



ITALIAN MINISTRY OF DEFENCE
Secretariat General for Defence - National Armaments Directorate
AIR ARMAMENTS DIRECTORATE



The Benefits of Harmonising Airworthiness Certification Criteria to Achieve Recognition of Certification (EMACC, UASS STANAGs)

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- UNCLASSIFIED -



- To provide examples of successful harmonisation activities in the field of airworthiness
- To “Socialize” these products that some of you may not be aware of



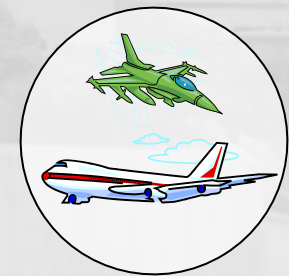
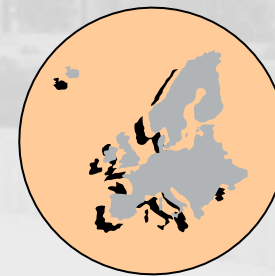
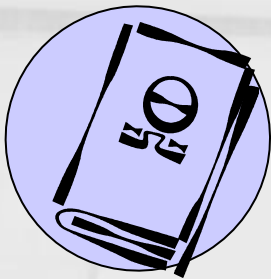
OVERVIEW



- **Harmonisation processes in the field of military airworthiness**
- **Case Studies**
 - ✓ **EMACC**
 - ✓ **STANAG 4761, 4702, 4703**



The Concept of Harmonisation in the field of Airworthiness of Military Aircrafts





INTRODUCTION



CIVIL WORLD



The operational environment and the mission profiles are limited and almost always the same

*Airworthiness is regulated by law
e.g. CS 25 / FAR 25*



INTRODUCTION



MILITARY WORLD



CONCEPT OF OPERATION



- ✓ The mission requirements are as important as airworthiness when providing the requested military capability
- ✓ The benefits for the State are related both to military aircrafts performances as well as their safety

Military aircrafts are characterized by great variety of:

- ✓ operational environments
- ✓ mission profiles
- ✓ new technology (evolving rapidly)

