

CERTIFICATION - The final and critical stage of every civil or military aviation program

Constantin OLIVOTTO*¹, Simion TATARU¹, Vasile STEFAN¹

*Corresponding author

*¹Aerospace Consulting, B-dul Iuliu Maniu 220, Bucharest 061126, Romania
colivotto@incas.ro

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Abstract: *As a general rule the final step in every aviation program is the certification of the airplane, an important step in which the airplane, the engines and the equipments are checked by an authority or commission according to the airworthiness rules. The main scope of the certification is to promote a safe aviation product and to protect the general public from unnecessary risk. In all the countries the national authorities require a civil certificability for all the parts or equipments and a full aircraft certification for a new or wholly modified airplane. The military aircrafts must pass and respond to a specific way of certification and many actual efforts are done in order to unify the different national rules in this field. This paper presents the existing situation in the certification of civil and military airplanes and the actual measures done for the unification of certification procedures in the world.*

Key Words: *civil certification, military certification, airworthiness standards, type certificates for airplanes, MAWA (Military Airworthiness Authorities).*

1. A SHORT HISTORY OF AVIATION CERTIFICATION

The aviation started at the beginning of the XX-th century with the flights made by some dedicated personalities like Orville Wright, Traian Vuia, Bleriot, Coanda and after them many other personalities succeeded in this new conquest of the aerial space. The technical progress was important in very short time and during of the World War I, the airplane was used as a military vehicle for fight, bombardment and reconnaissance.

The first International Civil Aviation conference, was held in 1910 when was attended by European governments. The second conference was held in Paris in 1919 and the International Commission for Air Navigation was created. [2]

In the time of peace after the war the early airmail service started in USA and Europe and the aviation started to be used in many commercial applications, but in general this early aviation progress was done with many human losses and with the many crashed airplanes.

In the Second World War the technical level of the aviation civil and military aviation got an extraordinary progress and integrated a lot of new mechanical, hydraulic, electrical and electronic systems.

The other major goal of all the countries was to establish some common standards in the aviation in order to realize a high level of safety for the aerial transport.

In this idea in 1944 in USA – Chicago, was held the Convention on International Civil Aviation. The documents made and signed by the representatives of 52 states established the formation of International Civil Aviation Organization (ICAO), a specialized agency of the United Nations charged with coordination and regulation of the international air transport.[1] The Convention establishes the rules of aircraft registration and safety, and details the rights of the signatories in relation to air transport. The Convention has since been revised eight times (in 1959, 1963, 1969, 1975, 1980, 1997, 2000 and 2006).[12]

The Convention on International Civil Aviation establish that ICAO will supervise "order in the air", obtain maximum technical standardization for international aviation, recommends certain practices that member countries should follow, and carry out other functions. Countries ratifying or acceding to the convention thereby agreed in advance to conform to the greatest possible extent to ICAO-adopted civil aviation standards and to endeavor according to ICAO-adopted recommendations. The Chicago Convention affirms every state's "complete and exclusive sovereignty over the airspace above its territory".

For the Civil Aviation in the USA, the President Franklin Roosevelt signed the Civil Aeronautics Act in 1938. The legislation established an independent Civil Aeronautics Authority (CAA), with a three-member Air Safety Board, that would conduct accident investigations and recommend ways of preventing accidents. The state documents expanded the government's role in civil aviation by giving CAA power to regulate airline fares and determine the routes individual carriers served. In 1940 President Roosevelt split the CAA into two agencies, the Civil Aeronautics Administration, which went back to the Department of Commerce, and the Civil Aeronautics Board (CAB). The offshoot of the original CAA retained responsibility for Air Traffic Control (ATC), crew members and aircraft certification, safety enforcement, and airway development.[3] CAB responsibilities included safety rulemaking, accident investigation, and economic regulation of the airlines. In August 23, 1958 it was signed the Federal Aviation Act, which transferred the Civil Aeronautics Authority's functions to a new independent Federal Aviation Agency (FAA) responsible for civil aviation safety. On November 1, 1958, retired Air Force General Elwood "Pete" Quesada became the first FAA Administrator sixty days later, on December 31, FAA began operations.[6]

