-to-day running of the Union (**Wikipedia 2009b**)
Extensible Markup Language (XML)	A specification for creating custom markup languages; the purpose is to help information systems to share structured data, to encode documents or to serialize data; helps in creating web pages, but also to define the content of a document separately from its formatting (**Microsoft 2009**)
Key Characteristics	The features of a material, process, or part whose variation has a significant influence on product fit, performance, service life or manufacturability (**EN 9100**)
Level of safety	The term safety is connected to the failure probability of an aircraft; however the safety requirements cannot be demanding in such a manner so to affect the practicability of an aircraft; therefore, the level of safety defines the acceptable failure probabilities (**De Florio 2006**)
Major change	Refers to all changes which are not minor changes (**EASA 2009b**, Article 21A.91)
Major repair	The effect is considered to be significant (**EASA 2009d**)
Minor change	Refers to a change which has no appreciable effect on the mass, balance, structural strength, reliability, operational characteristics, noise, fuel venting, exhaust emission, or other characteristics affecting the airworthiness of the product (**EASA 2009b**, 21A.91)
Minor repair	The effect is known to be without appreciable consequence (**EASA 2009d**)
Parts and Appliances	In the EASA Regulations, these terms refer to any instrument, equipment, mechanism, part, apparatus, appurtenance or accessory, including communications equipment, that is used or intended to be used in operating or controlling an aircraft in flight and is installed in or attached to the aircraft. It shall include parts of an airframe, engine or propeller (**EASA 2009b**)

Product	In the EASA Regulations, this term refers to the aircraft, engine or propeller (**EASA 2009b**)
Supplemental Type Certificate	If a person (organization) not being the TC holder, applies for a major change to the type design, this is done under the STC application (Article 21A.92, **EASA 2009b**)
Tender	Offer made by a supplier in response to an invitation to satisfy a contract award to provide a product (**EN 9100**)
Type Certificate	*The type-certificate and restricted type-certificate are both considered to include the type design, the operating limitations, the type-certificate data sheet for airworthiness and emissions, the applicable type-certification basis and environmental protection requirements with which the Agency records compliance, and any other conditions or limitations prescribed for the product in the applicable certification specifications and environmental protection requirements. The aircraft type-certificate and restricted type-certificate, in addition, both include the type-certificate data sheet for noise. The engine type-certificate data sheet includes the record of emission compliance* (**EASA 2009b,** Article 21A.41)
Type Design	**EASA 2009b,** Article 21A.31: *(a) The type design shall consist of:* *1. The drawings and specifications, and a listing of those drawings and specifications, necessary to define the configuration and the design features 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 necessary to ensure the conformity of the product;* *3. An approved airworthiness limitations section of the instructions for continued airworthiness as defined by the applicable airworthiness code; and* *4. Any other data necessary to allow by comparison, the determination of the airworthiness, the characteristics of noise, fuel venting, and exhaust emissions (where applicable) of later products of the same type.* *(b) Each type design shall be adequately identified.*
Type Investigation	**EASA 2009c** (GM No. 1 to 21A.239(a), Article 2.3): *The "Type Investigation" means the tasks of the organization in support of the type-certificate, supplemental type-certificate or other design approval processes necessary to show and verify and to maintain compliance with the applicable CS and environmental protection requirements.*
Web Portal	Examples of web portals are MSN, Yahoo!, AOL or iGoogle; a web portal gathers and presents information from various sources; besides a searching engine, it includes services like e-mail, news or entertainment.

1 Introduction

1.1 Motivation

This Technical Note is part of the research project CARISMA which is aimed to deliver results for ELAN GmbH with respect to the vision „Completion Center". The subject treated here refers to the WP 1, described in the appendix of the collaboration contract between Hamburg Innovation GmbH and ELAN GmbH as follows (**CARISMA 2009**):

> ***WP 1: Identification of the Process Chain "Cabin Conversion"***
> *In the frame of this work package all the elements of the process chain necessary for a successful cabin conversion should be identified and described. All the input parameters and all the relevant documents have to be considered.*
>
> *The Cabin Conversion (CCO) branch of ELAN deals with cabin conversion for the customer Airbus. Today only a small part of the necessary processes is being conducted by ELAN, another part of the process chain remains in the hands of the ordering customer. An investigation has to be conducted about how the processes are divided between ELAN and Airbus. From there on, all the necessary process steps should be identified in order to carry out an independent and successful cabin conversion, while fulfilling all the EASA requirements.*

1.2 Definitions

Process Following the definition of EN 9100/2003, a process can be defined as the activity using resources, and managed in order to enable the transformation of inputs into outputs; in this paper a process approach is used for investigating and de-scribing the development of the cabin (**EN 9100**).

Process Chain This term illustrates the processes, as part of a system, and the relations between them.

Cabin The cabin is the compartment and interior surrounding passengers and crew but also all systems, functions and services that ensure a safe and comfortable operation both in flight and on the ground (**AP 2289**).

Cabin Conversion Usually the term, unlike *cabin upgrade*, which refers to changes that improve an existing cabin layout, a conversion indicates a complete change of the cabin layout, which may include the change of the cabin purpose; e.g. pax-to-VIP conversion, Pax-to-Freighter Conversion (**Williams 2009**).

Certification This activity represents the sum of the activities for showing compliance with the applicable airworthiness standards; the compliance is proven by holding a type certificate, while the authorization for operation is shown by the certificate of airworthiness (**De Florio 2006**).

1.3 Purpose of the Work

The cooperation between the ELAN GmbH and HAW Hamburg has the purpose to bring ELAN forward on its way to develop itself and to create the resources to receive greater work packages in the frame of cabin conversions, having in mind the vision „Completion Center". The Cabin Conversion Division of ELAN managed to adapt to the actual economical context by creating a symbiotic relationship with the company V-Plane. The main purpose of ELAN is now to adapt and develop as an engineering office on the market.

Despite the economical and political issues the purpose of the CARISMA Project remains as initially defined in the appendix of the contract: to research the path towards becoming a Completion Center and receiving a DOA.

The first Work Package has, as a main goal, the identification of the processes inside a Completion Center delivering complete or partial conversions. However, it was discovered that the requirements of EASA with respect to design and engineering work are quite stringent. Part of the WP 1 became the initiation of a more detailed research towards receiving a DOA (Design Organization Approval). None of the identified processes is meaningful outside an approved design organization.

To summarize, the objectives of WP 1 are:

- to conduct an investigation towards the certification requirements with respect to cabin design and redesign work and the way these requirements can be fulfilled by a medium sized engineering office, like ELAN;
- to identify the EASA requirements for receiving a DOA;
- to adapt and transform these requirements into valid processes;
- to present the current status of ELAN and the relation with Airbus, as well as the common activities;
- to identify the general steps and processes required for ELAN to obtain a DOA;
- to identify the phases and processes required to conduct a complete cabin conversion;
- to investigate process representation models and to identify the suitable one, which is to be used in WP 3 for generating optimized processes and relations between processes.

1.4 Literature

For determining the EASA requirements for either obtaining a DOA or identifying the certification requirements with respect to cabin conversions, the sources used were the regulations provided by EASA. Contact with the German Civil Aviation Authority also helped in better understanding the complex process behind receiving the approval for setting up a design organization.

For determining the processes inside ELAN and the relation with Airbus, as well for identifying the processes required for conducting a cabin conversion, the cooperation with the team of the CCO (Cabin Conversion) department at ELAN was very helpful with this respect.

Few literature sources are available in the area of cabin conversions. For completing the work a large number of books were used either from the university library, or they were ordered especially for the purpose of using them for CARISMA. Such books are **De Florio 2006**, **Flouris 2008**, **Schrick 2008**. The available documentation from Airbus (**AP 1500**, **AP 2289**) was helpful especially in writing chapters 3 and 5. For analyzing process representation models conference publications (such as **Zha 2002** or **Nguyen 2008**) were used.

1.5 Structure of Work

The Technical Note is comprised of 6 chapters, besides the introductory chapter. Two appendices can be found at the end of the report.

Chapter 2 **Ensuring Safety in Aviation** – shows the perspective of the certification Agencies and certification principles and defines key terms like: type certification, continued airworthiness, design organization approval. This chapter also provides a summary of the cabin related certification requirements given in the EASA regulations.

Chapter 3 **Cabin Conversion at ELAN together with Airbus** – this chapter presents the current relation between ELAN and Airbus, as well as the main phases and processes inside the CCO Department for conducting these work packages. The cooperation between ELAN and V-Plane is not included.

Chapter 4 **Sequence of Events for ELAN to obtain DOA** – the investigation conducted in chapter 2 and concluded with the necessity of obtaining a DOA, sets the basis for chapter 4. The main issues with respect to DOA are analyzed from the point of view of ELAN and a sequence of events is proposed in order to be able to apply for such an approval.

Chapter 5 **Process Chain Description for Cabin Conversion** – the phases and sub-phases for completing a cabin conversion are here described. The chapter also comprises an analysis towards possible process representation models. The model of Design Structure Matrix is chosen and used, as it allows further optimization algorithms to be applied and thus obtaining a better process sequence.

Chapter 6 **Recommended Tools and Strategies for Completion Centers** – proposes several helpful ideas which could be implemented. It shortly presents some successful QM (Quality Management) strategies, which can be regarded by ELAN on its way towards becoming a Completion Center.

Chapter 7 **Conclusions** – presents a summary of important aspects related to the set up of a Completion Center

Appendix A **EASA Forms for Completion Center** – presents a collection of Forms which are to be filled in along the relation with the European Aviation Safety Agency (EASA)

Appendix B **Certification Requirements for Cabin Design and Conversion** – presents a collection of certification rules for cabin design compiled out of the EASA regulations for small and large aeroplanes.

2 Ensuring Safety in Aviation

2.1 Airworthiness and Aircraft Certification

In aviation the safety of the crew and passengers is quantified through the term *airworthiness*. If it is shown that the aircraft complies with the applicable standards, a *certificate of airworthiness* is issued for each aircraft individually, demonstrating that the required level of safety is being fulfilled.

JSP553 Military Airworthiness Regulations (2006) Edition 1 Change 5 (**JSP 2006**) gives a general definition of the term airworthiness, valid for both military and civil aircrafts:

> *The ability of an aircraft or other airborne equipment or system to operate without significant hazard to aircrew, ground crew, passengers (where relevant) or to the general public over which such airborne systems are flown.*

Three entities interact for achieving the safety requirements: the designer, the operator and the regulator (Fig. 2.1) (**Greenwood 2008**):

- *The regulator* sets the rules and certifies the products.
- *The designer* establishes and maintains an airworthy design.
- *The operator* operates and maintains the design within the procedures and limits specified by both the designer and the regulator.

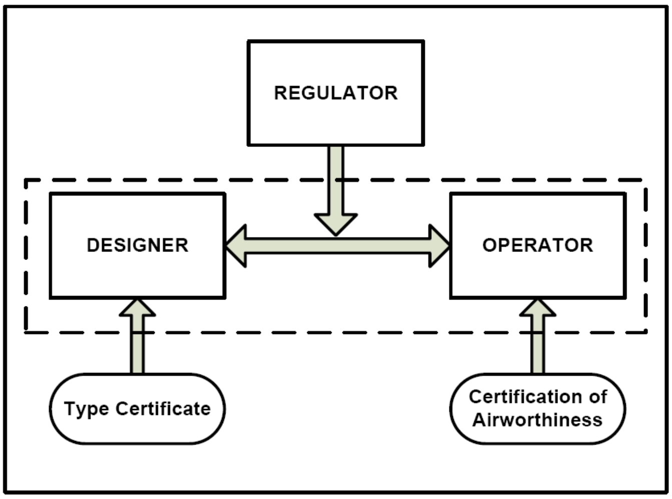

Fig. 2.1 Three entities define an airworthy aircraft

2.1.1. Certification Agencies

The International Civil Aviation Organization (ICAO)
After the Second World War, the technical development of the aircrafts had come to a point where the necessity, to develop principles for organizing a safe transportation of goods and people on large distances, was obvious. This was the reason why the US Government sent an invitation to 55 states to meet in Chicago in 1944. On 4 April 1947 *The International Civil Aviation Organization* was born with the purpose of planning and encouraging the development of airways, airports, air navigation but also aircraft design and aircraft operation, all under the principles of safety. The results of the meetings in 1944, forming the *Convention on International Civil Aviation*, were gathered in a preamble and 96 articles. After the creation of ICAO, 18 Annexes were added to the Convention, with the purpose of standardization of the safe operation of aircrafts. These Annexes were called *International Standards* and *Recommended Practices*. These documents were to be applied by all members who signed the convention with the purpose of achieving uniformity in applying the regulations; any difference between the applied standards and the ICAO standards was to be reported (**ICAO 2009a**).

The present organization of ICAO comprises of the following Bureaux“:

- *Air Navigation Bureau*, providing technical studies for the Air Navigation Commission as well as recommendations for Standards and Recommended Practices (SARPs).
- *Air Transport Bureau*, providing expert assistance required by the Assembly, Council, Air Transport Committee (ATC), Committee on Unlawful Interference (UIC), Committee on Joint Support of Air Navigation Services (JSC).
- *Legal Bureau*, providing advice and assistance to the Secretary General and through him to the various bodies of the Organization and to ICAO Member States on constitutional, administrative and procedural matters.
- *Technical Cooperation Bureau* providing assistance in project implementation with Neutrality, Transparency and Objectivity.
- *Bureau of Administration and Services*, providing the administrative support required by the Organization relating to personnel, language and publications, as well as for Quality Management.

The Annexes mentioned above are still valid today, with the applicable amendments. They contain the *principles and objectives* to be followed by the national authorities. The minimum level of airworthiness required to be maintained by the national standards of the member states is stated in Annex 8 to the Convention on International Civil Aviation - Airworthiness of Aircraft. This Annex contains the procedure for certification and continuing airworthiness of an aircraft, as well as technical requirements for large aeroplanes and helicopters. However, the certification *requirements and specifications* are covered by the airworthiness standards issued by JAA, FAA or EASA, according to these Annexes (**ICAO 2009a**).

Civil Aviation Authorities

The natural consequence of the events during 1944-1947, lead to the development of national standards for guaranteeing the safety. This is how the institutions and authorities responsible for achieving this were born. Their main responsibilities and tasks can be summarized as follows (**De Florio 2006**):

- To *prescribe* airworthiness requirements and procedures,
- To *inform* the interested parties regarding these prescriptions,
- To *control* the compliance of all pertinent prescriptions, for design and manufacturing, for maintenance and operation,
- To *certificate* the products and the organizations, meaning to prove via a document, that the compliance is achieved.

The Joint Aviation Authorities

The Civil National Authorities of a number of European states have joined together in 1970 to form what is called today *The Joint Aviation Authorities*. The purpose was to implement common safety standards and procedures for the member states, having in mind also the harmonization with the USA standards. The objectives of the JAA can be summarized as it is shown below (**JAA 2009**):

- To ensure the achievement among the member states of a high level of *aviation safety,*
- To *cooperate with EASA* in maintaining a unitary regulation also for non EU countries,
- To achieve a *cost effective safety system* so as to contribute to the efficiency of the civil aviation industry,
- To ensure fair and equal competition for the member states by *consolidating common standards*,
- To cooperate with other national authorities for a *worldwide safety improvement*.

In 2002 the Regulation (EC) No 1592/2002 was adopted by the European Parliament and the Council of the European Union (EU) and a new regulatory framework was created for the European aviation. According to this Regulation, for EU Member States national regulation in the airworthiness domain was to be replaced by the EU Regulation. Therefore, certification tasks have been transferred from National Authorities to EASA, while the non EU countries maintain their own responsibilities.

A transition from JAA to EASA was required for all member states. JAA continues to exist, while highly contributing to the EASA establishment. The status of EASA as a member of JAA was defined in November 2003, by signing the Cyprus Arrangement.

Consequently, a *Roadmap* for the establishment of clear milestones for JAA's future was developed and adopted in August 2005 by the JAA Board. A working group on the Future on the JAA was established; they created the so called FUJA Report proposing a transformation from JAA into JAA T (T for "transition"), comprising a Liaison Office (LO) in Cologne (Germany) and a Training Office (TO) in Hoofddorp (The Netherlands). This report was presented in August 2005, in Romania.

A reason to better understand the necessity of this transition in the today"s political and economical context is underlined by **De Florio 2006**:

> *[...] we are talking about authorities, not authority. [...] the JAA did not have the legal status of an authority and therefore a legally recognized power. They did not have the power to issues certificates. Instead, they could only recommend to the national authorities the release of such certificates under the relevant terms and conditions.*

In November 2005 the EU Commission began the legislative process to amend EASA Regulation (EC) 1592/2002 to extend the competences of EASA into the fields of operations and licensing. On 8 of April 2008 a new regulation entered into force: Regulation (EC) No. 216/2008, repealing the previous one. (**JAA 2009, EASA 2009a**)

The European Aviation Safety Agency

As mentioned earlier, the single authority of EASA has been created by adopting first the Regulation (EC) No. 1592/2002, on 15 July 2002 and later the (EC) No. 216/2008.

The European Aviation Safety Agency (EASA), providing common standards for the aviation safety and environmental protection in the EU countries, is responsible for approving any design, manufacture or maintenance of airplanes or components, as well as for monitoring the implementation of the safety rules.

Accordingly, the main *tasks* of the Agency can be classified as follows (**EASA 2009a**):

- EASA assists the European Commission by drafting aviation safety legislation and providing technical advice.
- EASA monitors the uniform implementation of the regulations by performing inspection, training and standardization programs.
- EASA collects and analysis data and develops research programs to improve aviation safety.
- EASA assists the European Commission by providing know-how support for issuing common rules for:
    - type-certification of aircraft, engines and parts,
    - approving of aircraft design, production and maintenance organizations (also outside the EU),
    - approving of air operations,
    - licensing the aircrew.

The regulations *structure* of the Agency is shown in Figure 2.2 and comprises of:

- *The Basic Regulations*
    - on common rules in the field of civil aviation and establishing a European Aviation Safety Agency

- *The Implementing Rules*
  - for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production
  - on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organizations and personnel involved in these tasks
- *The Acceptable Means of Compliance and Guidance Material* for Parts 21, M, 145, 66,147
- *The Airworthiness Codes*:
  - CS-Definitions
  - CS-22 Sialplanes and Powered Sailplanes
  - CS-23 Normal, Utility, Aerobatic and Commuter Aeroplanes
  - CS-25 Large Aeroplanes
  - CS-27 Small Rotorcraft
  - CS-29 Large Rotorcraft
  - CS-VLR Very Large Rotorcraft
  - CS-VLA Very Large Aeroplanes
  - CS-E Engines
  - CS-P Propellers
  - CS-34 Aircraft Engine Emissions and Fuel Venting
  - CS-36 Aircraft Noise
  - CS-APU Auxiliary Power Units
  - CS-ETSO European Technical Standard Orders
  - CS-AWO All Weather Operations

Federal Aviation Administration
The origin of the FAA was set on 20 May 1926 with the Air Commerce Act, destined to improve and maintain safety standards for air commerce. In 1938 the responsibilities were transferred from the Commerce Department to the independent authority called Civil Aeronautics Authority. The Federal Aviation Agency formed in 1958, had a broader authority then the CAA, including also the development of an air navigation system, common for military and civil aircrafts. The name Federal Aviation Administration was given in 1967, when the FAA became part of the Department of Transportation (**FAA 2009a**).

The activities of FAA refer to the safety of civil aviation, and can be summarized as follows (**De Florio 2006**):

- regulating civil aviation to promote safety,
- encouraging and developing civil aeronautics and new aviation technologies,
- developing and operating a system of air traffic control and navigation for both civil and military aircrafts,
- researching and developing the National Airspace System and civil aeronautics,
- developing and carrying out programs to control aircraft noise and other environmental effects of civil aviation,

- regulating US commercial space transportation.

Among the complex organization of FAR, the *Aviation Safety* office hosts the *Aircraft Certification Service*, responsible for administrating the *Federal Aviation Regulations* (FAR"s). The ACS is divided into more departments (**FAA 2009a**):

- Aircraft Engineering Division
- Production and Airworthiness Certification Division
- Planning and Program Management Division (responsible for FAR 21, among others)
- Small Airplane Directorate (responsible for FAR 23 and FAR 31)
- Transport Airplane Directorate (responsible for FAR 25)
- The Rotorcraft Directorate
- The Engine and Propeller Directorate

For 50 years, every year the Europe – US International Aviation Safety Conference takes place with the purpose of improving commonality of standards between Europe and USA. Open discussions take place also with industry representatives on current initiatives and strategic directions, with the declared scope to improve aviation safety and to facilitate, when appropriate, reciprocal acceptance of certificates/approvals by, whenever possible, harmonizing standards and implementing guidance (**FAA 2009b**).

Between non EU countries, like China, Brazil, Canada, Israel, Russia, including USA, bilateral agreements between the authorities need to be signed (**De Florio 2006**).

2.1.2 Document Hierarchy

It makes sense to further focus on the European Agency and its requirements. In Figure 2.2 the Regulations Structure of EASA can be observed. The focal point is represented by the Part 21, as it is dealing with Design Organization Approvals.

The destination and purpose of each document from the hierarchy described in Figure 2.2 was already briefly mentioned. This chapter pursues a concise description of the certification requirements involved by the aircraft cabin interior design and conversion activities. Having now the background knowledge about the Certification Agencies in general and about how the EASA works and its purpose, it makes sense to further investigate the necessary documentation to be considered in order to fulfill the customer requirements in this area.

Moreover, the purpose of Chapter 2 is to define the organizational background and the necessary resources for a medium sized company willing to work in the field of cabin conversion, in order to conduct an airworthy engineering design.

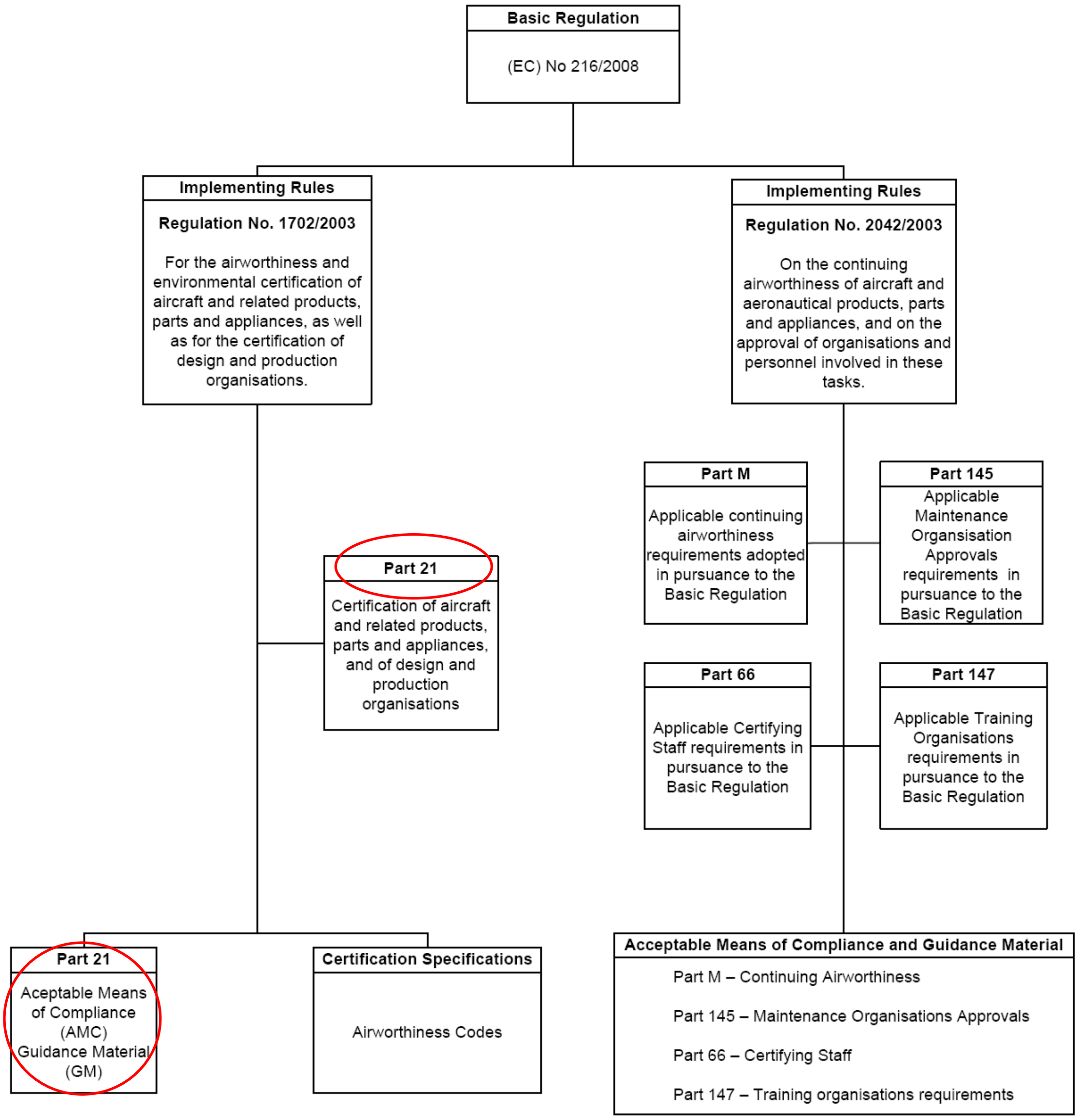

Fig. 2.2 EASA Regulations structure (**EASA 2009d**)

There are two Implementing Rules, containing the documents called *Parts*: (EC) No. 1702/2003, specifying the rules 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, and (EC) No. 2042/2003 specifying the rules for the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and for the approval of organizations and personnel involved in these tasks.

The *Certification Directorate* of EASA has the responsibility for the airworthiness and environmental certification of all products, parts and appliances designed, manufactured and maintained in the EU. It also has the task to issue type certificates and to approve design organizations. In order to fulfill this, the Agency closely collaborates with the National Aviation Authorities.

In order to see how these rules can be fulfilled in the case of cabin design and conversion, an analysis of the content of these documents is further required.

Approval of Design Organizations

The approval of Design Organizations must be made according to Annex Part 21, Subpart J, to (EC) No. 1702/2003. This document sets the requirements that need to be fulfilled by any organization wanting to develop design work for aeronautical products. However, requirements from Subpart J interfere with requirements from other subparts, therefore, a strict correlation must be made between requirements, within the scope of the approval.

The Acceptable Means of Compliance and Guidance Material illustrate the means by which the requirements stated in the rule can be achieved. These documents give valuable information about how such organizations can be set up, so to prove to EASA that they can comply with the requirements.

The design work needs a corresponding technical organization; once the compliance is demonstrated, the applicant receives a Type Certificate or, as it is the case, a Restricted or a Supplemental Type Certificate (**EASA 2009b**).

Approval of Production Organizations

The Production Organizations can be approved in two ways:

- Production Organization Approval, under Subpart G, of Part 21
- Production without Production Organization Approval, under Subpart F of Part 21

The Subpart G process is similar to the one for DOA, from Subpart J. The POA would also need to prove compliance by showing capability. The Subpart F process is applicable for those organizations, producing for example a limited number of units. If an organization is approved under this Subpart, then certain privileges suitable for approval under Subpart G are no longer valid, and the EASA needs to supervise the organization closer (**EASA 2009b**).

Certification Requirements

The fundamental requirement an organization performing either design or production needs to fulfill, is showing the capability to comply with the applicable norms, within the scope of approval. This capability is being evaluated by EASA by checking first of all the way the design/production work is being carried out. After getting the approval, the organization carries the responsibility for performing the work, and, under the granted privileges, it will be able to approve certain activities, without the implication of the Agency. The purpose of the Agency is to stimulate the independency of the design/production organizations, in order to increase the efficiency and in the same time the safety in aviation industry.

2.1.3 Certification Principles

When applying the certification regulations the *level of safety* concept must be properly understood and put in to practice by the design organizations. Therefore the definition of this term must balance the criteria of acceptability and practicability (**De Florio 2006**). For a better understanding, see Fig. 2.3. As the author remarks, beyond a certain point the increase of safety assumes too large expenditure, and therefore a loss in practicability.

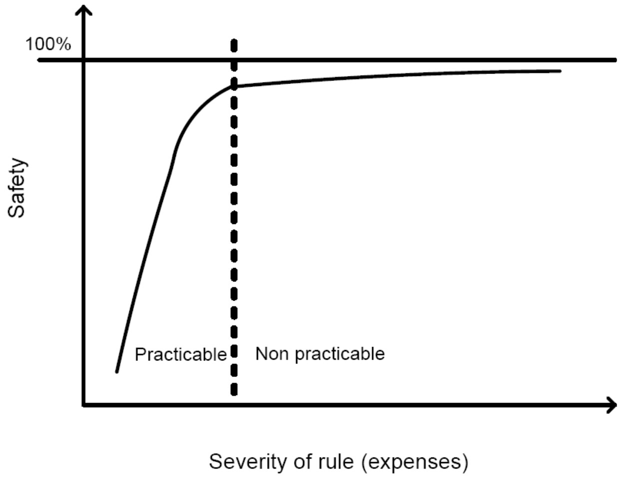

Fig. 2.3 Airworthiness rules (**De Florio 2006**)

As far as the cabin interior concerns, one of the stringent safety aspects is the protection of the passengers against *fire*. A design organization must develop tests together with EASA in order to prove that the acceptable safety level is being respected. The fire zones (e.g. electrical installation, in cabin) and also the flammable materials must be identified. The certification department of a design organization needs to conceive standards that provide rules for materials used in the cabin interiors from the point of view of flammability and smoke emissions (the so called MOC‟s (Means of Compliance)).

The more complex the aircraft and the higher the degree of redundancy, the more complex the rules for implementing safety become. The *safety assessment* is related to the *accident rate*. **De Florio 2006** shows another illustrating figure, describing these interrelations. These observations make sense especially due to the fact that the cabin is the compartment that should firstly ensure the safety of the passengers. Beyond the functional role (passenger transportation), the cabin also represents the interface with the travelers, and the safety comes before comfort.

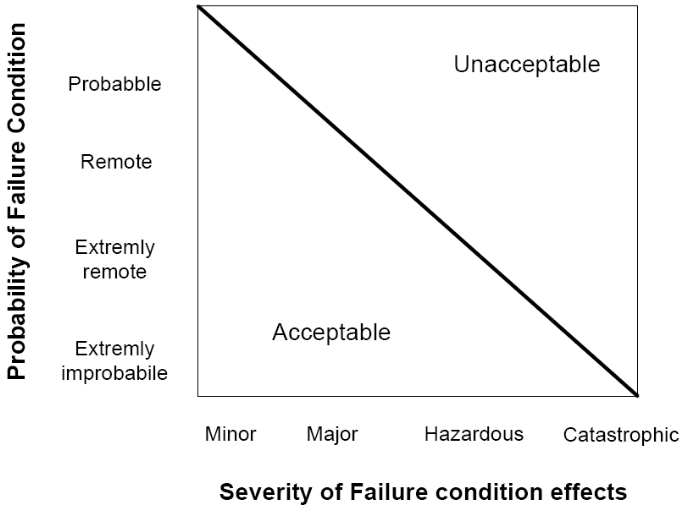

Fig. 2.4 Classification of failure conditions (**De Florio 2006**)

Another aspect further considered, also in the case of cabin conversion, is the structure requirements. Regarding structure, there are two definitions valid: a *safe-life* structure and a *fail-safe* structure (**EASA 2009a**). For aircrafts classified in the CS 25 the fail-safe structure is required. This means the design has to have a certain *damage-tolerance*. To be more specific, tests should be conducted in order to evaluate if the damage-tolerance is respected or not.

> *The residual strength evaluation must show that the remaining structure is able to withstand loads (considered as static ultimate loads) corresponding to the following conditions:*
> *(5)For pressurized cabins, the following conditions:*
> *(i)The normal operating differential pressure combined with the expected external aerodynamic pressures applied simultaneously with the flight loading conditions specified in subparagraphs (b)(1) to (b)(4) of this paragraph if they have a significant effect.*
> *(ii) The maximum value of normal operating differential pressure (including the expected external aerodynamic pressures during 1 g level flight) multiplied by a factor of 1·15 omitting other loads (EASA 25.571(b)(5)(i) and (ii))*(**CS 25 2009**, Paragraph 25 571 (b))

The cabin interior design has an obvious interface with the structure of the airplane, for example through the fasteners for galleys and lavatories, or through the air conditioning system. In the case of redesign of cabin, another good example showing the interference is transforming a pax version to freighter, requiring an extra cut into the fuselage for a cargo door.

All these aspects mentioned above need to be considered when setting the scene for the engineering work.

2.1.4 Type Certification

According to Article 2, from the Implementing Rule (EC) No. 1702/2003 (**EASA 2009b**), any product, part or appliance receives a certificate according to Part 21. A type certificate is only released if the organization proves its capability of conducting an airworthy design, by holding a DOA. The Agency will be the one issuing applicable airworthiness standards to show compliance (Paragraph 21A.16A). The airworthiness codes, together with the application for a TC form the *certification basis*. The applicant must show compliance with this basis and with the applicable environmental protection requirements, and must provide also the means by showing this compliance to the Agency. The process ends with a declaration of the applicant, respectively DOA Holder that the design complies with the certification basis (Paragraph 21A.20).

However, the type certificate does not represent the authorization to operate the aircraft; this is shown by the *certificate of airworthiness*, which is being released for every single airplane (new or used) (paragraph 21A.174).

The *type design* (see List of Definitions) must be adequately identified (Paragraph 21A.31), otherwise any deviation is considered to be a *change*, and must be correspondingly approved.

In this case, if a person (organization) not being the TC holder wishes to conduct modifications to the type design, and the respective modification is *major*, but a new certification basis is not required, then he must apply for a *Supplemental Type Certificate* (more on this in the next subchapters).

The *parts and appliances* installed on the products must be approved under Subpart K, Part 21 of the same document. The showing of compliance (paragraph 21A.303) must be made in conjunction with the other subparts (B, D and E) related to type certificates, changes to type certificates or supplemental type certificates for the respective product, or related to an ETSO authorization (Subpart O). The part or appliance can only be installed if an authorized *release certificate* (EASA Form 1), certifying airworthiness, accompanies the product and if the product is market as required in Subpart Q, for a proper identification (paragraph 21A.307).

2.1.5 Continued Airworthiness

An aircraft must not only comply with the applicable standards, but the designer must also provide instructions for maintaining the airworthiness. Section A, of (EC) No. 2042/2003, Part M, specifies the measures to be taken in order to ensure that airworthiness is maintained, including maintenance procedures. It also specifies the conditions to be met by the persons or organizations involved in such continuing airworthiness management (paragraph M.A.101, **EASA 2009e**). These instructions must be written in accordance with the applicable requirements.

The rules for continued airworthiness are contained in operational standards (like JAR OPS or FAR 43 – Maintenance, Preventive Maintenance, Rebuilding and Alterations) and maintenance standards (like the above mentioned document).

Associated with the certification of maintenance organizations (under Part 145), is the certification and training of personnel authorized to perform maintenance operations; this is specified in Part 66 (**EASA 2009e)**.

A maintenance program must be approved by the authority (paragraph M.A.302) and must be constantly reviewed and amended. This program must comply with the instructions for continuing airworthiness issued by TC or STC holders or, if this is not the case, with:

- the instructions issued by the competent authority or, if these two possibilities are excluded,
- the instructions defined by the owner or the operator and approved by the competent authority.

This program should provide all the details or maintenance, including (paragraph M.A.302(d)):

- Frequency of the maintenance operations

- Specific tasks linked to specific operations

The maintenance organizations are approved according to Subpart F; this subpart defines the requirements such an organization needs to fulfill (paragraph M.A.602).

2.2 Certification of Aircraft Cabins

Every product is designed by a design organization having a *type certificate*, where all the specifications of the product are mentioned (see List of Definitions). The respective design organization is approved by EASA and the type certificate is also issued by Agency. This type certificate shows that the design organization has proven compliance of the *type design* with all applicable requirements (21A.14, **EASA 2009b**).

In the case of cabin conversions, one is not talking about designing products (see List of Definitions), but designing changes to products. Therefore, the engineering office wanting to perform cabin design or cabin conversion design, should firstly decide the type of products for which it wants to work. Then the design work needs to be classified in either *minor or major change* to the type design. The minor changes to a type design are to be classified and approved either by the Agency or the design organization (further referred to as DO), under a procedure agreed with EASA (EC 1702/2003, subpart D, 21A.95, **EASA 2009b**).

The major changes can be classified by the DOA holder for the respective type certification. The DOA holder can further obtain an approval from EASA for performing these changes, by fulfilling the requirements stated in EC 1702/2003, subpart D, 21A.97 (**EASA 2009b**) (so by showing compliance). However, an engineering office does not need to have a type certificate for the respective aircraft for which it wants to perform the major change. It is enough if it applies for a *supplemental type certificate*, according to Subpart E from EC 1702/2003 (**EASA 2009b**).

For cabin refurbishment and conversion, major and minor changes need to be conducted, under the umbrella of an STC (if the changes are designed by other organizations then the TC holder). Figure 2.5 sums up what was earlier mentioned, and is based on the Part 21 requirements applied to cabin conversion/refurbishment.

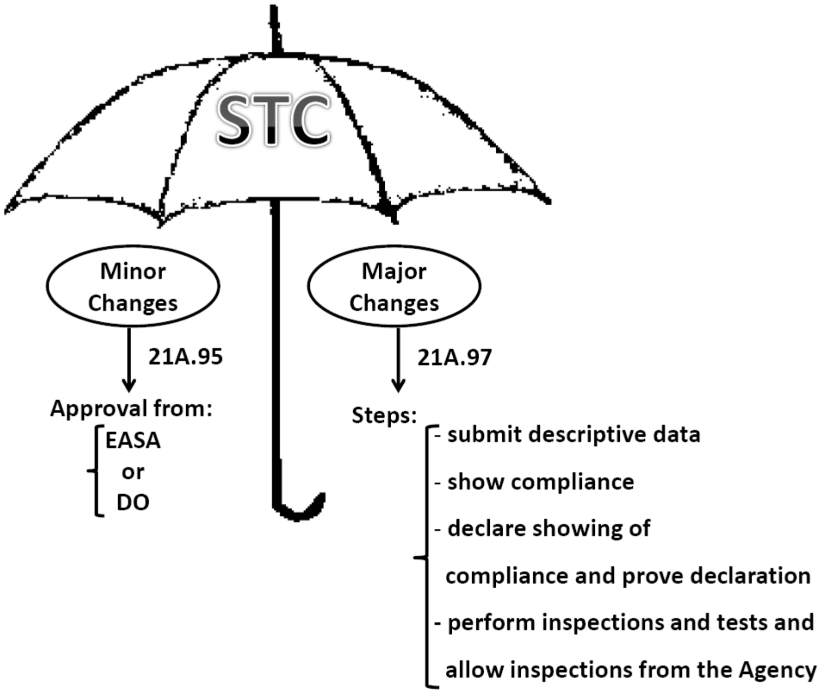

Fig. 2.5 Implications of minor and major changes (based on information from **EASA 2009b)**

2.2.1 Changes to Type Design

In the previous subchapters the minor and major changes were defined. The specification was made that, if a major change for a type design is required (like transforming a cabin interior from pax to cargo), this can be done by applying for a STC.

The type certification basis modifies once a change is introduced. The GM to Part 21 shows a procedure for establishing this basis (see Figure 2.6).

In this subchapter the requirements necessary to conduct the design of these changes, which are stated in the Subpart D of Part 21, will be mentioned.