Performance requirements are in the CONTRACT

Airworthiness is done by the same CONTRACT setting performance requirements



INTRODUCTION



MILITARY WORLD



CONCEPT OF OPERATION

Different types of capabilities are required

Different Design Usage Spectra are envisaged

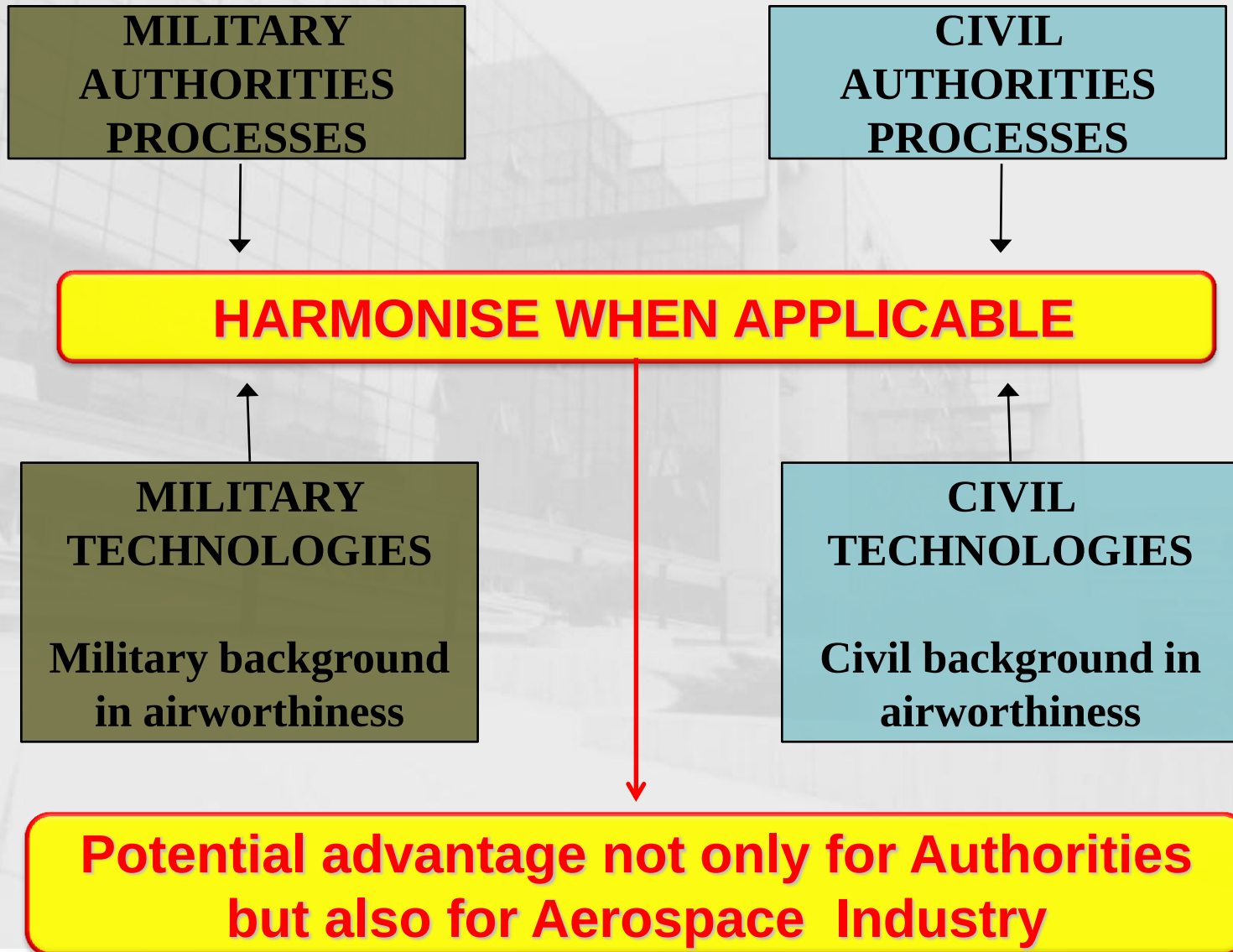
Different and new technologies are involved

*Performance and airworthiness requirements are intercorrelated
=> TAILORING IS THE BEST PROCESS IN MILITARY WORLD*





INTRODUCTION





INTRODUCTION



In the field of military airworthiness, a lot of resources are being spent in harmonisation initiatives within EU (EDA), NATO and US Services

! SHARE EXPERIENCE AND HARMONIZE !
(trying to avoid redundances when feasible)