In Europe, in 1970 the Joint Aviation Authorities (JAA) was establish as an asociated body of the European Civil Aviation Conference (ECAC) or Conférence Européenne de l'Aviation Civile (CEAC). ECAC was an intergouvernemental organization founded in 1955 and coordonated by the International Civil Organization (ICAO) and the Council of Europe.[5] The Joint Aviation Authorities was created as an associated body of the ECAC representing the Civil Aviation Regulatory Authorities of a number of European States who had agreed to co-operate in developing and implementing common safety regulatory standards and procedures. The basic idea of JAA was the unification of the aviation standards from all the european states at a high level of safety and establish general accepted rules for the aerial navigation over the Europe. Other objectiv was to harmonize the JAA regulations with those of the USA.[7]

On 15 July 2002 the European Aviation Safety Agency (EASA) was created as an independent agency of the European Union and reached full functionality in 2008.

In his documents are stipulated the main responsibilities, as folows:

- to give advice to the European Union for establish a new legislation for the civil aviation field;
- to implement and to monitor safety rules, including inspections in the Member States;
- to establish type-certification of aircraft and components, as well as the approval of organisations involved in the design, manufacture and maintenance of aeronautical products;
- to give authorization of third-country (non EU) operators;
- to made safety analysis and research.

It is very interested to compare the JAA objectives with the EASA objective and powers. The objectives of JAA are:

- to assure a high uniform level of safety for all the parts involved in civil aviation:
 - Design and Manufacture;
 - Operation and maintenance of aircrafts;
 - Licensing of the aviation personnel.
 - to maintain a good cost-effective system for all the activities;
 - to jointly implement the JAR documents using 'Joint Implementation Procedures' (JIP) for standardisation;
 - to establish procedures for Joint Certification (Multinational and Local);
 - to distribute and contribute to the free circulation of the documents JAA;
 - to limit the aircraft noise and emissions.
- The EASA objectives are: [13], [14]
- to obtain and maintain a high uniform level of safety by generating unified standards at European level for:
 - Type Certificate for aircraft;
 - Certification for aviation parts and appliances;
 - Environmental certificates;
 - Design Organisation Approvals.
 - to survey and give approvals for all state-members in the field of Maintenance and Production Organisation;
 - to assure an uniform level of the environmental protection;
 - to promote a general efficiency of the cost;
 - to assist the members in fulfilling their obligations under Chicago Convention.

The EASA has tasks for unification in the field of rules and procedures for others civil aviation operations such us: Licensing of Air Crews and Certification of non-Member State Airlines.

Apparently the EASA Agency is the successor of Joint Aviation Authorities, but it is a major difference in the power between the EASA and the JAA. JAA have not the legislation authority over the National Aviation Authorities. EASA as a new agency has the total authority to impose his rules. The National Aviation Authorities in each country is still responsible for approving production, maintenance, and training in each particular country but must follow the guidance and rules of the EASA.

The EASA Agency is in charge to unify at European level the documents and rules for quality and standardization in the production and design of aeronautical parts, issuing primary certification for aircrafts and approve maintenance organization. EASA approve the system of pilots qualification, procedures for obtaining licenses and the training system. This change in the national agency responsibilities is considered mandatory in actual conditions when the aerial traffic over the Europe has attend high values and the rules for safety must be the same for all the entities involved in this area for civil aviation operations.

2. CIVIL CERTIFICATION

By joining ICAO, EASA or others international aviation organisation all the states must collaborate in order to attend a high degree of uniformity in regulations, standards, procedures and organization in all matters concerning civil aviation.

A standard, as is defined by the first ICAO Assembly, is "any specification for physical characteristics, configuration, material, performance, personnel, or procedures who by his uniform application is recognized as *necessary* for the safety or regularity of international air navigation and to which member states *will conform*". Standards can include too

specifications for all others matters in aviation as the length of runways, the materials used in aircraft construction, the qualifications required for a pilot flying on an international route.[4]

A recommendation is any such specification, the uniform application of which is recognized as *"desirable in the interest of safety, regularity, or efficiency of international air navigation and to which member states will endeavor to conform"*.

Preparing and revising these standards and recommendations is largely the responsibility of ICAO's Air Navigation Commission, which plans, coordinates, and check up all activities in the field of air navigation.