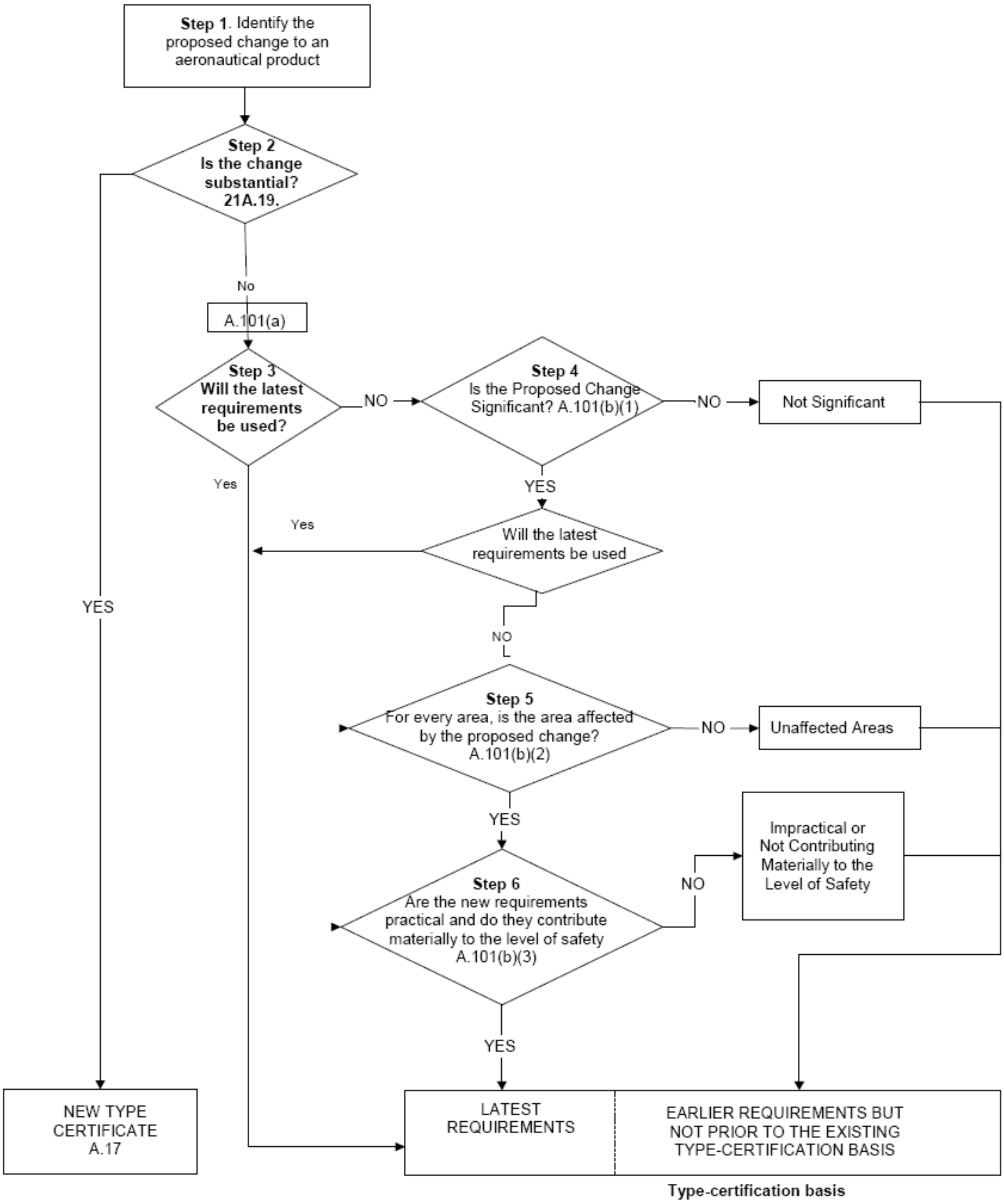

Fig. 2.6 Type Certification Basis for changed products (GM 21A.101, **EASA 2009c**)

Since the effect of the changes needs to be correctly appreciated and this is not an easy task, the Agency requires specific procedures for this process, and therefore it is important for a DO to be able to classify changes alone. According to the GM for 21A.91 (**EASA 2009c**):

> *[...]the TC or STC holder must provide procedures acceptable to the Agency for classification and approval of changes to type design and repairs and production deviations from the approved design data.*

The following sketch can be extracted (**EASA 2009c**) (Fig. 2.7):

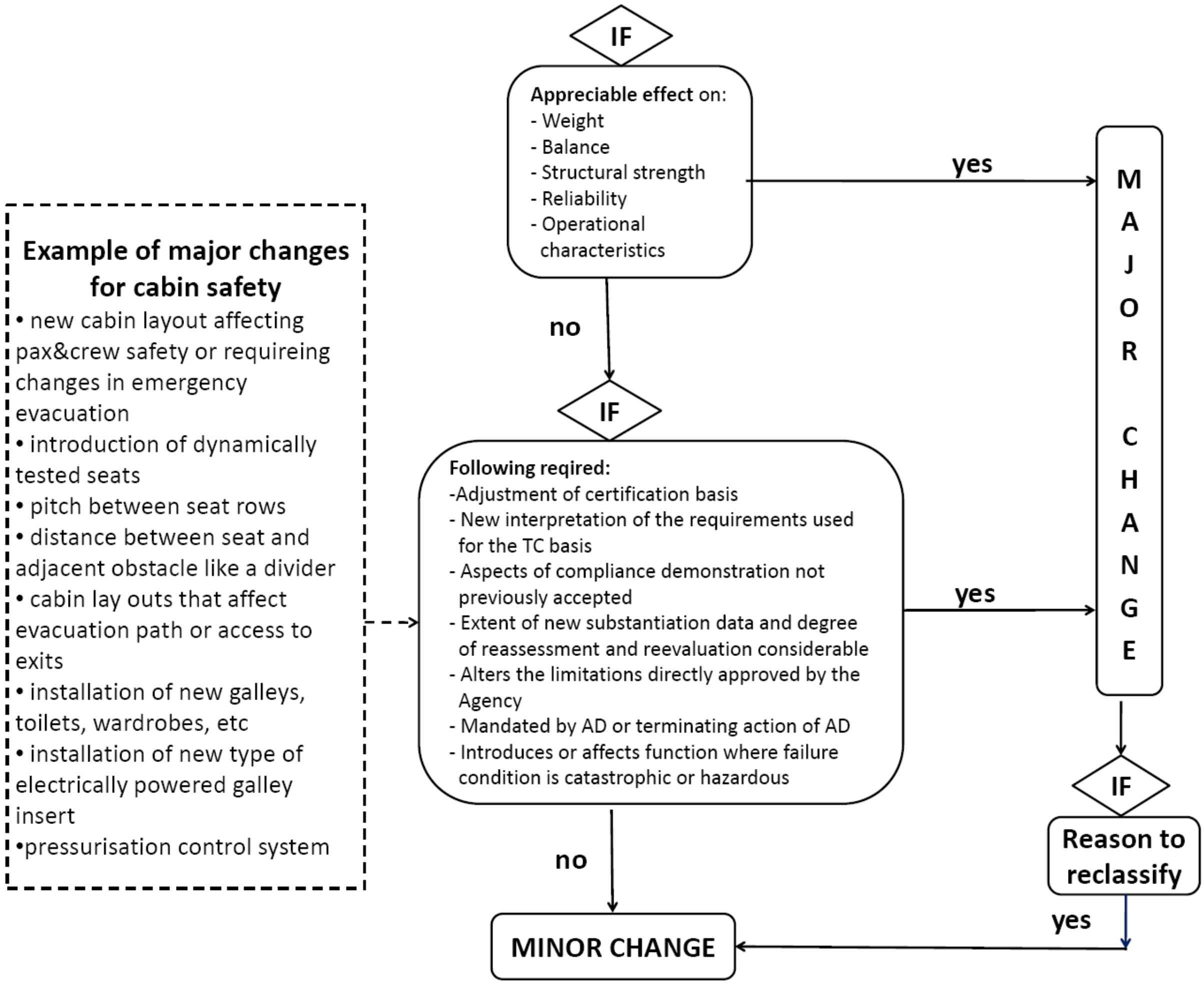

Fig. 2.7 Classification process of minor and major changes, according to AMC&GM to Part 21, Subpart B (**EASA 2009c**)

Minor changes as defined in Paragraph 21A.91 are considered to have no appreciable effect on airworthiness and, by definition, are *not significant*. Therefore an application for a change to a type-certificate (type design) as described in Paragraphs 21A.101(a) and Paragraph 21A.90 is considered as an application for a major change (**EASA 2009 c**, GM 21A.101).

At this moment it is important to understand the difference between the following terms:

- Significant change
- Non-significant change
- Substantial change

The explanation of these terms is linked with the term *product level change*. A product level change is a change or combination of changes that makes the product (aircraft, engine or propeller) distinct from other models of the product (e.g., range, payload, speed). A *significant change* is a product level change to the type-certificate to the extent that it changes one or more of the following: general configuration; principles of construction; a significant change can also result from specific assumptions used for the certification criteria, but not to the extent to be considered a substantial change. Not all product level changes are significant. In the same time, a substantial change is a product level design change which is so extensive that a substantially complete investigation of compliance with the applicable requirements is necessary and consequently a new type-certificate, in accordance with 21A.19 (**EASA 2009c**, GM 21A.101 (4)).

Legal Requirements

The article 21A.112B (a), Subpart E, (EC 1702/2003) referring to the demonstration of capability, states that a company needs to have a DOA in order to apply for a STC. At (b) is however stated, that an *alternative procedure* is to seek an Agency Agreement in order to fulfill the requirements from Subpart E. This procedure is explained in the AMC 21A.14 (**EASA 2009c**). The (b) article is suited for organizations which find themselves in a starting phase for obtaining a DOA, allowing it to later move towards fulfilling the missing requirements from Subpart J.

However, the holder of a DOA has the privileges mentioned in 21A.263 (**EASA 2009b**), which refer to the acceptance of compliance documents without further verification by the Agency and in the same time the DO shall be entitled to:

- classify changes to type design and repairs as „major" or „minor",
- approve minor changes to type design and minor repairs,
- issue information or instructions containing the following statement: „The technical content of this document is approved under the authority of DOA nr. [EASA]. J. [xyz].",
- approve documentary changes to the aircraft flight manual, and issue such changes containing the following statement: „Revision nr. xx to AFM ref. yyy, is approved under the authority of DOA nr.[EASA].J.[xyz].",
- approve the design of major repairs to products for which it holds the type-certificate or the supplemental type-certificate.

De Florio 2006 underlines one important aspect: the purpose of the authorities through DOA is a transfer of the responsibilities from the control of the *product* to the control of the *organization*, by means of audits of products or systems. The aim is to promote the self-control of the organization on their way to designing safe products, independent from the surveillance of the Agency. This means, if the DOA is replaced by an alternative procedure, these privileges are not allowed anymore. Therefore (**De Florio 2006**):

> *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.*

According to the article 21A.93 (**EASA 2009b**) an applicant for a change to the type design of a product needs to submit an application which has to include the description of the change, including the identification of:

- parts of the type design and manuals affected by the change,
- certification requirements and environmental protection requirements,
- necessary re-investigation in order to show compliance.

Examples of major changes in cabin design

It was mentioned earlier that the changes are classified under Subpart D. Under this subpart the TC holders can make changes to the type design. All other applicants must fulfill Subpart E requirements. The Fig. 2.6 uses terms like *substantial* or *significant* change. The AMC and GM to Part 21 (**EASA 2009c)** help in better understanding the difference between the two (see Paragraph GM 21.A101 referring to the „Establishment of the type-certification basis of Changed Aeronautical Products"). Of interest to us are those parts related to cabin conversion. Related to paragraph 21A.101 *Designation of applicable certification specifications and environmental protection requirements*, Table 2.1 gives illustrative examples of significant and not significant changes (note that there are no changes that can be called *substantial*, related to cabin conversion).

Table 2.1 Example of significant and not significant changes related to cabin safety[1] (Subpart D, **EASA 2009c**)

	Description of change	Is there a Change to the General Configuration (21A.101(b)(1)(i)	Is there a Change to the Principles of Construction? (21A.101(b)(1)(i)	Have the assumptions used for Certification been invalidated? (21A.101(b)(1)(ii)	Notes
Significant Change	Derivative model, e.g., increased passenger payload, freighter version or complete update of a certified aeroplane.	Yes	Yes	Yes	Multiple changes packaged into a new model. Increased payload new freighter would change the general configuration and assumptions. Updated aeroplane could change principles of construction
	Conversion –passenger or combi to all freighter including cargo door, redesign floor structure and 9g net or rigid barrier	Yes	No	Yes	Extensive airframe changes affecting load paths, aeroelastic characteristics, aircraft related systems for fire protection, etc. Design assumptions changed from passenger to freighter.
	Change in type or number of emergency exits in conjunction with an increase in the number of passengers demonstrated.	No	No	Yes	The new emergency egress requirements exceed those previously substantiated
	Main deck cargo door installation	Yes	No	No	Redistribution of internal loads, change in aeroelastic characteristics, system changes.
	Conversion from a passenger floor to a cargo floor and	No	No	Yes	Completely new floor loading and design. Redistribution of internal loads, change in cabin safety

[1] These examples were selected due to the connection with cabin conversion, however for every new STC application, the case must be separately treated, as exceptions may occur in practice.

	installation of a cargo handling system.				requirements, system changes
Not significant change	Installation or rearrangement of an interior in an aircraft.	No	No	No	Special conditions could be used for new and novel features
	Redesign floor structure	No	No	No	By itself, this is not a significant product level change. It could be a significant change if part of a cargo converted passenger airplane.

Table 2.2 illustrates example of major changes under Subpart E. The same source (**EASA 2009c**) divides examples into two categories: those for which a DOA is required (A) and those for which an alternative procedure may be used (B).

Table 2.2 Examples of major changes in type design, related to Subpart E (**EASA 2009c**)

	Kind of STC	Discipline	Category
CS 23	Change to seating configuration	Structures	B
	Light weight floor panels	Structures	B
	Avionics upgrades (EFIS, GPS, etc)	Equipment	B/A[2]
	Engine instrument replacement	Equipment	B
	Autopilot system installation	Equipment	A
	WX radar installation	Equipment	B
	Aeromedical system installations	Equipment	B
CS 25	Cabin layout (installation of seats (16G), galleys, single class or business/economy class, etc)	Cabin Safety[3]	B
	Floor path marking	Cabin Safety	B
	Crew rest compartment	Cabin Safety	A
	Change of cargo compartment classification (from class D to class C)	Cabin Safety	A
	Cargo door	Structure[4]	A
	Changes from passenger to freighter con-Figuration	Structure	A
	CVR; VHF; NAV; Meteo radar, GPWS	Avionics	B
	DFDR	Avionics	B/A
	Autopilot, HUD, EFIS, FMS; ILS Cat 3 ; RVSM ; TCAS, EGPWS ;	Avionics	A

2 B/A means that an assessment of consequences in terms of handling qualities, performance or complexity of showing of compliance may lead to classification in group A (**EASA 2009c**)

3 Basically all changes related to cabin configuration should be in group B (**EASA 2009c**)

4 STC which leads to reassess the loads on large parts of primary structure should be in group A (**EASA 2009c**)

2.2.2 Repairs

The term *repair* refers to all those necessary actions required for the elimination of damage and/or restoration to an airworthy condition of a product, part or appliance (**EASA 2009b**).

The procedure for establishing the approval of repair design is stated in Subpart M of Part 21. It makes sense to analyze this document also in the case of cabin design. Of interest for this paper are those repairs that require a design activity, and not the simple replacement of the damaged part (this would be the task for maintenance activities, according to EC 1702/2003).

Like in the case of designing changes, for designing major repairs it is also necessary to have either a DOA or to seek the Agency agreement. Having in mind the quotation mentioned earlier (**De Florio 2006**) it is further considered the case when the capability of the organization is demonstrated by holding a DOA, and not the case when the organization chooses to use the alternative procedure for DOA. The ADOAP (Alternative Procedures to DOA) is suitable only for small aeroplane designs (**EASA 2009b**).

The classification minor/major has to be made in accordance with the criteria for a change in the type design, mentioned in the previous chapter. For *major repairs* the criteria stated in the GM 21A.435 (**EASA 2009c**) are:

- The change has an appreciable effect on structural performance, weight, balance, systems, operational characteristics or other characteristics affecting the airworthiness of the product, part or appliance.
- It is necessary to apply extensive static, fatigue and damage tolerance strength justification and/or testing, or unusual testing and certification methods, techniques or practices (i.e., unusual material selection, heat treatment, material processes, jigging diagrams, etc.).
- It is necessary to re-assess and re-evaluate the original certification substantiation data in order to ensure that the aircraft still complies with all the relevant requirements.

If data is not available at the moment when the classification needs to be made, a re-evaluation of the classification can be later required (like in the case of minor/major changes).

If the DO (being also the TC or STC holder) has the privilege to classify and design major repairs (under procedures established with the Agency and with the help of GM‛s) and is able to declare that it can show compliance, then the Agency involvement in the approval is no longer required. However, the Agency‟s approval is required in cases of major repairs proposed by DOA holders, not being the TC or STC holder, and in cases of minor repairs proposed by persons not holding a design organization approval (**EASA 2009c**).

Another sketch shown in Fig. 2.8 gives a better understanding of the repair design approval process. The figure was build based on AMC&GM of Part 21, respectively GM 21A.437(a).

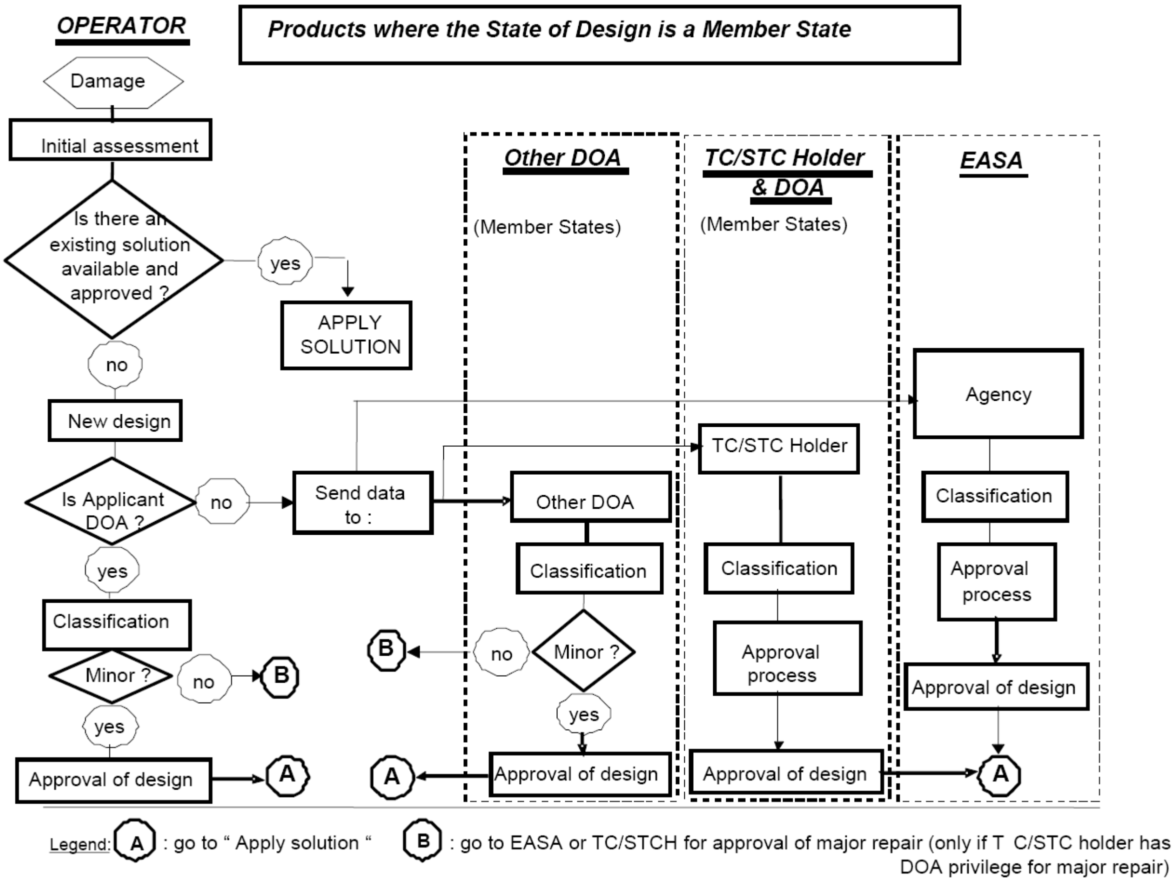

Fig. 2.8 Repair process approval when the state of design is an EU Member (GM 21A.431(a), **EASA 2009c**)

2.3 Requirements for Obtaining DOA for Cabin Conversion

2.3.1 Setting up the Approval Basis

In the previous subchapters the following were concluded (having in mind the hypothesis of an engineering design office with the size of ELAN):

- Cabin conversions are changes to the type design (major or minor).
- If the DO is not the TC holder, then a STC under Subpart E is required.
- It is also possible to seek the Agency‟s agreement, but it is not recommended (**De Florio 2006**).
- The organization having a DOA has certain privileges granted by the Agency.

The importance of obtaining a DOA is obvious. However, the Agency only approves this if all the requirements from Subpart J are fulfilled.

Some of the subjects we need to make clear regarding DOA are:

1. Agency‟s requirements

2. Scope and activities
3. Privileges
4. Staff – functions and responsibilities
5. Documents necessary to achieve the design purpose and the signatories

The *Agency"s requirements (1)* are stated, as mentioned, in the Subpart J, which establishes the procedure for the approval and the rules governing the rights and obligations of applicants and holders of such approvals.

The first and most important requirement is to prove by means of a *Design Assurance System*, that the design work is able to satisfy 3 major tasks (21A.239, **EASA 2009b**):

- It complies with the applicable type certification basis and environmental protection requirements.
- It is organized in such a manner that the responsibilities are properly discharged.
- The compliance is independently monitored, and the monitoring includes a feed-back system.

Another requirement is related to the documentation: a *handbook* (called Design Organization Manual) describing the organization, the procedures and products or changes to products to be designed, needs to be furnished. This is stated in article 21A.243 (**EASA 2009b**).

In addition, there are some requirements stated in 21A.245 (**EASA 2009b**) which refer to the qualification of the staff in all technical departments. A full and efficient coordination between and within the departments, performed by staff members in sufficient number and with sufficient experience is required.

Requirements about allowing the Agency to perform investigations, inspections or tests in order to check the validity of compliance are stated in article 21A.257 (**EASA 2009b**).

The design organization has, as follows from the requirements, these obligations (21A.265, **EASA 2009b**):

- To maintain and amend the handbook and use it as main document within the organization.
- To determine that the design complies and provide compliance documents to the Agency (except for minor changes and repairs, if these are approved under a privilege).
- To provide to the Agency information and instructions in case the safety level of the product is compromised (reference to paragraph 21A.3B).

The main duties and responsibilities of a design organization can be summarized as follows (**De Florio 2006, EASA 2009b**):

- designing,
- demonstrating compliance,
- independently checking the statements of compliance,
- providing items for continued airworthiness,

- checking the performance of the subcontractors (if it is the case),
- providing compliance documentation to the Agency,
- allowing inspections and tests for Agency to check the validity of statements of compliance.

The *scope and activities (2)* must be correspondingly named. The organization of the engineering office wanting to obtain this approval (as it is the case analyzed here) has as purpose the fulfilling of this scope, which needs to be properly defined. The scope of design has to be written on the *EASA Form 80*, *Application for Design Organization Approval (DOA)*, on the Field 2, page 2 (see Appendix).

The *privileges (3)* refer to those actions that a DO is entitled to perform after obtaining the approval. A list of the privileges was made in subchapter 2.2 (Legal Requirements).

The *functions and responsibilities of the staff members (4)*, as stated earlier, must be properly discharged. According to the paragraph 21A.239 (referring to the Design Assurance System) the number of personnel for assuming the main responsibilities is depending on the scope of work. The absolute minimum for a very limited scope could be defined for 5 persons:

- Head of the DO
- Head of the Office of Airworthiness
- Compliance Verification Engineer
- Design Engineer
- Quality Management Engineer

Part of *Documents necessary to achieve the design purpose (5)* is also the handbook, earlier referred to. This is the main document of the organization. Further documents must be furnished in order to show compliance. EASA is also asking for a statement of qualification and experience of the management staff and other persons responsible for making decisions affecting airworthiness and environmental protection in the organization (21A.243 (d), **EASA 2009b**).

Helpful in understanding the significance of some of the most important paragraphs, are the AMC and GM to Part 21 (**EASA 2009c**). To conclude the description of the main directions necessary to obtain a DOA, and based on the means of compliance, Table 2.5 provides a summary of information.

Table 2.3 AMC and GM to Part 21, Subpart J, main aspects

Topic	Paragraph	Statement	Action required (where it is necessary to mention)
DAS	GM No.1 to 21A.239(a) 2.1 Definitions	DAS is the organizational structure, responsibilities, procedures and resources to ensure the proper functioning of the DO	
	GM No.1 to 21A.239(a) 2.2 Definitions	DAS means: all those *planned and systematic actions* necessary to provide *adequate confidence* that the organization has the *capability* to: • *design* products or parts *in accordance* with the applicable CS and environmental protection requirements • *show and verify the compliance* with these CS and environmental protection requirements • *demonstrate* to the Agency *this compliance*	• Good understanding of the requirements; • Definition and implementation of the planned and systematic actions • Create compliance documentation; • Independently verify the showings of compliance
DAS – Planned and systematic actions	GM No.1 to 21A.239(a) 3.1.1 General	a. To *issue* or, where applicable, *supplement* or *amend* the *handbook* in accordance with 21A.243 […] b. To assure that all instructions of the Handbook are *adhered* to c. To conduct *Type Investigation* d. To *nominate personnel* […] f. […] to obtain the *agreement of the type-certificate* holder for the proposed *STC* g. To ensure full and *complete liaison between the type design organization and related organizations* having responsibility for products manufactured to the type-certificate	
	GM No.1 to 21A.239(a) 3.1.2 Compl. Verification	a. Approval by *signing* of all *compliance documents* […] b. *Approval of the technical content* of the manuals approved by the Agency […]	
	GM No.1 to 21A.239(a) 3.1.3 Office of Airworthiness	a. *Liaison* between the design organization and the Agency […] b. […] handbook is *prepared and updated* c. *Cooperation* with the Agency in developing procedures to be used for the type certification d. and e. Issuing of *guidelines for documenting compliance* […] *for the preparation of the manuals, Service Bulletins, drawings, specifications, and standards* f. and h. […] *procurement, distribution and interpretation* of applicable CS and environmental protection i. *Advising of all departments* of the DO in all questions regarding airworthiness, environmental protection approvals and certification j. *Preparation of the Type Investigation program* […] in concurrence with the Agency m. Establishing the *compliance checklist* and updating for changes n. *Checking that all compliance documents are prepared* as necessary to show compliance […] *and signing for release* of the documents. r. *Approving the classification of changes* in accordance with 21A.91 and granting the approval	

	GM No.1 to 21A.239(a) 3.1.4 Maintenance and Operating Instructions	a. Ensuring the *preparation and updating of all maintenance and operating instructions* (including Services Bulletins) needed to maintain airworthiness (continuing airworthiness)	
	GM No.1 to 21A.239(a) 3.2 Continued Effectiveness of the design assurance system	The organization should establish the means by which the continuing evaluation (system monitoring) of the design assurance system will be performed in order to ensure that it remains effective.	
	AMC 21A.239(b) Independent checking function of the showing of compliance	1. […] verification by a person *not creating* the compliance data 2. verification should be *shown by signing* compliance documents 3. *only one CVE* nominated *for each* relevant subject 4. *For STC cases*, *when* compliance statement and associated documentation are produced by the TC holder, and when these data are approved *under the system of the authority of TC holder*, then the STC applicant *does not need to provide*, within its own DOA, *the independent checking function* required in 21A.239(b) for these data.	
Data	AMC No. 1 to 21A.243(a) Data Requirements	This AMC refers to the information the handbook should contain. The main aspects to be considered are: • Description of *tasks* • Description of the *organization* • Description of assigned *responsibilities* • Description of the way in which the organization performs all the *design functions* in relation to airworthiness and continued airworthiness • Description of the *means of design* (human resources, facilities and equipment) • An outline of a system for *controlling and informing* the Staff • Description of the *recording system* • Description of the means by which the organization *monitors and responds* to problems during design, production and in service • Name of *authorized signatories* • A clear definition of the *tasks, competence and areas of responsibility of the Office of Airworthiness* • Description of the *procedures for the establishment and the control of the maintenance and operating instructions* • Description of the means by which the continuing evaluation (*system monitoring*) of the design assurance system will be performed in order to ensure that it remains *effective*	

Privileges	GM 21A.263(b) DOA privilege related to compliance documents	A compliance document is the *end result of a certification process*, where the showing of compliance is recorded. For each specific certification process, the Agency is involved in the process itself at an early stage, especially through the *establishment of the certification program* […]; the Agency should agree with the DOA holder documents to be accepted *without further* Agency *verification under the DOA privilege* of 21A.263(b)	

Chapter 4 proposes a more detailed approach to be followed by an engineering office, in the form of a process chain, in order to fulfill the requirements for obtaining a DOA.

2.3.2 Other Relevant Subparts for Design Organizations Performing Cabin Conversions

Not only Subpart J is to be analyzed if a company wants to receive DOA for cabin conversions. As stated earlier, the Supplemental Type Certificate would be required, therefore Subpart E – Supplemental Type Certificates should be investigated, and accordingly the requirements should be fulfilled. A correlation between all requirements stated in the Implementing Rule, together with those from the Basic Regulation, with the help of the AMC‟s and GM‟s should be achieved.

Other relevant Subparts from Part 21 for cabin conversions are:

- Subpart A, where general provisions are stated,
- Subpart B, where the procedure for issuing TC‟s and RTC‟s (Restricted Type Certificates) is described, together with the rights and obligations of the applicants,
- Subpart D, where the procedures for approving changes to type design (minor or major) under TC‟s or RTC‟s is described,
- Subpart E, where the same procedures, rights and obligations related to changes are described, but this time under STC‟s,
- Subpart J, which establishes the procedure for obtaining the DOA,
- Subpart M, where the procedure for the approval of repair design is described.

2.3.3 Application and Application Forms

The form and manner in which an organization applies for a DOA, is set by the Agency (article 21A.234, **EASA 2009b**). This application has to contain information about:

- The handbook, furnished under 21A.243,

- The statement of the qualifications and experience of the management staff and other persons responsible for making decisions affecting airworthiness and environmental protection (21A.243)

The Decision no 2005/05/c of the Executive Director of the Agency establishes certain application forms related to Agency‟s Internal Certification Working Procedures. Here the application Forms for DOA are shown. The Appendix in this paper presents the forms required for obtaining DOA. Below a list of these Forms is presented:

- Form 4 - Qualifications and Experience of Management Staff Personnel
- EASA Form 80 - Application for DOA (Design Organization Approval)
- EASA Form 81 - Application for Alternative Procedure to DOA
- EASA Form 82 - Application for Significant Changes to DOA

2.3.4 Quality Management System following EN 9100

The EN 9100 document standardizes *quality management system requirements* for the aerospace industry. The result of applying these common requirements (as a standard) is increasing quality and safety, and decreasing costs.

Applying this standard does not mean achieving uniformity in the structure of QM, rather to assess the organization‟s ability to meet customer, regulatory and organization‟s own requirements. Therefore, the adoption of this standard should be a strategic decision of an organization.

In order for an organization to function properly, numerous linked activities need to be identified and managed. According to **EN 9100** a *process* can be defined as such**:**

> *An activity using resources, and managed in order to enable the transformation of inputs to outputs, can be considered as a process.*

The recommendation of this standard for a good QM is the *process approach*:

> *The application of a system of processes within an organization, together with the identification and interactions of these processes, and their management, can be referred to as the "process approach"*

For every process defined in this paper, the PDCA (Plan-Do-Check-Act) methodology will be applied. This methodology, inspired by **EN 9100** assumes:

Plan:	establish the objectives and processes
Do:	implement the processes
Check:	monitor and measure processes
Act:	take actions to continually improve processes

2.3.5 Industry Experience with DOA

The EASA Rulemaking Directorate has published a questionnaire regarding the future of DOA. It is very interesting for us to see the statistics published by the Agency and to learn from the experience of other companies having experienced the DOA process. Here are the main remarks concerning our study case (**EASA 2009f**):

- Subcontractors (like ELAN) performing much of the design and compliance work, have limited eligibility to obtain a DOA, therefore the TC Holders must duplicate the review of compliance.
- Partners and suppliers are more and more located outside EU and USA (e.g. India, China); in such areas, reliance on the DOA system alone may not provide the necessary airworthiness safeguards.
- Many small companies answered that DOA system is not optimized enough for their market system; this is the case also for ELAN.
- The current DOA concept is much in favor of TC Holder organizations and does not allow a level playing field in the area of repair design approval. The approval process for major repairs currently requires design organizations to obtain approval from the competent authority. The general opinion is that this is very time consuming and does not reflect the needs of industry.
- Regarding the future efficiency of DOA concept, the general opinion is that the contribution of subcontractors and suppliers should be recognized.
- Opinions were in favor for recognizing the common standard EN 9100 by the Agency (also a remark for the future).

A recommendation or proposal for ELAN can be raised having in mind the following tendency (**EASA 2009f**):

> *Cooperation of different OEMs and/or Suppliers will increase leading to the creation of "Centers of Excellence" that will specialize in certain systems/parts and provide design and development expertise for various international programs. The composition of the cooperations will vary from project to project.*

While keeping in mind this tendency, a remark to the DOA system would be: the Agency should provide proper discharge of airworthiness/certification capabilities, to the suitable organization/person independent from its formal organization.

The Agency also proposes other three possible future certification concepts, each with pros and cons. At this stage it only makes sense to mention them:

- Modular approach to certification – which would ensure a clear definition of responsibilities,
- Industry self certification – the safety would be provided under privileges and responsibility of the product developer,
- Third party certification – this would encourage the greater focus on improvement of resources and costs reduction.

2.4 Certification Requirements for Aircraft Cabins

2.4.1 Airworthiness Requirements for Design

Requirements related to the organization of the engineering office in order to conduct a safe design are specified in the Implementing Rules mentioned in the previous paragraphs. In order to apply the specifications for airworthiness in practice, we also need to extract rules for cabin interior layout from the CS 23, respectively CS 25 (which are of interest for ELAN). These rules further help in designing the process chain for cabin conversion, but also in conceiving the testing and certification basis.

It has been found out that a very large number of regulation articles need to be accounted for when certifying a cabin design. The big amount of regulations which need to be considered, cannot be included in this paragraph. The Appendix of this Technical Note presents an extraction of the main requirements related to cabin, in the form of a table. The source used is the original documentation from **CS 25 2009** and **CS 23 2009**. Table 2.4 gives an overview of the table included in the Appendix, by showing one rule example.

Table 2.4 Example of requirement from CS 23 for cabin layout

Paragraph	Title	Rule Quotation	Rule interpretation and recommendations for cabin layout
CS 23.853 (c)(2)	Passenger and crew compartment interiors	Where the crew compartment is separated from the passenger compartment, there must be at least *one illuminated sign* (using either letters or symbols) notifying all passengers *when smoking is prohibited*;	When smoking is prohibited, there must be at least one illuminated sign

2.4.2 Airworthiness Requirements for Operation

It makes sense to begin this subchapter with a remark: if a DO has a TC for a product, this does not represent also the authorization for operation; for this a certificate of airworthiness is being issued (according to Subpart H, Part 21) and the operational life of the product begins with this issuance.

The additional requirements coming from the operation of the product, besides the basic requirements, need also to be considered from the point of view of cabin design. For this subchapter we will consider the JAA Requirements, called JAR.

As previously mentioned, the Joint Aviation Authorities (JAA) represents the regulatory authorities of a number of European states, having the same purpose as EASA: cooperation in developing and implementing common standards for ensuring a safe air transport system. It is an associated body of the European Civil Aviation Conference (ECAC), founded in 1955, as an intergovernmental organization. While EASA is building its own organization, the JAA continues to exist, contributing to the Agency"s growth, which is subsequently to absorb all its functions and activities. By signing the Cyprus arrangement on 28 November 2003, EASA became a full member of JAA. The Future of JAA (FJAA) was assigned to a working group, in charge of developing a "roadmap" for establishing the milestones for the medium-term activities of JAA. The final report of FJAA was presented to ECAC and adopted on 25 August 2005 in Romania (**De Florio 2006**).

Of interest in cabin design are also the rules mentioned in JAR-OPS 1 (Commercial Air Transportation). The JAR-OPS 1 prescribes requirements applicable to the operation of any civil aeroplane for the purpose of commercial transportation (**JAR-OPS 2007**). The paragraphs which need to be accounted for when making the design work are summarized in Table 2.5. The amount of information is enough to be included within the paper, rather than inserting it into an appendix, as it was the case with the certification requirements.

Table 2.5 Requirements from JAR-OPS 1 for cabin design

Paragraph	Title	Rule Quotation	Rule interpretation and recommendations for cabin layout
JAR-OPS1 1.270 (b)	Stowage of baggage and cargo	An operator shall establish procedures to ensure that *all baggage and cargo* on board, which might cause injury or damage, or obstruct aisles and exits if displaced, *is placed in stowages designed to prevent movement*.	Stowage design – to prevent movement
Appendix 1 to JAR-OPS 1.270 (a)(3)	Stowage of baggage and cargo	Underseat stowages must not be used unless the seat is equipped with a *restraint bar* and the baggage is of such size that it may adequately be restrained by this equipment;	Seat design – restraint bar properly designed
Appendix 1 to JAR-OPS 1.270 (a)(5)	Stowage of baggage and cargo	Baggage and cargo placed in lockers must not be of such *size* that they *prevent latched doors from being closed* securely;	Correspondence between baggage size and stowage size
Appendix 1 to JAR-OPS 1.270 (a)(6)	Stowage of baggage and cargo	Baggage and cargo must not be placed where it can impede *access to emergency equipment*;	Free access to emergency equipment
JAR-OPS 1.280	Passenger seating	An operator shall establish procedures to ensure that passengers are seated where, in the event that an emergency evacuation is required, they may *best assist and not hinder evacuation* from the	Position of seats for safe evacuation

		aeroplane.	
JAR-OPS 1.330	Accessibility of emergency equipment	The commander shall ensure that relevant emergency equipment remains easily *accessible* for immediate use.	Accessible position of emergency equipment
JAR-OPS 1.620	Mass values for passengers and baggage	Table 1, 2 and 3 (see reference **JAR-OPS1 2007**)	Loads for which the stowages need to resist
JAR-OPS 1.730	Seats, seat safety belts, harnesses and child restraint devices	Paragraph (a), (b), (c) (not quoted entirely here due to lack of space: (a)(6): The seats shall be forward or rearward facing within *15° of the longitudinal axis* of the aeroplane (b): All safety belts with shoulder harness must have a single point release.	Proper restraint systems; Proper position of cabin crew seats;
JAR-OPS 1.731	Fasten Seat belt and No Smoking signs	An operator shall not operate an aeroplane in are: which *all passenger seats* are not *visible from the flight deck*, unless it is equipped with a means of indicating to all passengers and cabin crew when seat belts shall be fastened and when smoking is not allowed.	Seat visibility insurance
JAR-OPS 1.735 (a)	Internal doors and curtains	[...]a *door between the passenger compartment and the flight deck compartment* with a placard „crew only" and a locking means to prevent passengers from opening it without the permission of a member of the flight crew	Crew/passengers separation
JAR-OPS 1.735 (d)	Internal doors and curtains	A *placard* on each internal door or adjacent to a curtain that is the means of access to a passenger emergency exit, to indicate that it must be secured open during take off and landing	Placards and indications for emergency exits: proper position and inscription
JAR-OPS 1.760 (a)	First-Aid Oxygen	[…]There shall be a *sufficient number of dispensing units*, but in no case less than two, with a means for cabin crew to use the supply. The dispensing units may be of a portable type	Number and position of emergency equipment (oxygen)
JAR-OPS 1.760 (b)	First-Aid Oxygen	The *amount of first-aid oxygen* required for a	Oxygen equipment and supply

		particular operation shall be determined on the basis of cabin pressure altitudes and flight duration,[…]	requirements
JAR-OPS 1.770 (b)(1)(iii)	Supplemental oxygen – pressurized aeroplanes	Oxygen masks shall be *located* so as to be within the *immediate reach* of flight crew members whilst at their assigned duty station.	Location of oxygen masks
JAR-OPS 1.770 (b)(1)(iv)	Supplemental oxygen – pressurized aeroplanes	Oxygen masks for use by flight crew members in pressurized aeroplanes operating at pressure altitudes above 25 000 ft, shall be a *quick donning type of mask*.	Type of oxygen mask
JAR-OPS 1.770 (b)(2)(ii)	Supplemental oxygen – pressurised aeroplanes	The *spare outlets and/or portable oxygen units* are to be distributed evenly throughout the cabin to ensure immediate availability of oxygen to each required cabin crew member regardless of his location at the time of cabin pressurization failure	Distribution of oxygen masks
JAR-OPS 1.790	Hand fire extinguishers	(a)...(f) refer to **JAR-OPS1 2007**	Location of fire extinguishers
JAR-OPS 1.815	Emergency lighting	The *emergency lighting system* must include: [...]Sources of general cabin illumination; Internal lighting in floor level emergency exit areas; Illuminated emergency exit marking and locating signs	Sources of illumination and position

3 Cabin Conversion at ELAN Together with Airbus

3.1 Airbus

The process of conversion can be defined as the sum of modifications taking place inside an aircraft, so to get from cabin type A to cabin type B. The product – the aircraft, is already designed by the TC holder and fulfils the rest of the airworthiness requirements. Therefore in the process of conversion, the DO which designed the aircraft has a major role. In order to conduct the design of a change, either minor or major, an organization not holding the TC for the respective product, can only show capability by applying for an STC under DOA.

In Germany, and also in Europe, one of the greatest design organizations and TC holder for most of the aircrafts flying nowadays is Airbus. It produces transport aircraft for long and medium range and it has also developed the propeller driven military airlifter A 400M. For its products Airbus uses the family concept (Figure 3.1). The leader in the single aisle category is the A320 family. Airbus has almost 9200 airplanes on order (see Table 3.1) (**Airbus 2009**).

As an international design organization Airbus is located in 16 sites over Europe, but also in China, Japan, Russia and North America. At Airbus Deutschland, in Hamburg, the final assembly line of four members of the A 320 family keeps many employees busy. In total a number of more than 10000 employees work at the site in Hamburg.