**Potential advantage not only for Authorities
but also for Aerospace Industry**



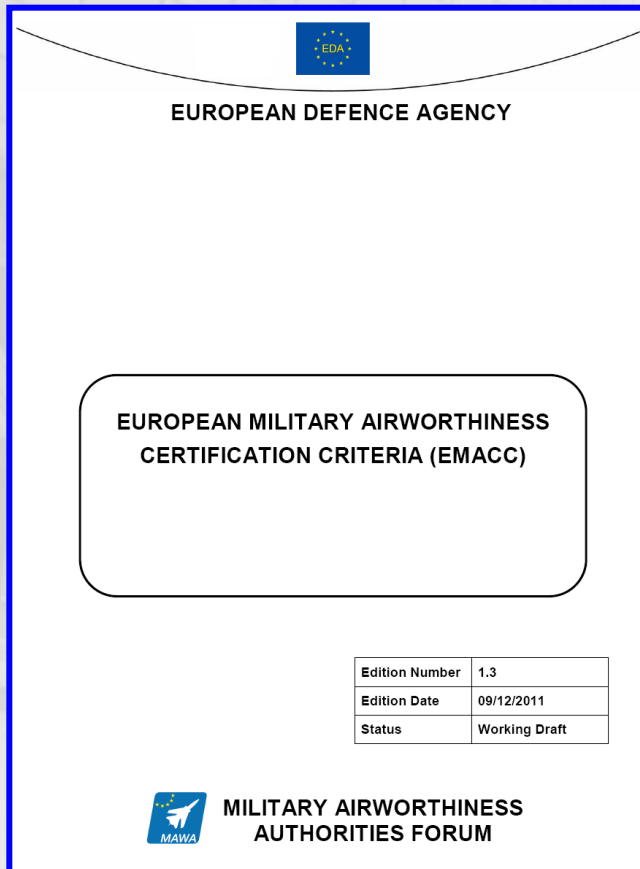
THE EXAMPLE OF EMACC

(European Military Airworthiness Certification Criteria)





THE EXAMPLE OF EMACC



- Under MAWA, a specific Task Force (TF4) is established to produce harmonised **European Military Airworthiness Certification Criteria (EMACC)**.