The various standards and recommendations that have been adopted by ICAO are grouped into 18 annexes at the Chicago Convention. The 18 annexes are the following:

1. Personnel Licensing—licensing of flight crews, air traffic controllers, and aircraft maintenance personnel;
2. Rules of the Air—rules relating to the conduct of visual and instrument flights;
3. Meteorological Services—provision of meteorological services for international air navigation and reporting of meteorological observations from aircraft;
4. Aeronautical Charts—specifications of aeronautical charts for use in international aviation;
5. Units of Measurement—dimensional systems to be used in air-ground communications;
6. Operation of Aircraft. Part I: International Commercial Air Transport; Part II: International General Aviation; Part III: International Operations—Helicopters. These specifications will ensure in similar operations throughout the world a level of safety above a prescribed minimum;
7. Aircraft Nationality and Registration Marks - requirements for registration and identification of aircraft;
8. Airworthiness of Aircraft - certification and inspection of aircraft according to uniform procedures;
9. Facilitation - simplification of customs, immigration, and health inspection regulations at international airports;
10. Aeronautical Telecommunications - standardization of communications equipment and systems and of communications procedures;
11. Air Traffic Services - establishment and operation of air traffic control, flight information, and alerting services;
12. Search and Rescue - organization and operation of facilities and services necessary for search and rescue;
13. Aircraft Accident Investigation - uniformity in the notification, investigation, and reporting of aircraft accidents;
14. Aerodromes - specifications for the design and equipment of aerodromes;
15. Aeronautical Information Services - methods for the collection and dissemination of aeronautical information required for flight operations;
16. Environmental Protection. Vol. I: Aircraft Noise - specifications for aircraft noise certification, noise monitoring, and noise exposure units for land-use planning. Vol. II: Aircraft Engine Emissions - standards relating to vented fuel and emissions certification requirements;
17. Security - specifications for safeguarding international civil aviation against acts of unlawful interference;
18. Safe Transport of Dangerous Goods by Air - specifications for the labeling, packing, and shipping of dangerous cargo.

ICAO studies many other important subjects, such as all-weather operations, supersonic evolutions, application of space techniques to aviation, automated-data interchange systems, and visual aids.

From the start the general civil approach in the aviation certification is to verify by specific tests the aircraft materials, the equipment and systems attending in final the aircrafts. Other approach in the aviation is to define an acceptable risk and after to prove the system compliance to this acceptable risk.

An important and definitory notion in the civil certification is Airworthiness concept. Airworthiness is a technical term used to qualify if an aircraft has been certified as suitable for executing safe flight. This certification is initially conferred by a Certificate of Airworthiness.

Other document essential is the Type Certificate (TC) that is awarded by an aviation regulating bodies to an aerospace manufacturers after it has been established that the particular design of a civil aircraft, engine, or propeller has fulfilled the regulating bodies' current prevailing airworthiness requirements for the safe conduct of flights under all normally conceivable conditions.

In general a Type Certificate is a design approval issued by the Civil Aviation Authority (CAA) of a given country (such a FAA for the US and EASA for Europe) when the applicant demonstrates that his product complies with the applicable regulations. The TC normally includes the type design, the operating limitations, the Type Certificate Data Sheet (TCDS), the applicable regulations, and other conditions or limitations prescribed by the CAA.

Type Certificate are normally issued for aviation airframes, engines and propellers. The Type Certificate is the foundation for other approvals, including production and airworthiness approvals.

A Supplemental Type Certificate (STC) is issued by the aviation Authority approving a product (aircraft, engine, or propeller) modification. The STC defines the product design change, states how the modification affects the existing type design, and lists serial number effectivity. It also identifies the certification basis listing specific regulatory compliance for the design change.

Some importants documents for the civil certification of the aircrafts issued in USA are the Federal Aviation Regulation nominated as:

- FAR-Part 23 – Airworthiness Standards: Normal, Utility, Acrobatic and Commuter Airplanes;
- FAR-Part 25 – Airworthiness Standards: Transport Category Airplanes;
- FAR-Part 27 – Airworthiness Standards: Normal Category Rotorcraft;
- FAR-Part 29 – Airworthiness Standards: Transport Category Rotorcraft.

In the FAR - Part 23 are explicitated airworthiness standards for airplanes in the normal, utility, aerobatic, and commuter categories. This standards has a large number of regulations to ensure airworthiness in areas such as structural loads, airframe, performance, stability, controllability, and safety mechanisms, how the seats must be constructed, oxygen and air pressurization systems, fire prevention, escape hatches, flight management procedures, flight control communications, emergency landing procedures, and other limitations, as well as testing of all the systems of the aircraft.