Fig. 3.1 Airbus seat-range diagram. Airbus family members are shown based on the aircraft's number of seats and range (**Airbus 2009**)

Table 3.1 List of Airbus products (**Airbus 2009**)

Family	Product	Number of Seats	Range
A 300/310	A 300-600	266	4050 NM 7500 km
	A 310	220	5200 NM 9600 km
A 320	A 318	107	3250 NM 6000 km
	A 319	124	3700 NM 6800 km
	A 320	150	3050 NM 5700 km
	A 321	185	3000 NM 5600 km
A 330/340	A 330-200	253	6750 NM 12500 km
	A 330-300	295	5650 NM 10500 km
	A 340-200	240	8000 NM 14800 km
	A 340-300	295	7400 NM 13700 km
	A 340-500	313	9000 NM 16700 km
	A 340-600	380	7900 NM 14600 km
A 380	A 380	555	8000 NM 15000 km

As mentioned earlier, in order to conduct the design of the products, Airbus is the holder of a DOA for the products listed in Table 3.1. This grants Airbus the privileges (**Airbus DOM 2006**):

- to perform design activities under Part 21within the scope of approval,
- to submit compliance documents for obtaining a TC or approvals for major changes or repairs to EASA; the Agency accepts the submitting without further verification,
- to perform, by means of DAS, the classification of changes and repairs into minor or major,
- to approve minor changes and repairs,
- to approve the design of major repair for products for which it holds the TC.

3.2 Cabin Design and Cabin Conversion at Airbus

As an international company, Airbus has a complex organization. The design of an aircraft is the sum of the inputs of all country members; therefore a strict coordination between their activities is required.

The procedure for creating standard cabins at Airbus is explained in the AP 2289 Design New Cabin and Cargo (DnCC) (**AP 2289**). The processes describing the development of the cabins are derived from the design of an aircraft, explained in AP 2054 (DnA – Design New Aircraft), and is correspondingly adapted.

However, Airbus deals with all types of cabin conversions scenarios (**Williams 2009**):

- The *Upgrade Services Department* carries out the design of modifications related to cabins, while finding retrofit solutions for customers.
- The *Airbus Corporate Jet Center* deals with VIP Completions in partnership with Stork Fokker, Lufthansa Technik, Jet Aviation, Associated Air Center and others. This division is specialized in managing the specifics of the VIP market segment, including designing and subcontracting VIP cabins for all Airbus aircrafts.
- A *Joint Venture* between *Airbus, The Russian Industrial Foundation and EADS-EFW* is dealing with Pax-to-Freighter conversions. Within EADS, EFW (Elbe Flugzeugwerke GmbH) is the centre of competence for the conversion of Airbus passenger aircraft into freighters (A300 & A310 wide body aircraft) and the associated maintenance. EFW sources the original components for the standard Airbus freighter variants directly and exclusively from Airbus (OEM Original Equipment Manufacturer).

The Upgrade Services Department is the one with which ELAN dealt so far, by delivering work packages for Airbus customers in the area of cabin retrofitting and refurbishing.

3.2.1 Cabin Design

As mentioned above, for a new Cabin & Cargo design and development, the processes at Airbus are described in the documents called Airbus Procedures. The AP 2289 indicates nine design phases required for conducting the design (**AP 2289**), as follows:

- Concept Phase
- Architecture Phase
- Definition Phase
- Design Phase
- MCA (Major Component Assembly) Preparation Phase
- FAL (Final Assembly Line) Preparation Phase
- Manufacturing & Testing Phase
- Adjustment Phase
- Final Project Phase

Each phase is divided in what Airbus calls “swim lanes” (**AP2289**):

- Project Management
- Industrial Design
- Engineering Vendor Management
- Cabin & Cargo Integration
- Electrical Systems
- Mechanical Systems
- Cabin & Cargo Furnishing

- Structure Design
- Manufacturing & Assembly

For a complete cabin retrofit design the procedure is adapted for the Upgrade Services organization.

3.2.2 Upgrade Services Airbus

The Upgrade Services department at Airbus is the one providing *retrofit solutions* for the customers, starting from producing Service Bulletins and ending with full embodiment of aircraft upgrades. The services are provided for all Airbus-in-Service aircrafts and the organization fulfills the EN 9100 norms (**A10 SU**).

The Upgrade Services organization is divided in departments, each accountable for a specific mission:

- SUA – Marketing Services
- SUM – divided in four sub-departments, responsible for:
    - SUMC – Freighter
    - SUML – Leasing
    - SUMX – Pax to Pax
    - SUMT – Turn-key & Asset projects
- SUY – System Operations
- SUC – Cabin Operations

In charge of implementing a Quality Management System according to EN 9100, is SQU department. The Business Control department is called FCBSU and supports Profit & Loss management. The Airworthiness & Certification department is called EAR.

3.3 ELAN GmbH

ELAN GmbH is a young company formed as a result of the joint venture of Lühmann Ingenieur AG and EDAG Sigma Concurrent Engineering GmbH. The company offers development services in the frame of aircraft structure and cabin, aircraft systems and systems integration (**ELAN 2009**). ELAN is owned by EDAG, a company having almost 5000 employees operating in machine and plant engineering as well as production. Another subsidiary of EDAG is Albert Mühlenberg Apparatebau GmbH, which is developing cabin interior solutions for VIP modules and has gained a lot of experience in producing galleys and other cabin interior equipment for a wide range of customers (**Mühlenberg 2009**).

One of the two companies which joined forces together with ELAN is, as mentioned above, EDAG Sigma. The activities of this company are focused on developing structural components for Airbus, on-board toilets for Dasell or VIP cabin interiors for Lufthansa Technik. The second company, Lühmann Ingenieur AG GmbH has many years experience in developing cabin interiors for the aeronautical industry (**ELAN 2009**).

The transport aircraft manufacturers (like Airbus) have adopted the strategy of outsourcing a large part of the design work. Therefore, subcontractors deliver a great part of the results, especially in the field of cabin conversion, which is always an open item for airliners or VIP aircraft owners. The future tendency at Airbus (**V-Plane 2009)** is to more and more outsource their work, therefore the work packages for subcontractors become larger and larger. Therefore it is stringent for the subcontractors to enlarge their capabilities to be able to deal with these new requirements.

In this context ELAN GmbH is looking to develop its capabilities towards those of a completion center, in order to be able to fulfill not only larger work packages from Airbus, but also from other companies. The next paragraph describes the present status of the company.

3.3.1 Present Activities in the Cabin Conversion Department

The main customer of ELAN GmbH is Airbus. However the cabin conversion department develops cabin modifications also for other clients like: Lufthansa Technik AG, Cirrus Aircraft or Dasell Cabin Interior GmbH.

The engineering work comprises of creating documentation and technical drawings for designing retrofit solutions. The philosophy of the company is customer oriented. However, ELAN tends to be Airbus dependent, and therefore, without the capability of receiving larger work packages, the vulnerability of the cabin conversion department is increasing. This fact became evident during the first trimester of 2009, at the peak of the economical downturn.

In the process chain of cabin conversion at Airbus ELAN takes part by compiling construction documents for all aircraft types mentioned in Table 3.1 in the form of technical drawings and accompanying part lists (**ELAN 2009**). The result of the work packages is internally checked by the Team Leader from ELAN and then further transmitted to Airbus. Airbus conducts another verification of the design work; if the results are approved, they are then used in the content of the Service Bulletins (SB), MAS or TRS documents.

A similar strategy is used also for non-Airbus clients. The company is flexible enough to be able to satisfy retrofit requirements for both small (CS 23) and large (CS 25) aircrafts.

The tools used to develop the design work are also provided by Airbus or used by accessing the Airbus network. These tools are:

- Catia Cadam Drafting
- Catia V4 and V5
- TAKSY
- Zamis (Image Master)
- Pace RETROGEN

3.3.2 Process Chain Description of the Present Activities at ELAN

The work packages received from the customers need to be properly organized in order to deliver on time quality results. Provided here is the brief description of these activities, being valid especially for the Airbus customer.

Currently, the type of work mentioned above, respects the logic of six phases (see Figure 3.2). The detailed description of the processes within the company was performed by the CCO department of ELAN. The processes are presented here, without directly describing all the connections between them and the personnel involved. A detailed analysis is not the purpose of this TN.

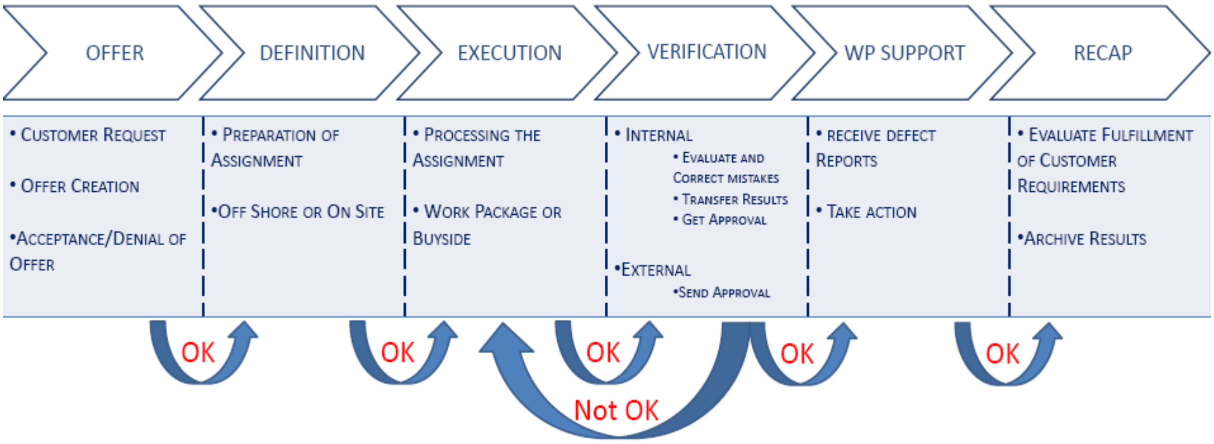

Fig. 3.2 Process Chain for the present status of ELAN GmbH: General view and aspects.

The *offer phase* at ELAN comprises of activities like:

- Receiving a customer request,
- Elaborating a solution proposal, followed by
- Negotiations and a final decision of the customer.

The *definition phase* meets the decision of developing the work *off shore* or *on site*. In most of the cases the work is done off shore (which means outside the country, for instance the work can be outsourced in countries like India). The work is being assigned to a team leader starting with the offer phase; he will continue to be responsible for the project in the definition phase and during the rest of the phases up to delivery.

The *execution phase* consists of developing the design work under the control of the team leader. The resources for conducting the engineering design are provided by Airbus, as mentioned above.

The *verification* of the design is first internally performed. After that, the TC holder (Airbus) performs further verifications, as in present ELAN has not yet the privileges granted by a DOA. In order to allow Airbus to verify the documents, they are transmitted via a data transfer system.

The *WP Support phase* incorporates the handling of defect reports. One reason why defects appear is the following: while the design is being processed, slight modifications in the customer request may occur; therefore the responsibility of the mistakes lies often in the hands of Airbus. Good communication between the two parts prevents this from happening.

The *Recap phase* incorporates gathering and evaluating the tasks with respect to their duly fulfillment, according to the customer specifications; this information is used as feedback for future projects. At this stage, the archiving of the documents is being performed.

The process description briefly presented here requires the following observations:

- Each step needs to receive an *OK*.
- Each step can be worthy of *Not OK*.
- Each step may require further processing
- Each step may require the following recommendations:
    - always apply "*Lessons Learned*",
    - document each action.

The conclusion to be drawn from the above description is that the *Team Leader* has great responsibility within the company for the project assigned to him. He will be in charge of:

- creating an offer,
- negotiating the offer,
- evaluating costs and comparing them with the customer"s offer,
- evaluating the "do-ability" of the work,
- defining the deadlines,
- choosing a team,
- supervising the work,
- evaluating results.

Each project needs a management system for:

- proper information interchanging between ELAN and the customer,
- properly defining requirements of the customer.

The above falls also in the responsibility of the team leader, but in the same time this is part of the responsibility of the management of the department.

3.4 Description of Activities Together with Airbus

As earlier mentioned, the activities conducted by ELAN with Airbus are part of the Upgrade Services Department. The drawings and the corresponding part lists become part of the SB"s and MAS"s which are to be approved by Airbus. The process of creating them takes place as described in the previous paragraph.

It must be mentioned that the tendency at Airbus is to outsource bigger and bigger work packages. The complex organization of the company is rather not helpful in delivering optimized results. Therefore, the Airbus “dependency” of the small subcontractors must be reoriented and transformed into self responsibility. In this way, an engineering office of the size and capacity of ELAN would have to cope alone with the work resulting from customer requirements and with the strings attached to a successful delivery. However the “Airbus experience”, as previously described, is useful and provides the necessary background to achieve this goal.

4 Requirements for ELAN to Obtain DOA

In the previous chapters it was concluded that obtaining a DOA would be necessary for ELAN. The main requirements imposed by the Agency to obtain this approval were described. The task of this chapter is to give a practical description of the required actions from the organizational point of view. The specific case here deals with cabin conversions performed by a medium sized engineering office, like ELAN. Figure 4.1 shows the main sources of information for generating an overview of the required organizational system.

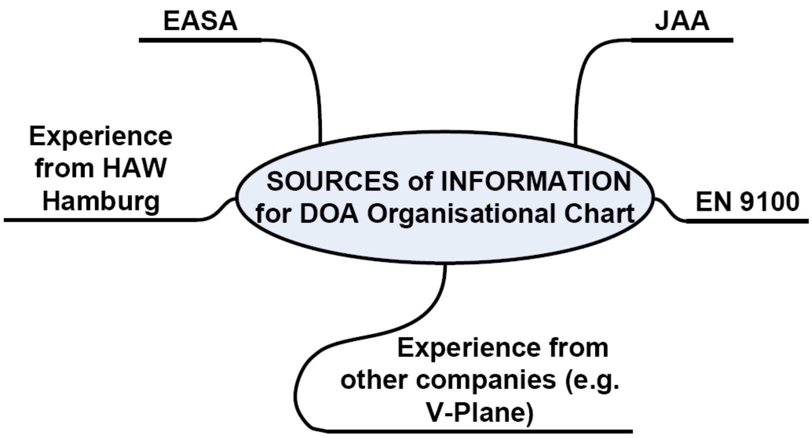

Fig. 4.1 Sources of information necessary for transforming ELAN GmbH into an organization ready to apply for a DOA

4.1 Scope of Design and Privileges

The „scope of approval" of the Design Organization must be mentioned in the EASA Forms. For DOA, EASA Form 80 must be filled in (see the Appendix of this paper). For our study case – the medium sized engineering office, carrying out cabin conversions, the scope of approval must contain the following:

- Product Type:
    - Small Aeroplanes (CS 23)
    - Large Aeroplanes (CS 25)
- Activities:
    - Supplemental type certificate (for each product)
    - Minor changes and repairs
    - Major changes and repairs
- Technical Fields
    - Installation of avionics and equipment
    - Environmental systems
    - Electrical systems
    - Cabin interior

- Galleys or other interior equipment

If the DOA is granted, the engineering office would have the following privileges (article 21A.263(c), **EASA 2009b**) (see Figure 4.2):

- Classify changes
- Approve minor changes and repairs
- Approve documentary changes to the flight manual (FM)
- Approve design of major repairs to products for which it holds the STC

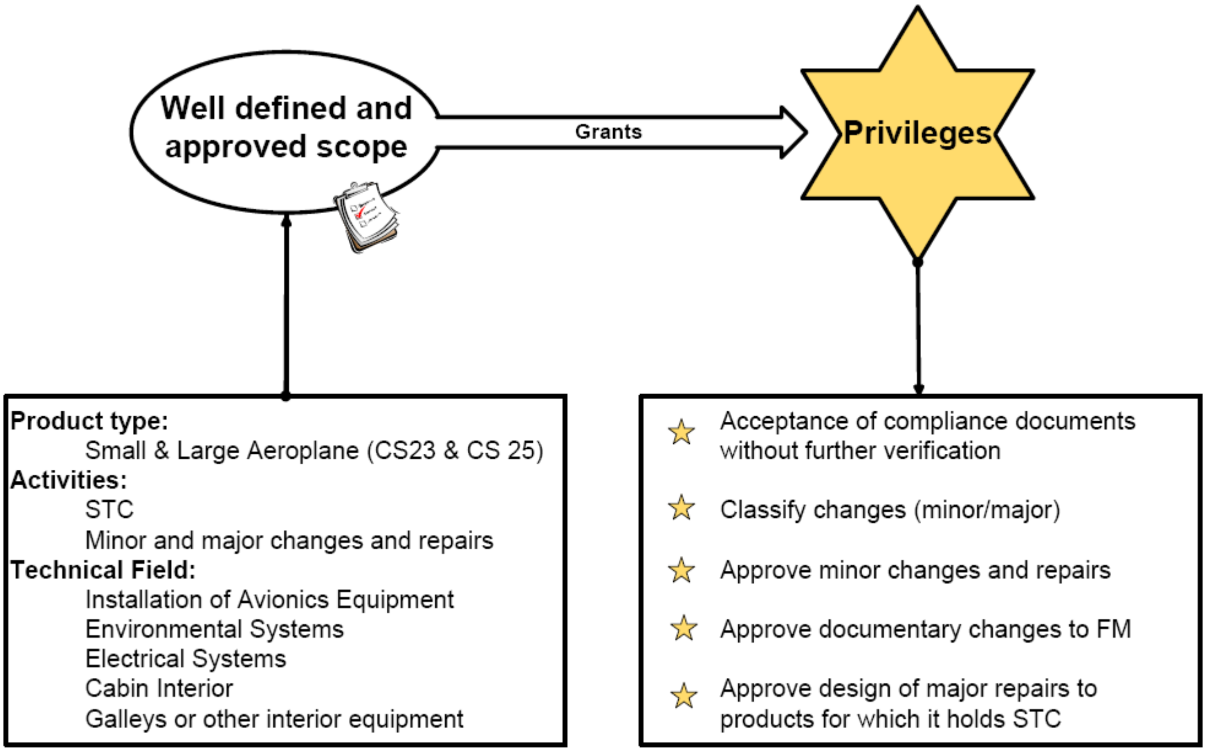

Fig. 4.2 Scope and privileges under DOA for an engineering office in the domain of cabin conversion

4.2 Personnel

Paragraph 2.3 shortly described the main requirements imposed by the EASA for obtaining the DOA. This subchapter intends to describe the functions and responsibilities of the personnel required for undertaking the design of certified cabin layouts.

The paragraphs of Subpart J related to personnel are (**EASA 2009b**):

> *21A.243 Data*
> *(d) The design organization shall furnish a statement of the qualifications and experience of the management staff and other persons responsible for making decisions affecting airworthiness and environmental protection in the organization.*

21A.245 Approval Requirements
The design organization shall demonstrate, on the basis of the information submitted in accordance with 21A.243 that, in addition to complying with 21A.239 (referring to the DAS):
(a) The staff in all technical departments are of sufficient numbers and experience and have been given appropriate authority to be able to discharge their allocated responsibilities and that these, together with the accommodation, facilities and equipment are adequate to enable the staff to achieve the airworthiness, noise, fuel venting and exhaust emissions objectives for the product.
(b) There is full and efficient coordination between departments and within departments in respect of airworthiness and environmental protection matters.

The statement of qualification, referred to in 21A.243 (d) (**EASA 2009b**) is shown in the Appendix.

The qualification required for each function is to be described in the DOM (Design Organization Manual). According to the paragraph 21A.239 (referring to the Design Assurance System, **EASA 2009b**), the number of personnel for assuming the main responsibilities is depending on the scope of work. The absolute minimum for a very limited scope could be defined for 5 persons; these functions can be further supplemented in the case for an engineering office of the size of ELAN:

- Head of the DO
- Head of the Office of Airworthiness
- Compliance Verification Engineer
- Design Engineer
- Quality Management Engineer

After consulting also the corresponding GM&AMC, the hierarchy and relations between functions shown in Figure 4.3 and Table 4.1 is proposed to conduct the design organization. This is only a preliminary description, detailed task sheets should be developed once the process of approval begins.

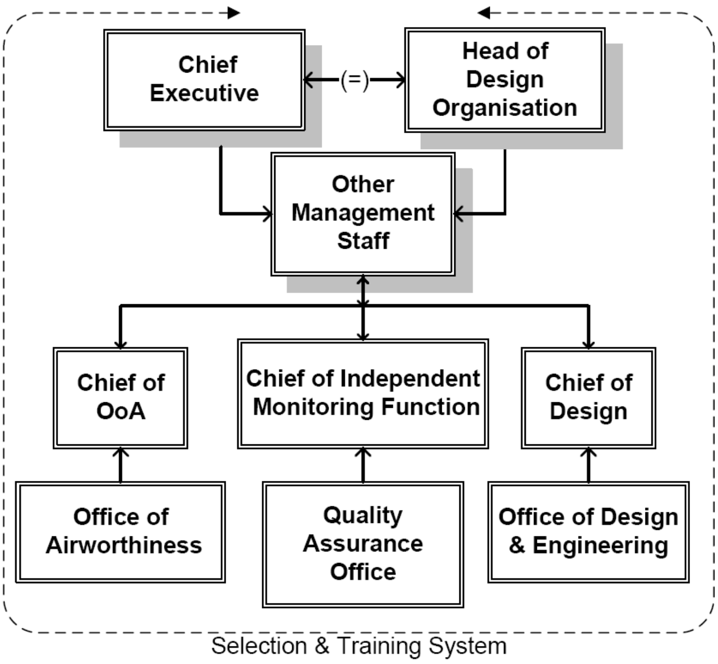

Fig. 4.3 General description of the EASA required Management Staff in a Design Organization

Table 4.1 Description of Functions and responsibilities for the personnel required to obtain DOA

Function		Description of responsibilities
Chief Executive		• Provides the *necessary resources* for the proper functioning of the design organization
Head of Design Organization		• Is the one carrying the responsibility over the design organization for complying with the EASA requirements, by signing the *declaration of compliance*, mentioned in 21A.20 and 21A.97; • He also must ensure that the handbook (DOM) is *prepared and updated*, as required in 21A.243 and that all personnel under his authority applies it; • Chief Executive and Head of DO can be the *same person*
Office of Airworthiness	**Chief of OoA**	• Is the main *interface* between the airworthiness work developed by the DO and the Agency, and also manages the personnel under his authority; • Ensures the *liaison* between DO and EASA regarding all aspects related to Type investigation; • Ensures cooperation in developing *procedures* to be used in the certification process; • Regularly *reports to the Agency* about the progress of TI progress and *announces scheduled tests*; • Ensures cooperation in proposing the *certification basis*; • *Selects* qualified staff; • *Reports* to directly to the *Head of DO*; • Providing *verification* to the head of the design organization that all activities required for Type Investigation have been properly completed; • Ensures *cooperation with the Design & Engineering Office* in elaborating manuals, SB"s, drawings, specifications and standards; • He ultimately *connects* the work related to showing compliance with the Agency and the Head of DO/Chief Executive; • Ensures the initiation of *activities as a response to failure* (accident/incident/in-service experience) evaluation and complaints from the operation and *providing of information to the Agency* in case of airworthiness impairment (continuing airworthiness); • *Ensures that the manuals* approved by the Agency, including any subsequent revisions (the Aircraft Flight Manual, MMEL, the Airworthiness Limitations section of the Instructions for Continued Airworthiness and the Certification Maintenance Requirements (CMR) document, where applicable) *are checked* to determine that they meet the respective requirements, and that they are provided to the Agency for approval.
	Airworthiness Engineer	• Provides *guidelines for documenting* compliance; • *Interprets* CS and environmental requirements and transforms it into procedures; • *Advises* all departments in questions related to airworthiness, environmental protection and certification; • *Checks* the required *type design definition documents* described in 21A.31 and ensures that they are provided to the Agency for approval when required; • Provides *certification expertise* to the Chief Engineer/Head of Organization; • Receives and reviews the results from the CVE"s and *signs* the *documents requiring release* (like compliance documents) *and documents requiring approval*; • Ensures *procurement and distribution* of applicable CS and environmental protection requirements and other specifications; • *Prepares the Type Investigation program* and co-ordination of all tasks related to Type Investigation in concurrence with the Agency; • Ensures *cooperation in preparing test programs* needed for demonstration of compliance; • Establishes the *compliance checklist* and updating for changes;

		• *Monitoring of significant events on other* aeronautical products as far as relevant to determine their effect on airworthiness of products being designed by the design organization; • Ensures *cooperation in preparing Service Bulletins,* with special attention being given to the manner in which the contents affect airworthiness and environmental protection and granting the approval on behalf of the Agency; • Advising the Agency with regard to the issue of airworthiness directives in general based on Service Bulletins.
	Compliance Verification Engineer	• He is responsible for fulfilling article *21A.239(b)*, referring to the independent checking function of showing of compliance • It *manages the demonstration of compliance*; • Approves *compliance documents*, by signing them (including test programs); • Approves *technical content*, including revisions of manuals; • Can *involve* in the showing of compliance process; • The CVE and the person creating the compliance data are *not* the same, but they may collaborate; • The CVE (for STC cases, as it is the case of cabin conversions) does *not* need to provide the independent checking function, required in 21A.239(b), *for those compliance documents* produced and approved under the authority of the *TC holder*; *One* CVE is nominated for each relevant subject; (AMC 21A.239(b)3) • *Checks* that all compliance documents are prepared *as necessary to show compliance* with all CS and environmental protection requirements, as well as for completeness;
Office of Design & Engineering	**Chief of Design**	• Take *responsibility* over the design function; • *Coordinates* the design; • Has the responsibility for setting the *direction of the design effort*; • *Directs the designers* under his authority responsible for creating the drawings; • Is responsible *for selecting and updating the tools* for developing the design work, for him and designers under his authority;
	Design Engineer	• Ensures *cooperation in preparing Service Bulletins*; • Fulfils the design work *according to the specifications* of the OoA; • *Develops the concept* of the product; • Is responsible for *choosing proper tools and give feedback to Chief of Design regarding selection of tools and their functioning*; • Conducts the part of the design development related to *planning* and *execution*;
	Design Verification Engineer	• Conducts the part of the design development related to *verification* of the design; • *Collaborates* with the design engineer in the developing the approved version

Independent System Monitoring Office	**Chief of Independent Monitoring Function**	• Is in charge of the *continued effectiveness* of DAS; • *Establishes* the *means by which* the continuing evaluation (*system monitoring*) of the design assurance system *will be performed* in order to ensure that it remains effective; • Ensures the *independent monitoring function*; • Designs the *feedback system*; • Ensures the implementation of *correcting actions* (21A.239(a)3) • Continuously *evaluates* the DO; • *Chooses and applies the best strategy* for quality assurance; • The chosen system should have such results that an *increase of the customer confidence* can be measured; it also must show that the DO is *responsible*, and *trustworthy*; • *Identifies the critical quality processes*; • Develops a *system for detecting failures* in the functioning of the organization; • It is recommended that he applies the *PDCA procedure*, from EN 9100; • He must *develop/apply suitable methods of quality control* • *Reports* to the Head of DO, under who"s control develops the activities;
	Quality Assurance Responsible	• Complementary to the activities of the Chief of Independent Monitoring Office, who is in charge of the internal quality of the from the point of view of design organization, one person needs to ensure the *quality from the point of view of company organization*, by keeping contact and receiving feedback from *potential customers*, and the "outer world", for continuously being updated with the *market expectations*; if one looks *inside*, the other looks *outside*, but they have a common goal, which is ensuring quality from both point of view: airworthiness standards and customer standards. • Keeps the *contact with the customers* and properly *interprets* its *requirements*; • *Updates the catalogue* of products together with the Design and Engineering Office, and the management of the DO; • Establishes the *responsibilities and the necessary qualification*, accounting for the EASA requirements with this respect, of the personnel involved in taking decisions which affect the quality of the work; • Creates the *procedures* to be followed for assuring quality, by writing proper documentation;
	Monitoring Personnel	• Helps the Chief of Independent Monitoring System in *administrating the feedback data;* • Has experience in *proposing corrections*, for *each field of activity*;

The personnel nominated in the Design Organization Manual, and being part of Design Assurance System, has functions and responsibilities discharged for every technical field written in the Scope of Approval:

- Installation of avionics and equipment
- Environmental systems
- Electrical systems
- Cabin interior
- Galleys or other interior equipment

This means that qualified personnel for all three tasks: design, certification and monitoring, must be selected. Behind this selection, a proper *Training and Selection System* must be ensured, either by subcontracting or by developing own training capabilities. Details are depicted in Fig.4.3 and Fig. 4.4.

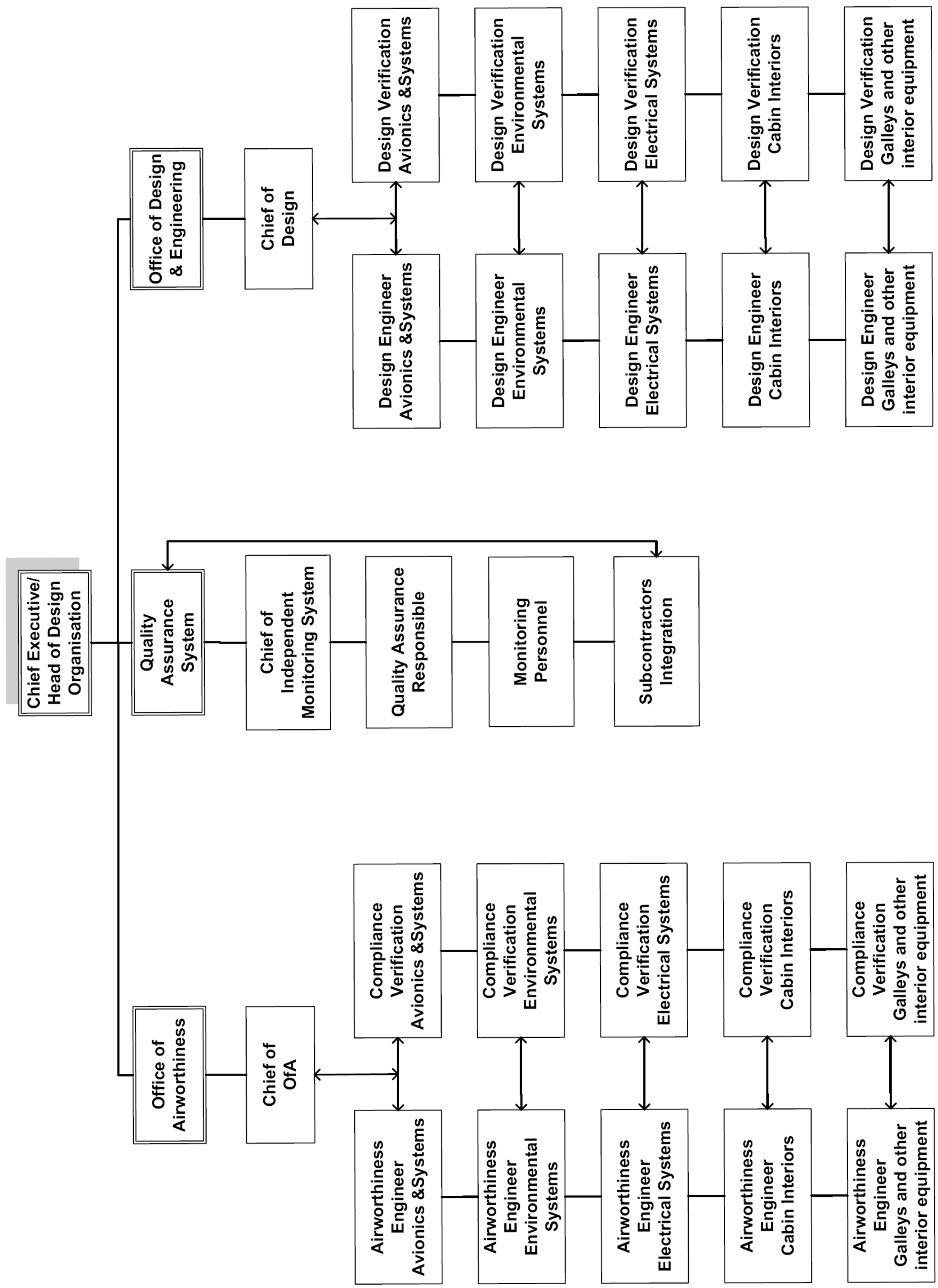

Fig. 4.4 Personnel within DO (according to EASA recommendation for ensuring approval)

4.3 Monitoring System

The duties of the Monitoring System must be set according to the requirements from EN 1702/2003. The reason EASA is asking for an independent monitoring system is to make sure that undetectable errors and failures, which may not be observed by the Agency, are kept under control. Through the DOA itself the Agency is looking to develop among the design companies a safer and more complex self-control function. The purpose is to discharge the responsibility of certifying the product on the engineering and certification team of the DO, while EASA is supervising carefully the actions.

The responsibilities of the personnel in the Independent Monitoring System Office have already been mentioned. This System is an obligatory part of the Design Assurance System for any organization wanting to get the DOA. Here is what the Agency states in article 21A.239 (**EASA 2009b**):

> *(a) This design assurance system shall be such as to enable the organization:*
> *3. To independently monitor the compliance with, and adequacy of, the documented procedures of the system. This monitoring shall include a feed-back system to a person or a group of persons having the responsibility to ensure corrective actions.*
> *(b) The design assurance system shall include an independent checking function of the showings of compliance on the basis of which the organization submits compliance statements and associated documentation to the Agency*

The personnel involved in the monitoring function carries also the responsibility of the integration of the subcontractors, according to EASA. If part of the work is to be outsourced to organizations not having a DOA, the monitoring function of the contractor should be applied to the products coming from the subcontractors so as to ensure the airworthiness and quality expectations. In fact, all the eventual suppliers, whether they have a DOA or not, need to conform to the prescriptions of the contracting design organization.

The description of the procedures within the Monitoring System is the task of the Monitoring Office. The same division is responsible for ensuring the quality expectations coming from the customer. The personnel involved in Quality Assurance will conduct the research towards the implementation of the proper Quality Management System. The decision will be taken whether to opt for the EN 9100 standard and/or for additional QM Tools.

4.4 Design Organization Manual

In the previous subchapter the persons responsible for writing and updating the DOM, as well as for applying it properly, were identified.

According to Subpart J, 21A.243(a) (**EASA 2009 b**), the DO has the obligation to describe the organization, the relevant procedures and the products or changes to products to be designed inside the Design Organization Manual, called *handbook* by the Agency. Another requirement from the Agency is the continuing amendment of the handbook, whenever a change in the DO occurs (21A.243(c)). The article 21A.265, about the obligations of the DOA holder, states at paragraph (a) that the handbook must be maintained in conformity with the design assurance system and at paragraph (b) that the Agency must be assured that the handbook is used as a basic working document within the organization.

To summarize, the Design Organization Manual (DOM) must specify all the instructions and procedures within the organization, required to perform the design. The information provided by the handbook must include the description of (AMC No. 1 to 21A.243(a), **EASA 2009d**):

- Tasks
- Organization
- Assigned responsibilities
- Human resources, facilities and equipment
- Recording system
- System monitoring of the design assurance system
- System for controlling and informing the staff of the organization of current changes in engineering drawings, specifications and design assurance procedures
- Record keeping system to comply with 21A.105
- Authorized signatories
- The means by which the organization monitors and responds to problems affecting the airworthiness, so as to comply with 21A.3
- The way in which the DO performs all the design functions
- The clear definition of the tasks, competence and areas of responsibility of the Office of Airworthiness

4.5 Quality Management Strategies and Tools

This subchapter proposes some of the Quality Management Systems applicable in the organizations performing design in the aeronautical industry. The usage of a proper QM strategy can ensure better results, can control the eventual errors propagation and can help to properly discharge the activities. QM is not just about fulfilling a requirement coming from EASA, but can provide the management with optimized solutions for controlling the quality of the design and design organization functioning. Paragraph 3.1 indicated the main duties of the office; the purpose is here to shed some light in the way the quality management may be applied in practice.

4.5.1 European Standard EN 9100

The first model to be accounted for was already briefly discussed in Chapter 2: the European Standard EN 9100. This is a standard, representing a model for quality assurance in design, development, production, installation and servicing in aerospace industry and was created by the European Association of Aerospace Industries – Standardization (AECMA-STAN). Germany is one of the countries which are bound to implement this European Standard as a national standard (**EN 9100**).

In Chapter 2 the term *process* was defined as an activity which transforms the inputs into outputs by using *properly managed* resources. The Quality Management System Requirements are based on these main tasks (**EN 9100**):

- identification of the processes and their application,
- determination of the sequence and interaction of these processes,
- determination of criteria and methods for ensuring operation and control,
- ensuring the availability of the resources,
- monitoring, measuring and analyzing the processes,
- archiving planned results and improving the processes.

In the process-based QM model, illustrated in Figure 4.5, one can notice that the most important role is played by the customer (**EN 9100**). Since the customer requirements represent the input, it is highly required that they are properly defined, while adapting them to the certification requirements.

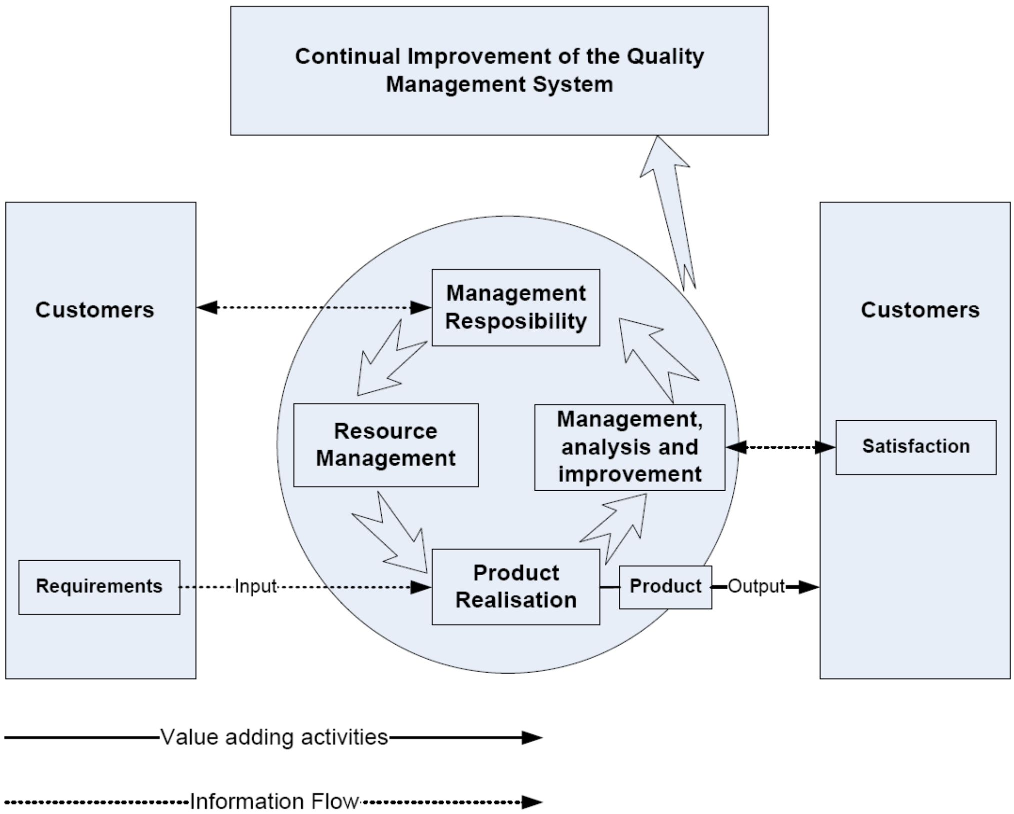

Fig. 4.5 Model of a process-based quality management system indicated by EN 9100

Table 4.2 breaks down the QM Requirements and shows the guidelines for fulfilling them.