- EMACC is an European handbook detailing technical military airworthiness certification criteria, intended to be used to tailor the **airworthiness basis** for Military Type Certification activity.



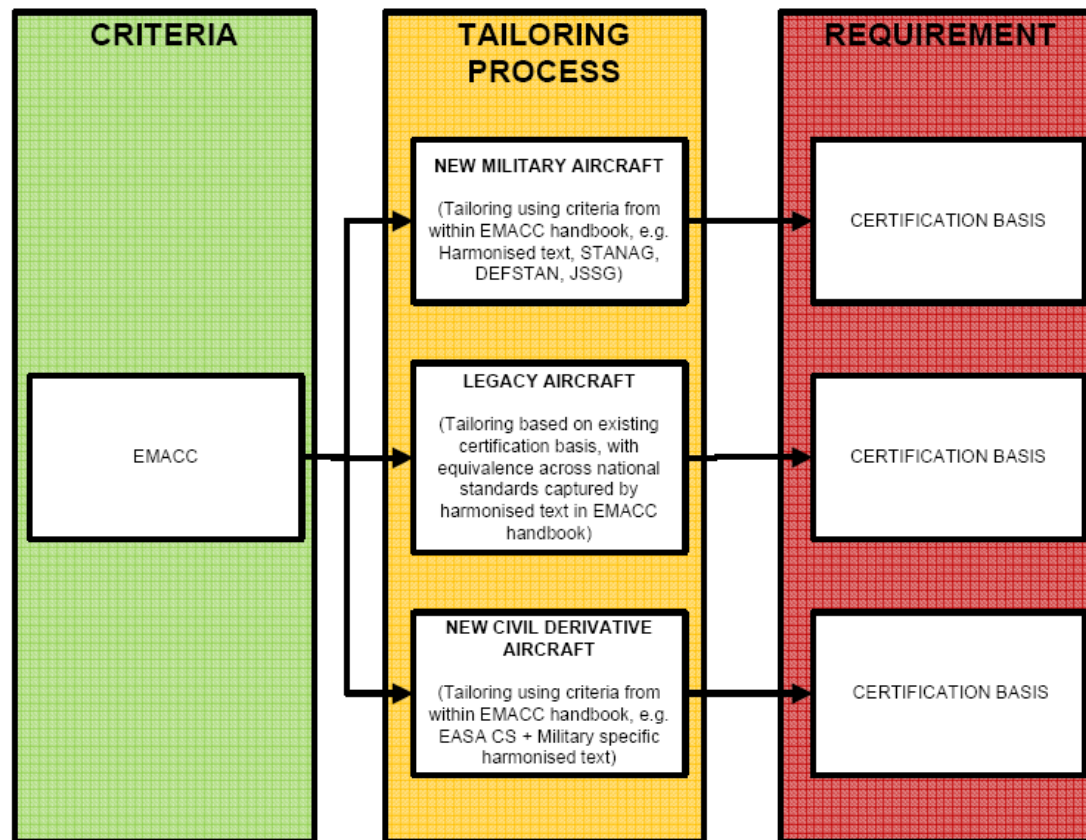
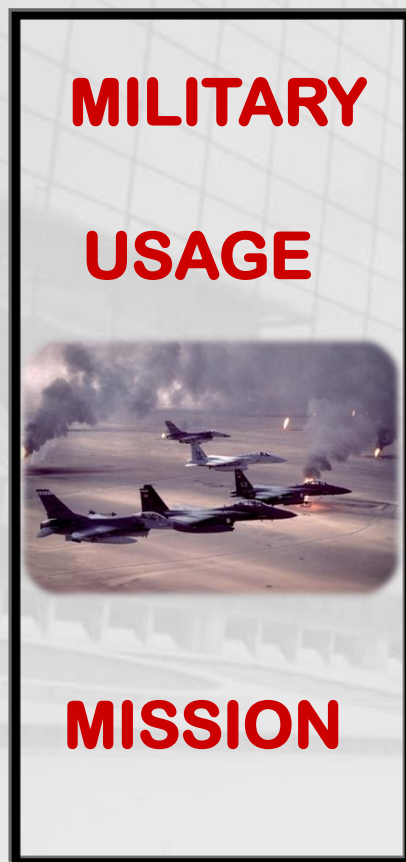
THE EXAMPLE OF EMACC