In EASA, according with the work system, the Agency must issue certification specifications, including airworthiness codes and acceptable means of compliance, as well as guidance material to be used in the certification process of all elements and for the entire airplanes. One of the basic document of EASA is Certification Specifications for Normal, Utility, Aerobatic and Commuter Category Aeroplanes indicative CS-23.

In this documents it is specified the Airworthiness Code for aircrafts concerning general elements, flight performance, elements of structure, rules for design and construction, powerplant specifications, equipment and operating limitations.[11]

The Aviation Civil Authority from each country must survey if all the organisations, factories, operators and other entities are in respect with the European rules.

3. MILITARY CERTIFICATION

Military aviation is an important factor in security and defence of each states. The force is impresionant, but the military aviation in Europe is formed by many entities, many types of aircrafts and use a huge variety of weapons. In the field of military aviation each country operate with a separate aviation safety systems independently from each other and each country is individually responsible for the regulation and safety of its aircrafts. All military airworthiness activities are conducted and regulated on a national basis and harmonisation is only achieved at cooperation level in commun project level and repeated again for each new project.

In general most military authorities have not published military airworthiness design standards for an acceptable level of safety. Their demands are based on civil regulatory standards like FARs, CARs, JARs, etc.[8]

Actually in Europe the national defence organisations are paying more and more attention to aviation safety because in actual times the military and civil operations are more and more interrelated and the responsibility of military organisations rised the level of safety for their personnel, organisations and equipments.

International regulations and standards for military aviation safety are in general more limited that the civil regulation , the various defense organisations have different views on the subject, which leads to diversity in organisational structure of military aviation safety. [10]

The Military Certification is not equivalent to the Civil Certification, it concern the general concept of airworthiness, rules for design, imposed performances, specific elements in the design of systems and others procedures releted to their missions. Each Governments have his rules for “Self-Certify” the state of military aircraft as airworthy and in order to compliant to some specified and controlled airspace performance requirements. In the rules for military aircrafts the operation risk and time of use is defined for each type of aircraft. In the national documents the conditions for acceptance in specific tasks and the risk levels can vary with aircraft purpose and type.

In general for the military airplans the military specification and documents nominate some specified elements like :

- Handling qualities;
- Weapons, amunition stores and self defence suites;
- Specific operations in wartime;
- Military role & mission and tasks;
- Operational field and usage environment.

In USA the document MIL-STD-882 is the general document of DoD for standard practice and is considered as a basic document for all the system to be use in military purpose.

The last edition of MIL-STD-882D was edited on 10 Feb 2000 February 10 and the draft of the new version of this standard is MIL-STD-882D Change 1 (draft) dated March 2010.

The scope and idea of this military standard is simple and was presented by an official as "what you want vs. how to do it".

Military Qualification concern the whole platform, the propulsion, the equipments, the weapon system, from its component elements, the design characteristics up to its operational use. This qualification requires the knowledge of a large variety of engineering disciplines such as flight performances, handling qualities, structures, avionics and mission systems, software, human factors, safety, test installations and instrumentation.

The military qualification of an aircraft (or part of an aircraft) constitutes the process of verifying that a specific aircraft configuration complies with a specified set of requirements, taking into account its intended operational use.

In general there are two parts of the military qualification procedures:

1. Military airworthiness qualification is an activity concerning to verify the compliance with applicable airworthiness requirements;
2. Military Performance qualification has the activities consisting in the compliance with contractual performance and functional requirements.

Each qualification process is individualized and conducted by a commission nominated by the MoD in accordance with the following steps:

- A first verification is concerning if the product correspond generally with the document with requirements issued at the start by the Ministry of Defence. The documents must contain specified product configuration, its qualification status and the applicable requirements and rules for use;
- A second document is done concerning the verification methods that will be used and the activities that will be performed to demonstrate compliance with each requirement made by the MoD.;
- Determination of performances and product demonstration in experimental verification and tests activities. The results are all recorded and documented in Test Reports and Verification Reports;
- A final check in which the product is tested in action in a real environment. The results of this test together with a summary of all the qualification process and a recommendation for type certification positive or negative is specified in the final Report made by the commission of qualification of the product.

Under Regulation 216/2008, EASA is not legally competent and therefore not entitled to certify design data of aeronautical products/parts/appliances for military purposes even they comply with military standards. EASA can only certify design data as fit to be used for the purposes of operations falling under the scope of Reg. 216 civil operations, and only as far as they comply with the relevant EASA certification specifications and other applicable requirements.