Table 4.2 Quality System Requirements. Model for Quality Assurance (**EN 9100**)

Quality System Requirements	Description
Management responsibility	• Initiates the required *actions to prevent nonconformities* related to the product, process and quality system; • *Identifies and record* problems, in case they appear; • *Initiates, recommends and provides solutions* through designated channels; • *Verifies and controls the implementation* of the solutions; • Enough *authority to and organizational freedom* to resolve matter pertaining to quality; • The management has persons under its authority for *reporting and ensuring the correct implementation* of the quality system.
Quality system	• Must furnish *documented procedures* for fulfilling quality requirements and ensure that they are *implemented and accessible* to responsible personnel; • Must furnish *Quality planning*: definition and documents about *how the quality requirements are to be met*, by: ▪ identification and acquisition of all tools necessary to achieve required quality; ▪ verification at appropriate stages of design; ▪ identification and selection of subcontractors (if it‟s the case); ▪ clarification of standards of acceptability ▪ establishment of appropriate process controls; ▪ identification of requirements for maintenance and operation.
Contract review	• The organization must *establish and maintain documented procedures* for tender review (see List of Definitions), to ensure ▪ adequate definition and documentation of requirements; ▪ capability of fulfilling them; • The organization must *record* the contracts.
Design control	• Defining *responsibilities and authorities* for the approval of the design; • Planning of *phases* of design with respect to organization, task sequence, mandatory steps, methods of control; • Giving *attention* to: ▪ *design effort structuring* according to complexity; ▪ *tasks and resources* analysis; • Defining *organizational and technical interfaces* between groups performing design activities; • Defining, identifying and documenting design inputs and design outputs; the design outputs should also provide: ▪ *data to allow* the product to be *identified, manufactured, inspected, used and maintained*, by defining *drawings, part list, specifications* and a listing of all those; ▪ i*nformation* on *material, processes, type of manufacturing and assembly* in order to ensure conformity of the product; • Ensuring the validation of proper and on time *review* of the design, for ensuring validation; • *Taking corrective actions* taken when necessary;

	• Demonstrating *validity* through reports, calculations or test results at the completion of the development.
Document and data control	• Establish and maintain documented procedures to *control all documents and data* that relate to the requirements; • Ensure *pertinent issues of documents*; • Establish *system controls in accordance with customer requirements* when customer furnished digital data is used.
Product identification and traceability	• Establish and maintain *documented procedure* (main source EASA).
Process control	• Production operation needs to be carried out *in accordance with approved data: drawings, part lists, process flow charts, production and inspection documents*; • A *control of tools* and *equipment* is required.
Inspection and testing	• Each inspection, including in-process inspections, must be *properly documented* by specifying resources, implementation methods, and recording methods; • *Authorized personnel, and criteria of acceptance* must be identified.
Control of inspection, measuring and test equipment	• Proper *definition of responsibilities* in order to achieve that.
Inspection and test status	• Indication of conformance or non-conformance by suitable means; • Identification of *authorized personnel*.
Control of nonconforming product	• Nonconforming products must not be used/installed; • Nonconforming products are to be *reviewed by authorized personnel*, under documented procedures.
Corrective and preventive action in the case of nonconformity	• The corrective actions assume *investigation* of cause, *determination* and *application* of corrective actions; • The preventive actions assume the *use of proper information* (e.g. processes, audit results) to determine steps needed to solve problems.
Control of quality records	• Documented procedures for *identification, collection, indexing, access, filling, storage, maintenance and disposition* of quality records; • *Availability* for authority is required
Internal quality audits	• Documented procedures for *planning and implementing* internal quality audits; *tools and techniques* shall be developed to support the audit: check-sheets, process flowcharts.
Training	• *Indentify training needs* in order to achieve and maintain awareness and understanding of the procedures
Servicing	• Procedures for *performing and verifying* repairs
Statistical Techniques	• Can be used to *support*: ▪ design verification (reliability, safety); ▪ process control; ▪ inspection; ▪ quality management; ▪ failure mode and effect analysis;

A very important *observation*: the EN 9100 cannot replace the requirements imposed by EASA for fulfilling an airworthy design, but can help in managing these requirements. In the same time, it can be observed that some of the requirements of the model proposed by EN 9100 are very similar to those written in the Agency‟s regulations. An optimal inter-correlation between the obligatory model – EASA and the additional guidance document – EN 9100, should be achieved. The advantage of using EN 9100 is that the proposed model can be used at all levels of complexity of the organization, respective design work, and ensures good results when adequately applied.

4.5.2 Other Quality Management Tools

Six Sigma is a model for quality improvement originally developed by Motorola as a *business management strategy*. The idea behind the model is to identify and remove the causes of defects (anything that can lead to customer dissatisfaction) and errors behind the business processes.

The term six sigma has the following background: if one has six standard deviations between the process mean and the nearest specification limit, there will be practically no items that fail to meet specifications. In a capability study, the number of standard deviations between the process mean and the nearest specification limit is given in *sigma units*. As process standard deviation goes up, or the mean of the process moves away from the centre of the tolerance, fewer standard deviations will fit between the mean and the nearest specification limit, decreasing the sigma number and increasing the likelihood of items outside specification (**Wikipedia 2009a**).

Other useful tools for improving quality are:

- Quality Function Deployment
- Failure Mode and Effect Analysis
- Statistical Process Control
- Poka Yoka

Schrick 2008 shows the use of the above methods in the Aerospace industry, in Figure 4.6.

Quality Function Deployment (QFD) is, according to **Akao 1990**:

> *A method to transform user demands into design quality, to deploy the functions forming quality, and to deploy methods for achieving the design quality into subsystems and component parts and ultimately to specific elements of the manufacturing process.*

The QFD is also a key practice of Design for Six Sigma, mentioned earlier. The market need is analyzed by listening to the *Voice of Customer* and sorting and numerically valuating them. One of the techniques and tools based on QFD is *House of Quality*, which is a graphic tool defining the relation between customer requirements and product capabilities in the form of a *planning matrix* (**Schrick 2008**).

Failure Mode and Effect Analysis (FMEA) is a procedure for covering and evaluating the potential failure modes (FM) within a system and then determining its consequences (EA). The defects can arise in the process definition, or in the design activity. The inputs of a FMEA can be the results from QFD and the outputs are then inputs for other Quality Engineering Methods, like

Fault Tree Analysis, *Statistical Process Control* (also recommended by EN 9100) or *Design of Experiments* (**Schrick 2008**).

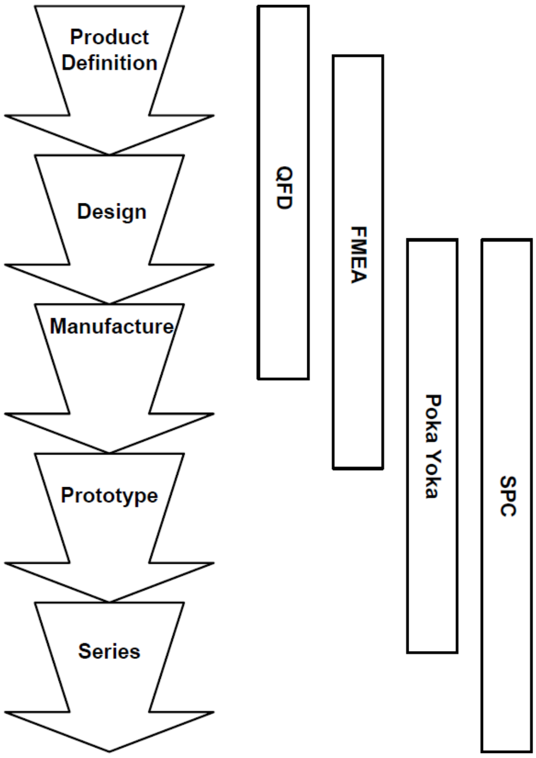

Fig. 4.6 Application of the quality models during the development of a product (based on data from **Schrick 2008**)

Statistical Process Control (SPC) is a method for monitoring a process by using control charts, which allow the use of objective criteria in order to distinguish the variations of o process. For achieving this, collecting data at various points within the process, by applying a statistical approach is required. (**Schrick 2008**).

Poka Yoke means in Japanese *fail-safe*; it is also a method focused on reducing failure, especially due to human inputs. The idea behind this concept is to force the correct operation by putting limits on how this operation can be performed. **Schrick 2008** quotes 3 types of Poka Yoke precautions:

- Error source inspection
- 100% examination
- Immediate measures

A disadvantage of this method is that it is only useful for known errors.

If the customer has certain requirements related to quality management, these must be incorporated in the system. For example, the major player Airbus asks the Design Suppliers to respect the requirements written in AP 1500, "General Requirements for Engineering Design Suppliers".

4.6 Documents within the Design Organization

A change, minor or major, is being approved once a document of compliance is released and signed by the corresponding person. The scope of a Completion Centre is not only about conducting complete conversions, but also partial modifications, according to customer requirements. The process of approval, however, is the same, no matter if the size of the work package is big or small.

In the next chapter, the detailed description of the process chain inside the Completion Center is performed. Within the CC the document flow needs to be set up as well.

The documents can be divided into these categories:
1. Documents between customer and design organization
2. Documents within the organization
3. Documents between design organization and EASA

Part of the *first* category are the *documents resulting from the negotiations* with the customer, as well as the documents delivered in the end as *design documentation and manuals* (which can represent in fact the *deliverables* for those Completion Center performing only the design and engineering work and not its embodiment on the aircraft – the case of ELAN as well).

Part of the *second* category, contributing to the huge amount of documents exchanged within the departments of the DO, are the *documents describing the procedures* within the Design Organization. Examples are the DOM, which is compulsory for obtaining the DOA, according to the EASA regulations, or procedures described by the management, in order to set guidelines for the personnel under their responsibility. Within the DO are the *documents describing the design work*, as well as the *reports showing the design verification results*.

The most important documents inside the DO, showing the way towards achieving a safe and certifiable design are the *compliance documents* and the *approval documents* (it is to remember that the DO itself can only approve minor changes).

Part of the *third* category are the standardized *forms* filled in by the design organization when applying for an STC, or for a major change. Once the Agency approves the applications, the DO receives the required *certificate*. Between EASA and DO *application and approval documents for major changes* are also inter-exchanged.

4.7 Process Schematics for Obtaining DOA

4.7.1 Overview

The Technical Note distinguishes between processes *within* the Completion Center and processes *for becoming* a Completion Center. The relation between the Completion Centre and DOA is one of interdependency: you cannot get to perform the design inside a Completion Center without having DOA, and a DOA requires a scope, which is given by the design activities within the CC. In the same time, everything is happening under the surveillance of EASA. See the Figure 4.7, for a better illustration.

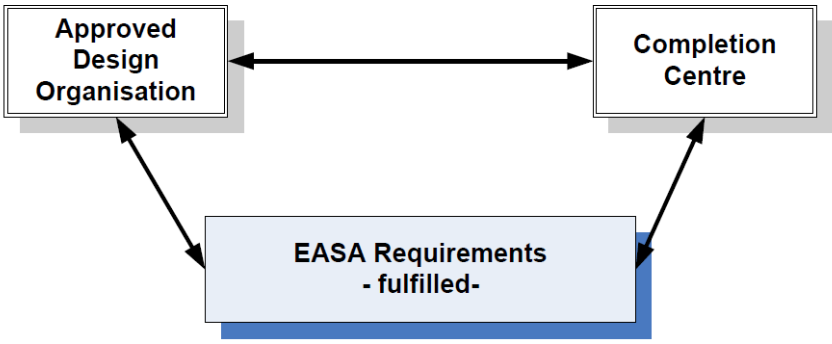

Fig. 4.7 Relation between DO, CC and EASA; each item depends on the other two

In order to achieve the purpose of obtaining the right to perform design inside an approved organization, some factors, playing a decisive role, need to be considered (see Figure 4.8):

- Tools
- Infrastructure
- Qualified personnel

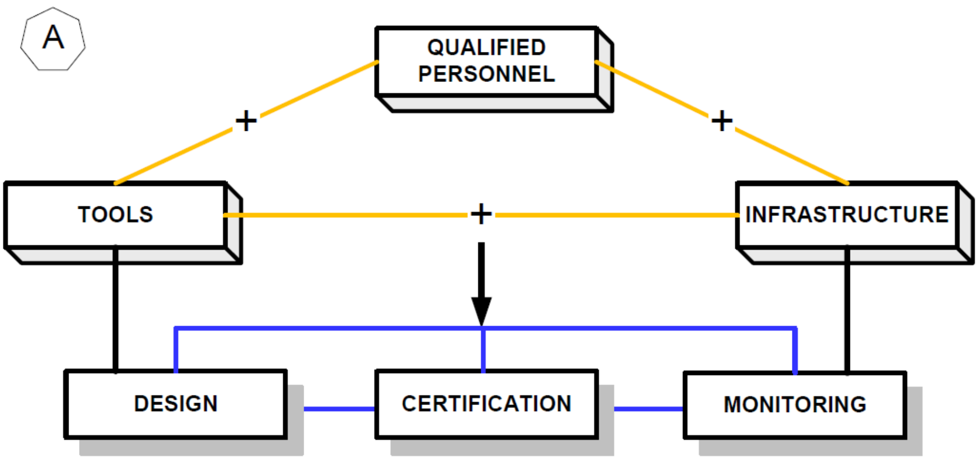

Fig. 4.8 Basic requirements for obtaining DOA and ensuring a safe design

The *qualified personnel* must be selected for the key functions in:

- Organization – to make all actions efficient, fast, accurate and trustworthy,

- Certification – to identify rules and approve changes,
- Design – for creating concepts, drawings and for calculating loads,
- Engineering – for finding an optimum for the design solution.

The *tools* must be the result of high tech investments in:
- Design,
- Organization – for organizing data and work flow, for data storage and data transfer,
- Certification – for test equipment.

The *infrastructure* should ensure, besides computers, offices and office supplies, the connection with partners providing the in depth view of practical cabin conversion, or the environment for creating mock-ups.

On the other hand, parallel to developing this system, shown in Figure 4.8, something else needs to be done: the company needs to create and sell an *image*. The confidence of the customers can be won by creating a *virtual catalogue* and by showing the capabilities of the company. It is not enough to become a Completion Center, but you need to be recognized like one (see Figure 4.9).

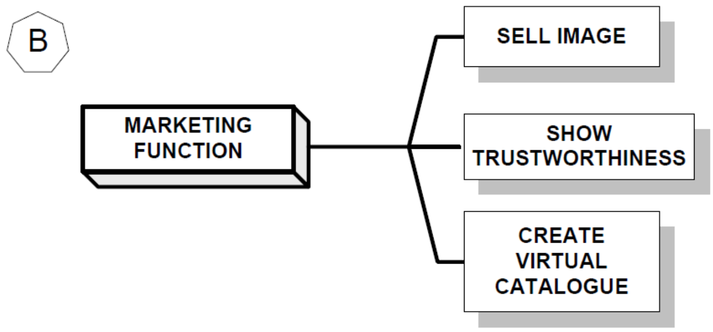

Fig. 4.9 The second important function: to gain customer trust

4.7.2 Process Chain Description

The implementation of the EASA standards for creating a Design Organization can follow this sequence (**CAMR 2009**):
- Preparation
- Implementation
- Evaluation
- Learning

The *preparation phase* includes:
- understanding the EASA requirements for DOA,
- identifying the purpose of DOA,
- identifying the objectives for getting the DOA,

- identifying and evaluating the consequences of receiving the approval,
- identifying the consequences of not having a DOA,
- identifying the most important points of the integration of the new organization within the company,
- assigning a responsible person/team capable of evaluating the DO implementation process,
- determining the functions and responsibilities of the personnel involved in getting the DOA,
- identifying the activities, already existing in the company, which can be part of DO,
- defining clear goals and proper management strategy for implementing DO concept,
- identifying the key performance indicators,
- identifying the type of necessary documents inside the DO, by respecting EASA indications,
- identifying the simplest and clearest way to create the documents, by considering aspects like: form, annotations, signatories,
- preparing the *implementation plan*, based on a schedule,
- preparing the implementation processes,
- evaluating the costs and the revenues.

Part of the *implementation plan* prepared during this phase should, first of all, consists of all the aspects quoted in the Part 21 and the other relevant parts referred to in this chapter. Secondly, other sources, such as technical documentation standards or quality management standards, can be taken into account. This means that the implementation plan must include prescriptions regarding:

- the set up of the Design Assurance System,
- the functions and responsibilities of the personnel inside the DO,
- the creation of the DOM,
- the way the Monitoring System will function,
- the tools necessary for the flawless functioning of the DO,
- the showing of compliance,
- the Quality Management Strategy.

The preparation phase is of major importance and implies the contact with the EASA.

The *Implementation phase* includes:

- implementing the plan elaborated during the preparation phase,
- collecting data to supply it to the evaluation phase,
- supervising the planned integration,
- creating a knowledge base.

The *Evaluation phase* includes:

- evaluating the functioning of the components of the DO,
- reviewing the processes, if it‟s necessary,
- standardizing the processes,

- evaluating and standardizing the document flow,
- establishing monitoring measures,
- analyzing and evaluating the tools.

The *Learning phase* includes:

- assessing the results from the evaluation phase,
- reflecting on the possible improvements and implementing them,
- standardizing all the procedures inside the DO,
- standardizing the document flow, regarding annotations, form and signatories,
- standardizing the communication system within the DO and with the EASA,
- standardizing the data storage.

These phases were established with the help of the methodology for implementing the concurrent engineering concept developed at the Center for Advanced Manufacturing (CAMR) of the University of South Australia. The concurrent engineering concept will also be presented in the following chapters.

4.7.3 Process Chain Representation

The relations between the phases and sub-phases for implementing the Design Organization concept can be visualized in Figure 4.10.

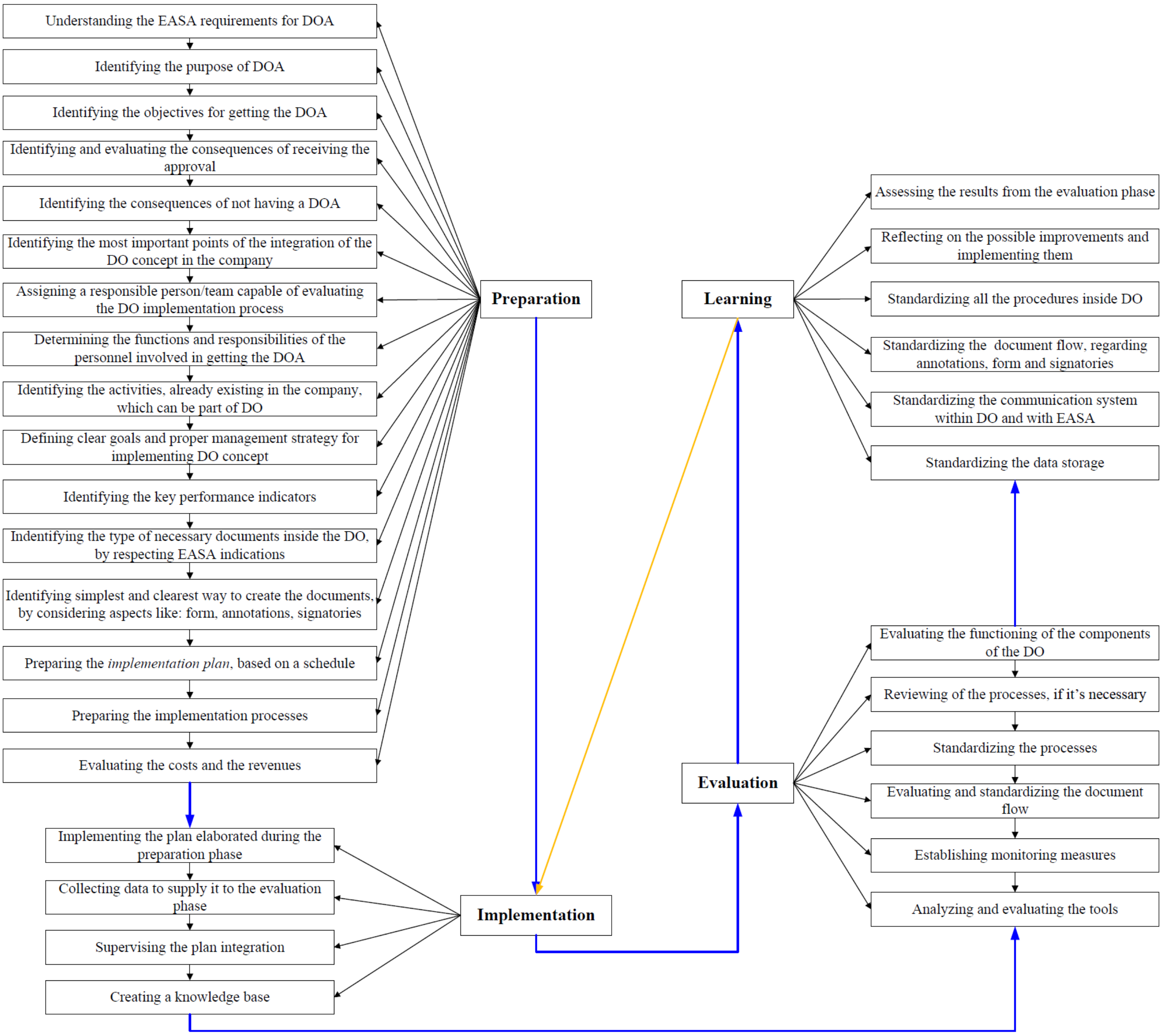

Fig. 4.10 Preparation for DOA implementation – Process Chain representation

5 Process Chain Description for Cabin Conversion

5.1 Introduction

After shedding some light on the process chain schematics for getting to the Completion Center, it is now time to investigate the processes *within* the Completion Center.

Cabin conversions are either minor or major changes to type design, covered by an STC. Whether the change is for transforming an aircraft from pax to pax, from cargo to pax, or the other way around, the processes are the same, the personnel and the resources are also the same, although each case should be treated separately.

The starting point for designing cabin conversions is the one described in Chapter 4: getting DOA for being able to show capability of showing airworthiness (Figure 4.7 up to 4.10). The flow of processes and documents should be in such a way organized, that it minimizes the inputs like: *time, effort* and, especially, *errors*.

As also indicated in the EN 9100, the customer is the core of all activities build up inside the Completion Center. The first phase, therefore, is the *Offer Phase*. If the offer is accepted by both sides, then the technical document, describing it and the technical implications, heads towards the *Conversion Processing*. The output, summarized all together in the *Hand Over Phase* comes back to the customer, and a circle closes. The natural consequences of the correct functioning of this system are the *feedback output* from the customer and the update of the *virtual catalogue* of the engineering office.

In elaborating the process chain description we use the concept of *concurrent engineering*, a concept which will be explained in this chapter and also recommended for the wide use throughout the engineering office.

As shown earlier, there are three main parts into which the work inside the Completion Center can be divided. Therefore the process chain description will be divided also into three parts (see Figure 5.1.):

- Part A, referring to the offer phase description,
- Part B, referring to the description of the processes for completing the conversion,
- Part C, describing the end processes and the deliverables going to the customer.

Feedback coming from customers is used to improve the efficiency of the actions within the completion center, functioning as a system (besides the feedback system from the DO).

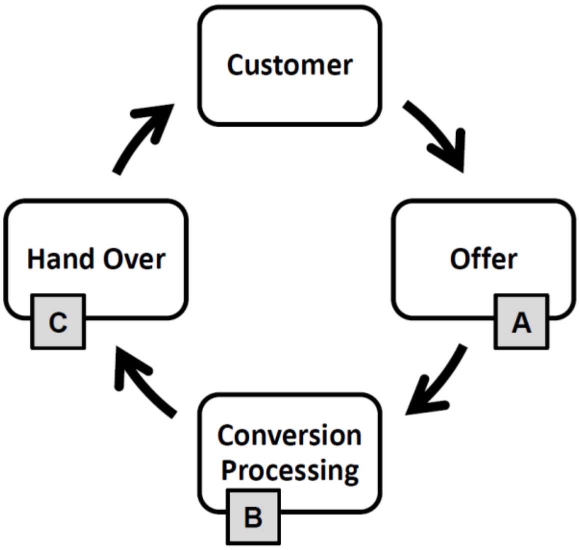

Fig. 5.1 Completion Center Concept for ELAN GmbH

5.2 Process Chain Description

5.2.1 Background

As shown in the previous paragraph, it can be useful to implement in the conversion processes the tasks of concurrent engineering, described first of all through the parallelization of tasks.

The description proposed in this chapter shows a three dimensional process modeling inspired by concurrent engineering.

The main phases of the conversion process are represented in the *horizontal plan*. The certification of the design should cover all the phases and should be introduced from the early stage of the *concept* of the design process. Therefore it will be included into the *vertical plan* (indicated through a pyramid), which meets the horizontal plan in all the points represented by the phases. The assembly of the two plans forms the *solid view* on the development process (see Figure 5.2).

The horizontal plan is represented by circles. The circle is the geometrical form which allows communication between engineering teams in all directions (red dotted line). The Certification phase, represented in the vertical plan, has a volumetric form, due to its major implications over the work activities. The Offer phase is represented as a starting point of the process, sustaining the whole development cycle. As the stress engineers would say, this point has to handle the „pressure" of the decision whether to initiate the work process or not. This decision is the result of the negotiations between the customer and ELAN.

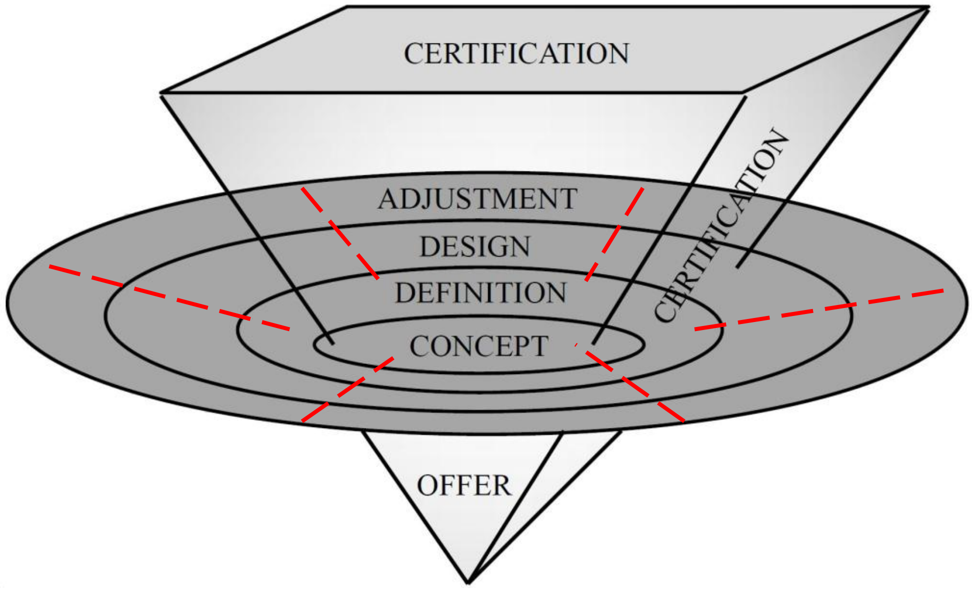

Fig. 5.2 Representation of the conversion processing cycle

Aspects from concurrent engineering integrated into the approach represented in Figure 5.2 are:

- Communication among engineering teams,
- Parallelization of tasks: the demonstration of compliance function is initiated from the early phase of the conception, validating all the phases.

5.2.2 Description of Phases

A. Offer phase

As mentioned in Chapter 4, the main requirements necessary to set up the Completion Center are firstly the organization of the company, as to receive the DOA, and secondly creating a trustworthy image of the company. The first requirement ensures safety through compliance of the processes with the EASA requirements. The second action brings the customers into enabling the actual work flow process, by accepting the offer from ELAN.

To underline the competence of a Completion Centre at ELAN, a virtual catalogue is used as ELAN‟s business card for the customer. It can contain examples of virtual conversions, which should be conducted, also with the purpose of testing the correct set up of the process chain. Each capability, from each technical field should be virtually shown, by using rendering programs, or outputs from programs like CCD, Catia V4, V5, Solid Works, Autocad or Pcelab Cabin. The catalogue should also include the description of the workflow, organization and quality management strategies used to ensure the success of the design. These actions would give the client enough confidence in order to accept an offer from ELAN.

The Offer Phase usually starts with the *Customer Request* (**AP 2439**) which is formalized through a preliminary document called here *Customer Request Technical Sheet* (CRTS). The CRTS briefly describes the requirements of the customers and the implications within the Completion Centre. In the same time, this document represents the first decision point for both sides. If the two parts agree, then a document called *Technical Offer* document will describe in detail the actions which are to be followed in order to finalize the customer request.

Parallel to this activity, ELAN should make a *feasibility study*, in order to check if the work package has advantages for ELAN. For example, it would be quite difficult to comply with the requirements from customers having products not conforming to the type certification basis.

If each decision gate ends with a "yes", the outputs enter the Process Chain B (See Figure 5.3 and 5.4)

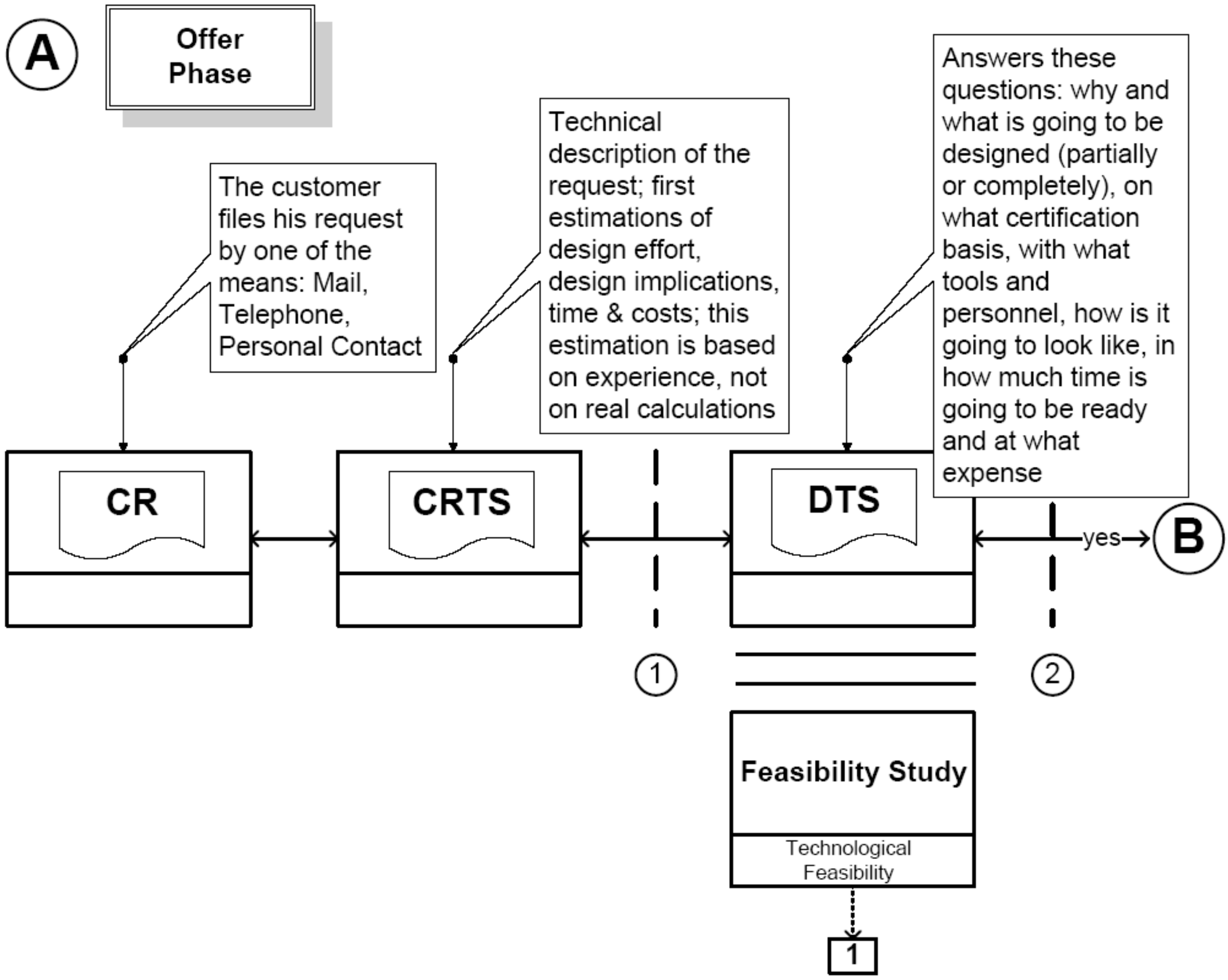

Fig. 5.3 Process Chain description A, referring to the Offer Phase

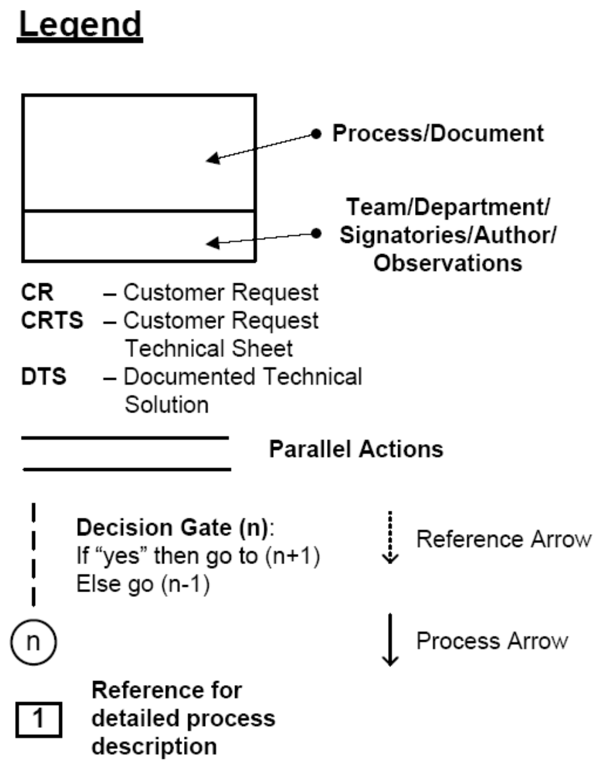

Fig. 5.4 Legend to Process Chain description A, referring to the Offer Phase

B. Conversion Processing Cycle

The conversion processing or Part B, is graphically illustrated in Figure 5.2. The conversion cycle gathers all the phases related to the design and certification of the conversion work. These phases are:

1.) Concept
2.) Definition
3.) Design
4.) Adjustment

Each phase has its own number of sub-phases, which can be divided in smaller processes. The representation of these phases and the corresponding sub-phases are given in the form of a matrix, which is an instrument of the concurrent engineering concept. The generation of this matrix was made by reference to **Eppinger 2002** (see Chapter 5.3.2).

1.) Concept Phase

The first stage in the development of a product is the conception. The main actions required at the beginning of a project (**AP 2289**) are mainly referring to:

- understanding and filtering the customer requirements,
- understanding and filtering the certification requirements,
- making an internal feasibility study,
- studying the design possibilities,
- organizing the work flow,

- developing the preliminary design,
- developing the testing and verification methods.

2.) Definition Phase

The definition phase approaches the same issues more in depth, with the purpose of achieving the final version of the design. The main steps are:

- defining the certification basis,
- defining the Means of Compliance (Office of Airworthiness, OoA together with EASA)
- defining the process steps,
- assigning and organizing a team,
- analyzing mechanical and electrical loads, tolerances,
- analyzing interference between components,
- testing the design,
- validating the design concept.

3.) Design Phase

The design engineers perform the design work based on the prescriptions of the Chief of Design, assigned already in the conception phase, and those of the airworthiness engineers and Compliance Verification Engineers, CVE‟s. Mainly, during this phase it is required to:

- perform the design according to the prescriptions elaborated during the earlier phases,
- verify the design (DVE, Design Verification Engineers),
- give feedback to the project responsible.

The design verification is strictly connected with the adjustment of the design. All the error adjustments are performed in the design phase. While implementing the design definition into practice, different technical fields can get into conflict. It may be the case, for example, that due to the necessity of repositioning of a monument in the design phase, new electrical contacts have to be designed. These faults should be detected by the design verification engineers in the design phase. During this phase such situations are analyzed and adjusted, based on the reports of the Design Verification Engineers.

The design verification comprises sub-processes referring to:

- taking over the defect reports from the DVE‟s,
- analyzing the available solutions,
- finding the optimal solution,
- restoring the design,
- validating the design.

An observation is here required: *Adjustment phase* (detailed below) does not refer to the adjustment of the design, but to the improvements brought to the overall functioning of the DO, which can be made once the whole process of conversion is finished. For a company looking to set itself up as design organization and to perform certified cabin design, this function is highly important especially when signing the first contracts.

4.) Certification

According to article CS 25.21 from **EASA 2009c** the certification process of an aircraft means ensuring that the design complies with all the requirements stated in the specifications emitted by the Authority. For efficiency, the certification process should start from the early phase of the conception, in parallel to the design development activities. For reducing time and errors, certain aspects need to be considered already when the concept is developed. The certification process is under the responsibility of the Office of Airworthiness. Mainly the steps are:

- establishing contact with the authorities,
- creating the means of compliance (tests and corresponding documentation),
- creating and approving the certification documentation, under DOA privileges,
- creating certification documentation for getting EASA approval (where the privileges do not apply),
- signing the declaration of compliance (a task of the head of DO).

5.) Adjustment Phase

Once the conversion processing is finished, the design verified and certified, and the engineers start preparing the documentation in the form required by the customer, the overall functioning of the DO is analyzed during a dedicated phase. This task is performed by the Monitoring System of the approved DO and starts by gathering feedback data from all the departments and personnel involved in the process. The purpose is to get to a clear understanding of the strengths and weaknesses of the Process Management, and to look for optimization points. All the observations related to aspects like: the work flow organization, the tools used to perform the work, the documents flow and signatories should be included in reports having as result updated procedures. To summarize, the main activities required by this phase are:

- getting functioning feedback from all departments,
- proposing optimized solutions,
- creating updated processes, procedures, and internal manuals.

C. Hand Over

Once the design is performed and verified, the next step is to hand over the results to the customer (Fig. 5.5). The results are produced in the form of written documentation. The size and complexity of the technical documentation depends on the size of the work package. Since ELAN does not plan to deliver the actual conversion work, the technical documentation must describe the assembly process in detail. The deliverable is therefore, a document, gathering all the data necessary for the design to be executed: technical documentation, procedures and instructions for assembly, part lists, instructions and cautions for continued airworthiness and maintenance. Besides the technical documentation, assistance should be provided as well. To summarize, the steps involved in this phase require:

- taking over the final version of the design documentation,
- creating the Assembly Manuals, based on the design documentation,
- verifying the documentation,
- providing assistance,
- delivering the results to the customer.

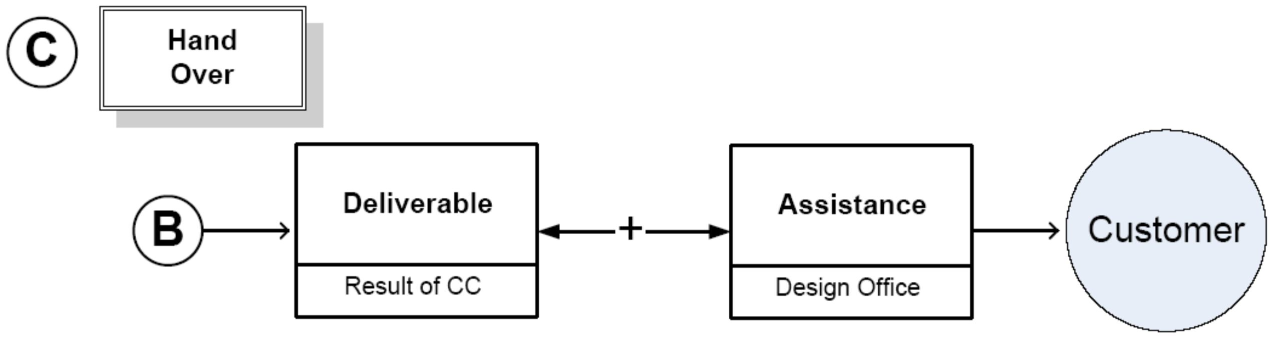

Fig. 5.5 Process Chain description C, referring to the Hand-Over Phase

Figure 5.6 shows the summary and the instruments used for the phases situated in the horizontal plain of representation. The representation concept was inspired by **Spiegel 2008**.

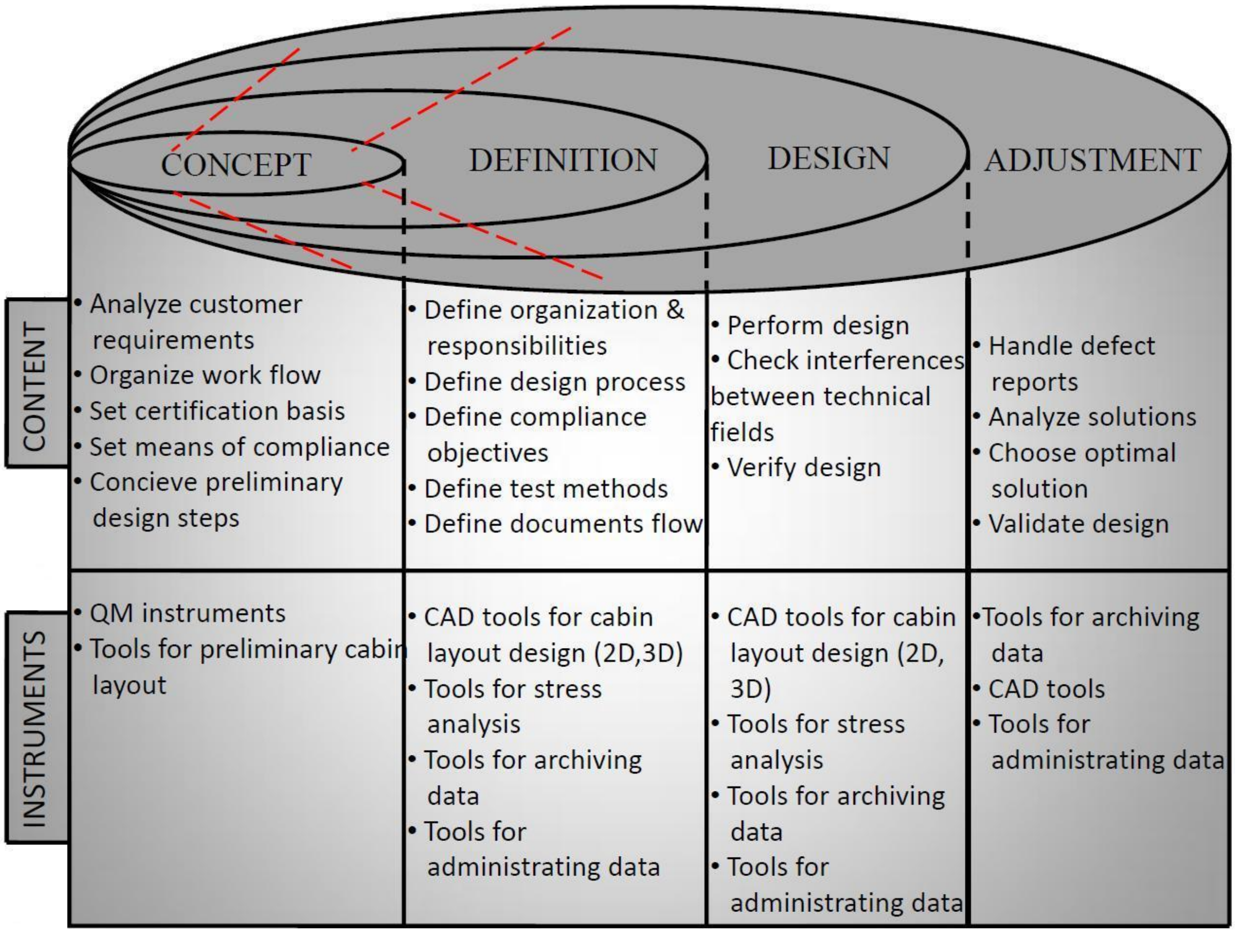

Fig. 5.6 Basic content and instruments for each phase represented in the horizontal plain

The processes briefly presented here need an adequate representation model. Ideally the chosen model allows the optimization especially regarding the order of the processes and their duration. The next paragraph presents several variants and chooses one fitting the requirements.