- ❑ **EMACC is NOT intended to be a Certification Specification containing the specific quantitative REQUIREMENTS to which the product is to be certified.**
- ❑ **EMACC provides**
 - 1. a complete set of airworthiness criteria to be considered (like an airworthiness checklist)**
 - 2. a complete sources list of state of the art rules and standards applicable to each criterion**
 - 3. an expanded text harmonized among previous standards to help in the tailoring process of defining quantitative airworthiness requirements**



THE EXAMPLE OF EMACC



Step 0

Step 1

Step 2

Step 3



THE EXAMPLE OF EMACC



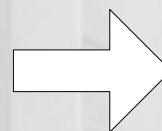
Approach in two steps

- Starting point:
MIL-HDBK-516B Change 1
- DOORs database with existing 516B criteria, US DoD/Mil and FAA cross-references

STEP 1

- Adding cross-references to European and NATO documents where equivalence is deemed possible:
 - Def Stan 00-970
 - STANAGs
 - EASA CSs

MIL-HDBK- 516B		
Existing US Information		
Criteria	US DoD/Mil Cross Reference	FAA Cross Reference



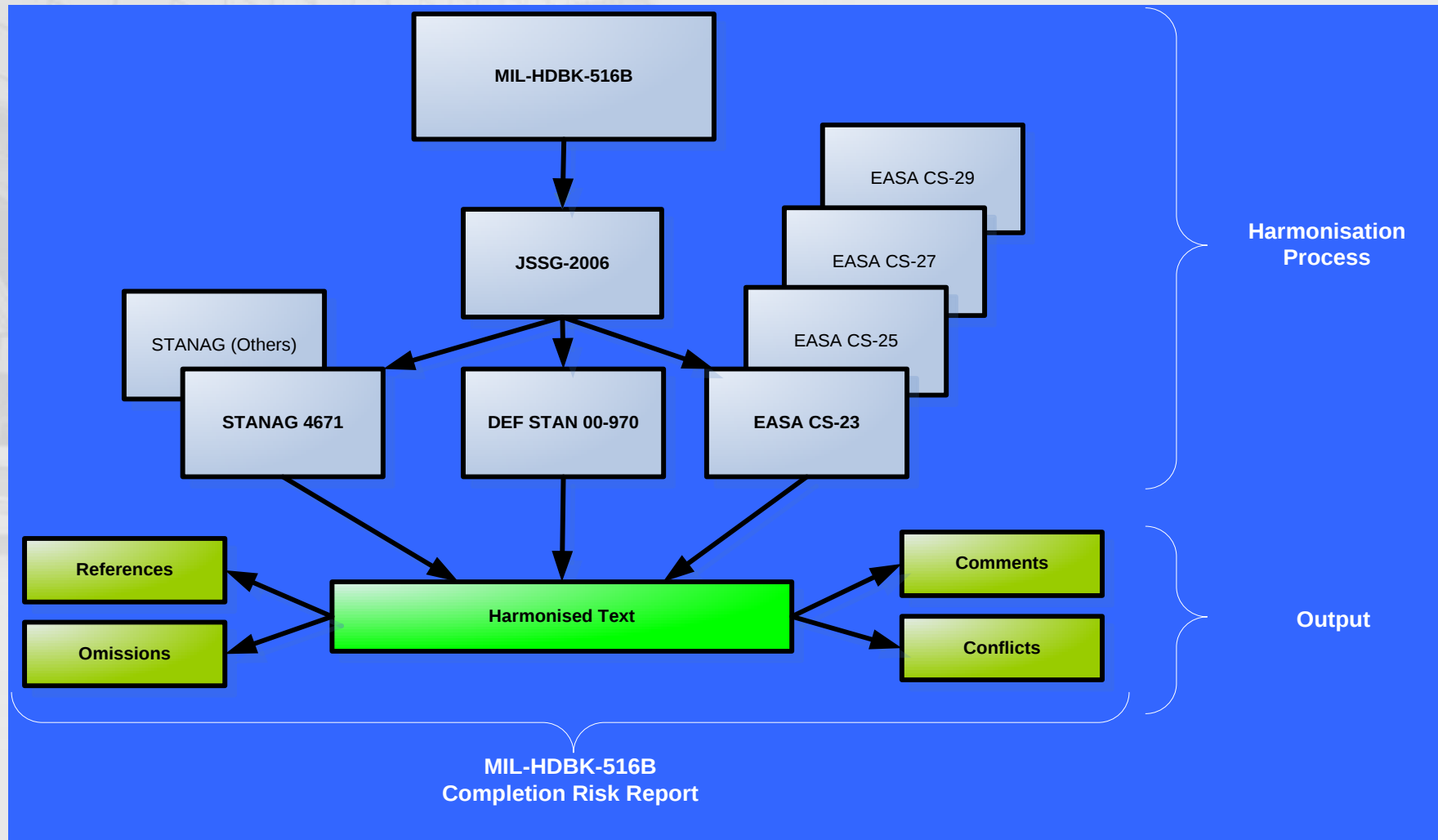
Deliverable D1				
European Equivalent MIL-HDBK- 516B				
Existing US Information			Missing Euro Information	
Criteria	US DoD/Mil Cross Reference	FAA Cross Reference	DefStan 00-970 Cross Reference	JSSG Cross Reference
				STANAG Cross Reference
				EASA Civil Standard Cross Reference



THE EXAMPLE OF EMACC



STEP 2: Harmonisation among different standards





THE EXAMPLE OF EMACC



FRAMEWORK

INFORMATION SOURCES

HARMONISED CRITERIA

5.4. DAMAGE TOLERANCE AND DURABILITY (FATIGUE).

5.4.1 Verify that all safety-of-flight (SOF) structure, including dynamic components, have adequate safe life or damage tolerance capability (depending on certification authority) for the required service life.