In case that an EASA Type Certificate has been issued to a civil aircraft configuration that subsequently will be used for military operations, EASA will be responsible to ensure the continued validity of the EASA TC in accordance with Annex Part 21 to Regulation 1702/2003.

Others two problems in the military certification are:

- the use of the civil airplanes for military transports;
- the rules for navigation of the military aeroplanes on the civil routes and under the civil control.

This two situation are more and more frequent and special document are issued by the civil authorities, for example in USA it is in function the Advisory circular AC 20-169 regarding the type certification requirements for commercial derivative aircraft (CDA). CDA

are aircraft that have been modified with specialized equipment to perform military and other non-civil missions. CDA are operated-by, or under the operational control of, governmental entities with certain limited exceptions, as public aircraft.

4. MILITARY AIRWORTHINESS AUTHORITIES (MAWA)

Today, European Union Member States operate aviation safety systems independently from each other. As a result, all military airworthiness activities are conducted and regulated on a national basis, and any harmonisation is achieved at individual project level only. This individual way of test in the military aviation multiplied for every state is not cost-effective and generates many problems in multinational programmes and is a primary cause for delays.

The NATO and the European Defence Authorities start some effort in order to harmonize and unify the European strategy on military airworthiness.

The Military Airworthiness Authorities (MAWA) Forum, created in 2008, is formed from representatives of national military airworthiness authorities from 26 European nations. The MAWA is made under the auspices of the European Defence Agency (EDA).

Developing a common airworthiness concepts will also result in considerable savings in terms of initial procurement costs as well as unlock the potential for more collaborative capability sustainment therefore further reducing whole life costs.

The goals of the MAWA forum have as the targets:

- to elaborate with adequate consultation, and publish European Military Airworthiness Requirements (EMARs) for the use of the Authorities in the field of airworthiness;
- to define the general structure of the whole set of EMARs. On this base each Authority can adopt this structure and work to minimize any national regulatory differences across European programmes with the aim that each individual existing EMAR can be integrated in a uniform code for all European;
- to establish procedures for the use of each Military Authorities that allow the use of only one set of technical findings of compliance in the field of design, manufacture and maintenance;
- to establish administrative and technical procedures, regulatory frameworks, and certification processes which would replace the currently existing national administrative documents;
- to take into account existing harmonized arrangements for appropriate multinational programmes;
- to form of a European Military Joint Airworthiness Authority.

5. CERTIFICATION IN ROMANIA

The certification of the aircrafts in Romania was integrated with the general international rules for civil aviation and military aviation even from the beginnings of the flights organisation. Starting the year 1920 it was official nominated the first Romanian Aviation Authority stipulated in a special Decree no. **2705 published in “Monitorul oficial” no. 67.**

In 1965 Romania joined at the Convention on International Civil Aviation Organisation (ICAO) and after this moment the national aviation authority is responsible to apply all the documents of the Chicago Convention and its annexes at national level. In 1991, Romania joined at the Member States of the European Civil Aviation Conference (ECAC). The Romanian Civil Aviation Authority ensure the implementation and compliance with

safety regulatory rules and laws of the EUROCONTROL – ESARR. In December 2000 the Romanian Civil Aviation Authority was received as full membership in JAA.

The main objectives of the Romanian Civil Aviation Authority are established in order to harmonize the national activities with the rules of international aviation organizations to which Romania is part (ICAO, ECAC, JAA, EUROCONTROL). The Authority concerns are focused: the integration of the national aviation legislation with the EU legislation on civil aviation, to control the activities concerning the certification type, the design, the manufacture and maintenance of aircraft and the crew licensing. Certification of civil aircraft shall be registered in Romania, and their engines and propellers must have too a type certificate issued under specific regulations for the product, including all parts and equipment installed on it.[5]

For the military aviation, in Romania the Ministry of Defence (RoMoD), and Romanian Airforce have established The National Military Aeronautical Authority. This authority will assure the military aircraft certification and will act by his special departments in order to assure the integration with NATO rules and to cooperate with the civil aviation authorities of the country.