5.3 Process Representation Models

Process planning and modeling activities have a vital importance in fulfilling the customer expectations. Strategies need to be chosen in order to establish and improve processes, to document them (e.g. for compliance reasons), to define roles and responsibilities as well as to understand the relation between the processes and the activities.

Models allow processes to be controlled and analyzed with the purpose of improving them. There are numerous approaches available to support process management, each depicting various aspects.

5.3.1 Flow Charts

Typically, processes are modeled as flow charts which produce large process maps to describe how a company is progressing from a customer request to the delivery. They are focusing on information flow from one activity to another. Most of them capture the interactions between tasks, documents, events, roles / resources, and time (see Table 5.1). Some of these methods, applicable also in aerospace industry, are (**König 2008**):

1.) *Structured Analysis and Design Technique (SADT)* – it is part of a series of structured methods, which represent a collection of analysis, design, and programming techniques. Basically it describes systems as hierarchy of functions and can be used as a functional analysis tool; it uses successive levels of detail: either through a top-down decomposition approach or by means of activity models and data model diagrams (**Nam Pyo Suh 2001**).

2.) *Integrated Definition (IDEF)* – is a family of modeling languages covering function modeling, information modeling, knowledge acquisition or object-oriented analysis and design; IDEF0 is a language building on SADT, and IDEF1 addresses information models There are up to 14 languages (developed through US Air Force funding), each having a specific purpose; IDEF 3 refers to Process Description Capture (**Mayer 1995**).

3.) *UML-Activity diagrams* – includes a set of graphical notations techniques to create abstract models of specific systems; it uses entity relationship diagrams and work flow modeling (**Noran 2009**).

4.) *Business Process Modeling Notation (BPMN)* – provides a graphical notation for specifying business processes in a Business Process Diagram (BPD); it is similar to UML; it uses elements like flow objects, connecting objects, swim-lanes and artifacts (**Noran 2009**).

5.) *XML Process Definition Language (XPDL)* – is a format standardized by the Workflow Management Coalition (WfMC) to interchange Business Process definitions between different workflow products; it has been designed specifically to store all aspects of BPMN diagrams (**Simpson 2004**).

6.) *Process Module Methodology (PMM)* – is used for flexible planning, monitoring and controlling of highly complex dynamic development processes. The fundamental approach adopted here is to specify the process steps but not the order in which they should occur, allowing the process to be amended easily when they run (**Bichlmaier 1999**).

7.) *Event-driven Process Chains (EPC)*, either event-driven or object-oriented (oEPC) – are used to analyze processes for the purpose of an ERP (Enterprise Resource Planning) implementation, which is a computer software system used to manage and coordinate resources, information and functions of a company (**Van der Aalst 2009**).

8.) *PERT (Program Evaluation and Review Technique)* – is a method to analyze the involved tasks in completing a given project; it identifies the minimum time needed to complete the total project; it uses key terms like: critical path, lead time, optimistic time or expected time (**Chanas 2001**).

9.) *Critical Path Method (CPM)* – it determines critical activities using the same approach as PERT: by representing the duration along with the processes and relations between them and by calculating critical project times, like for instance the latest time an activity can start without affecting the project (**Chanas 2001**).

10.) *Work Breakdown Structure (WBS)* – illustrates all the activities being part of a project, by breaking them down elementary activities. The method is used also in the aerospace sector: Airbus has set the WBS usage as requirement for their sub-contractors. The WBS is detailed enough and can be used as management control tool (**AP 1500**). Along with the WBS, the OBS (Organization Breakdown Structure, for personnel and responsibilities) and the RBS (Resources Breakdown Structure, for identifying resources associated to the work package) can be used.

11.) *GANTT* – is a bar chart illustrating a project schedule, by representing start and finish dates; it is highly used in every domain of activity.

Table 5.1 Comparison of common process modeling methodologies (**König 2008**)

	Task				Document				Event					Role / Ressource					Time		
Process Modeling Methodologies \ Constructs	Function	Operation	Activity	Transition	Data Object	Attribute	Input	Output	Event	Message	Object	State	Places	Organizational Unit	Ressource	Attribute	Methods & Tools	Resources	Milestone	Lead Time	Start / End Time
UML	x		x		x	x	x	x	x		x			x	x	x	x		x		
EPC	x				x				x					x	x				x		
oEPK		x				x				x	x			x		x					
IDEF			x				x	x				x									
Petri-Net			x	x									x								
PMM			x				x	x									x	x	x		
PERT			x																	x	x

Table 5.1 compares some of the methodologies briefly presented above. These methodologies were studied having in mind the type of processes involved in cabin conversion. It can be seen that flow charts are not the only available method.

5.3.2 Matrix Representation

Another possible way of representation for system analysis and management is the use of matrices. Well researched and documented is the Design Structure Matrix (DSM) and its derivatives: Domain Mapping Matrix (or DMM, allowing mapping of two different views of a system) and Multiple Domain Matrix (or MDM, combining a DSM and a DMM into a complete system representation).

The DSM is a square matrix that shows relationships between elements of a system (**DSM 2009a**). The Design Organization, as EASA requires, needs to function as a system which has to prove to the authorities that it is able to deliver certified designs or modifications to designs. The optimal functioning of the DO as a system is determined by interactions between its constituent elements. The DSM provides a simple representation of these elements, allowing the analysis of the interactions between them and permitting their visualization.

The first step in using this approach is to identify all the sub-systems of the systems. In our case the system is represented by the set of tasks to be performed inside the Completion Center, for achieving a certified cabin conversion. The task names are placed down the side of the matrix as row headings and across the top as column headings in the same order. If there exists a relationship between node i and node j, then the value of element ij (row i, column j) is unity (or marked with an X). Otherwise, the value of the element is zero (or left empty). In the binary matrix representation of a system, the diagonal elements of the matrix do not have any interpretation in describing the system, so they are usually either left empty or blacked out (see Figure 5.7) (**DSM 2009b**).

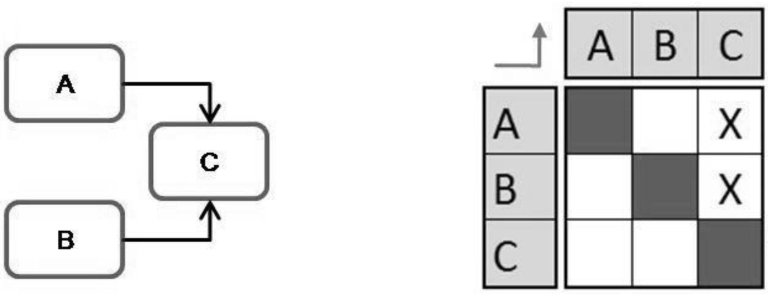

Fig. 5.7 Design Structure Matrix in contrast to a direct graph (digraph) (**DSM 2009b**)

The difference between the two forms of representation is shown in Figure 5.7. Matrices are useful in systems modeling as they can represent the presence or absence of a relationship between pairs of elements in a system. It provides a mapping of the tasks and allows a detailed analysis of a limited set of elements in the context of the overall structure. Reading along a specific row reveals which tasks receive information from the task corresponding to that row (**DSM 2009b**).

The way to „read" the matrix is:

- Task A transfers information to Task C,
- Task B transfers information to Task C.

If the arrow would have been positioned the other way around, then the following relations would have been valid:

- Task C transfers information to Task A,
- Task C transfers information to Task B.

There are three types of configuration possibilities of the interrelations between tasks (**Eppinger 2002**) (see Figure 5.8):

- Parallel
- Sequential
- Coupled

The *parallel* configuration shows that the tasks are independent on each other (example: between tasks A and K there is no information flow). The *sequential* configuration shows the information flow is unidirectional between two tasks (example: task C receives information from task B). In the case of *coupled* tasks the information flow is dual, coming from both start and end task (example: task H receives information from task E, task D receives information from task E and task D gives back information to task H). The user can set the direction of the information flow (so the direction of the arrow) as he likes it.

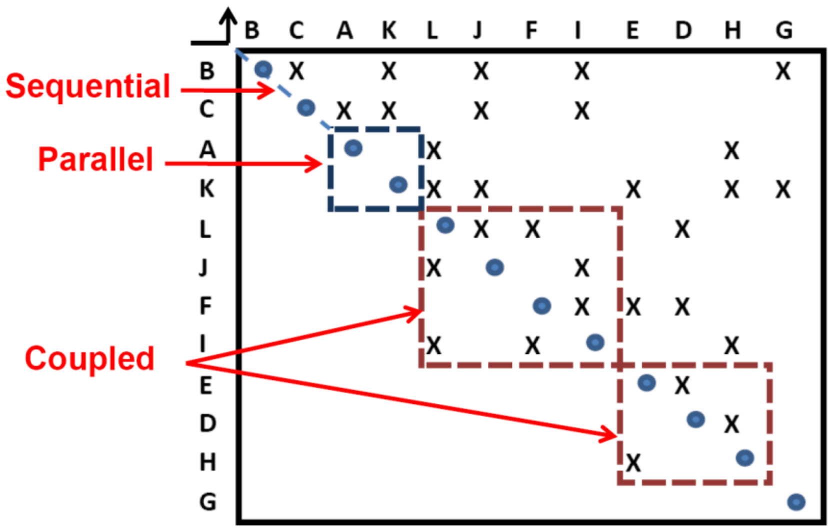

Fig. 5.8 Configuration possibilities of the interrelations between tasks (adapted from **Eppinger 2002**)

The complexity of the matrix representation approach for illustrating processes consists of identifying the elements of the system and the relations between them. The elements together with the corresponding relations form domains. A DSM cannot contain more than one domain; however the representation of more DSM‟s can be coupled into one matrix, called Multiple Domain Matrix.

More than one hundred processes have been identified as belonging to the phases briefly presented earlier. In the case of such complex systems three variants can be adopted for use:

1) *Coarse Matrix* - showing only the main phases and the relations between them,
2) *Fine Matrix* - showing the relation between all tasks,
3) *Hierarchical Matrix* - as a combination between the two, but more interface friendly, allowing the visualization of relations between all tasks, but not in detail.

The list of processes can be fed into DSM tools for further optimization. Having the relations between the processes, and the way to visualize the feedback loops, algorithms, like partitioning, clustering or triangularization, can be applied in order to minimize the delays and the waiting times. However this TN aims only to present the relation chain between tasks, while the optimization is kept as a subject for later investigation (WP 3).

		1	2	3	4	5	6	7
Offer	1	1	X	X	X	X	X	X
Concept	2		2	X	X	X	X	X
Definition	3		X	3	X	X	X	X
Design	4			X	4	X	X	X
Adjustment	5					5		
Certification	6				X	X	6	X
Handover	7					X		7

Fig. 5.9 Coarse DSM Matrix

Figure 5.9 shows the coarse matrix. The reading direction is upwards. Therefore the interpretation is:

- Each phase delivers information downstream in a feed-forward sense.
- The Offer Phase gives information to all other phases, becoming the initial condition for conducting the design work.
- Between Design and Definition phases the information flows upstream as feedback, due to the existing x mark under the main diagonal.
- Certification is a process giving feedback especially to Design.
- The Adjustment phase receives information from all phases

Instead of using an X mark, the relations can be quantified and numerical DSMs can be generated. Relations of minor importance can be neglected and feedback loops reduced. The algorithms mentioned earlier are explained in **DSM 2009a** and **DSM 2009b**, where research and commercial tools are recommended for use.

Meaningful for WP 1 is to list the processes and sub-processes, without yet considering the optimal relations between them. This is the task of WP 3. A matrix filled with „x" signs marking the direction of the information flow, would look like in Figure 5.10.

Figure 5.10 presents the hierarchical matrix, obtained from the fine matrix. The fine matrix makes the reading difficult, therefore the hierarchical matrix is useful to see the overall display and feedback loops rather between phases and not between particular processes. For elaborating the fine matrix behind the hierarchical matrix, an Excel Program available in **DSM 2009b**, allowing also the partitioning of the matrix, has been used.

Figure 5.10 shows the phases, the corresponding tasks, and the relations between them. We can notice the similarities between the course matrix and the hierarchical matrix. Where the big X marks have not been drawn, the connection between the processes is considered to be small enough as to neglect the information flow between the processes and to consider them independent.

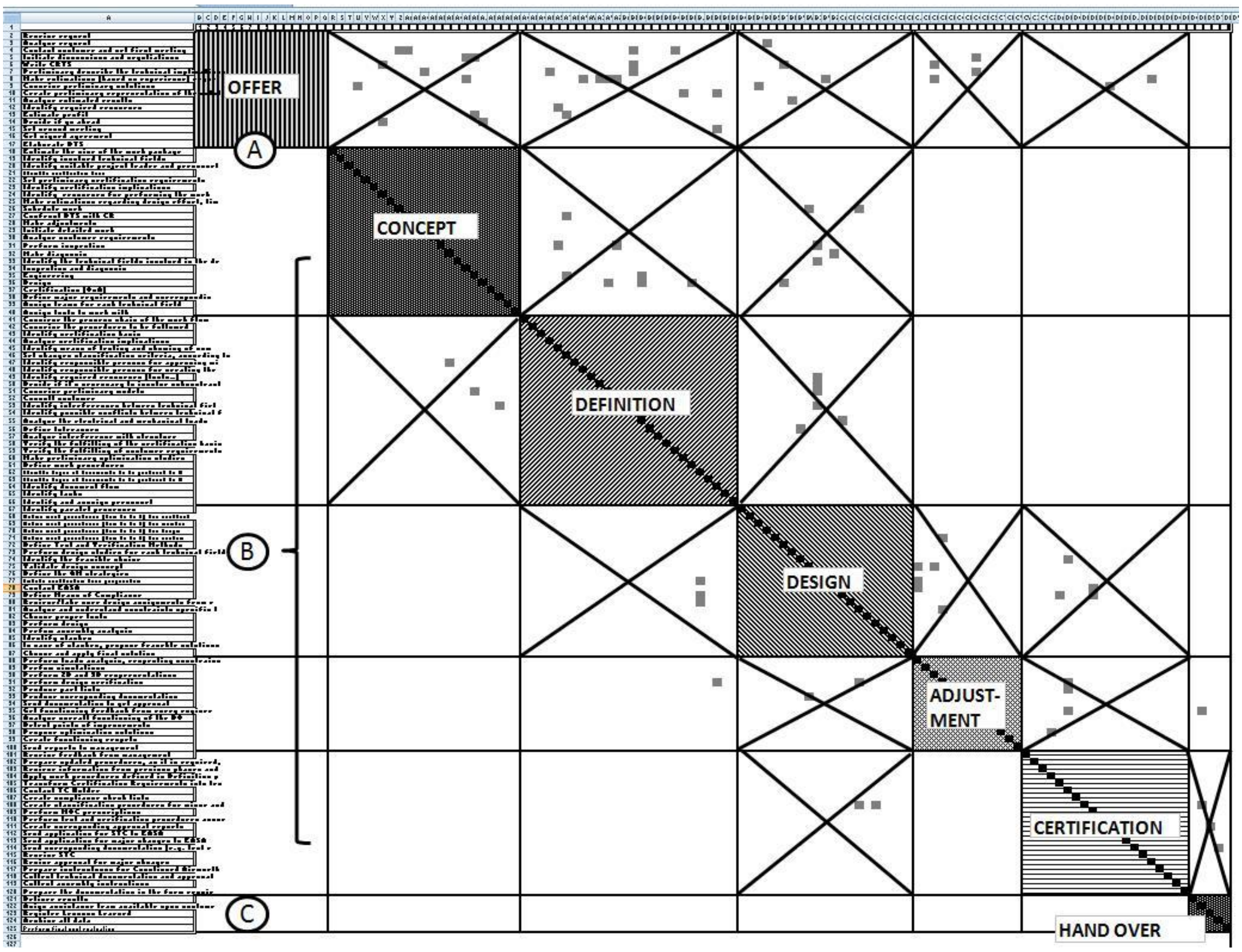

Fig. 5.10 Hierarchical DSM Matrix for cabin refurbishing processes at ELAN

The process of completing the matrix is iterative. First the field must be filled in with dots marking the relation between processes/direction of information flow. Next the dots under the diagonal (if the arrow has an upwards direction, like in Figure 5.9) must be moved, close to or above the diagonal, by clustering, triangularization or other suitable procedures. As mentioned, part of WP is only to list the processes, while optimization studies require in depth analysis, and expert interviews. The process chain is designed having in mind the future requirements (i.e. optimization). It makes sense, therefore, to present already what is to be expected from WP3.

The *triangularization* is suitable when the purpose is to reduce feedback flows (that is for instance time, which is important for the case treated by this TN). But this is the case only for time-based processes. If it must be dealt with design activities (teams or design components), the goal changes into finding subsets of DSM elements (i.e. clusters or modules) that are mutually exclusive or minimally interacting subsets, i.e. clusters as groups of processes that are interconnected among themselves to an important extent while being little connected to the rest of the system. The procedure is called *clustering*. An example of a situation when clustering is needed is: when the number of people working on a project and the relations between them are known and set into a matrix and the purpose is to see which of them should work together in a team (**DSM 2009b**).

The DSM is not just a method of representation but it gives the possibility to optimize the processes, especially regarding *time efficiency* and also *consistency* of some of the processes. The partitioning algorithm (or trianglularization) for a simple matrix can follow these steps:

- Identify elements which do not receive information from the others (by looking for empty columns) and move them to the left.
- Identify elements which do not give information to the others (by looking for empty rows) and move them to the right.
- If after steps 1 and 2 there are no remaining elements in the DSM, then the matrix is completely partitioned; otherwise, the remaining elements contain information circuits, for their determination special algorithms exist.

For complex systems, tools were developed to automate the procedure.

Besides telling that two elements depend on each other and how, as it is the case in binary matrices, it is possible to quantify the „strength" of the relationships, through the representation with numerical matrices.

The more scientific approach, combining linear algebra with design management is the eigen structure analysis, as a method of the numerical matrices. It calculates the remaining work after each iteration and analysis the significance of the eigen values and eigen vectors: therefore it identifies for the management the tasks which are more demanding regarding time consumption.

It can be concluded that process modeling requires scientific input and research. The success of the method, however, depends on finding real world information with enough *accuracy*

Another observation is that the type of information fed into the matrix needs a corresponding optimization method. It can make more sense to split the processes into groups and afterwards connect the DSM into a Multiple Domain Matrix.

For the tasks representation in cabin conversion and refurbishing, for ELAN, the following steps were followed:

- ELAN engineers were interviewed.
- Different sources of data were analyzed (ELAN, Airbus, V-Plane, internet).
- A list of tasks was created.

The following steps are still to be accomplished and their importance is vital for the correct representation. These are however part of WP 3:

- further analysis of the relations between tasks,
- further interviewing the ELAN engineers,
- receiving and analyzing the feedback information from ELAN,
- further detailing the tasks.

5.4 The Elements of the Process Chain

The identified processes, corresponding to each phase, are listed in Figures 5.12, 5.13, 5.14, 5.15, 5.16, 5.17 and 5.18. Marked in red are those processes related to certification. As mentioned, the certification of the design must begin as early as possible, so to prevent design failures and delays.

Each process can be called out by means of the code. The coding of the processes showed here is a simple one, corresponding to the limited number of processes aimed to be described in the preliminary phase of the CARISMA project (WP1). For a complete description, the QM division should choose a suitable coding system for the process maps, able to ease the manipulation while providing basic information about the processes.

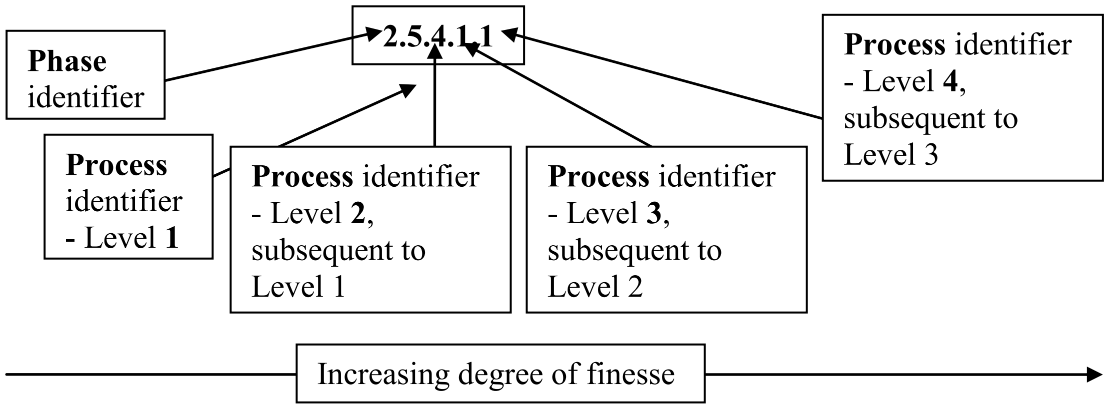

Fig. 5.11 Coding system used for the preliminary identified process illustration

1. OFFER		1.1	Receive request		
		1.2	Assign Offer Leader*		
		1.3	Analyze request		
		1.4	Contact customer and set first meeting		
		1.5	On the first meeting: initiate discussions and negotiations		
	+	1.6	Write CRTS (Customer Request Technical Sheet) in which:		
			1.6.1	Preliminary describe the technical implications	
			1.6.2	Make estimations (based on experience) regarding design effort, time, costs	
		1.7	Conceive preliminary solutions (for discussing it with the customer)		
		1.8	Create preliminary representation of the solutions found (with tools which fit the marketing function, i.e. Pacelab Cabin, Aircraft Scanner)		
	+	1.9	Make feasibility study		
			1.9.1	Analyse estimated results	
			1.9.2	Identify required resources	
			1.9.3	Estimate profit	
		1.10	Decide if go ahead; if yes, then:		
		1.11	Get signed agreement within a second meeting		
	+	1.12	Write DTS (Detailed Technical Sheet)		
			1.12.1	Estimate the size of the work package	
			1.12.2	Identify involved technical fields	
		+	1.12.3	Identify certification basis	
				1.12.3.1	Identify certification implications
				1.12.3.2	Set preliminary certification requirements
			1.12.4	Identify resources for performing the work	
			1.12.5	Make estimations regarding design effort, time, costs	
		1.13	Identify suitable project leader and personnel		
		1.14	Confront DTS with CR		
		1.15	Make adjustments		
		1.16	Send results further down (concept) in order for the work to be initiated		

Fig. 5.12 Process illustration: Offer Phase

2. CONCEPT		2.1	Analyze customer requirements
		2.2	Perform aircraft inspection
		2.3	Write document describing diagnosis
		2.4	Identify the technical fields involved in the design process*
	+	2.5	Initiate team organization for- and division of responsibilities between
		2.5.1	Engineering
		2.5.2	Design
		2.5.3	Certification (OoA)
	+	2.5.4	Quality Assurance
	+	2.5.4.1	for each technical field
		2.5.4.1.1	Avionics & Equipment
		2.5.4.1.2	Environmental Systems
		2.5.4.1.3	Electrical Systems
		2.5.4.1.4	Cabin Interior
		2.5.4.1.5	Monuments and other Equipment
		2.5.4.1.6	Emergency & Safety Equipment
	+	2.6	Plan the design & engineering process (by the Engineering and Design Office)
		2.6.1	Assign teams for each technical field
		2.6.2	Assign tools to work with
		2.6.3	Choose QM strategy (! Before defining processes)
		2.6.4	Concieve the process (what) chain of the work flow
		2.6.5	Conceive the procedures (how) to be followed
		2.6.6	Make optimization studies
	+	2.7	Plan the certification process (by Office of Airworthiness)
		2.7.1	Contact EASA and TC Holder
		2.7.2	Identify certification basis
		2.7.3	Analyze certification requirements
		2.7.4	Transform Certification Requirements into technical rules
		2.7.5	Identify means of testing and showing of compliance (MOC's)
		2.7.6	Set classification procedures for minor and major chnages according to EASA (AMC&GM Part 21)
		2.7.7	Send application for STC to EASA
		2.7.8	Send application for major changes to EASA
		2.7.9	Identify responsible persons for approving minor changes
		2.7.10	Identify responsible persons for creating the documentation to be sent to EASA for approval (for major changes)
		2.7.11	Verify the consistency of the certification basis
		2.8	Identify required resources and tools
		2.9	Decide if it's necessary to involve subcontractors
		2.10	Conceive preliminary models
		2.11	Consult/report to customer
		2.12	Verify the fulfilling of customer requirements
		2.12	Validate concept (regarding all aspects: work flow, work procedures, design…)

Fig. 5.13 Process illustration: Concept Phase

3. DEFINITION			
		3.1	Define the QM strategy and follow it when detailing the processes
	+	3.2	Organize work flow (who & what does)/Create Work Breakdown Structure
		3.2.1	Identify and asssign personnel
		3.2.2	Identify tasks
		3.2.3	Define work procedures, corresponding to the type of work
	+	3.2.4	Identify types of documents and document flow
	+	3.2.4.1	to be produced by Design Engineers:
		3.2.4.1.1	Enginnering Orders
		3.2.4.1.2	Instructions for installation und assembly
		3.2.4.1.3	Appendices to CMM (Component Maintenance Manual)
			and AMM (Aircraft Maintenance Manual)
	+	3.2.4.2	to be produced by Airworthiness Engineers:
		3.2.4.2.1	Documents for showing compliance
		3.2.4.2.2	Approval documents
		3.3	Identify parallel processes and prescribe the parallel process performing
		3.4	Schedule work
	+	3.5	Define work procedures (how to do it) for
		3.5.1	Certification
		3.5.2	Monitoring
		3.5.3	Design
		3.5.4	Quality Assurance
		3.5.5	Relation with subcontractors
	+	3.6	Define the design concept
	+	3.6.1	Perform design studies for each technical field
		3.6.1.1	Identify interferences between technical fields
		3.6.1.2	Identify possible conflicts between technical fields
		3.6.2	Identify the feasible choice
		3.6.3	Validate design concept
	+	3.7	Prepare Certification
		3.7.1	Define Test and Verification Methods, according to the MOC's and specific
			for the type of design
		3.7.2	Create compliance check lists

Fig. 5.14 Process illustration: Definition Phase

4. DESIGN			
		4.1	Recieve and understand design assignments from responsible person (Chief of Design)
	+	4.2	Analyze and understand constraints specific to the design:
		4.2.1	Certification constraints
		4.2.2	Customer constraints
		4.2.3	Design limits
		4.3	Optimize tool selection (already indicated in concept phase, but also in concept phase)
	+	4.4	Perform design, including:
		4.4.1	Perfom simulations
		4.4.2	Perform 2D and 3D respresentations
	+	4.5	Perform design analysis and verification (Design Verification Engineer-DVE)
		4.5.1	Analyze the electrical and mechanical loads
		4.5.2	Analyze interference with structure
		4.5.3	Define tolerances
		4.5.4	Perfom assembly analysis
		4.5.5	Identify clashes
		4.5.6	In case of clashes, propose feaseble solutions
		4.5.7	Choose and apply final solution
	+	4.6	Perform design analysis and verification (Compliance Verification Engineer-CVE)
		4.6.1	Confrunt results of the DVE with the prescriptions from MOC's
		4.6.2	Report uncompliance back to the DVE
		4.7	Choose and apply final solution (after receiving feedback from CVE)
		4.8	Produce part lists
		4.8	Produce coresponding documentation (as described in the definition phase)
		4.10	Send documentation to get approval (to the OoA)

Fig. 5.15 Process illustration: Design Phase

5. CERTIFICATION		5.1	Receive documentation to be approved
	+	5.2	Perform test and compliance verification procedures according to MOC
		5.2.1	for each component
		5.2.2	for the assembled components
		5.3	Create coresponding approval reports
		5.4	Send coresponding documentation (e.g. test results) to EASA (for major chnages)
		5.5	Approve minor changes under the DO priveleges
		5.6	Receive STC
		5.7	Recive approval for major chnages
		5.8	Prepare instructuons for Continued Airworthiness

Fig. 5.16 Process illustration: Certification Phase

6. HAND OVER	6.1	Collect technical documentation and approval documents
	6.2	Collect assembly instructions
	6.3	Prepare the documentation in the form required by the customer
	6.4	Deliver results
	6.5	Asign assistance team available upon customer request
	6.6	Register Lessons Learned
	6.7	Archive all data
	6.8	Perform final cost evaluation

Fig. 5.17 Process illustration: Hand-Over Phase

7. ADJUSTMENT	7.1	Get functioning feedback from every engineering department
	7.2	Analyze overall functioning of the DO
	7.3	Detect points of improvement
	7.4	Propose optimized solutions
	7.5	Create functioning reoprts
	7.6	Send reports to management
	7.7	Receive feedback from management
	7.8	Prepare updated procedures, as it is required, after reciveing instructions from management

Fig. 5.18 Process illustration: Adjustment Phase

5.5 Example of Cabin Modification

In addition to complete conversions, modifications to aircraft cabins can also be conducted within a Completion Center. In Figure 5.19 an example of partial modification is shown, starting from the customer request, up to delivery. Due to the smaller number of processes, a direct representation is chosen.

After the negotiations taking place in the Offer Phase, the requirements from the customer find an answer in the Documented Technical Solution (DTS). The Delegated Team (DT) can draw the preliminary conclusion towards the classification of change. The DTS will be part of the Change Proposal (CP). The CVE will receive and analyze the CP, and will approve by signing the CAS (Change Approval Sheet), if the change is minor; if the change is major EASA involvement for approval is required. The approved Change Proposal forms the SB (Service Bulletin), which, together with the part lists and kits, as well with the maintenance and continuing airworthiness instructions, forms the deliverable, which goes to the customer.

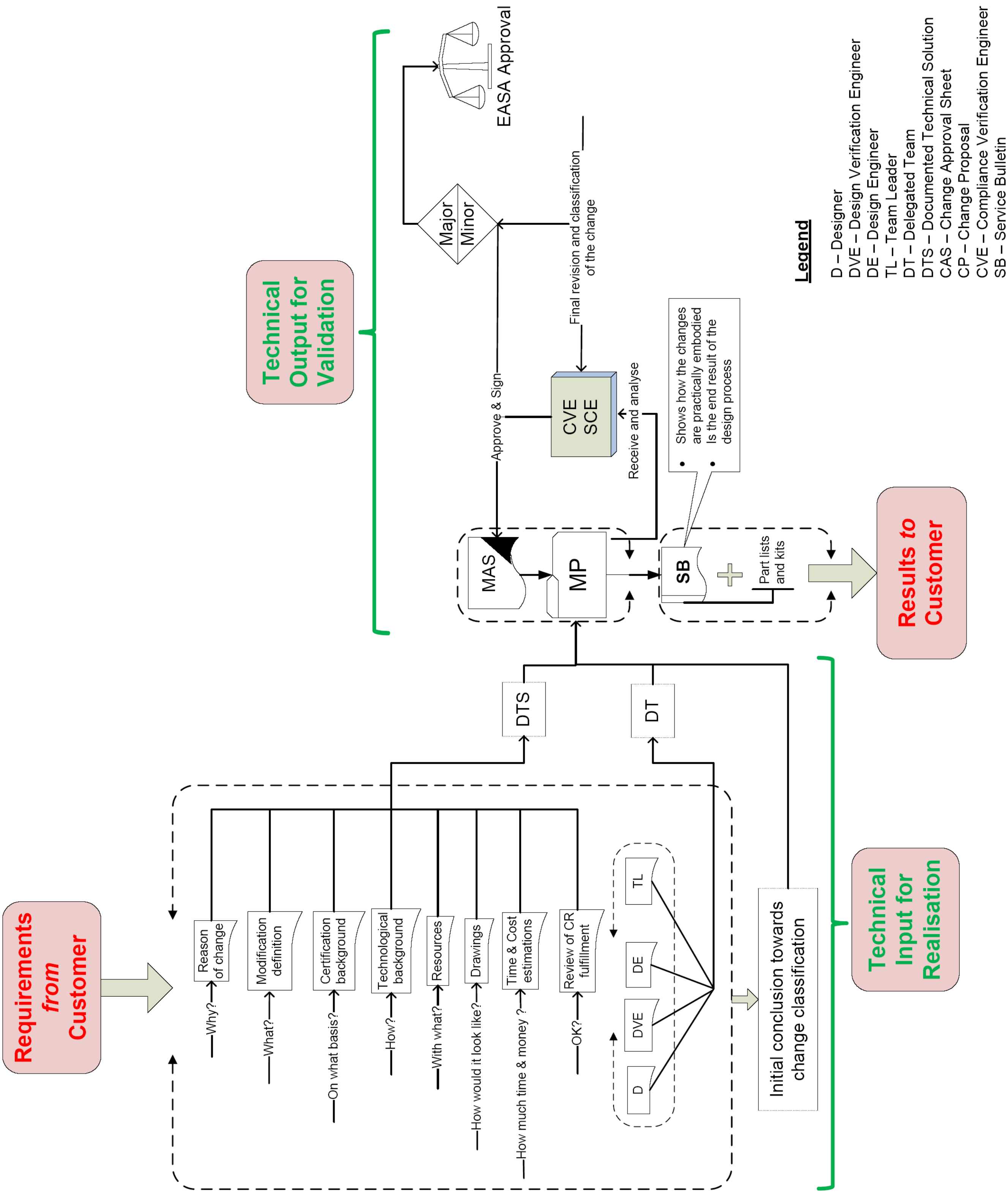

Fig. 5.19 Process Chain description for a partial cabin conversion example

6 Recommended Tools and Strategies for Completion Centers

6.1 Management Tools and Strategies

This paragraph briefly presents a selection of tools and strategies which can be implemented for achieving the quality expectations.

1.) Concurrent Engineering

The *Concurrent Engineering* concept is suitable for optimizing design cycles, especially in the preliminary phases. In this chapter the processes behind an airworthy design are going to be described, whether it is for a complete cabin design or the design of a cabin modification. Optimizing a process chain of a complex system, like a Completion Center, means looking to minimize the errors. Using a concurrent engineering approach, for example by developing parallel design tasks, is helpful in minimizing errors. Here, the concept is briefly presented. Later on it is applied for describing the process chain within the Completion Center.

The Concurrent Engineering can be defined in contrast to the „Waterfall Model". While the Waterfall Model uses a sequential approach in the design process of a product, the Concurrent Engineering takes into account all the elements of the life cycle of the product at an early stage and in the same time (or concurrently). Therefore, processes like establishing requirements, creating and running computational models or testing the product are optimized through the iterative design approach (**Zha 2002**).

Some of the driving characteristics of this concept are:

- Parallelization of the design tasks,
- Early design reviews,
- Proper software tools, allowing adaptation of the design in an early phase,
- Good communication among the engineering team.

To achieve the results which come along with the implementation of Concurrent Engineering, it is necessary to create a specific design environment. An example of an organization using the principles of this concept is the European Space Agency (ESA). The ESA has created a Concurrent Design Facility (CDF), where the future space missions are being studied before the development phase begins (**ESA 2009**). Another organization using this concept is the DLR, with the same purpose of conducting studies in the preliminary phases of the design. Their facility is called Concurrent Engineering Facility (CEF) (**DLR 2009**).

The design environment in such a Concurrent Engineering Facility should allow efficient data interchange and communication between the engineers responsible for different tasks. Therefore, it should be modeled through at least the use of (**ESA 2009**):

- an array of design stations equipped with Hardware and Software tools suitable for each discipline,
- video conferencing equipment,
- access to Knowledge databases.

The concurrent engineering concept applied in such a design facility proves its efficiency in the early phases of the design, by integrating the perspectives of all design phases. In cabin refurbishing, for example, it is important to consider the certification requirements already in the preliminary discussions (**V-Plane 2009**). The consequence is reducing later modifications and delays in the end phases of the cabin design.

The process description proposed in this chapter takes into account the benefits of the concurrent engineering applied to cabin redesign within a Completion Center.

2.) Data Management System

Elements used in the integrated and collaborative product development can be selected and used for managing a Completion Center. The DO, according to EASA, needs to bring together several organizational systems: the Engineering & Design System, the Monitoring System, the Design Assurance System or Compliance Assurance System (Office of Airworthiness). Collaboration in this context would be the main way to allow team members to manage the processes, to ensure the consistency of the information and to ease the data exchange. In parallel to a concurrent tasking approach, cooperation becomes a tool for ensuring the unification of the systems, and their proper functioning, satisfying the requirements from EASA.

The notion *Engineering Data Management* (EDM) is a tool used for such cases, when collaborative work is required to unify several systems with the purpose of an optimal functionality (**Dustdar 2003**). Some basic requirements with respect to data management would need to consider the following abilities of the DMS (**Nguyen 2008**):

- to store and retrieve data throughout the entire life cycle,
- to use standardized data,
- to provide data associativity and data linking,
- to allow the access of the process flows and process connections.

For achieving a process harmonization, leading to optimal results, **Nguyen 2008** considers that 3 issues need to be approached:

- activity scheduling and synchronization,
- workflow control,
- enabling concurrent engineering and collaborative design.

3.) Fault-trees and Fishbones

A local strategy, aimed for the design engineers and project managers, highly used in aerospace in order to analyze faults and examine risk, is the use of fault trees and Ishikawa fishbones.

Usually these are the strategies used in aerospace for qualitative cause and effect analysis (**Flouris 2008**):

- Ishikawa fishbones
- Failure mode and effect analysis (FMEA)
- Risk classification matrices
- Failure mode and effect criticality analysis (FMECA)

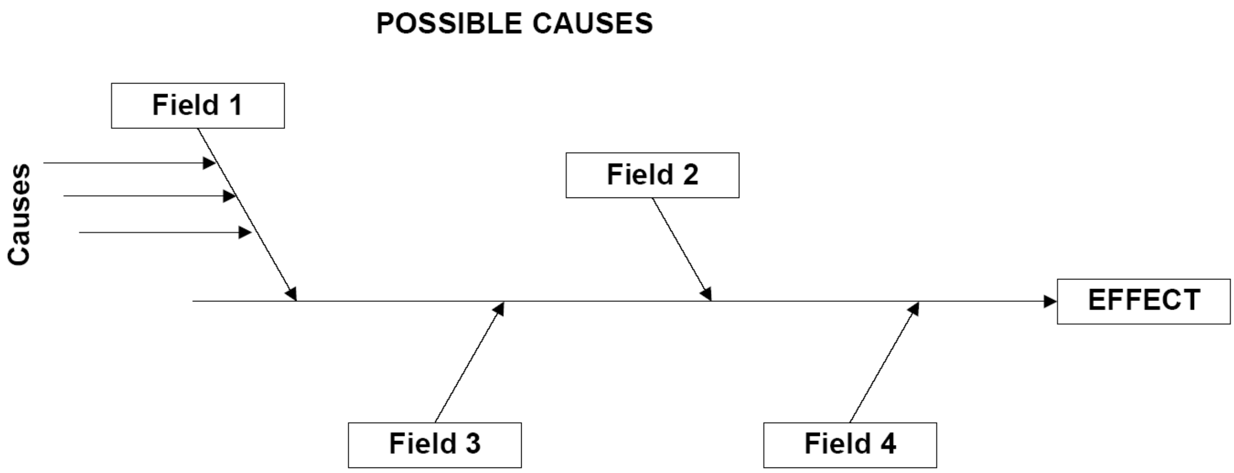

Fig. 6.1 Structure of an Ishikawa fishbone

Ishikawa fishbones (Figure 6.1) can be used to analyze failures or poor performance in project organization; in order to build it, the manager starts thinking about the effect and then looks back for possible causes (**Flouris 2008**).

The FMEA, contrary to the fishbone analysis, starts by considering possible risk events (failure modes) and then attempts to predict all their possible effects. A FMEA can be structured as in Table 6.1, but can contain hundreds of items when the system to be analyzed has a high degree of complexity. The last column includes actions that could diminish or prevent damage.

Table 6.1 Structure of a FMEA

Item		Failure Mode	Cause of failure	Effect	Recommended pre-emptive action
1	Name				
2	Name				

The risk classification matrix comprises of nine sections. The risk is not evaluated numerically (like in the case of FMEA) (see Figure 6.2) (**Flouris 2008**).