US Cross References		European Cross References	
<i>Comm'l Doc:</i>			
<i>DoD/MIL Doc:</i>	JSSG-2006: A.3.12 Damage Tolerance, pg 398 JSSG-2006: A.4.12 Damage Tolerance, pg 400 (for compliance development)	<i>Def-Stan 00-970 Reference:</i>	00-970 3.2.3 00-970 Part 1 Sec 3 3.2.2 00-970 Part 1 Sec 3 3.2.3 00-970 Part 1 Sec 3 3.2.8 00-970 Part 1 Sec 3 3.2.9 00-970 Part 1 Sec 3 3.2.10 00-970 Part 1 Sec 3 3.2.11 00-970 Part 1 Sec 3 3.2.12 00-970 Part 1 Sec 3 3.2.13
		<i>STANAG Reference:</i>	4671 305 4671 570 4671 572 4671 573 4671 575
<i>FAA Doc:</i>	14CFR reference: 23.571, 23.572, 23.573; 25.571; 27.571; 29.571.	<i>EASA CS Reference:</i>	CS 23.571 CS 23.572 CS 23.573 CS 23.575 CS 25.571 CS 27.571 CS 29.571
<i>Harmonised Text:</i>	The airframe structure and associated components, whose failure would be catastrophic, must be shown by analysis supported by test evidence and, if available, service experience, to meet the fatigue requirements of a damage tolerant or, if not applicable a safe life design methodology over the design service life of the aircraft. The fatigue evaluation must include the requirements of subparagraph (1), (2), and (3) and also must include a determination of the probable locations and modes of damage caused by fatigue, considering environmental effects, intrinsic/discrete flaws, or accidental damage.		



THE EXAMPLE OF EMACC



- **EMACC will be ready by the beginning of 2013**
- **EMACC Custodian Support activity for next years**
- **Refinement based upon changes within information sources**
- **Potential future TF4 opportunity: Harmonisation with US process (MIL HDBK 516B team)**



International rules to integrate a military aircraft in the airspace



**Military
Aviation**



NATO
+
OTAN

NORTH ATLANTIC COUNCIL

CONSEIL DE L'ATLANTIQUE NORD

**UAV Flight in Non-
Segregated
Airspace (FINAS)
Military Working
Group**

THE EXAMPLES of STANAG 4671, 4702, 4703

*Harmonization of airworthiness requirements for UASs
in NATO*



THE EXAMPLE OF STANAGs



Derived from CS23

Added specific sections for UASs (eg Data Link, Ground Station)
Included a lot of experience from various NATO Nations

Ed 1 ratified

Ed 2 non ratifiable is the last version

Ed 3 will start ratification in fall 2013



STANAG 4671 (Ed2)

Fixed Wing UAS from 150 to 20,000 kg



Cross walk exercise with MIL-HDBK-516

Identified gaps not covered by a CS23 derived STANAG (eg in the Vehicle Control Functions field)

A lot of effort is being dedicated to harmonize safety requirements for Edition 3 => above a weight breakpoint safety will be increased of an order of magnitude



THE EXAMPLE OF STANAGs



Derived from CS27

Added specific sections for UASs (eg Data Link, Ground Station), taken from STANAG 4671

Included a lot of experience from various NATO Nations

Ed 1 started ratification this year



STANAG 4702 (Ed1)

Rotary Wing UAS from 150 to 3750 kg





THE EXAMPLE OF STANAGs



Invented from the Essential Requirements of Airworthiness

Ed 1 started ratification this year

**EXCELLENT EXAMPLE OF
HARMONIZATION**

Contribution from previous
certification programs of light UASs
and from all participant Nations

Harmonized Military Essential
Requirements are used as starting point to
develop new STANAG 4703
+ CS_VLA + CS_22 + ASTM F2245-06
+ STANAG_4671 + DEF_STAN_00_56
+ EN_9100

EDA adopted the Military Essential Requirements
in the Basic Framework Document



STANAG 4703 (Ed1)

**Fixed Wing UAS below 150 kg
Reciprocating/Electrical/Turbine
engines**



EU Regulation (EC) N°216/2008 defines Essential
Requirements for Airworthiness of civil aircrafts

OCCAR Procedure for Airworthiness
finalized in 2009 included Military version
of Essential Requirements for Airworthiness
(harmonized also with industry - ASD)



STANAG 4703



AIMs

the amount of certification evidences
required should
be as **LIGHT** as possible

USAR-LIGHT must be **RIGOROUS** and
COMPLETE
in addressing those design attributes
which may endanger safety

being **FLEXIBLE** and not prescriptive,
in order not to limit the Manufacturers
design solutions



STANAG 4703



AIMs

as **light** as possible

rigorous and complete
in addressing all design attributes

flexible and not prescriptive

A set of Airworthiness Codes doesn't exist for any type of aircraft < 150 kg

A single complete set of Airworthiness Codes cannot be flexible enough to consider all the variety of configurations in this UAS category

A complete set of airworthiness codes would result to be excessively prescriptive to this UAS category Manufacturers.