The RoMoD is responsible for:

- elaboration of the strategy for the national military aviation, in accordance with the NATO defense policy;
- implementation of the regulations and recommendations coming from international organizations to which Romania is part;
- coordination of the aviation safety system in the military aviation;
- release the technical certification for the military aircrafts;
- inspection of the military flight safety and the aviation security rules for the military aviation;
- coordination of the personnel certification including:
 - elaboration of all qualification documents for this category of the aviation personal;
 - issue regulations rules and documents concerning all the military aviation positions;
 - tests organization;
 - organisation of the military training for all categories of personnell.

Regarding the certification of the new military products the RoMoD developed a document nominated “Norme de evaluare, certificare si supraveghere a calitatii la furnizorii de produse si servicii de natura sistemelor de armamente si echipamentelor majore” - Cod OMCAS AQ-MIL-01.

Other document in this field is “I-1001.4 - Instructiuni privind procesele de testare, evaluare si omologare a produselor”.

All the documents issued by RoMoD are made accordance with the NATO documents regarding the military certification and quality assurance looking to specify the certification way for the military products. Romania is now member in MAWA and will apply the unified documents issued by this organization.[13]

6. A GUIDE TO PRODUCT CERTIFICATION

This Guide has an overview of the Product Certification Phases that move from early project concept and initiation to the post certification activities. This Guide describes for each Certification Phase how to plane, manage, certification documents and working relationship between EASA and the Applicant. The Guide can be used by EASA and the Applicant for Type Certification, Supplemental Type Certification and other design approvals.

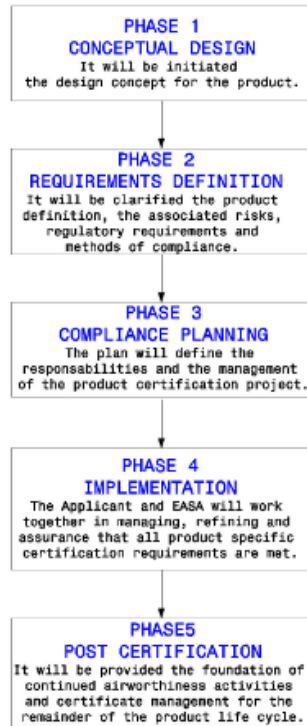


Fig.1 Certification Process Roadmap

CONCLUSIONS

Certification for aviation is a complicated and difficult problem and it cover not only the design of the aircrafts, but include the control of all elements involve in aviation: the engines and airborne systems, the ground infrastructure, the certification of the personnel. The civil aviation start the procee for certification and this process is in continuing development. In this document we discuss only the certification at aircraft level.

After studing and analysing the general official documents for civil and military certification some conclusions are relevant in order to make a disjunction of the problems in this area where the elements and documents are in motion.

One general conclusion is to clarify from start the meaning of two notions:

- the certification is for an aircraft the acceptance that it can flight in safety conditions,
- the qualification is the acceptance by a nominated authority that an aircraft cover the performances required in his class of functionality.

It is also very clear that for the a civil product the important characteristic is the degree of safety and for the military products the important elements to be controlled are the achievements in performances and after the general standards of safety. In Europe in the civil regulatory structure the important document is Regulation (EC) 2042/2003 on Continuing Airworthiness.

Other important conclusion appear as evident if we start to compare the documents and norms for civil and military certification: the idea to unify in a simple mode and to compare the civil and military norms and rules for certification is not possible.

Many elements are fully different and we can quote:

- the typical maneuvers and stress type calculations of the performances;
- the level of engines power;
- the level of noise generated;
- the ways of evacuation of the pilots and many others.

For example analyzing American documents (the FAR document and the MIL-STD - 1797 A) for stability and control even for a class of similar transport aircraft we can see that the military standard is more precise in performances than the civil who give only qualitative performances.

In conclusion when we must certify a military aircraft it is important to follow the military standards or the specific requirement stipulated.

The integration in the military field and the unification of the system of qualification was started by the important factors in the military aviation industry. It is important to mention that the certification and the qualification of the military products regarding their airworthiness will remain at national level of decision.

The MAWA activity, his road map and documents issued to make standardization at the European military level are very important and Romania as a NATO and EU member must follow this way. The documents issued by MAWA will cover the certification for products, services, organizations and personnel involved in military aviation and will in an essential mode raise the safety standards in this field.

In final an unitary structure of certification documents will lead to a:

- concrete military & civil cooperation in industry for some common systems used in aviation;
- effective reduction in costs and time for new aircrafts development;
- a better safety for military aircrafts.

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