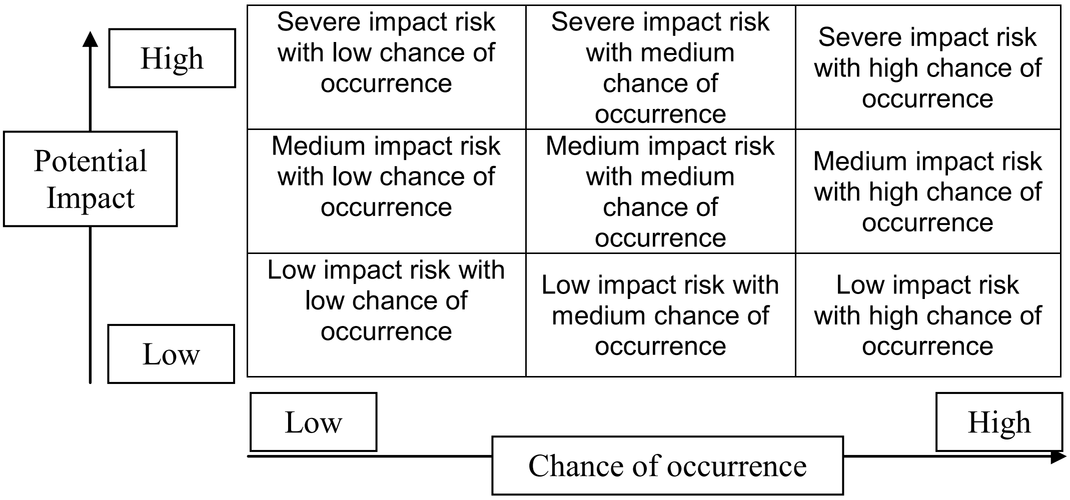

Fig. 6.2 Risk classification matrix

The FMECA is a FMEA which allows the risk quantification as well. Numbers from 1 to 5, expressing the degree of significance are included in the chart (5 indicates the highest degree of significance). Once the items are quantified, a total ranking column is completed, and the items can be rearranged so that the activities with the highest risk come on top of the list (see Table 6.2) (**Flouris 2008**).

Table 6.2 Structure of a FMECA

Item		Failure Mode	Cause of Failure	Effect	Chance	Severity	Detection difficulty	Total Ranking
1	Name				A1: 1 to 5	B1: 1 to 5	C1: 1 to 5	A1xB1xC1
2	Name				A2: 1 to 5	B2: 1 to 5	C2: 1 to 5	A2xB2xC2

4.) Work Breakdown Structure

The FMEA and WBS have been already briefly mentioned. Their importance is proven however to be high in design and engineering, that is the reason they were here included.

The WBS is a logical, hierarchical tree of all the tasks needed to complete a project (**Flouris 2008**). The WBS is organized in layers; the number of layers expresses how detailed the tasks are described (see Figure 6.3). For very small projects the work breakdown can be comprised of a tasks list. But even if it‟s small or large, every project should have one (**Devaux 1999**):

> *If I could wish but one thing for every project, it would be a comprehensive and detailed WBS. The lack of a good WBS probably results in more inefficiency, schedule slippage, and cost overruns on projects than any other single cause. When a consultant is brought in to perform the role of ‚project doctor‟, invariably there has been no WBS developed. No one knows what work has been done, nor what work remains to be done. The first thing to do is assemble the planning team and teach them how to create a WBS.*

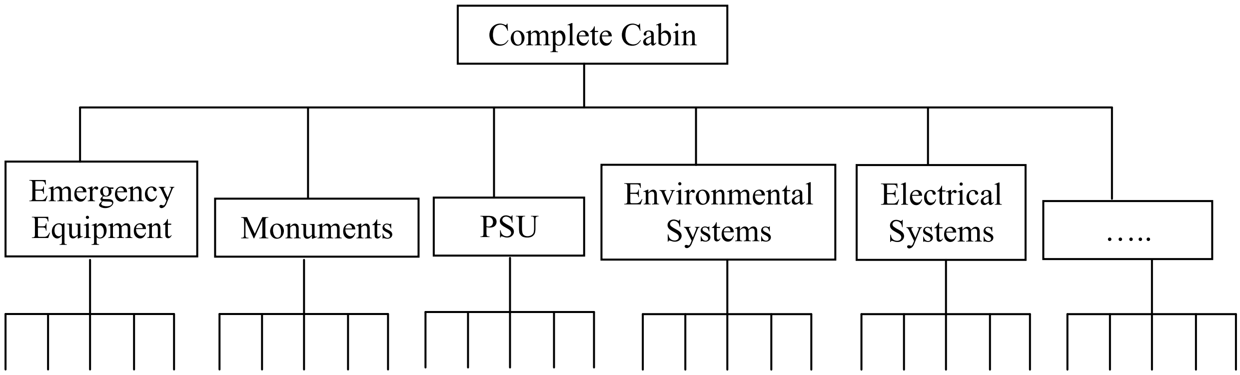

Fig. 6.3 Example of WBS for cabin design/redesign, showing that the WB uses as many levels as necessary

5.) Coding Systems

Usually it is not sufficient to name the tasks inside of any type of process representation. In order to locate a process inside the process chain coding systems are helpful.

The enabling of a coding system should bring the advantage of indicating short and precise data with respect to a specific item (an activity, a processes or documents).

It can be the case that the customer requires the use of their coding system, as it is the case with the Airbus coding system for drawings, used also by ELAN.

An example of a coding system was adapted from **Flouris 2008** in Figure 6.4.

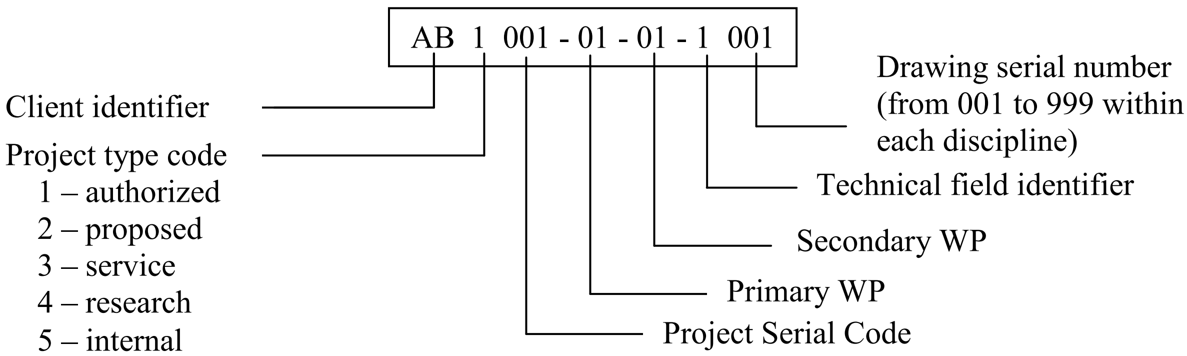

Fig. 6.4 Example of coding arrangement (adapted from **Flouris 2008**)

6.) Joint Venture

To adapt to the fluctuations of the economy, symbiotic relations can be fruitful. The reasons to form joint venture relations can have different reasons, besides economical downturns, but the purpose is always to come out with a win-win situation. Between ELAN and V-Plane such a relation has been established and the cooperation for a specific project has begun. Figure 6.3 shows an example of a joint venture organization, based on which any project could be conducted.

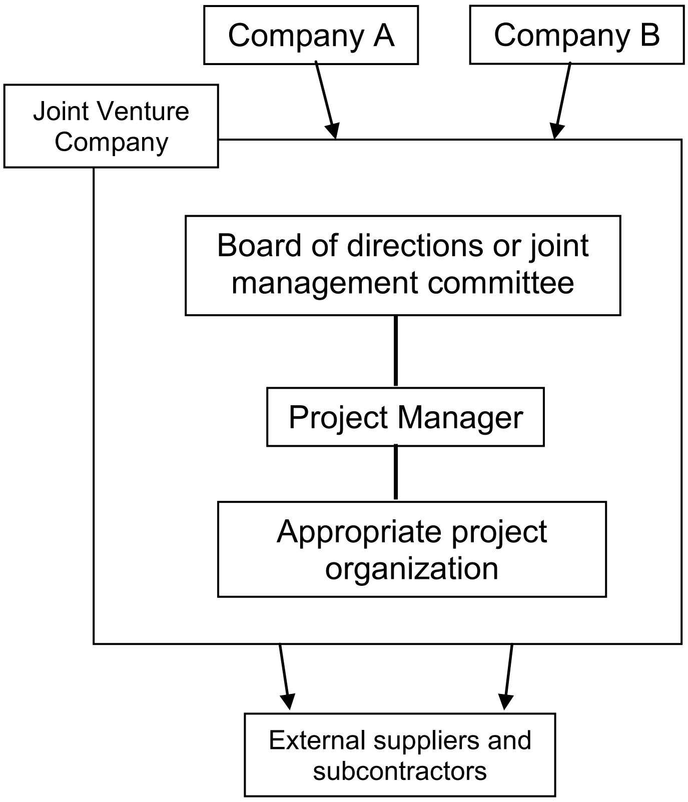

Fig. 6.5 One form of a joint venture organization (**Flouris 2008**)

6.2 Technical Documentation Tools and Strategies

1.) The Use of S1000D Standard

The S1000D is an international standard for creating technical documentation. This specification was initially developed by AeroSpace and Defence Industries Association of Europe (ASD), and later jointly by ASD, Aerospace Industries Association of America (AIA), and the Air Transport Association of America (ATA). The idea of this standard was launched as an extension of ATA 100. It utilizes a Common Source Database for automating processes and helping the user to administrate data modules (see next paragraph) (**S1000D 2009a**).

The S1000D standard requires a document to be broken down into individual data items which can be marked with individual XML labels, and be part of a hierarchical XML structure, designed specifically for each different knowledge domain. This permits the updating of single data items without necessarily changing the path down the XML tree which points to them. Knowledge so partitioned and classified can therefore be shared among many publications, and updating of items in the underlying S1000D (XML) document will automatically affect updating of the dependent publications (**S1000D 2009c**).

The standard is developed, controlled and maintained under the supervision of the *Steering Committee* formed by members coming from government and aviation industry, as well as from defense land and sea industry. The Steering Committee manages working groups addressing either the review and development process of the standard, through the *Production and Publishing Working Group (PPWG)* or the rapid development of information technology, through the *Electronic Publications Working Group (EPWG)* (**S1000D 2009b**).

2.) Interactive Electronic Technical Manual

A special form of the technical documentation is the electronic technical documentation. The data linkage or the issuing process of the documents needs the use of a Common Source Database as well. An IETM can be designed as a portal for managing technical documentation. The main advantage would be the ease manipulation of a large amount of information. Such a system is designed for interactive display by means of a computer controlled EDS.

Specifications regarding requirements governing the creation and development of IETMs and associated presentation software are contained in standards. An example of such a standard is MIL-PRF-87268A from 1 October 1995 (**MIL-PRF 1995**).

Such a system could be adapted for the use inside a Completion Center, for administrating the data, either technical information or internal procedures.

7 Conclusions

Several aspects must be considered when setting up a Completion Center, inside which cabin design and conversion is made possible for others then the aircraft manufacturers (or TC holders):

1. The organizational aspects, comprising of procedures and approvals, for creating the environment towards developing a compliant design,
2. The tools for designing, archiving and administrating data,
3. The infrastructure for performing the design and the required tests for showing compliance
4. The qualified personnel able to split all the responsibilities,
5. A way of representing processes and procedures inside DO which allows optimization,
6. A clear definition of the procedures for design and engineering activities,
7. The creation of a knowledge database from all possible sources.

Related to aspect 1, the frame is represented by an organization having a DOA. EASA asked the industry about its opinion on the DOA concept (see also Chapter 2.3.5). The questionnaire was evaluated by EASA and the following tendency was detected (**EASA 2009f**):

> *Cooperation of different OEMs (Original Equipment Manufacturer) and/or Suppliers will increase leading to the creation of "Centers of Excellence" that will specialize in certain systems/parts and provide design and development expertise for various international programs.*

If this tendency is considered, a remark to the DOA system would be: the Agency should provide proper discharge of certification capabilities, to the suitable organization, independent from its formal organization.

A formalized relationship between major partners is now however possible. The "Centers of Excellence" can be composed of (parts of) companies who (temporarily) join in a well defined manner for a single or for multiple projects.

Another observation is: partners and suppliers are more and more located outside the EU and the USA (e.g. India, China); in such areas, reliance on the DOA system alone may not provide the necessary airworthiness safeguards.

The Agency proposes other three possible future certification concepts, replacing DOA, each with pros and cons (**EASA 2009f**):

- Modular approach to certification – which would ensure a clear definition of responsibilities,
- Industry self certification – the safety would be provided under privileges and responsibility of the product developer,
- Third party certification – referring to outside agencies taking over the certification work; this would encourage the greater focus on improvement of resources and would also cause a costs reduction.

Related to the aspect 2, the pertinent observation is that the existing range of tools for drafting, for 2D and 3D representation, for quality management implementation, for administrating data and monitoring the design, must be tailored according to the needs and the scope of the design organization.

Aspects 3 and 4 involve investments; therefore feasibility studies must be performed in order to see if the Completion Center represents a business case for the engineering office wanting to perform cabin design and conversion.

Aspect 5 draws attention to the importance of the Quality and Management methodologies and strategies used for developing the „product" called cabin design and conversion. Investigations need to be conducted for choosing proper models. The success of an optimized system definition becomes more and more a key factor. Choosing the right model out of the large range of tools and concepts can make the difference in market shares.

Aspects 6 and 7 represent key factors for the successful functioning of the company and their fulfillment guaranties the capability of delivering a large palette of refurbishing scenarios.

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Appendix A

EASA Forms for Completion Centers

Behind every application for which EASA approval is required there is a standardized written Form. Based on such a Form the process of approval begins. When the Forms are sent to EASA, the person/organization applying must fulfill all the conditions written in the applicable regulations. Once EASA concludes that all the required conditions are fulfilled, the approval is given in the form of a certificate. The most important Forms needed inside a Completion Center, are:

- EASA Form 80: Application for Design Organization Approval (DOA)
- EASA Form 81: Application for Alternative Procedures to Design Organization Approval (ADOA)
- EASA Form 82: Application for Significant Changes to Design Organization Approval (DOA)
- EASA Form 4: Qualifications and Experience of Management Personnel within DO
- EASA Form 31: Application for Approval of Major Change / Major Repair Design
- EASA Form 32: Application for Approval of Minor Change / Minor Repair Design
- EASA Form 33: Application for Approval of Supplemental Type Certificate (STC)

Through an application a natural or legal person requests to benefit from the services provided by EASA, therefore must respect the regulation referring to applicable fees and charges: Commission Regulation (EC) No 593/2007 (**EASA 2009g**).

The term *fees* refers to the amounts payable by applicants to obtain, maintain or amend the certificates (Article 2 (a), **EASA 2009g**) referred to in Article 15 of Regulation (EC) No 1592/2002, in which DOA certificate, among others, is also included (**EASA 2009h**). The fees need to cover all the expenses involved by the certification tasks (Article 3, Paragraph 1, **EASA 2009g**) and consist of a flat amount and a variable amount payable by the applicant (Article 4 (a) and (b), (**EASA 2009g**).

The term *charges* refers to the amounts payable by applicants for services other than certification tasks (including the supply of goods) (Article 2 (b) and Article 10, Paragraph 1, **EASA 2009g**). All the amounts are paid in Euros.

Below, the Forms, as required by EASA, are included.

EASA Form 80

Issue 6, dated 05.01.2009

	European Aviation Safety Agency Application for Design Organisation Approval (DOA)

IMPORTANT NOTE: PLEASE FOLLOW THE INSTRUCTIONS AT PAGE 4
(ALL FIELD TITLES ARE HYPERLINKED TO THE INSTRUCTIONS)

1. Applicant

1.1 Applicant's Reference *(if applicable)* **1.2** Company Name **1.3** Company registration number **1.4** Address *(registered business & postal address, if different)* **1.5** Contact Person **1.6** Telephone **1.7** Fax **1.8** E-mail **1.9** Location(s)	
1.10 Financial Contact *(if applicable)* *1.10.1.* Complete Address *1.10.2.* Telephone *1.10.3.* Fax *1.10.4.* E-mail	

2. Scope of design

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

2.1 Product Type (1) **2.1.1. Activity (1)** **2.1.1.1. Technical fields (1)** **2.1.1.2. Technical fields (2)** **2.1.1.3. Technical fields (…)** **2.1.1.4. Technical fields (n)** **2.1.2. Activity (2)** **2.1.2.1. Technical fields (1)** **2.1.2.2. Technical fields (2)** **2.1.2.3. Technical fields (…)** **2.1.2.4. Technical fields (n)**	
2.2 Product Type (2) **2.2.1. Activity (1)** **2.2.1.1. Technical fields (1)**	

3. List of products (only for DOA applications related to TC and ETSOA for APU)

4. Limitations

5. Other information

6. Outline of data required under 21A.243

The applicant shall provide the draft handbook, or an outline, including company flow-charts and, as relevant, description and information on design activities and organisation of partners or subcontractors.

7. Agency's fees and charges

Applicants will be charged in accordance with the Commission Regulation (EC) No. 593/2007 of 31 May 2007 and any subsequent amendment, on the fees and charges levied by the European Aviation Safety Agency (http://www.easa.europa.eu/home/regul_fees_charges_en.html).

Applicants are required to supply a signed certificate from an authorised representative of the organisation concerned in order for EASA to determine the corresponding fee category.
(see required information in attachment 1)

In the case of withdrawal of the application, or other cases of interruption that qualify under Article 8(7) of Commission Regulation (EC) No 593/2007, EASA will recover the working hours already spent, up to an amount equal to the applicable flat fee. EASA will also recover, if applicable, the corresponding travel costs outside the territories of the EU Member States.

8. Applicant's financial details

EASA will only be able to return prepaid amounts if the attached THIRD PARTY FINANCIAL INFORMATION page is duly provided.

9. Applicant's declaration

I have accessed, read and agree to be bound by the Agency's Terms of Payment (available here: http://www.easa.europa.eu/ws_prod/g/doc/Regulation/Terms%20of%20payment%20July%202007.pdf).
Accordingly, I agree to pay the fees levied by EASA in respect of the issuance of a DOA certificate and am aware of the consequences of non-payment.

10. Signature

Date	Name of Chief Executive or Authorised Representative Printed Name	Signature

This Application, together with :

- a copy of the national Companies register,
- attachment 1 "Information required for calculation of fee category",
- attachment 2 "EASA third party financial information",
- the documents listed under § 6 above,

should be sent by fax, e-mail or regular mail to:

European Aviation Safety Agency
Applications and Procurement Services Department
Manager of the Organisations / Flight Standards Applications Management Section
Postfach 10 12 53
D-50452 Köln
Germany

Fax: +49 221 89990 9514
E-mail: doa@easa.europa.eu

INSTRUCTIONS

Information to be entered into application for DOA form:

The use of this form is required to enable EASA to process applications without undue delay. The individual fields of the application form may be varied in size to allow entry of all required information. It is strongly recommended to use the English language.

Note: all field numbers are hyperlinked to the corresponding form field

Field 1.1	Enter your reference (optional)
Field 1.2	Enter the name of the legal entity making the application
Field 1.3	Enter Company registration number and provide copy of national Companies register
Field 1.4	Enter complete registered business address and add postal address if different e.g. for mailing or billing purposes
Field 1.5 - 1.8	Enter name, telephone, fax and e-mail of contact person for this application
Field 1.9	Enter locations covered by this DOA application
Fields 1.10	Enter name, address, telephone, fax and e-mail of financial contact for this application
Fields 2	Identify the product type, the activity/ies for each product type and the related technical field(s) for each activity, in accordance with the lists 1 to 3, add lines as appropriate depending on number of activities and related technical fields; fill in a separate table (section 2.1-2.3) for each product type (copy and paste section as necessary)

Field 2.1

List 1 - Product types	• Large aeroplane
	• Small aeroplane
	• Sailplane/powered Sailplane
	• Very light aeroplane
	• Small rotorcraft
	• Large rotorcraft
	• Very light rotorcraft
	• Gyroplane
	• Airship
	• Balloon
	• Turbine engine
	• Piston engine
	• Auxiliary Power Unit
	• Propeller

Field 2.1.1

List 2 - Activity	
	• Type Certificates/ETSOA for APU
	• Supplemental Type Certificates/ETSOA for APU
	• Changes to type design by TC holders and continued airworthiness
	• Repairs
	• Minor changes only
	• Minor repairs only

Field 2.1.1.1

List 3 - Technical fields	
	• All (in case of Type Certificates)
	• Avionics
	• Installation of avionics equipment
	• Structure
	• Performance
	• Environmental systems
	• Hydro mechanical systems
	• Electrical systems
	• Cabin interiors
	• Galleys or other interiors equipment
	• Powerplant/Fuel system
	• Software
	• Transmissions
	• Noise
	• FADEC (Full Authority Digital Engine Control)
	• Non critical engine parts
	• Thrust reversers

Field 3 List all products for which TC application (or ETSOA for APU) is requested

Field 4 Specify as necessary appropriate limitations, such as :

- Software level
- Primary/Secondary structure
- Others (to be specified)

Field 5 Add information on schedule for Type Certificate, STC or other design approval

Field 6 See Annex Part 21 to Commission Regulation (EC) No 1702/2003 of 24 September 2003 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations (OJ L 243, 27 September 2003, p. 6), as last amended, which is available in all EU languages under the respective link of the EASA website: http://www.easa.europa.eu

Attachment to DOA application form

Information required for calculation of fee category
(cf. Explanatory Note of Annex to Commission Regulation (EC) No 593/2007)

Number of staff *(see Note 1 below)*			[Number of staff]
DOA Categories:	***Nature:***	***Cases:***	*[tick box, as appropriate]*
1A	Type Certificate applicant or holder of highly complex or large product(s)	• Large Aeroplanes • Small and Large Rotorcraft • UAVs (Large) • Turbine Engines	☐
1B	Type Certificate applicant or holder of complex or small-medium product(s) ETSOA APU (large)	• Small Aeroplanes • Very Light Rotorcraft • Gyroplanes • UAVs (small-medium) • Piston Engines • Large APU	☐
2A	STC / Changes / Repairs, unrestricted	Scope including at least structure, installation of avionics, hydro-mechanical systems, electrical systems, cabin interiors,	☐
1C	Type Certificate applicant or holder of less complex or very small product(s) ETSOA APU (small)	• Sailplanes, powered Sailplanes • Very Light Aeroplanes • Airships • Balloons • Propeller • Small APU	☐
2B	STC / Changes / Repairs, restricted (technical fields)	Scope with restricted technical fields	☐
3A	Minor Changes / Repairs, unrestricted	Scope including at least structure, installation of avionics, hydro-mechanical systems, electrical systems, cabin interiors,	☐
2C	STC / Changes / Repairs, restricted (aircraft size)	Scope limited to one category of product only	☐
3B	Minor Changes / Repairs, restricted (technical fields)	Scope with restricted technical fields	☐
3C	Minor Changes / Repairs, restricted (aircraft size)	Scope limited to one category of product only	☐

Date	**Name of Chief Executive or Authorised Representative**	**Signature**
	Printed Name	

Note 1: The number of staff should be calculated as follows, for all sites involved in design and certification activities under the approval:

All staff involved in:
- Managing the design organisation;
- Drawing, calculating, testing, simulating;
- Producing and verifying compliance documentation;
- Performing airworthiness office tasks;
- System monitoring.

In addition, for Design subcontractors, the following staff should be counted:
- All staff involved in producing compliance documents;
- All staff involved in verifying compliance documents;
- All staff involved in airworthiness office tasks;
- All staff involved in system monitoring.

Staff not working full time should be counted, with appropriate ratio.

See also http://www.easa.eu.int/home/cert_faq_en.html for more information on fees and charges

EASA THIRD PARTY FINANCIAL INFORMATION

	BANK ACCOUNT OWNER INFORMATION
	LAST NAME:
	FIRST NAME:
	ADRESS:
	CITY: POSTCODE:
	COUNTRY: VAT NUMBER:
	PHONE:
	E-MAIL:
	BANK ACCOUNT INFORMATION
	NAME OF THE BANK:
	ADDRESS OF THE BANK:
	CITY: POSTCODE:
	IBAN (MANDATORY): (International Bank account number)
	BIC/SWIFT CODE (MANDATORY):

STAMP AND SIGNATURE OF THE BANK REPRESENTATIVE:	SIGNATURE OF THE BANK ACCOUNT OWNER:
DATE:	DATE:

EASA Form 81

Issue 6, dated 05.01.2009

	European Aviation Safety Agency Application for Alternative Procedures to Design Organisation Approval (ADOA)

IMPORTANT NOTE: PLEASE FOLLOW THE INSTRUCTIONS AT PAGE 4

(ALL FIELD TITLES ARE HYPERLINKED TO THE INSTRUCTIONS)

1. Applicant

1.1 Applicant's Reference *(if applicable)* **1.2 Company name** **1.3 Company registration number** **1.4 Address** (registered business & postal addresses, if different) **1.5 Contact Person** **1.6 Telephone** **1.7 Fax** **1.8 E-mail** **1.9 Location(s)**	
1.10 Financial Contact (if applicable) ***1.10.1.* Complete Address** ***1.10.2.* Telephone** ***1.10.3.* Fax** ***1.10.4.* E-mail**	

2. Scope of application

This application is submitted in following context (please tick A or B):

☐ (A) It is the first application for the acceptance of the Alternative Procedures to DOA

☐ (B) It is an application subsequent to an update of the procedures as per one or more of the following reasons (please tick one or more of boxes 1, 2, and 3)

- ☐ (1) changes to the scope of work of the AP (e.g. new ETSO, additional technical fields, etc)
- ☐ (2) changes impacting the showing of compliance with Part 21 (e.g. change to the design practices, resources, sequence of activities, organization, etc)
- ☐ (3) changes, other than above, affecting the content of the previous EASA finding of compliance (e.g. company name, company address, handbook/procedures references, title or issue/date)

3. Scope of design

3.1 Eligibility		**3.2 Description of case**
☐ **TC**	*as per 21A.14(b)*	*name and category of product*
☐ **STC**	*as per 21A.112B(b) and GM 21A.112B(b)*	*description and products on which it applies*
☐ **Major repair**	*as per 21A.432B(b)*	*description and products on which it applies*
☐ **ETSO**	*as per 21A.602B(b)(2)*	*provide ETSO numbers and titles*

4. Reference of Procedures

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

5. Other information

6. Agency's fees and charges

Applicants will be charged in accordance with the Commission Regulation (EC) No. 593/2007 of 31 May 2007 and any subsequent amendment, on the fees and charges levied by the European Aviation Safety Agency (http://www.easa.europa.eu/home/regul_fees_charges_en.html).

In the case of withdrawal of the application, or other cases of interruption that qualify under Article 8(7) of Commission Regulation (EC) No 593/2007, EASA will recover all working hours already spent. EASA will recover, if applicable, the travel costs outside the territories of the EU Member States.

7. Applicant's financial details

EASA will only be able to return prepaid amounts if the attached THIRD PARTY FINANCIAL INFORMATION page is duly provided.

8. Applicant's declaration

I have accessed, read and agree to be bound by the Agency‟s Terms of Payment (available here: http://www.easa.europa.eu/ws_prod/g/doc/Regulation/Terms%20of%20payment%20July%202007.pdf). Accordingly, I agree to pay the fees levied by EASA in respect of the issuance of an EASA finding of compliance and am aware of the consequences of non-payment.

9. Signature

Date	Name of Chief Executive or Authorised Representative Printed Name	Signature

This Application, together with :

- a copy of the national Companies register,
- attachment "EASA third party financial information",
- the documents listed under § 3 above, if available,

should be sent by fax, e-mail or regular mail to:

European Aviation Safety Agency
Applications and Procurement Services Department
Manager of the Organisations / Flight Standards Applications Management Section
Postfach 10 12 53
D-50452 Köln
Germany

Fax: +49 221 89990 9514
E-mail: doa@easa.europa.eu

INSTRUCTIONS

Information to be entered into the application for alternative procedures to DOA form:

The use of this form is required to enable EASA to process applications without undue delay. The individual fields of the application form may be varied in size to allow entry of all required information. It is strongly recommended to use the English language.

Note: all field numbers are hyperlinked to the corresponding form field

Field 1.1	Enter your reference (optional) For application related to update of procedures, enter the EASA AP number (required)
Field 1.2	Enter the name of the legal entity making the application
Field 1.3	Enter Company registration number and provide copy of national Companies register
Field 1.4	Enter complete registered business address and add postal address if different e.g. for mailing or billing purposes
Fields 1.5 - 1.8	Enter name, telephone, fax and e-mail of contact person for this application
Field 1.9	Enter locations covered by this application for alternative procedures to DOA
Fields 1.10	Enter name, address, telephone, fax and e-mail of financial contact for this application
Field 2	Tick box A in case of first application; In case of application subsequent to any update of procedures: tick box B and one or more of boxes 1,2 , and 3
Field 3.1	Identify eligibility by ticking the related checkbox and indicate which case applies
Field 3.2	add description of case indicated under 2.1. Categories to be used are the categories described in 21A.14(b).
Field 4	If available, provide the procedures; add rows if necessary
Field 5	Add information on schedule and application reference for Type Certificate, STC, ETSO or other design approval. Add information on existing Type Certificate, STC, ETSO or other design approvals.

EASA THIRD PARTY FINANCIAL INFORMATION

BANK ACCOUNT OWNER INFORMATION	
	LAST NAME:
	FIRST NAME:
	ADRESS:
	CITY: POSTCODE:
	COUNTRY: VAT NUMBER:
	PHONE:
	E-MAIL:
BANK ACCOUNT INFORMATION	
	NAME OF THE BANK:
	ADDRESS OF THE BANK:
	CITY: POSTCODE:
	IBAN (MANDATORY): (International Bank account number)
	BIC/SWIFT CODE (MANDATORY):

STAMP AND SIGNATURE OF THE BANK REPRESENTATIVE: DATE:	SIGNATURE OF THE BANK ACCOUNT OWNER: DATE:

EASA Form 82

Issue 6, dated 05.01.2009

European Aviation Safety Agency

Application for Significant Changes to Design Organisation Approval (DOA)

IMPORTANT NOTE: PLEASE FOLLOW THE INSTRUCTIONS AT PAGE 4

(ALL FIELD TITLES ARE HYPERLINKED TO THE INSTRUCTIONS)

11. Applicant

11.1 Applicant's Reference *(if applicable)* **11.2** Company Name **11.3** Company registration number **11.4** Address *(registered business & postal address, if different)* **11.5** Contact Person **11.6** Telephone **11.7** Fax **11.8** E-mail **11.9** Location(s)	
11.10 Financial Contact *(if applicable)* ***11.10.1.*** Complete Address ***11.10.2.*** Telephone ***11.10.3.*** Fax ***11.10.4.*** E-mail	

12. Identification of significant change(s)

12.1 Changes to the organisation (ref. 21.A247 and GM 21A.247)

12.2 Changes to the scope

12.2.1. Product Type (1) **12.2.1.1. Activity (1)** **12.2.1.1.1. Technical fields (1)** **12.2.1.1.2. Technical fields (2)** **12.2.1.1.3. Technical fields (…)** **12.2.1.1.4. Technical fields (n)** **12.2.1.2. Activity (2)** **12.2.1.2.1. Technical fields (1)** **12.2.1.2.2. Technical fields (2)** **12.2.1.2.3. Technical fields (…)** **12.2.1.2.4. Technical fields (n)**	
12.2.2. Product Type (2) **12.2.2.1. Activity (1)** **12.2.2.1.1. Technical fields (1)**	

12.3 Changes to the list of product types

12.4 Changes to limitations

12.5 Changes to the privilege(s)

12.6 Changes to staff number and/or DOA category

Fill in table at page 6, as relevant.

13. Other information

14. Outline of data required under 21A.243

The applicant shall provide the draft revised handbook, or an outline, with the information related to the significant changes, including company flow-charts and, as relevant, description and information on design activities and organisation of partners or subcontractors.

15. Applicant's declaration

I have accessed, read and agree to be bound by the Agency"s Terms of Payment (available here: http://www.easa.europa.eu/ws_prod/g/doc/Regulation/Terms%20of%20payment%20July%202007.pdf). Accordingly, I agree to pay the fees levied by EASA in respect of any surveillance activities related to my DOA certificate and am aware of the consequences of non-payment.

16. Signature

Date	Name of Chief Executive or Authorised Representative Printed Name	Signature

This Application together with a copy of the national Companies register and the documents listed under § 4 above should be sent by fax, e-mail or regular mail to:

European Aviation Safety Agency
Applications and Procurement Services Department
Manager of the Organisations / Flight Standards Applications Management Section
Postfach 10 12 53
D-50452 Köln
Germany

Fax: +49 221 89990 9514
E-mail: doa@easa.europa.eu

INSTRUCTIONS

Information to be entered into application for significant changes to DOA form:

The use of this form is required to enable EASA to process applications without undue delay. The individual fields of the application form may be varied in size to allow entry of all required information. It is strongly recommended to use the English language.

Note: all field numbers are hyperlinked to the corresponding form field

Field 11.1 Enter your EASA DOA number

Field 11.2 Enter the name of the legal entity making the application

Field 11.3 Enter Company registration number and provide copy of national Companies register

Field 1.4 Enter complete registered business address and add postal address if different e.g. for mailing or billing purposes

Fields 11.5 - 11.8 Enter name, telephone, fax and e-mail of contact person for this application

Field 11.9 Enter locations covered by this application for significant changes to DOA

Fields 1.10 Enter name, address, telephone, fax and e-mail of financial contact for this application

Field 12.1 Add description of changes to the organisation. See Decision 2003/1/RM of the Executive Director of the Agency of 17 October 2003 on acceptable means of compliance and guidance material for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations ("AMC and GM to Part 21") under the respective link of the EASA website: http://www.easa.europa.eu

Fields 12.2 Identify the product type, the activity/ies for each product type and the related technical field(s) for each activity, in accordance with the lists 1 to 3, add lines as appropriate depending on number of activities and related technical fields; fill in a separate table (section 2.1-2.3) for each product type (copy and paste section as necessary)

Field 12.2.1

List 1 - Product types	• Large aeroplane
	• Small aeroplane
	• Sailplane/powered Sailplane
	• Very light aeroplane
	• Small rotorcraft
	• Large rotorcraft
	• Very light rotorcraft
	• Gyroplane
	• Airship
	• Balloon
	• Turbine engine
	• Piston engine
	• Auxiliary Power Unit
	• Propeller

Field 12.2.1.1

List 2 - Activity	• Type Certificates/ETSOA for APU
	• Supplemental Type Certificates/ETSOA for APU
	• Changes to type design by TC holders and continued airworthiness
	• Repairs
	• Minor changes only
	• Minor repairs only

Field 12.2.1.1.1

List 3 - Technical fields	• All (in case of Type Certificates)
	• Avionics
	• Installation of avionics equipment
	• Structure
	• Performance
	• Environmental systems
	• Hydro mechanical systems
	• Electrical systems
	• Cabin interiors
	• Galleys or other interiors equipment
	• Powerplant/Fuel system
	• Software
	• Transmissions
	• Noise
	• FADEC (Full Authority Digital Engine Control)
	• Non critical engine parts
	• Thrust reversers

Field 12.3 Indicate new product(s) to be added

Field 12.4 Indicate changes in limitations

Field 12.5 Indicate new privilege(s) to be added

Field 12.6 **IMPORTANT NOTE:**
If changes mentioned in 2.1, 2.2 and 2.4 are affecting the staff number and/or category of DOA, send the attachment to this Form 82 with the updated information. The next surveillance fee due will be adjusted accordingly.

Field 13 Add information on schedule for Type Certificate, STC or other design approval

Field 14 See Annex Part 21 to Commission Regulation (EC) No 1702/2003 of 24 September 2003 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations (OJ L 243, 27 September 2003, p. 6), as last amended, which is available in all EU languages under the respective link of the EASA website.

Attachment to Application for Significant Changes to Design Organisation Approval (DOA)

Information required for calculation of fee category

(cf. Explanatory Note of Annex to Commission Regulation (EC) No 593/2007)

Number of staff *(see Note 1 below)*			[Number of staff]
DOA Categories:	***Nature:***	***Cases:***	*[tick box, as appropriate]*
1A	Type Certificate applicant or holder of highly complex or large product(s)	• Large Aeroplanes • Small and Large Rotorcraft • UAVs (Large) • Turbine Engines	☐
1B	Type Certificate applicant or holder of complex or small-medium product(s) ETSOA APU (large)	• Small Aeroplanes • Very Light Rotorcraft • Gyroplanes • UAVs (small-medium) • Piston Engines • Large APU	☐
2A	STC / Changes / Repairs, unrestricted	Scope including at least structure, installation of avionics, hydro-mechanical systems, electrical systems, cabin interiors,	☐
1C	Type Certificate applicant or holder of less complex or very small product(s) ETSOA APU (small)	• Sailplanes, powered Sailplanes • Very Light Aeroplanes • Airships • Balloons • Propeller • Small APU	☐
2B	STC / Changes / Repairs, restricted (technical fields)	Scope with restricted technical fields	☐
3A	Minor Changes / Repairs, unrestricted	Scope including at least structure, installation of avionics, hydro-mechanical systems, electrical systems, cabin interiors,	☐
2C	STC / Changes / Repairs, restricted (aircraft size)	Scope limited to one category of product only	☐
3B	Minor Changes / Repairs, restricted (technical fields)	Scope with restricted technical fields	☐
3C	Minor Changes / Repairs, restricted (aircraft size)	Scope limited to one category of product only	☐

Date	**Name of Chief Executive or Authorised Representative** Printed Name	**Signature**

Note 1: The number of staff should be calculated as follows, for all sites involved in design and certification activities under the approval:

All staff involved in:
- Managing the design organisation;
- Drawing, calculating, testing, simulating;
- Producing and verifying compliance documentation;
- Performing airworthiness office tasks;
- System monitoring.

In addition, for Design subcontractors, the following staff should be counted:
- All staff involved in producing compliance documents;
- All staff involved in verifying compliance documents;
- All staff involved in airworthiness office tasks;
- All staff involved in system monitoring.

Staff not working full time should be counted, with appropriate ratio.
See also http://www.easa.eu.int/home/cert_faq_en.html for more information on fees and charges

EASA THIRD PARTY FINANCIAL INFORMATION

BANK ACCOUNT OWNER INFORMATION	
LAST NAME:	
FIRST NAME:	
ADRESS:	
CITY:	POSTCODE:
COUNTRY:	VAT NUMBER:
PHONE:	
E-MAIL:	
BANK ACCOUNT INFORMATION	
NAME OF THE BANK:	
ADDRESS OF THE BANK:	
CITY:	POSTCODE:
IBAN (MANDATORY): (International Bank account number)	
BIC/SWIFT CODE (MANDATORY):	
STAMP AND SIGNATURE OF THE BANK REPRESENTATIVE: DATE:	SIGNATURE OF THE BANK ACCOUNT OWNER: DATE:

European Aviation Safety Agency – Ottoplatz 1 – 50679 Köln – Germany
Phone: 49 (0) 221 8999 0000 - Fax: 49 (0) 221 8999 0999 - Website: www.easa.europa.eu

EASA Form 4

Issue 1, dated 04.12.2007

Qualifications and Experience of Management Personnel for which a statement must be furnished to EASA as required by Part 21A.243(d)[5].

1. Title / First Name / Surname:

2. Position within the Organisation:

3. Qualifications relevant to the item (2) position:

4. Work experience relevant to the item (2) position:

5. Organisation:

Signature: .... Date: ....

On completion, please send this form under confidential cover to EASA[6].

[5] See also GM No 1 to 21A.243(d), paragraph 3.2 and GM No 2 to 21A.243(d), paragraph 1.

[6] European Aviation Safety Agency
Organisations Department
Design Organisations Manager
Postfach 10 11 53
D-50452 Köln
Germany

EASA Form 31

Issue 6, dated 05.01.2009

European Aviation Safety Agency
Application for Approval of Major Change / Major Repair Design

1. Applicant	
1.1 Applicant‟s Reference *(if applicable)*	Internal Reference
1.2 Name	Name
1.3 Address *(registered business/postal address)*	Address
1.4 Contact Person	Contact Person
1.5 Telephone	Phone
1.6 Fax	Fax
1.7 E-mail	E-mail
1.8 Part 21 Demonstration of Capability *(if applicable)*	Part 21 Demonstration of Capability
1.9.1 Financial Contact *(if applicable)*	Financial Contact
1.9.2 Complete Address	Address
1.9.3 Telephone	Phone
1.9.4 Fax	Fax
1.9.5 E-mail	E-mail

2. Classification, product identification and fees information

Applicants will be charged in accordance with the Commission Regulation (EC) No. 593/2007 of 31 May 2007 and any subsequent amendment, on the fees and charges levied by the European Aviation Safety Agency (http://www.easa.europa.eu/home/regul_fees_charges_en.html).

In the case of withdrawal of the application, or other cases of interruption that qualify under Article 8(7) of Regulation 593/2007, EASA will recover any fees due, calculated on an hourly basis but not exceeding the applicable flat fee. In case the certification task is charged on an hourly rate, the working hours already spent will be fully recovered. EASA will also recover travel costs outside the territories of the EU Member States.