Nevertheless a minimum set of basic Airworthiness Codes could help both the Applicant and the Authority in performing UAS certification activities



STANAG 4703



1) What are the minimum requirements required by law to be fulfilled in order to recognize a type design as airworthy?

In EU Civil Aviation the minimum Essential Requirements for Airworthiness are established by **Regulation (EC) N°216/2008 (Annex 1)** of the European Parliament and of the Council



OCCAR-JMAG (BE+DE+FR+IT+SP+UK) agreed among themselves and with ASD (the association of EU Aerospace Industries) a military version of the Essential Requirements adopted then by **MAWA** as the basis of their regulatory framework.



STANAG 4703



ANNEX 1

Essential requirements for airworthiness referred to in Article 21

1. Product integrity: product integrity must be ensured for all anticipated flight conditions for the operational life of the aircraft. Compliance with all requirements must be shown by assessment or analysis, supported, where necessary, by tests.

1.a Structures and materials: the integrity of the structure must be ensured throughout, and sufficiently beyond, the operational envelope for the aircraft, including its propulsion system, and must ensure the operational life of the aircraft.

1.a.1 All parts of the aircraft, the failure of which could reduce the structural integrity, must comply with the following conditions without detrimental deformation or failure. This includes all items of significant mass and their means of restraint.

1.a.1.a All combinations of load reasonably expected to occur within, and sufficiently beyond, the weights, centre of gravity range, operational envelope and life of the aircraft must be considered. This includes loads due to gusts, manoeuvres, pressurisation, movable surfaces, control and propulsion systems both in flight and on the ground.

1.a.1.b Consideration must be given to the likely failures induced by emergency landings either on land or on water.

1.a.1.c Dynamic effects must be covered in the structural response to these loads.

1.a.2 The effects of fatigue, wear, corrosion, instability and excessive vibration.

1.a.3 The manufacturing processes and materials used in the construction of the aircraft must result in known and reproducible structural properties. Any changes in structural performance allowed in the operational environment must be accounted for.

1.a.4 The effects of ageing must be considered. The structural integrity must be shown to be maintained throughout the operational life of the aircraft, and the structural integrity below an acceptable residual strength level. All necessary measures for ensuring continued airworthiness in this regard must be promulgated.

1.b Propulsion: the integrity of the propulsion system (i.e. engine and, where appropriate, propeller) must be demonstrated throughout, and sufficiently beyond, the operational envelope of the propulsion system and must be maintained for the operational life of the propulsion system.

1.b.1 The propulsion system must produce, within its stated limits, the thrust or power demanded of it at all required flight conditions, taking account of environmental effects and conditions.

1.b.2 The fabrication process and materials used in the construction of the propulsion system must result in known and reproducible structural behaviour. Any changes in structural performance allowed in the operational environment must be accounted for.

1.b.3 The effects of cyclic loading, environmental and operational degradation and their subsequent effects must be shown to not reduce the integrity of the propulsion system below acceptable levels. All necessary measures for ensuring continued airworthiness in this regard must be promulgated.

1.b.4 All necessary instructions, information and procedures for the safe and correct operation of the propulsion system and the aircraft must be promulgated.

1.c Systems and equipment

1.c.1 The aircraft must not have design features or details that experience has shown to be hazardous.

1.c.2 The aircraft, including those systems, equipment and appliances required for type certification, or by operating rules, must function as intended under any foreseeable operating conditions, throughout, and sufficiently beyond, the operational envelope of the aircraft, taking due account of the system, equipment or appliance operating

HARMONIZED:

- Civil-Military
- with Industry (ASD)
- EDA MAWA

HIGH LEVEL ESSENTIAL REQUIREMENTS: minimum top level AW topics

TOP LEVEL + ESSENTIAL + QUALITATIVE = FLEXIBLE & NOT PRESCRIPTIVE = APPLICABLE TO ALL CONFIGURATIONS



2) How to demonstrate compliance with the Essential Requirements for Airworthiness?