☐ **Major Change** ☐ **Major Repair**	☐ **Simple**	☐ **Standard**
	☐ **Complex** ☐ Involving changes to an aircraft"s geometry and/or power plant	

☐ Including Change to approved parts of Flight Manual (FM)

2.1 Fixed wing aircraft

Large Aeroplanes	Small Aeroplanes
☐ over 150 000 kg	☐ over 5 700 kg tons up to 22 000 kg (incl. commuter)
☐ over 50 000 kg up to 150 000 kg	☐ over 2 000 kg up to 5 700 kg
☐ over 22 000 kg up to 50 000 kg	☐ up to 2 000 kg
☐ over 5,7 tons up to 22 tons (excluding commuter)	☐ VLA, powered sailplanes, sailplanes

2.2 Rotorcraft	☐ Large (CS-29 and CS-27 Cat. A)	☐ Medium (other CS-27)	☐ Small (CS-27 of less than 4 seats and VLR)

2.3 Balloons, Airships	☐ Balloon	☐ Airship

2.4 Propulsion

Engines	APU	Propellers
☐ turbine engine above 25 kN take-off thrust	☐	☐ propeller for use on aircraft over 5 700 kg MTOW
☐ turbine engine up to 25 kN take-off thrust		☐ propeller for use on aircraft up to 5 700 kg MTOW
☐ turbine engine above 2000 kW take-off power		
☐ turbine engine up to 2000 kW take-off power		
☐ non-turbine engine		
☐ CS-22H class engine, CS VLR App. B		

3. Applicable Airworthiness Code

☐ CS-25	☐ CS-23	☐ CS-VLA	☐ CS-22	☐ CS-E
☐ CS-29	☐ CS-27	☐ CS-VLR	☐ CS-P	☐ Other *
* specify Code				

4. Applicability / Description	
4.1 Applicability	
4.2 Foreign Approval Reference *(if applicable)*	
4.3 Title	
4.4 Description	
4.5 Affected Areas (including manuals)	
4.6 Re-Investigations	
4.7 Justification *(non TC-holder repairs only)*	

5. Financial information

EASA will only be able to return prepaid amounts if the attached THIRD PARTY FINANCIAL INFORMATION page is duly provided.

6. Applicant's declaration

I confirm that the information contained herein is correct and complete. I have accessed, read and agree to be bound by the Agency"s Terms of Payment (available here: http://www.easa.europa.eu/home/regul_fees_charges_en.html). Accordingly, I agree to pay the fees levied by EASA in respect of the issuance of an approval of a major change / major repair design and am aware of the consequences of non-payment.

7. Signature

Date	Name Name	Signature

This Application together with the completed EASA THIRD PARTY FINANCIAL INFORMATION page should be sent by fax, e-mail or regular mail to:

European Aviation Safety Agency
Applications and Procurement Services Department
Manager of the Products Applications Management Section
Postfach 10 12 53
D-50452 Köln
Germany

Fax: +49 – (0)221 - 89990 ext. 4447
E-mail: **MajorChange-MajorRepair@easa.europa.eu**

DO NOT FORGET TO SIGN THE APPLICATION FORM

Information to be entered into major change / major repair design approval application form :

Note: STC holders are requested to use this form also for major changes to their STC and make reference to the STC in field 4.1.

The use of this form is required to enable EASA to process applications without undue delay. The individual fields of the application form may be varied in size to allow entry of all required information. It is strongly recommended to use the English language.

Field 1.1: enter your reference (optional)

Field 1.2: enter the name of the legal entity making the application

Field 1.3: enter registered business address to be printed on the certificate; add postal address if different e.g. for mailing or billing purposes

Field 1.4-1.7: enter name, telephone, fax and e-mail of contact person for this application

Field 1.8: for EU applicants: make reference to DOA / alternative procedures approval or related application made to EASA e.g. for extension of scope related to this design change

Field 1.9.1-1.9.5: enter name, address, telephone, fax and e-mail of financial contact for this application

Field 2: In case of a major change / repair please tick the dedicated box for the kind of major change / repair and identify the classification simple, standard, complex which is referring to the explanatory note of the Annex of the new Fees & Charges Regulation:

	Simple	**Standard**	**Complex**
EASA Supplemental Type Certificate (STC) EASA major design changes EASA major repairs	STC, major design change, or repair, only involving current and well-proven justification methods, for which a complete set of data (description, compliance check-list and compliance documents) can be communicated at time of application, **and** for which the applicant has demonstrated experience, **and** which can be assessed by the project certification manager alone, or with a limited involvement of a single discipline specialist.;	All other STC, major design changes or repairs.	Significant (*) STC or major design change.
Validated US Federal Aviation Administration (FAA) STC	Basic (**)	Non-basic	Significant non-basic
Validated FAA major design change	Level 2 (**) major design changes when not automatically accepted. (***)	Level 1 (**)	Significant level 1
Validated FAA major repair	N/A (automatic acceptance)	Repairs on critical component (**)	N/A

(*) "Significant" is defined in paragraph 21A.101 (b) of the Annex to Regulation (EC) No 1702/2003 (and similarly in FAA 21.101 (b)).
(**) "Basic", "level 1", "level 2" and "critical component" are defined in the technical implementation procedures for airworthiness and environmental certification (TIP) to the EU/US draft bilateral aviation safety agreement.
(***) Automatic acceptance criteria by EASA for FAA level 2 major changes are defined in EASA Executive Director Decision 2004/04/CF, or in the technical implementation procedures for airworthiness and environmental certification (TIP) to the EU /US draft bilateral aviation safety agreement, as applicable.

Field 2.1: the weight category shall refer to the maximum take-off weight (MTOW) of the aircraft type/model as specified in the type certificate data sheet

Field 2.4: changes/repairs on APU shall be regarded as changes/repairs to engines of the same power rating

Field 3: identify the applicable airworthiness code proposed to be used for EASA certification

Field 4.1: enter make, type / model, EASA - or grandfathered NAA-TC / -ETSO number of the original product / equipment, or reference to STC (in case of major change by STC-holder)

Field 4.2: for non EU applicants: enter reference to approval of the State of Design of the change / repair

Field 4.3: give a title of the design change / repair design

Field 4.4: give a brief description of the design change / damage and repair design

Field 4.5: identify all parts of the type design and the approved manuals affected by the change / repair, and the certification specifications and environmental protection requirements with which the change / repair has been designed;
if necessary make reference to further attached documents in e.g. relating to Part 21, § 21A.101 compliance

Field 4.6: identify any re-investigations necessary to show compliance of the changed / repaired product / equipment with the applicable certification specification and environmental requirements; if necessary make reference to further attached documents

Field 4.7: third party major repairs only: justify that the information provided is adequate either from own resources or through an arrangement with the TC-holder

Field 5: once the financial information is registered in the EASA database with the first application, there is no need to complete the form again, unless the data have been changed

Field 7: signature of an authorised representative of the applican

EASA THIRD PARTY FINANCIAL INFORMATION

BANK ACCOUNT OWNER INFORMATION	
LAST NAME:	
FIRST NAME:	
ADRESS:	
CITY:	POSTCODE:
COUNTRY:	VAT NUMBER:
PHONE:	
E-MAIL:	
BANK ACCOUNT INFORMATION	
NAME OF THE BANK:	
ADDRESS OF THE BANK:	
CITY:	POSTCODE:
IBAN (MANDATORY): (International Bank account number)	
BIC/SWIFT CODE (MANDATORY):	

STAMP AND SIGNATURE OF THE BANK REPRESENTATIVE:	SIGNATURE OF THE BANK ACCOUNT OWNER:
DATE:	DATE:

EASA Form 32

Issue 6, dated 05.01.2009

European Aviation Safety Agency
Application for Approval of Minor Change / Minor Repair Design

1. Applicant	
1.1 Applicant‟s Reference *(if applicable)*	Internal Reference
1.2 Name	Name
1.3 Address *(registered business/postal address)*	Address
1.4 Contact Person	Contact Person
1.5 Telephone	Phone
1.6 Fax	Fax
1.7 E-mail	E-mail
1.8.1 Financial Contact *(if applicable)*	Financial Contact
1.8.2 Complete Address	Address
1.8.3 Telephone	Phone
1.8.4 Fax	Fax
1.8.5 E-mail	E-mail

2. Classification, product identification and fees information

☐ Minor Change ☐ Minor Repair

☐ Including Change to approved parts of Flight Manual (FM)

Applicants will be charged in accordance with the Commission Regulation (EC) No. 593/2007 of 31 May 2007 and any subsequent amendment, on the fees and charges levied by the European Aviation Safety Agency (http://www.easa.europa.eu/home/regul_fees_charges_en.html).

In the case of withdrawal of the application, or other cases of interruption that qualify under Article 8(7) of Regulation 593/2007, EASA will recover any fees due, calculated on an hourly basis but not exceeding the applicable flat fee. In case the certification task is charged on an hourly rate, the working hours already spent will be fully recovered. EASA will also recover travel costs outside the territories of the EU Member States.

2.1 Fixed wing aircraft

Large Aeroplanes	Small Aeroplanes
☐ over 150 000 kg	☐ over 5 700 kg up to 22 000 kg (incl. commuter)
☐ over 50 000 kg up to 150 000 kg	☐ over 2 000 kg up to 5 7000 kg
☐ over 22 000 kg up to 50 000 kg	☐ up to 2 000 kg
☐ over 5 700 kg up to 22 000 kg (excluding commuter)	☐ VLA, powered sailplanes, sailplanes

2.2 Rotorcraft	☐ Large (CS-29 and CS-27 Cat. A)	☐ Medium (other CS-27)	☐ Small (CS-27 of less than 4 seats and VLR)

2.3 Balloons, Airships	☐ Balloon	☐ Airship

2.4 Propulsion

Engines	APU	Propellers
☐ turbine engine above 25 kN take-off thrust	☐	☐ propeller for use on aircraft over 5 700 kg MTOW
☐ turbine engine up to 25 kN take-off thrust		☐ propeller for use on aircraft up to 5 700 kg MTOW
☐ turbine engine above 2000 kW take-off power		
☐ turbine engine up to 2000 kW take-off power		
☐ non-turbine engine		
☐ CS-22H class engine, CS VLR App. B		

3. Applicable Airworthiness Code

☐ CS-25	☐ CS-23	☐ CS-VLA	☐ CS-22	☐ CS-E
☐ CS-29	☐ CS-27	☐ CS-VLR	☐ CS-P	☐ Other *
* specify Code				

4. Applicability / Description	
4.1 Applicability	
4.2 Foreign Approval Reference *(if applicable)*	
4.3 Title	
4.4 Description	
4.5 Affected Areas (including manuals)	

5. Financial information

EASA will only be able to return prepaid amounts if the attached THIRD PARTY FINANCIAL INFORMATION page is duly provided.

6. Applicant's declaration

I confirm that the information contained herein is correct and complete. I have accessed, read and agree to be bound by the Agency"s Terms of Payment (available here: http://www.easa.europa.eu/home/regul_fees_charges_en.html). Accordingly, I agree to pay the fees levied by EASA in respect of the issuance of an approval of a minor change / minor repair design and am aware of the consequences of non-payment.

7. Signature

Date	Name	Signature
	Name	

This Application together with the completed EASA THIRD PARTY FINANCIAL INFORMATION page should be sent by fax, e-mail or regular mail to:

European Aviation Safety Agency
Applications and Procurement Services Department
Manager of the Products Applications Management Section
Postfach 10 12 53
D-50452 Köln
Germany

Fax: +49 – (0)221 - 89990 ext. 4448
E-mail: **MinorChange-MinorRepair@easa.europa.eu**

DO NOT FORGET TO SIGN THE APPLICATION FORM

Information to be entered into minor change / minor repair application form:

The use of this form is required to enable EASA to process applications without undue delay. The individual fields of the application form may be varied in size to allow entry of all required information. It is strongly recommended to use the English language.

Field 1.1: enter your reference (optional)

Field 1.2: enter the name of the legal entity making the application

Field 1.3: enter registered business address to be printed on the certificate; add postal address if different e.g. for mailing or billing purposes

Field 1.4-1.7: enter name, telephone, fax and e-mail of contact person for this application

Field 1.8.1-1.8.5: enter name, address, telephone, fax and e-mail of financial contact for this application

Field 2: identify minor change or minor repair

Field 2.1: identify the kind of product / equipment for which an application is made by ticking the related checkboxes; the weight category shall refer to the maximum take-off weight (MTOW) of the aircraft type/model as specified in the type certificate data sheet

Field 3: identify the applicable airworthiness code proposed to be used for EASA certification

Field 4.1: enter manufacturer, type / model, EASA - or grandfathered NAA-TC / -ETSO number of the original product / equipment

Field 4.2: for non EU applicants: enter reference to approval of the State of Design of the change / repair

Field 4.3: give a title of the design change / repair design

Field 4.4: give a brief description of the design change / damage and repair design

Field 4.5: identify all parts of the type design and the approved manuals affected by the change / repair, and the certification specifications and environmental protection requirements with which the change / repair has been designed

Field 5: once the financial information is registered in the EASA database with the first application, there is no need to complete the form again, unless the data have been changed

Field 7: signature of an authorised representative of the applicant

EASA THIRD PARTY FINANCIAL INFORMATION

	BANK ACCOUNT OWNER INFORMATION
	LAST NAME:
	FIRST NAME:
	ADRESS:
	CITY: POSTCODE:
	COUNTRY: VAT NUMBER:
	PHONE:
	E-MAIL:
	BANK ACCOUNT INFORMATION
	NAME OF THE BANK:
	ADDRESS OF THE BANK:
	CITY: POSTCODE:
	IBAN (MANDATORY): (International Bank account number)
	BIC/SWIFT CODE (MANDATORY):

STAMP AND SIGNATURE OF THE BANK REPRESENTATIVE:	SIGNATURE OF THE BANK ACCOUNT OWNER:
DATE:	DATE:

European Aviation Safety Agency – Ottoplatz 1 – 50679 Köln – Germany
Phone: 49 (0) 221 8999 0000 - Fax: 49 (0) 221 8999 0999 - Website: www.easa.europa.eu

EASA Form 33

Issue 6, dated 05.01.2009

	European Aviation Safety Agency Application for Approval of Supplemental Type Certificate (STC)
1. Applicant	
1.1 Applicant‟s Reference *(if applicable)*	Internal Reference
1.2 Name	Name
1.3 Address *(registered business/postal address)*	Address
1.4 Contact Person	Contact Person
1.5 Telephone	Phone
1.6 Fax	Fax
1.7 E-mail	E-mail
1.8 Part 21 Demonstration of Capability *(if applicable)*	Part 21 Demonstration of Capability
1.9.1 Financial Contact *(if applicable)*	Financial Contact
1.9.2 Complete Address	Address
1.9.3 Telephone	Phone
1.9.4 Fax	Fax
1.9.5 E-mail	E-mail

2. Classification, product identification and fees information

Applicants will be charged in accordance with the Commission Regulation (EC) No. 593/2007 of 31 May 2007 and any subsequent amendment, on the fees and charges levied by the European Aviation Safety Agency (http://www.easa.europa.eu/home/regul_fees_charges_en.html).

In the case of withdrawal of the application, or other cases of interruption that qualify under Article 8(7) of Regulation 593/2007, EASA will recover any fees due, calculated on an hourly basis but not exceeding the applicable flat fee. In case the certification task is charged on an hourly rate, the working hours already spent will be fully recovered. EASA will also recover travel costs outside the territories of the EU Member States.

Major Change classified as	☐ **Simple**	☐ **Standard**
	☐ **Complex** ☐ Involving changes to an aircraft"s geometry and/or power plant	

☐ Including Change to approved parts of Flight Manual (FM)

2.1 Fixed wing aircraft

Large Aeroplanes	Small Aeroplanes
☐ over 150 000 kg	☐ over 5 7 000 kg up to 22 000 kg (incl. commuter)
☐ over 50 000 kg up to 150 000 kg	☐ over 2 000 kg up to 5 700 kg
☐ over 22 000 kg up to 50 000 kg	☐ up to 2 000 kg
☐ over 5 700 kg up to 22 000 kg (excluding commuter)	☐ VLA, powered sailplanes, sailplanes

2.2 Rotorcraft	☐ Large (CS-29 and CS-27 Cat. A)	☐ Medium (other CS-27)	☐ Small (CS-27 of less than 4 seats and VLR)

2.3 Balloons, Airships	☐ Balloon	☐ Airship

2.4 Propulsion

Engines	APU	Propellers
☐ turbine engine above 25 kN take-off thrust	☐	☐ propeller for use on aircraft over 5 700 kg MTOW
☐ turbine engine up to 25 kN take-off thrust		☐ propeller for use on aircraft up to 5 700 kg MTOW
☐ turbine engine above 2000 kW take-off power		
☐ turbine engine up to 2000 kW take-off power		
☐ non-turbine engine		
☐ CS-22H class engine, CS VLR App. B		

3. Applicable Airworthiness Code

☐ CS-25	☐ CS-23	☐ CS-VLA	☐ CS-22	☐ CS-E
☐ CS-29	☐ CS-27	☐ CS-VLR	☐ CS-P	☐ Other *
* specify Code				

4. Applicability / Description	
4.1 Applicability	
4.2 Foreign Approval Reference *(if applicable)*	
4.3 Title	
4.4 Description	
4.5 Affected Areas (including manuals)	
4.6 Re-Investigations	
4.7 Justification *(non TC-holder repairs only)*	

5. Financial information

EASA will only be able to return prepaid amounts if the attached THIRD PARTY FINANCIAL INFORMATION page is duly provided.

6. Applicant's declaration

I confirm that the information contained herein is correct and complete. I have accessed, read and agree to be bound by the Agency‟s Terms of Payment (available here: http://www.easa.europa.eu/home/regul_fees_charges_en.html). Accordingly, I agree to pay the fees levied by EASA in respect of the issuance of a Supplemental Type Certificate and am aware of the consequences of non-payment.

7. Signature

Date	Name	Signature
	Name	

This Application together with the completed EASA THIRD PARTY FINANCIAL INFORMATION page should be sent by fax, e-mail or regular mail to:

European Aviation Safety Agency
Applications and Procurement Services Department
Manager of the Products Applications Management Section
Postfach 10 12 53
D-50452 Köln
Germany

Fax: +49 – (0)221 - 89990 ext. 4446
E-mail: STC@easa.europa.eu

DO NOT FORGET TO SIGN THE APPLICATION FORM

Information to be entered into STC approval application form:

Note: STC holders are requested to use EASA Form 31 for major changes to their STC and make reference to the STC in field 4.1.

The use of this form is required to enable EASA to process applications without undue delay. The individual fields of the application form may be varied in size to allow entry of all required information. It is strongly recommended to use the English language.

Field 1.1: enter your reference (optional)

Field 1.2: enter the name of the legal entity making the application

Field 1.3: enter registered business address to be printed on the certificate; add postal address if different e.g. for mailing or billing purposes

Field 1.4-1.7: enter name, telephone, fax and e-mail of contact person for this application

Field 1.8: for EU applicants: make reference to DOA / alternative procedures approval or related application made to EASA e.g. for extension of scope related to this design change

Field 1.9.1-1.9.5: enter name, address, telephone, fax and e-mail of financial contact for this application

Field 2: In case of a major change please tick the dedicated box for the kind of major change and identify the classification simple, standard, complex which is referring to the explanatory note of the Annex of the new Fees & Charges Regulation:

	Simple	**Standard**	**Complex**
EASA Supplemental Type Certificate (STC) EASA major design changes EASA major repairs	STC, major design change, or repair, only involving current and well-proven justification methods, for which a complete set of data (description, compliance check-list and compliance documents) can be communicated at time of application, **and** for which the applicant has demonstrated experience, **and** which can be assessed by the project certification manager alone, or with a limited involvement of a single discipline specialist.;	All other STC, major design changes or repairs.	Significant (*) STC or major design change.
Validated US Federal Aviation Administration (FAA) STC	Basic (**)	Non-basic	Significant non-basic
Validated FAA major design change	Level 2 (**) major design changes when not automatically accepted. (***)	Level 1 (**)	Significant level 1
Validated FAA major repair	N/A (automatic acceptance)	Repairs on critical component (**)	N/A

(*) "Significant" is defined in paragraph 21A.101 (b) of the Annex to Regulation (EC) No 1702/2003 (and similarly in FAA 21.101 (b)).
(**) "Basic", "level 1", "level 2" and "critical component" are defined in the technical implementation procedures for airworthiness and environmental certification (TIP) to the EU/US draft bilateral aviation safety agreement.
(***) Automatic acceptance criteria by EASA for FAA level 2 major changes are defined in EASA Executive Director Decision 2004/04/CF, or in the technical implementation procedures for airworthiness and environmental certification (TIP) to the EU /US draft bilateral aviation safety agreement, as applicable.

Field 2.1: the weight category shall refer to the maximum take-off weight (MTOW) of the aircraft type/model as specified in the type certificate data sheet

Field 3: identify the applicable airworthiness code proposed to be used for EASA certification

Field 4.1: enter make, type / model, EASA - or grandfathered NAA-TC / -ETSO number of the original product / equipment, or reference to STC (in case of major change by STC-holder)

Field 4.2: for non EU applicants: enter reference to approval of the State of Design of the change / repair

Field 4.3: give a title of the design change / repair design

Field 4.4: give a brief description of the design change / damage and repair design

Field 4.5: identify all parts of the type design and the approved manuals affected by the change / repair, and the certification specifications and environmental protection requirements with which the change / repair has been designed;
if necessary make reference to further attached documents in e.g. relating to Part 21, § 21A.101 compliance

Field 4.6: identify any re-investigations necessary to show compliance of the changed / repaired product / equipment with the applicable certification specification and environmental requirements; if necessary make reference to further attached documents

Field 4.7: third party major repairs only: justify that the information provided is adequate either from own resources or through an arrangement with the TC-holder

Field 5: once the financial information is registered in the EASA database with the first application, there is no need to complete the form again, unless the data have been changed

Field 7: signature of an authorised representative of the applicant

EASA THIRD PARTY FINANCIAL INFORMATION

BANK ACCOUNT OWNER INFORMATION	
	LAST NAME:
	FIRST NAME:
	ADRESS:
	CITY: POSTCODE:
	COUNTRY: VAT NUMBER:
	PHONE:
	E-MAIL:
BANK ACCOUNT INFORMATION	
	NAME OF THE BANK:
	ADDRESS OF THE BANK:
	CITY: POSTCODE:
	IBAN (MANDATORY): (International Bank account number)
	BIC/SWIFT CODE (MANDATORY):

STAMP AND SIGNATURE OF THE BANK REPRESENTATIVE:	SIGNATURE OF THE BANK ACCOUNT OWNER:
DATE:	DATE:

European Aviation Safety Agency – Ottoplatz 1 – 50679 Köln – Germany
Phone: 49 (0) 221 8999 0000 - Fax: 49 (0) 221 8999 0999 - Website: www.easa.europa.eu

Appendix B

Certification Requirements for Cabin Design and Conversion

Paragraph	Title	Rule Quotation	Rule interpretation and recommendations for cabin layout
CS 23.535 (b)	Emergency landing conditions	The items of mass within the cabin, that could injure an occupant, experience the _static inertia loads_ corresponding to the following _ultimate load factors:_ i) Upwards, 3-0 g; ii)Forward, 18-0 g; and iii)Sideward, 4-5 g;	The ultimate load factors of the cabin components must not overcame specified values
CS 23.562 (c)	Emergency landing dynamic conditions	When contact with adjacent seats, structure or other items in the cabin can occur, _protection_ must be provided so that head impact does not exceed _a head injury criteria (HIC) OF 1000_;	Cabin components must provide proper protection in case of impact with passengers
CS 23.773 (a)(1)	Pilot compartment view	Each pilot compartment _must be arranged with sufficiently extensive clear and undistorted view_ to enable the pilot to safely taxi, take-off, approach, land and perform any manoeuvres within the operating limitations of the aeroplane;	The cabin of the pilot must provide sufficient visibility
CS 23.773 (a)(2)	Pilot compartment view	Each pilot compartment must be _free from glare and reflections_ that could interfere with the pilot‟s vision. Compliance must be shown in all operations for which certification is requested;	The windows in the cabin of the pilot must be protected against reflections
CS 23.773 (a)(3)	Pilot compartment view	Each pilot compartment must be _designed so that each pilot is protected from the elements_ so that _moderate rain conditions_ do not unduly impair the pilot‟s view of the flight path in normal flight and while landing;	The pilot‟s visibility on rain conditions must be within acceptable limits especially in critical flight phases
CS 23.777 (a)	Cockpit Controls	Each cockpit control must be located and (except where its function is obvious) identified to provide _convenient operation and to prevent confusion and inadvertent operation_;	Proper positioning of the cockpit controls – for convenient operation
CS 23.777 (b)	Cockpit Controls	The controls must be located and arranged so that the pilot, when seated, has _full and unrestricted movement of each control_ without interference from either his clothing or the cockpit structure;	Proper positioning of the cockpit controls – for unrestricted movement
CS 23.777 (c)	Cockpit Controls	_Power plant controls_ must be located:	Locations for power plant controls

		1) For twin-engined aeroplanes, *on the pedestal or overhead at or near the centre of the cockpit*; 2) For single and tandem seated single-engine aeroplanes, *on the left side console or instrument panel*; 3) For other single-engine aeroplanes *at or near the centre of the cockpit, on the pedestal, instrument panel, or overhead*; and 4) For aeroplanes with side-by-side pilot seats and with two sets of powerplant controls, *on left and right consoles*;	
CS 23.777 (d)	Cockpit Controls	*Aeroplanes with tandem seating or single-place aeroplanes* may utilise *control locations* on the *left side* of the *cabin compartment*; however, location *order* from left to right must be power (thrust) lever, propeller (rpm control) and mixture control;	Cockpit controls location for tandem and single place aeroplanes
CS 23.783 (a)	Doors	Each *closed cabin* with passenger accommodations must have *at least one* adequate and easily accessible *external door*;	Number of external doors for closed cabins
CS 23.783 (b)	Doors	Passenger doors *must not be located* with respect to any *propeller disc or any other potential hazard* so as to endanger persons using that door;	Passenger doors – must not be located near sources of potential hazards
CS 23.783 (f)(1)	Doors	*Each passenger entry door* must qualify as *a floor level emergency exit*. This exit must have a *rectangular opening* of not less than 0.61 m (24 in) wide by 1.22 m (48 in) high, with corner radii not greater than one-third the width of the exit;	Dimensions of emergency exits
CS 23.783 (f)(2)	Doors	If an integral stair is installed at a passenger entry door, *the stair must be designed so that*, when subjected to the inertia loads resulting from the ultimate static load factors in CS 23.561 (b)(2) and following the collapse of one or more legs of the landing gear, *it will not reduce the effectiveness of emergency egress through the passenger entry door*;	Integrated s tair design so that the effectiveness of emergency egress through the passenger entry door will not be reduced
CS 23.785 (2)(i)	Seats, berths, litters, safety belts and shoulder harnesses	The *cabin area surrounding each seat*, including the structure, interior walls, instrument panel, and seats, within striking distance of the occupant"s head or torso (with the restraint system fastened) must be *free of potentially injurious objects, sharp edges, protuberances, and*	Potentially injurious objects, sharp edges, protuberances, hard surfaces must not stand near the seat area

		hard surfaces;	
CS 23.785 (2)(j)	Seats, berths, litters, safety belts and shoulder harnesses	Each seat track must be *fitted with stops to prevent* the seat from *sliding off the track*	Seat rails must be provided with stops
CS 23.785 (2)(k)	Seats, berths, litters, safety belts and shoulder harnesses	Each seat/restraint system may use *design features*, such as crushing or separation of certain components, *to reduce occupant loads* when showing compliance with the requirements of CS 23.562; otherwise, the system must remain intact;	Design of the seat/restraint system so to reduce loads
CS 23.785 (2)(l)	Seats, berths, litters, safety belts and shoulder harnesses	For the purposes, a *front seat* is a seat *located at a flight crew member station* or *any seat located alongside such a seat*;	Definition of the front seat
CS 23.785 (2)(m)	Seats, berths, litters, safety belts and shoulder harnesses	*Each berth, or provisions for a litter*, installed *parallel to the longitudinal axis of the aeroplane*, must be *designed so that the forward part has a padded end-board, canvas diaphragm*, or equivalent means that can withstand the load reactions from a 98 kg (215 lb) occupant when subjected to the inertia loads resulting from the ultimate static load factors of CS 24.561 (b)(3). Each berth or litter must have an occupant restraint system and *may not have corners or other parts likely to cause serious injury* to a person occupying it during emergency landing conditions;	Provisions for berths
CS 23.787 (a)(2)	Baggage and cargo compartments	*Each baggage and cargo compartment* must have means to *prevent the contents of any compartment from becoming a hazard* by shifting, and to protect any control, wiring, lines, equipment, or accessories whose damage or failure would affect safe operations;	Proper depositing of baggage and cargo
CS 23.787 (a)(3)	Baggage and cargo compartments	*Each baggage and cargo* compartment must have *a means to protect occupants from injury by the contents of any compartment*, located aft of the occupants and separated by structure, *when the ultimate forward inertia load factor is 9g* and assuming the maximum allowed baggage or cargo weight for the compartment;	Cargo compartment design so to protect passengers under ultimate load factor conditions
CS 23.787 (b)	Baggage and cargo compartments	*Aeroplanes that provide for baggage or cargo to be carried in the same compartment as passengers must have a means to protect the occupants from injury* when the baggage or cargo is subjected to the inertia loads resulting from the ultimate static load factors of CS 23.561 (b)(3), assuming the	Stowages must retain the baggage under ultimate load factor conditions

		maximum allowed baggage or cargo weight for the compartment;	
CS 23.787 (c)	Baggage and cargo compartments	For aeroplanes that are used only for the carriage of cargo, the *flight crew emergency exits must meet the requirements of CS 23.807 under any* baggage or cargo loading *conditions*;	Crew emergency exits for freighters must meet requirements under any conditions
CS 23.807 (a)(1)	Emergency exists	*For all aeroplanes with a seating capacity of two or more*, excluding aeroplanes with canopies, there must be *at least one emergency exit on the opposite side of the cabin from the main* door specified in CS 23.783;	A second emergency exit on the opposite side of the main door is required
CS 23.807 (a)(3)	Emergency exits	If the pilot compartment is separated from the cabin by a door that is likely to block the pilot‟s escape in a minor crash, there must be *an exit in the pilot‟s compartment*;	Escape of crew must be ensured through an additional door if it‟s required
CS 23.811 (c)(2)	Emergency exit marking	*The identity and location of each emergency exit* must be recognizable from a distance equal to the *width of the cabin*;	The position of the emergency exits so as to be recognizable
CS 23.812 (a)	Emergency lighting	*An emergency lighting system*, independent of the main cabin lighting system, *must be installed*. However, the source of general cabin illumination may be common to both emergency and main lighting system if the power supply to the emergency lighting system is independent of the power supply to the main lighting system;	An emergency lighting system must be installed
CS 23.812 (h)	Emergency lighting	The emergency lighting system must provide *internal lighting*;	Emergency Internal lighting
CS 23.813 (b)(1)	Emergency exit Access	*The passageway leading* from the aisle to the passenger entry door must be *unobstructed* and at least *51 cm (20 in) wide*;	Unobstructed 51 cm wide passageway
CS 23.813 (b)(2)	Emergency exit Access	There must be *enough space next to the passenger entry door* to allow assistance in evacuation of passengers without reducing the unobstructed width of the passageway below 51 cm (20 in);	Enough space next to the entry door so to allow emergency assistance
CS 23.813 (b)(3)	Emergency exit access	If it is necessary to pass through a passageway between passenger compartments to reach a required emergency exit from any seat in the passenger cabin, *the passageway must be unobstructed*; however, *curtains may be used* if they allow *entry through the passageway*;	Curtains may be used if they allow free passage
CS 23.813 (b)(4)	Emergency exit access	*No door may be installed* in any partition between passageway compartments *unless* that *door has a means to latch it in the open position*. The latching means must be able *to withstand the loads* imposed upon it by the door when the door is	The latching means for keeping the passageway doors open must withstand the loads

		subjected to the inertia loads resulting from the ultimate static load factors prescribed in CS 23.561(b)(2);	
CS 23.813 (b)(5)	Emergency exit Access	If it is necessary *to pass through a door-way separating the passenger cabin from other areas* to reach a required emergency exit from any passenger seat, the door must have *a means to latch it in the open position*;	Doors between passageways must be designed so as to stay open
CS 23.853 (a)	Passenger and crew compartment interiors	*The materials* must be at least *flame-resistant*;	Flame-resistant materials for cabin interior
CS 23.853 (c)(1)	Passenger and crew compartment interiors	There must be an adequate number of self-contained, *removable ashtrays*;	Removable ashtrays
CS 23.853 (c)(2)	Passenger and crew compartment interiors	Where the crew compartment is separated from the passenger compartment, there must be at least *one illuminated sign* (using either letters or symbols) notifying all passengers *when smoking is prohibited*;	When smoking is prohibited, there must be at least one illuminated sign
CS 25.561 (a)	Emergency Landing Conditions General	*The aeroplane*, although it may be damaged in emergency landing conditions on land or water, *must be designed* as prescribed in this paragraph *to protect each occupant* under those conditions;	The aeroplane/cabin must protect each occupant in emergency landing conditions
CS 25.561 (b)(1)	Emergency Landing Conditions General	The structure must be designed to give each occupant *every reasonable chance of escaping serious injury in a minor crash landing* when *proper use is made of seats, belts, and all other safety design provisions*;	Cabin interior safety provisions, along with the structure must ensure survival in minor crash landings
CS 25.561 (b)(2)	Emergency Landing Conditions General	The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a minor crash landing *when the wheels are retracted* (where applicable);	Structure provisions for safety when wheels are retracted
CS 25.561 (c)(1)	Emergency Landing Conditions General	For *equipment, cargo in the passenger compartments and any other large masses*, the following rule apply: these items *must be positioned so* that if they break loose *they will be unlikely to*: i) cause direct injury to occupants; ii) penetrate fuel tanks or lines or cause fire or explosion hazard by damage to adjacent systems or iii) nullify any of the escape facilities for use after an emergency landing;	Position and fastening for equipment, cargo in the passenger compartments
CS 25.561 (c)(2)	Emergency Landing Conditions General	For *equipment, cargo in the passenger compartments and any other large masses*, the following rules apply: *when such positioning* [see CS 25.561 (c)(1)] *is not practical* (e.g. fuselage mounted engines or auxiliary power units) *each such item*	Position, fastening and loads for equipment, cargo in the passenger compartments

		<u>of mass must be restrained under all loads up to those specified in subparagraph (b)(3)</u> of this paragraph. The local attachments for these items should be designed to withstand 1-33 times the specified loads if these items are subject to severe wear and tear through frequent removal (e.g. quick change interior items);	
CS 25.785 (a)	Seats, berths, safety belts and harnesses	*<u>A seat (or berth for a non-ambulant person)</u>* must be provided *<u>for each occupant who has reached his or her second birthday</u>*;	Children above 2 years of age must have their own seat and proper berth
CS 25.785 (b)	Seats, berths, safety belts and harnesses	*<u>Each seat, berth, safety belt, harness</u>*, and adjacent part of the aeroplane at each station designated as during take-off and landing *<u>must be designed so that a person making proper use of these facilities will not suffer serious injury</u>* in an *<u>emergency landing</u>* as a result of the inertia forces specified in CS 25.561 and CS 25.562;	Cabin safety provisions must ensure survival in emergency landing conditions
CS 25.785 (c)	Seats, berths, safety belts and harnesses	Each seat or berth must be approved	Equipment must be certified
CS 25.785 (d)	Seats, berths, safety belts and harnesses	*<u>Each occupant of a seat</u>* (see AMC 25.785 (d)) *<u>that makes more than an 18-degree angle with the vertical plane containing the aeroplane centreline</u>* must be *<u>protected</u>* from *<u>head injury</u>* by *<u>a safety belt</u>* and an energy absorbing rest that will support the arms, shoulders, head and spine, or by a safety belt and shoulder harness that will prevent the head from contracting any injurious object. Each occupant of any other seat must be protected from head injury by a safety belt and, as appropriate to the type, location, and angle of facing of each seat, by one or more of the following: 1) a shoulder harness that will prevent the head from contracting any injurious object; 2) the elimination of any injurious object within striking radius of the head; 3) an energy absorbing rest that will support the arms, shoulders, head and spine;	Provisions for safety belts
CS 25.785 (e)	Seats, berths, safety belts and harnesses	Each berth must be designed so that the forward part has a padded end board, canvas diaphragm, or equivalent means, that can withstand the static load reaction of the occupant when subjected to the forward inertia force specified in CS 25.561. Berths must be free from corners and protuberances likely to cause injury to a person occupying	The conditions for berths designing

		the berth during emergency conditions;	
CS 25.785 (h)(1)	Seats, berths, safety belts and harnesses	*A cabin crewmember seat* must be located adjacent to each *Type A emergency exit*. Other cabin crewmember seats must be evenly distributed among the required floor level emergency exits to the extent feasible;	Crewmember seat distribution
CS 25.785 (h)(2)	Seats, berths, safety belts and harnesses	*Each seat located in the passenger compartment* and designed for use during take-off and landing by a *cabin crewmember* required by the Operating Rules must be, to the extent possible, without compromising proximity to a required floor level emergency exit, located to provide a *direct view of the cabin area for which the cabin crewmember is responsible*;	Direct view of the cabin area
CS 25.785 (h)(3)	Seats, berths, safety belts and harnesses	*Each seat located in the passenger compartment* and designed for use during take-off and landing by a *cabin crewmember* required by the Operating Rules must be positioned so that *the seat will not interfere* with the use of a *passageway* or *exit* when the seat is not in use;	Attendant seat position so as to not interfere with the passageway or exit
CS 25.785 (h)(4)	Seats, berths, safety belts and harnesses	*Each seat located in the passenger compartment* and designed for use during take-off and landing by a *cabin crewmember* required by the Operating Rules must be located to *minimize the probability that occupants would suffer injury by being struck by items dislodged* from service areas, stowage compartments, or service equipment;	Crew equipment displacement must not affect passengers in emergency cases
CS 25.785 (h)(5)	Seats, berths, safety belts and harnesses	*Each seat located in the passenger compartment* and designed for use during take-off and landing by a *cabin crewmember* required by the Operating Rules must be *either forward or rearward facing with an energy absorbing rest* that is designed to support the arms, shoulders, head and spine;	Position of attendant seats
CS 25.785 (h)(6)	Seats, berths, safety belts and harnesses	*Each seat located in the passenger compartment* and designed for use during take-off and landing by a *cabin crewmember* required by the Operating Rules must be *equpped* with a *restraint system* consisting of a combined safety belt and shoulder harness unit with a single point release;	Restraint system of the attendant seat
CS 25.785 (i)	Seats, berths, safety belts and harnesses	Each safety belt must be equipped with a metal-to-metal latching device	Metal-to-metal latching device for seat belts
CS 25.785 (j)	Seats, berths, safety belts	If the seat backs do not provide a firm handhold, *there must be a*	Prescriptions for seat design – handgrips

	and harnesses	*handgrip or rail along each aisle to enable persons to steady themselves* while using the aisles in moderately rough air;	
CS 25.787 (a)	Stowage compartments	If the aeroplane has a passenger-seating configuration, excluding pilot seats, of 10 seats or more, *each stowage compartment in the passenger cabin*, except for under seat and overhead compartments for passenger convenience, must be completely *enclosed*;	The stowages in the passenger cabin must be enclosed
CS 25.787 (b)	Stowage compartments	There must be a *means to prevent the contents in the compartments from becoming a hazard* by shifting, under the *loads specified* in subparagraph (a) of this paragraph (see AMC 25.787(b));	Design so to prevent (under specified loads) hazardous shifting
CS 25.789 (a)	Retention of items of mass in passenger and crew compartments and galleys	*Means must be provided* to *prevent each item of mass* (that is part of the aeroplane type design) in a passenger or crew compartment or galley *from becoming a hazard by shifting under the appropriate maximum load factors* corresponding to the specified flight and ground load conditions, and to the emergency landing conditions of CS 25.561(b);	Design so to prevent (under specified loads) hazardous shifting
CS 25.789 (b)	Retention of items of mass in passenger and crew compartments and galleys	Each *interphone restraint system* must be designed so that when subjected to the *load factors* specified in CS 25.561 (b)(3), the interphone will remain in its stowed position;	Conditions of designing the interphone
CS 25.791 (a)	Passenger information signs and placards	If *smoking* is to be *prohibited*, there must be at least one placard so stating that is legible to each person seated in the cabin. If *smoking* is to be *allowed*, and if the crew compartment is separated from the passenger compartment, there must be at least one sign notifying when smoking is prohibited;	No smoking placards: visible for every passenger
CS 25.791 (b)	Passenger information signs and placards	*Signs that notify when seat belts should be fastened* and that are installed to comply with the Operating Rules must be installed so as to be *operable from either pilot's seat* and, when illuminated, *must be legible* under all probable conditions of cabin illumination *to each person seated in the cabin*;	Fasten seat belts sign: visible for every passenger
CS 25.791 (c)	Passenger information signs and placards	A *placard* must be located *on or adjacent to the door of each receptacle used for the disposal of flammable waste materials* to indicate that use of the receptacle for disposal of cigarettes, etc., is prohibited;	Placards for flammable waste materials
CS 25.791	Passenger	*Lavatories must have "No Smoking"*	Design directives for

(d)	information signs and placards	<u>*or "No Smoking in Lavatory" placards positioned adjacent to each ashtray.*</u> The placards must have red letters at least 13 mm (0-5 inches) high on a white background of at least 25 mm (1-0 inches) high. (A No Smoking symbol may be included on the placard);	"No Smoking" placards
CS 25.791 (e)	Passenger information signs and placards	<u>*Symbols*</u> that clearly express the intent of the sign or placard may be used <u>*in lieu of letters*</u>;	Symbols can replace letters
CS 25.793	Floor surfaces	<u>*The floor surface*</u> of all areas, which are likely to become wet in service, must have slip resistant properties;	Slip resistant properties for wettable floor areas
CS 25.807 (a)(7)	Emergency exits	<u>*Type A*</u>. This type is <u>*a floor level exit with a rectangular opening*</u> of not less than 1.07 m (42 inches) wide by 1-83 m (72 inches) high with corner radii not greater than one-sixth of the width of the exit;	Definition and dimensions of a Type A Emergency exit
CS 25.807 (b)	Emergency exits	<u>*Step down distance*</u>, as used in this paragraph, means <u>*the actual distance between the bottom of the required opening and a usable foot hold*</u>, extending out from the fuselage, that is large enough to be effective without searching by sight or feel;	Definition of the step down distance
CS 25.807 (e)(2)	Emergency exits	For <u>*aeroplanes*</u> that have a passenger seating configuration of 10 seats, <u>*one exit above the waterline in a side of the aeroplane*</u>, meeting at least the dimensions of a Type III exit for each unit (or part of a unit) of 35 passenger seats, but no less than two such exits in the passenger cabin, with one on each side of the aeroplane, <u>*is requested*</u>;	Prescriptions for exits above the waterline
CS 809 (f)	Emergency Exit Arrangement	Each door must be located where persons using them <u>*will not be endangered by the propellers*</u> when appropriate operating procedures are used;	Position of the doors with respect to other elements
CS 25.811 (a)	Emergency exit marking	<u>*Each passenger emergency exit*</u>, its means of access, and its means of opening must be conspicuously <u>*marked*</u>;	Marking of the emergency exits
CS 25.811 (b)	Emergency exit marking	<u>*The identity and location of each passenger emergency*</u> exit must be <u>*recognisable*</u> from a distance equal to <u>*the width of the cabin*</u>;	Emergency exits must be recognisable
CS 25.811 (c)	Emergency exit marking	Means must be provided to <u>*assist the occupants in locating the exits*</u> in conditions of <u>*dense smoke*</u>	Proper marking of the emergency exits
CS 25.811 (d)(1)	Emergency exit marking	There must be a <u>*passenger exit locator sign above the aisle (or aisles) near each passenger emergency exit*</u>, or at another overhead location if it is more practical because of low headroom, except that one sign may serve more	„Exit" sign above the aisle near each passenger emergency exit

		than one exit if each exit can be seen readily from the sign;	
CS 25.811 (d)(2)	Emergency exit marking	*A passenger emergency exit marking sign next to each passenger emergency exit*, except that one sign may serve two such exits if they both can be seen readily from the sign;	„Exit" sign next to each emergency exit
CS 25.811 (d)(3)	Emergency exit marking	There must be a *sign on each bulkhead or divider* that prevents fore and aft vision along the passenger cabin *to indicate emergency exits* beyond and obscured by the bulkhead or divider, except that if this is not possible the sign may be placed at another appropriate location;	„Exit" sign on each bulkhead or divider
CS 25.811 (e)(1)	Emergency exit marking	Each passenger emergency exit must have, on or near the exit, a *marking that is readable from a distance of 76 cm* (30 inches);	Readable „Exit" sign from a specific distance
CS 25.811 (e)(2)	Emergency exit marking	Each passenger emergency exit *operating handle* and the cover removal *instructions*, if the operating handle is covered, must: i) be self-illuminated with an initial brightness of at least 0.51 candela/m^2 (160 microlamberts), or ii) be conspicuously located and well illuminated by the emergency lighting even in conditions of occupant crowding at the exit;	Required properties for each operating handle and cover removal instructions of the exits
CS 25.811 (g)	Emergency exit marking	Each sign required by sub-paragraph may use the word “exit” in its legend in place of the term “emergency exit” or a *universal symbolic exit sign* (See AMC 25.812 (b)(1), AMC 25.812 (b)(2) and AMC 25.812 (e)(2)). *The design of exit signs must be chosen to provide a consistent set throughout the cabin*;	Prescriptions for the „Exit" sign
CS 25.812 (a)(1,2)	Emergency lighting	*An emergency lighting system*, independent of the main lighting system, *must be installed*. The emergency lighting system must include: 1) illuminated emergency exit marking and locating signs and 2) exterior emergency lighting;	Prescriptions for emergency illumination
CS 25.812 (c)	Emergency lighting	*General illumination* in the passenger cabin must be provided so that when measured along the centreline of main passenger aisle(s), and cross aisle(s) between main aisles, *at seat* armrest height and at 1.02 m (40-inch) intervals, *the average illumination is not less than 0.5 lux (0.05 foot candle) and the illumination at each 1.02 m (40 inch) interval is not less than 0.1 lux (0,01 foot candle)*;	Prescriptions for general illumination
CS 25.812 (g)(1,2)	Emergency lighting	In the dark of the night, *the floor proximity emergency escape path*	Prescriptions for the floor proximity

		<u>*marking must enable each passenger to*</u>: 1)after leaving the passenger seat, <u>*visually identify the emergency escape*</u> path along the cabin aisle floor to the first exits or pair of exits forward and aft of the seat, and 2) <u>*readily identify each exit from the emergency escape path by reference*</u> <u>*only to markings and visual features not more than 1.2 m (4 ft) above the cabin floor*</u> (see AMC 25.812 (e)(2));	emergency escape path marking
CS 25.813 (a)	Emergency exit access	There must be a <u>*passageway leading from each main aisle to each Type I, Type II, or Type A emergency exit and between individual passenger areas*</u>. If two or more main aisles are provided, there must be a cross aisle leading directly to each passageway between the exit and the nearest main aisle;	Escape passageways
CS 25.813 (b)	Emergency exit access	<u>*Adequate space to allow crew-member(s) to assist in the evacuation of passengers must be provided*</u> as follows: 1) The assist space must not reduce the unobstructed width of the passageway below that required for the exit; 2) For each Type A exit, assist space must be provided at each side of the exit regardless of whether the exit is covered by CS 25.810(a); 3) For any other type exit that is covered by CS 25.810(a), space must at least be provided at one side of the passageway;	Space provisions for assisting passengers in emergency cases
CS 25.813 (c)	Emergency exit access	<u>*There must be access from each aisle to each Type III or Type IV exit*</u>, and -1) For aeroplanes that have a passenger seating configuration, excluding pilot"s seats, of 20 or more, <u>*the projected opening of the exit provided may not be obstructed and there must be no interference in opening the exit by seats, berths, or other protrusions*</u> (including seatbacks in any position) for a distance from that exit not less than the width of the narrowest passenger seat installed on the aeroplane; 2) For aeroplanes that have a passenger seating configuration, excluding pilot"s seats, of 19 or less, there may be <u>*minor obstructions*</u> in this region, if there are compensating factors to maintain the effectiveness of the exit;	Unobstructed opening position for the emergency exits
CS 25.813 (d)	Emergency exit access	If it is necessary to pass through a passageway between passenger compartments to reach any required emergency exit from any seat in the	Unobstructed passageways towards emergency exits; curtains may

<table>
<tr><td></td><td></td><td>passenger cabin, the passageway must be unobstructed. However, curtains may be used if they allow free entry through the passageway;</td><td>be used</td></tr>
<tr><td>CS 25.813 (e)</td><td>Emergency exit access</td><td>No door may be installed in any partition between passenger compartments;</td><td>No door between passenger compartments</td></tr>
<tr><td>CS 25.813 (f)</td><td>Emergency exit access</td><td>If it is necessary to pass through a doorway separating the passenger cabin from other areas to reach any required emergency exit from any passenger seat, the door must have a means to latch it in open position. The latching means must be able to withstand the loads imposed upon it when the door is subjected to the ultimate inertia forces, relative to the surrounding structure, listed in CS 25.561 (b);</td><td>Doors between pax area and other areas must be able to remain open</td></tr>
<tr><td>CS 25.832 (a)(1,2)</td><td>Cabin ozone concentration</td><td>The aeroplane cabin ozone concentration during flight must be shown not to exceed: 1) 0-25 parts per million by volume, sea level equivalent, at any time above flight level 320 and 2) 0-1 parts per million by volume, sea level equivalent, time-weighted average during any 3-hour interval above flight level 270;</td><td>Prescriptions for the ozone concentration</td></tr>
<tr><td>CS 25.832 (c)(2)</td><td>Cabin ozone concentration</td><td>The aeroplane ventilation system, including any ozone control equipment, will maintain cabin ozone concentrations at or below the limits prescribed by sub-paragraph (a) of this paragraph;</td><td>Prescriptions for the ventilation system</td></tr>
<tr><td>CS 25.851 (a)(1)</td><td>Fire extinguishers</td><td>Hand fire extinguishers (See AMC 25.851(a)). The following minimum number of hand fire extinguishers must be conveniently located and evenly distributed in passenger compartments (See AMC 25.851(a)(1)):
<table>
<tr><th>Passenger capacity</th><th>Number of extinguishers</th></tr>
<tr><td>7 to 30…</td><td>1</td></tr>
<tr><td>31 to 60…</td><td>2</td></tr>
<tr><td>61 to 200…</td><td>3</td></tr>
<tr><td>201 to 300…</td><td>4</td></tr>
<tr><td>301 to 400…</td><td>5</td></tr>
<tr><td>401 to 500…</td><td>6</td></tr>
<tr><td>501 to 600…</td><td>7</td></tr>
<tr><td>601 to 700…</td><td>8</td></tr>
</table></td><td>Emergency equipment: number of hand fire extinguishers</td></tr>
<tr><td>CS 25.851 (a)(2)</td><td>Fire extinguishers</td><td>At least one hand fire extinguisher must be conveniently located in the pilot compartment (see AMC 25.851 (a)(2));</td><td>Emergency equipment: hand fire extinguisher for pilots</td></tr>
<tr><td>CS 25.851 (a)(3)</td><td>Fire extinguishers</td><td>At least one readily accessible hand fire extinguisher must be available for use in each Class A or Class B cargo or baggage compartment and in</td><td>Emergency equipment: hand fire extinguisher for cargo</td></tr>
</table>

		each Class E cargo or baggage compartment that is accessible to crewmembers in flight;	
CS 25.851 (a)(4)	Fire extinguishers	At least *one hand fire extinguisher* must be located *in*, or readily accessible for use in, *each galley located above or below the passenger compartment*;	Emergency equipment: hand fire extinguisher for galley
CS 25.851 (a)(5)	Fire extinguishers	Each hand fire extinguisher *must be approved*	Prescriptions for hand fire extinguishers
CS 25.851 (a)(6)	Fire extinguishers	At least *one of the required fire extinguishers* located in the passenger compartment of an aeroplane with a passenger capacity of at least 31 and not more than 60, and at least *two of the fire extinguishers* located in the passenger compartment of an aeroplane with a passenger capacity of 61 or *more must contain Halon 1211* (*bromochlorodifluoromethane*), or equivalent, as the extinguishing agent. The type of extinguishing agent used in any other extinguisher required by this paragraph must be appropriate for the kinds of fires likely to occur where used;	Prescriptions for fire extinguishers: minimum number of halon based extinguishers
CS 25.851 (a)(7)	Fire extinguishers	*The quantity of extinguishing agent* used in each extinguisher required by this paragraph must be *appropriate for the kinds of fires likely to occur* where used;	Prescriptions for fire extinguishers: appropriate quantity
CS 25.851 (a)(8)	Fire extinguishers	*Each extinguisher* intended for use in a personnel compartment *must be designed to minimize the hazard of toxic gas concentration*;	Prescriptions for fire extinguishers: toxic gas concentration
CS 25.853 (a)	Compartments interiors	*Materials* (including finishes or decorative surfaces applied to the materials) *must meet the applicable test criteria prescribed in Part I of Appendix F* or other approved equivalent methods, regardless of the passenger capacity of the aeroplane;	Test criteria for materials (reference to Part I of Appendix F)
CS 25.853 (d)(1,2,3,4)	Compartments interiors	Except as provided in sub-paragraph (e) of this paragraph, *the following interior components* of aeroplanes with passenger capacities of 20 or more *must* also *meet the test requirements of parts IV and V of appendix F, or other approved equivalent method*, in addition to the flammability requirements prescribed in sub-paragraph (a) of this paragraph: 1) *interior ceiling and wall panels, other than lighting lenses and windows*; 2) *partitions, other than transparent panels needed to enhance cabin safety*; 3) *galley structure*, including exposed surfaces	Test criteria for other interior components (reference to Parts IV and V of Appendix F)

		of stowed carts and standard containers and the cavity walls that are exposed when a full complement of such carts or containers is not carried; and 4) *large cabinets and cabin stowage compartments* for stowing small items such as magazines and maps;	
CS 25.853 (e)	Compartments interiors	*The interiors of compartments*, *such as pilot compartments, galleys, lavatories, crew rest quarters, cabinets and stowage compartments*, *need not meet the standards of sub-paragraph (d) of this paragraph,* provided the interiors of such compartments are *isolated from the main passenger cabin* by doors or equivalent means that would *normally* be *closed* during an emergency landing condition;	Prescriptions for cabin interior components: isolated and closed in emergency cases
CS 25.859 (a)(3)	Combustion heater fire protection	The following *combustion heater fire zones* *must be protected from fire* in accordance with the applicable provisions of CS 25.1181 to 25.1191 and 25.1195 to 25.1203 : (…)(3) *the part of the ventilating air passage that surrounds the combustion chamber*. However, no fire extinguishment is required in cabin ventilating air passages;	Fire protection prescriptions for the combustion heater fire zones
CS 25.899 (a)	Electrical bonding and protection against static electricity	*Electrical bonding and protection against static electricity must be designed to minimise accumulation of electrostatic charge*, which would cause: 1) Human injury from electrical shock; 2) Ignition of flammable vapours or 3) Interference with installed electrical/electronic equipment;	Provisions for the protection against static electricity
CS 25.899 (b)	Electrical bonding and protection against static electricity	*Compliance with sub-paragraph (a) of this paragraph* may be shown by: 1) Bonding the components properly to the airframe or 2) Incorporating other acceptable means to dissipate the static charge so as not to endanger the aeroplane, personnel or operation of the installed electrical/electronic systems;	Means of showing compliance for protection against static electricity
CS 25.1301 (a)	Function and installation	*Each item of installed equipment* must: 1) Be of a kind and design appropriate to its intended function; 2) Be labeled as to its identification, function, or operating limitations, or any applicable combination of these factors (See AMC 25.1301 (a)(2)); 3) Be installed according to limitations specified for that equipment;	Properties for each item of installed equipment
CS 25.1301 (b)	Function and installation	*Electrical wiring interconnection* systems must meet the requirements of subpart H of this CS-25;	Prescriptions for the electrical wiring interconnection

CS 25.1309 (a)(1)	Equipment, systems and installations	*The aeroplane equipment and systems* must be designed and installed so that *those required for type certification or by operating rules*, or whose improper functioning would reduce safety*, perform as intended under the aeroplane operating and environmental conditions*;	Equipment systems designed as stated, in the type design and operating instructions
CS 25.1309 (a)(2)	Equipment, systems and installations	*The aeroplane equipment and systems* must be designed and installed so that *other equipment and systems are not a source of danger in themselves and do not adversely affect the proper functioning* of those covered by sub-paragraph (a)(1) of this paragraph;	Prescriptions for the design of equipment and systems
CS 25.1353 (a)	Electrical equipment and installations	Electrical equipment and controls must be installed so that *operation of any one unit or system of units will not adversely affect the simultaneous operation of any other electrical unit or system essential to the safe operation*. Any electrical interference likely to be present in the aeroplane must not result in hazardous effects upon the aeroplane or its systems except under extremely remote conditions (See AMC 25.1353(a));	Electrical interferences – controlled and not leading to hazard
CS 25.1353 (b)	Electrical equipment and installations	*Electrical Wiring Interconnection System components* must meet the requirements of 25.1703, 25.1707, 25 1711 and 25.1717;	Electrical Wiring Interconnection – reference to prescriptions
CS 25.1357 (a)	Circuit protective devices	*Automatic protective devices* must be used *to minimize distress to the electrical system and hazard to the aeroplane* in the event of wiring faults or serious malfunction of the system or connected equipment (See AMC 25.1357 (a));	Safety measures for electrical systems – protective devices
CS 25.1357 (c)	Circuit protective devices	*Each re-settable circuit protective device* must be *designed* so that, when an overload or circuit fault exists, it *will open the circuit irrespective of the position of the operating control*;	Safety measures for electrical systems – re-settable protective devices
CS 25.1357 (g)	Circuit protective devices	*Automatic reset circuit breakers may be used as integral protectors for electrical equipment* (such as thermal cutouts) if there is circuit protection to protect the cable to the equipment;	Safety measures for electrical systems – automatic reset circuit breakers
CS 25.1360 (a)	Precautions against injury	*Shock.* The electrical system must be designed so as *to minimize the risk of electric shock* to crew, passengers and servicing personnel and also to maintenance personnel using normal precautions (See AMC 25.1360);	Safety measures for electrical systems – electric shock
CS 25.1411 (a)	Safety equipment General	*Accessibility*. Required safety equipment to be used by the crew in an emergency must be *readily accessible*;	Accessibility prescriptions for safety equipment

CS 25.1411 (b)	Safety equipment General	_Stowage provisions._ _Stowage provisions for required emergency equipment_ must be furnished and must: 1) Be arranged so that the equipment is directly accessible and its location is obvious and 2) Protect the safety equipment from inadvertent damage;	Provisions for depositing emergency equipment
CS 25.1411 (d)(1)	Safety equipment General	_Liferafts._ _The stowage provisions for the liferafts_ described in CS 25.1415 _must accommodate enough rafts for the maximum number of occupants_ for which certification for ditching is requested;	Provisions for depositing liferafts – sufficient number
CS 25.1411 (d)(2)	Safety equipment General	_Liferafts. Life rafts must be stowed near exits_ through which the rafts can be launched during an unplanned ditching;	Provisions for depositing liferafts – near exits
CS 25.1411 (d)(3)	Safety equipment General	_Liferafts. Rafts automatically or remotely released outside the aeroplane must be attached to the aeroplane by means of the static line_ prescribed in CS 25.1415;	Provisions for leaching outer liferafts
CS 25.1411 (d)(4)	Safety equipment General	_Liferafts._ The stowage provisions for each portable life raft _must allow rapid detachment and removal of the raft for use at other than the intended exits_;	Provisions for leaching outer liferafts
CS 25.1411 (e)	Safety equipment General	_Long-range signalling device._ The stowage provisions for the _long-range signalling device_ required by CS 25.1415 must be _near an exit available_ during an unplanned ditching;	Provisions for depositing emergency equipment – long-range signaling device
CS 25.1411 (f)	Safety equipment General	_Life-preserver stowage provisions._ The stowage provisions for life preservers described in CS 25.1415 must accommodate _one life preserver for each occupant_ for which certification for ditching is requested. Each life preserver must be within _easy reach_ of each seated occupant;	Provisions for depositing emergency equipment – life-preserver
CS 25.1411 (g)	Safety equipment General	_Life line stowage provisions._ If certification for ditching under CS 25.801 is requested, there must be _provisions to store the lifelines_. These provisions must: 1) Allow one life line to be attached to each side of the fuselage and 2) Be arranged to allow the lifelines to be used to enable the occupants to stay on the wing after ditching. This requirement is not applicable to aeroplanes having no over-wing ditching exits;	Provisions for depositing emergency equipment – life line
CS 25.1415 (a)	Ditching equipment	_Ditching equipment_ used in aeroplanes to be certified for ditching under CS 25.801, and required by the Operating Rules, _must meet the requirements of this paragraph_;	Provisions for ditching equipment (reference)
CS 25.1415	Ditching equipment	_Each liferaft and each life preserver_	Provisions for

(b)		*must be approved*. In addition: 1) Unless excess rafts of enough capacity are provided, the buoyancy and seating capacity beyond the rated capacity of the rafts must accommodate all occupants of the aeroplane in the event of a loss of one raft of the largest rated capacity; and 2) Each raft must have a trailing line, and must have a static line designed to hold the raft near the aeroplane but to release it if the aeroplane becomes totally submerged;	ditching equipment – liferafts
CS 25.1415 (c)	Ditching equipment	*Approved survival equipment* must be attached to, or stored adjacent to, each liferaft;	Provisions for ditching equipment – survival equipment
CS 25.1415 (d)	Ditching equipment	There must be *an approved survival type emergency locator transmitter* for use in one life raft;	Provisions for ditching equipment – ELT for liferafts
CS 25.1415 (e)	Ditching equipment	For aeroplanes, not certificated for ditching under CS 25.801 and not having approved life preservers, *there must be an approved flotation means for each occupant*. This means must be within easy reach of each seated occupant and must be readily removable from the aeroplane;	Provisions for ditching equipment – flotation means
CS 25.1421	Megaphones	If a megaphone is installed, a restraining means must be provided that is capable of *restraining the megaphone when it is subjected to the ultimate inertia forces* specified in CS 25.561 (b)(3);	Restraining means prescriptions for megaphones
CS 25.1423 (g)	Public address system	*For each required floor-level passenger emergency exit* which has an adjacent cabin crew member seat, have a *microphone* which *is readily accessible to the seated cabin crew member*, except that one microphone may serve more than one exit, provided the proximity of the exits allows unassisted verbal communications between seated cabin crew members;	Prescriptions for PA system: microphone availability
CS 25.1439 (a)	Protective breathing equipment	*Fixed* (stationary, or built in) *protective breathing equipment must be installed* for the use of the flight crew, and *at least one portable protective breathing equipment shall be located at or near the flight deck for use by a flight crew member*. In addition, portable protective breathing equipment must be installed for the use of appropriate crew members for fighting fires in compartments accessible in flight other than the flight deck. This includes isolated compartments and upper and lower lobe galleys, in	Prescriptions for breathing equipment – number and location, for flight crew members

		which crew member occupancy is permitted during flight. Equipment must be installed for the maximum number of crew members expected to be in the area during any operation;	
CS 25.1439 (b)(1)	Protective breathing equipment	The equipment must be designed *to protect the appropriate crewmember from smoke, carbon dioxide, and other harmful gases* while on flight deck duty or while combating fires;	Prescriptions for breathing equipment – for crew members
CS 25.1439 (b)(2)	Protective breathing equipment	*The equipment must include*: i) Masks covering the eyes, nose and mouth or ii) Masks covering the nose and mouth, plus accessory equipment to cover the eyes;	Prescriptions for breathing equipment – type of masks
CS 25.1439 (b)(3)	Protective breathing equipment	*Equipment*, including portable equipment, *must allow communication with other crewmembers while in use*. Equipment available at flight crew assigned duty stations must enable the flight crew to use radio equipment;	Prescriptions for breathing equipment – communication for crew members
CS 25.1439 (b)(4)	Protective breathing equipment	The part of the equipment protecting the eyes *must not cause any appreciable adverse effect* on vision and must allow corrective glasses to be worn;	Prescriptions for breathing equipment – protection for the eyes
CS 25.1439 (b)(5)	Protective breathing equipment	The equipment must supply *protective oxygen* of *15 minutes* duration per crewmember *at a pressure altitude of 2438 m* (8000 ft) with a respiratory minute volume of 30 litres per minute BTPD;	Prescriptions for breathing equipment – O_2 quantity
CS 25.1441 (a)	Oxygen equipment and supply	If certification with *supplemental oxygen equipment* is requested, the equipment must meet *the requirements of this paragraph and CS 25.1443 through 25.1453*;	Prescriptions for breathing equipment – supplemental oxygen equipment
CS 25.1441 (b)	Oxygen equipment and supply	*The oxygen system must be free from hazards* in itself, in its method of operation, and in its effect upon other components;	Prescriptions for breathing equipment – O_2 system free of hazards
CS 25.1443 (d)	Minimum mass flow of supplemental oxygen	If first-aid oxygen equipment is installed, *the minimum mass flow of oxygen to each user may not be less than 4 litres per minute, STPD*. However, there may be means to decrease this flow to *not less than 2 litres per minute*, STPD, at any cabin altitude. The quantity of oxygen required is based upon an average flow rate of 3 litres per minute per person for whom first-aid oxygen is required;	Prescriptions for breathing equipment - minimum mass flow of O_2
CS 25.1447 (c)(1)	Equipment standards for oxygen dispensing units	There must be an *oxygen-dispensing unit* connected to oxygen supply terminals immediately available to each occupant, wherever seated(…).The crew must be	Prescriptions for breathing equipment – oxygen-dispensing unit – number and availability

		provided with a *manual means* to make the dispensing units immediately available in the event of failure of the automatic system. The total number of dispensing units and outlets *must exceed the number of seats by at least 10%;*	
CS 25.1447 (c)(4)	Equipment standards for oxygen dispensing units	*Portable oxygen equipment* must be immediately *available for each cabin crewmember*;	Prescriptions for breathing equipment – portable oxygen equipment – availability
CS 25.1541 (a)	Markings and placards General	The aeroplane must contain: 1) *The specified markings and placards* and 2) *Any additional information, instrument markings, and placards required for the safe operation* if there are unusual design, operating, or handling characteristics;	Provisions for markings and placards – availability
CS 25.1541 (b)	Markings and placards General	*Each marking and placard* prescribed in sub-paragraph (a) of this paragraph: 1) *Must be displayed in a conspicuous place* and 2) *May not be easily erased, disfigured, or obscured*;	Provisions for markings and placards – location
CS 25.1557 (a)	Miscellaneous markings and placards	*Baggage and cargo compartments and ballast location*. *Each baggage and cargo compartment*, and each ballast location *must have a placard stating any limitations on contents*, including weight, that are necessary under the loading requirements […].	Provisions for baggage and cargo marking
CS 25.1557 (c)	Miscellaneous markings and placards	*Emergency exit placards.* Each *emergency exit placard* must meet the requirements of CS 25.811;	Provisions for emergency exit placards
CS 25.1561 (b)	Safety equipment	*Each location*, such as a locker or compartment, *that carries* any fire extinguishing, signalling, or other *lifesaving equipment must be marked accordingly*;	Marking provisions – safety equipment
CS 25.1561 (c)	Safety equipment	*Stowage provisions* for required emergency equipment *must be conspicuously marked* to identify the contents and facilitate the easy removal of the equipment;	Marking provisions – stowage for safety equipment
CS 25.1561 (e)	Safety equipment	*Approved survival equipment must be marked* for identification and method of operation	Marking provisions – approved survival equipment
Appendix F (a)(1)(i)	Part I Criteria and Procedures for Showing Compliance with CS 25.853, 25.855 or 25.869	*Interior ceiling panels, interior wall panels, partitions, galley structure, large cabinet walls, structural flooring, and materials used in the construction of stowage compartments* (other than underseat stowage compartments and compartments for stowing small items such as magazines and maps) *must be self-extinguishing when tested vertically in accordance with the applicable portions of Part I of this Appendix*. The average burn	Fire protection provisions for cabin interior components

		length may not exceed 15 cm (6 inches) and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 3 seconds after falling;	
Appendix F (a)(1)(ii)	Part I Criteria and Procedures for Showing Compliance with CS 25.853, 25.855 or 25.869	_Floor covering, textiles_ (including draperies and upholstery)_, seat cushions, padding, decorative and non-decorative coated fabrics, leather, trays and galley furnishings, electrical conduit, thermal and acoustical insulation and insulation covering, air ducting, joint and edge covering, l_iners of Class B and E _cargo or baggage compartments, floor panels_ of Class B, C, D, or E cargo or baggage compartments, _insulation blankets, cargo covers and transparencies, moulded and thermoformed parts, air ducting joints, and trim strips_ (decorative and chafing), that are constructed of materials not covered in sub-paragraph (iv) below, must be _self-extinguishing when tested vertically in accordance with the applicable portions of Part I of this Appendix or other approved equivalent means_. The average burn length may not exceed 20 cm (8 inches), and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 5 seconds after falling;	Fire protection provisions for other cabin interior components
AMC 25.851 (a)(1) (1)	Fire Extinguishers	_The number and location of hand fire extinguishers_ should be such as _to provide adequate availability for use_, account being taken of the number and size of the passenger compartments and the location of toilets, galleys, etc. These considerations may result in the number being greater than the minimum prescribed;	Number and location of hand fire extinguishers
AMC 25.851 (a)(1) (2)	Fire Extinguishers	Where _only one hand extinguisher is required_ it should be _located at the cabin crew member station_, where provided, _otherwise near the main entrance door_.	If only one hand extinguisher is required – location provisions
AMC 25.851 (a)(1) (3)	Fire Extinguishers	Where _two or more hand extinguishers are required_ and their location is not otherwise dictated by consideration of paragraph 1 above, _an extinguisher should be located at each end of the cabin and the remainder distributed throughout the_	Two or more hand extinguishers – distribution provisions

		<u>*cabin*</u> as evenly as is practicable.	
AMC 25.851 (a)(2)	Fire Extinguishers	There should be at least <u>*one fire extinguisher suitable for both flammable fluid and electrical equipment fires installed in each pilot"s compartment*</u>. Additional extinguishers may be required for the protection of other compartments accessible to the crew in flight (e.g. electrical equipment bays) or from consideration of CS 25.851(a)(2);	Type of fire extinguishers – provisions
AMC 25.851 (b)(5)(a)	Built-in Fire Extinguishers – Compartment Classification	<u>*A Class A compartment*</u> is one that <u>*is located so close to the station*</u> of a crewmember <u>*that the crewmember would discover the presence of a fire immediately.*</u> In addition, each part of the compartment is easily accessible so that the crewmember could quickly extinguish a fire with a portable fire extinguisher. A Class A compartment is not required to have a liner;	Class classification with respect to fire protection – Class A provisions
AMC 25.851 (b)(5)(b)	Built-in Fire Extinguishers – Compartment Classification	<u>*A Class B compartment*</u> is one that is more remote than a Class A compartment and <u>*must*</u>, therefore, <u>*incorporate a fire or smoke detection system to give warning at the pilot or flight engineer station*</u>. Because a fire could not be detected and extinguished as quickly, <u>*a Class B compartment must have a liner in accordance with CS 25.855*</u>;	Class classification with respect to fire protection – Class B provisions
AMC 25.851 (b)(5)(c)	Built-in Fire Extinguishers – Compartment Classification	<u>*A Class C compartment*</u> differs from a Class B compartment in that it is not required to be accessible in flight and <u>*must*</u>, therefore<u>*, have a built-in fire extinguishing system to suppress or control any fire occurring therein*</u>. A Class C compartment must have a liner and a fire or smoke detection system in accordance with CS 25.855 and 25.857	Class classification with respect to fire protection – Class C provisions
AMC 25.851 (b)(5)(d)	Built-in Fire Extinguishers – Compartment Classification	<u>*FAR Amendment 25-93 removed the Class D cargo compartment classification*</u> for new aeroplanes effective March 19, 1998	Class classification with respect to fire protection – Class D provisions
AMC 25.851 (b)(5)(e)	Built-in Fire Extinguishers – Compartment Classification	<u>*A Class E compartment is particular to an all-cargo aeroplane*</u>. Typically, a Class E compartment is the entire cabin of an all-cargo aeroplane; however, other compartments of such aeroplanes may be classified as Class E compartments. A fire in a Class E compartment is controlled by shutting off the ventilating airflow to or within the compartment. <u>*A Class E compartment must have a liner and a fire or smoke detection system installed in accordance with CS 25.855;*</u> however, it is not required to have a built-in fire suppression	Class classification with respect to fire protection – Class E provisions

		system;	
AMC 25.853	Compartment interiors	*Relevant part of the FAA Advisory Circular 25-17 Transport Airplane Cabin Interiors Crashworthiness Handbook*, dated 15/7/91, AC 25.853-1 dated 17/9/86 and AC 25-18 dated 6/1/94 *are accepted by the Agency as providing acceptable means of compliance with CS 25.853*;	Cabin Interior components – crashworthiness provisions – reference to FAA
AMC 25.857	Cargo Compartment Classification	*Relevant part of the FAA Advisory Circular 25-17 Transport Airplane Cabin Interiors Crashworthiness Handbook*, dated 15/7/91, AC 25-9A Smoke Detection, Penetration, and Evacuation Tests and Related Flight Manual Emergency Procedures, dated 6/1/94, and AC 25-18 Transport Category Airplanes Modified for Cargo Service, dated 6/1/94, and AC 25-18 Transport Category Airplanes Modified for Cargo Service, dated 6/1/94 *are accepted by the Agency as providing acceptable means of compliance with CS 25.857*;	Cargo compartment classification – provisions – reference to FAA
AMC 25.1360 (b)	Precaution Against Injury	1) *For equipment which has to be handled during normal operation* by the flight or cabin crew, *a temperature rise of the order of 25°C, for metal parts, should not be exceeded*. For other equipment, mounted in parts of the aeroplane normally accessible to passengers or crew, or which may come into contact with objects such as clothing or paper, *the surface temperature should not exceed 100°C*, in an ambient temperature of 20°C; 2)The heating surfaces of properly installed cooking apparatus are excluded from these requirements; 3) The provision of guards around hot surfaces is an acceptable method of complying with these requirements;	Temperature prescriptions for equipment
AMC 25.1447 (c)(4)	Equipment Standards for Oxygen Dispensing Units	1) *The equipment* should be so *located* as to be *within reach* of the *cabin crewmembers* while seated and restrained at their seat stations; 2) *The mask/hose assembly* should be already *connected to the supply source*, and oxygen should be delivered with no action being required except turning it on and donning the mask; 3) Where a cabin crewmember"s work area is not within easy reach of the equipment provided at his seat station, *an additional unit should be provided at the work area*;	Provisions for the O_2 units

AMC 25.1721 (a)	Protection of EWIS	Special consideration should be given to _EWIS_ that are routed to, around, and on passenger seats. It should be _protected_ so that _passengers cannot damage it_ with their feet or access it with their hands;	Prescriptions for EWIS – location – out of passenger reach
AMC 25.1721 (b)	Protection of EWIS	_EWIS located in the lavatories should not be readily accessible by passengers or aircraft cleaners_. It should be designed and installed so that it cannot be damaged by the removal and replacement of items such as rubbish containers;	Prescriptions for EWIS – location – out of aircraft cleaners reach
AMC 25.1721 (c)	Protection of EWIS	_EWIS located in the galleys should not be readily accessible by cabin crew, aircraft cleaners, or passengers_. EWIS should be designed and installed so that galley equipment, including galley carts, cannot come into contact with it and cause damage;	Prescriptions for EWIS – galley location – out of passenger and aircraft cleaners reach
AMC 25.1721 (d)	Protection of EWIS	As with EWIS located in baggage and cargo compartments, _EWIS in areas such as landing gear bays, the APU compartment, and electrical and electronic bays should be designed and installed to minimize potential for maintenance personnel stepping, walking, or climbing on them._ Where the structure does not afford adequate protection, other protection such as a mechanical guard should be provided;	Prescriptions for EWIS – location – out of maintenance personnel reach
AC No: 20-60 (3)	Accessibility to excess emergency exits	_Background._ The referenced regulations require, in part, that _excess emergency exits be „readily accessible"_;	Provisions for excess emergency exits – accessibility
AC No: 20-60 (4)(a)	Accessibility to excess emergency exits	_Acceptable Means of Compliance._ A Type I or Type II excess emergency exit is _„readily accessible"_ under the referenced regulations _if access is provided from the aisle_: (1) by means of an unobstructed passageway at least 20 inches wide; (2) by means of an unobstructed passageway at least 20 inches wide at the outboard seat location and at least 15 inches wide at the inboard seat locations; or (3) by removing the outboard seat nearest the centreline of the exit, and by establishing two unobstructed passageway (one forward, and one aft, of the row from which the outboard seat was removed) each at least 8 inches wide;	Provisions for the access to emergency exits
AC No: 20-60 (4)(b)	Accessibility to excess emergency exits	_A Type III or Type IV excess emergency exit is „readily accessible" if access is provided from the aisle in_	Definition of „readily accessible" emergency exit

		<u>*accordance with FAR 25.813 (c) or FAR 121.310 (f)(3)*</u> except that the outboard seat back (as well as the inboard seat backs) may obstruct the projected exit opening when reclined;	
AC No: 25.807 (3)(a)	Uniform Distribution of Exits	When considering the exit distribution, <u>*both passenger distribution and the placement of exits along the length of the passenger compartment should be considered*</u>. Other factors such as types of exits installed and maintenance of reasonable separation between adjacent exits should also be considered;	Exit distribution must be made according to the number of passengers
AC No: 25.807 (3)(d)	Uniform Distribution of Exits	Amendments 25-6/ and 121-205 were adopted June 13, 1989, effective July 24, 1989, specifying <u>*a maximum distance of no more than 60 feet between adjacent exits.*</u> This new requirement must be complied with as well as the requirement for uniformly distributed exits when developing exit configurations;	Amendment for the uniform distribution of exits
AC No: 25.807 (4)(a)	Uniform Distribution of Exits	<u>Passenger zone.</u> <u>*A section of the passenger cabin*</u> which is <u>*bounded longitudinally by a pair of exits on both ends*</u> or, in instances where there are passenger seats installed beyond the most forward or most aft pair of exits, <u>*a section of the passenger cabin bounded by the start or end of the passenger cabin and the nearest pair of exits*</u>. Airplanes with ventral or tail cone exits which allow for an increase in passenger seating beyond Tables 1 and/or 2 (see paragraph 5a for explanation of tables) can have this unpaired exit be the aft bound of the last zone. Exit centrelines or the centreline of the front tie-down of the passenger seat furthest from the exit, for the second type of zone discussed above, should be used for determining the actual start or finish of a zone;	Definition of the passenger zone
AC No: 25.807 (4)(b)	Uniform Distribution of Exits	<u>Exit rating.</u> <u>*The increase in passenger seating configuration allowed by the installation of a pair of that type of exit, as listed in CS 25.807 (c)(2), Amendment 25-39*</u>. For example, the exit rating for a pair of Type A exits is 110. For airplanes whose maximum capacity is determined by Table 1 (see paragraph 5a), the rating of the Type I exits varies (see paragraph 6a (1) for method of determining rating). Ratings for the generally unpaired ventral or tail cone exits are as	Definition of exit rating

		determined by CS 25.807 (c)(4);	
AC No: 25.807 (4)(c)	Uniform Distribution of Exits	Maximum passenger seating configuration (or maximum passenger capacity). The theoretical maximum number of passenger seats that can be installed in an airplane *based upon the exit configuration and the exit ratings* of CS 25.807 (c);	Definition of maximum passenger capacity
AC No: 25.807 (4)(d)	Uniform Distribution of Exits	Passenger cabin length. *Usually the distance from the centreline of the forward most exit to the centerline of the aft most exit in the airplane* (…). If there are four or more rows of passenger seats located beyond the most forward or most aft exits, then the cabin starts or ends at the centerline of the front stud of the most forward and/or most aft passenger seat. For airplanes with tail cone or ventral exits, for which additional passenger capacity has been given or is being sought, the end of the cabin should be considered to be the bulkhead through which the passengers must pass in order to gain access to the tail cone opening or ventral stairs;	Definition of passenger cabin length
AC No: 25.807 (4)(e)	Uniform Distribution of Exits	Exit unit. *A dimensionless number that is related to the exit rating of a pair of exits of the same type and uses the rating of the Type III exit (35) as the baseline*. The exit unit value of a pair of exits is *determined by* dividing the rating of the exit by 35 and rounding the value down to the next quarter of a unit. Typical values for exits (rating shown in parentheses) are as follows: (1) Type III (35) and Type II (40) -1.0; (2) Two pairs of Type III exits which are located within three rows of each other (70) – 2.0; (3) Type I (45) – 1.25; (4) Oversized Type I with dual slide, so-called Type „B" (80) – 2.25 or (75) – 2.0; (5) Type A (110) – 3.0;	Definition of the exit unit
AC No: 25.807 (4)(f)	Uniform Distribution of Exits	Fuselage length factor. A length *determined by dividing the length of the passenger cabin by the sum of the exit units* in each zone in the airplane;	Definition of the length factor
AC No: 25.807 (4)(g)	Uniform Distribution of Exits	Exit offset. *The distance between the proposed exit centerline and the calculated exit centerline* using paragraph 6b(2);	Definition of the exit offset
AC No: 25.807 (4)(h)	Uniform Distribution of Exits	Individual zone passenger capacity. The *maximum number of passengers which may be seated in an individual zone.* That number is the *sum of the*	Definition of the individual zone passenger capacity

		ratings of the exits which bound the zone. Note: For airplanes with more than one zone, the sum of all the individual zone passenger capacities will exceed the allowable maximum passenger seating configuration. This is because non-end-of-cabin exit ratings will be double counted;	
AC No: 25.807 (4)(i)	Uniform Distribution of Exits	Sequential zone passenger capacity. *The maximum number of passengers which may be seated* in two or more adjacent zones. That number is the sum of the ratings of the exits which either bound or are included within the adjacent zones	Definition of the sequential zone passenger capacity