For UAS<150 kg the best proposed solution is a **hybrid approach** in which compliance with Essential Requirements is demonstrated through detailed arguments made of the following:

- a clear definition of the **design usage spectrum**
- a **minimum set of airworthiness codes**
- verification of the design criteria by the Authority
- process evidences (e.g. Safety Management System)



STANAG 4703



MANDATORY AIRWORTHINESS ESSENTIAL REQUIREMENTS	DETAILED ARGUMENTS	MEANS OF EVIDENCE
ER.1 <u>Product integrity</u> ER.1.1 <u>Structures and materials</u> ER.1.2 <u>Propulsion</u> ER.1.3 <u>Systems and equipments</u> ER.1.4 <u>Regs for Continued</u> <u>airworthiness</u> ER.2 <u>Airworthiness aspects of</u> <u>product operation</u> ER.3 <u>Organisations</u>	Compliance with the Essential Requirements may be shown by the Applicant through these detailed arguments or by any other argument which meets the intent behind them with comparable level of safety to be agreed with the Certifying Authority, wherever a "should" statement appears FLEXIBILITY= Few "must" statements Many "should" statements	Acceptable type of evidence to be presented to the Authority



STANAG 4703



Direct arguments

STANAG 4671

CS-22

(Certification Specifications for Sailplanes And Powered Sailplanes)

CS-VLA

(Certification Specifications for Very Light Aeroplanes)

ASTM F2245-06

(Standard Specification for Design Performance of a Light Sport Aircraft)

Indirect process arguments

DEF STAN 00-56

(Safety Management Requirements for Defence Systems)

**Quality Management System
+ Product Safety declared as an
objective in the Quality Policy
(ISO 9100 + ISO 9004)**

**+ a certain
degree of
invention**





STANAG 4703



3) Can some requirements be relaxed for very Light UAS?

official medical studies:
any vehicle under **25 ft-lb**

PhD dissertation:
any vehicle under **49 ft-lb**

(Very Low Energy
threshold that cannot
cause fatalities)



... Lethality Threshold of 66J



NEW STANAG 4xxx



STANAG 4xxx

Rotary Wing UAS < 150 kg

A new team has been established to develop a new STANAG, similar in structure to the 4703, applicable to rotary wing UAS < 150kg
START IN SPRING 2013



CONCLUSIONS (1/2)



- **MILITARY AIRWORTHINESS HARMONISATION IS NOW A NEED UNDER THE WILL OF NATIONS**
- **DUPLICATION OF EFFORT MUST BE AVOIDED (LACK OF NATIONAL SPECIALISTIC RESOURCES)**
- **THERE ARE BENEFITS IN USING A COMMON APPROACH IN THE AIRWORTHINESS**
 - **TO PROVIDE MILITARY AIRCRAFTs CAPABLE OF PERFORMING THEIR MISSION SAFELY**
 - **THE POTENTIAL SAVINGS IN TIME, COST AND EFFORT FOR BOTH AUTHORITIES AND INDUSTRY.**
- **USE THE SUCCESS OF THE EARLY STAGES TO ENABLE STRONGER HARMONISATION**



CONCLUSIONS (2/2)



- **EU EFFORTS TO DEVELOP EMACC SHOULD BE HARMONIZED WITH US PROCESS OF REVISION OF THE MIL-HDBK-516, POSSIBLY SHARING BACKGROUND EXPERIENCES AND KNOW-HOW**
- **RELEVANT NATIONS AROUND THIS TABLE ARE RECOMMENDED TO CONSIDER NEW STANAGS 4702 AND 4703 FOR CONSIDERATION AND RATIFICATION**



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The benefits of harmonising In the field of airworthiness

Any question?

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