European Military Airworthiness Certification Criteria (EMACC) Guidebook

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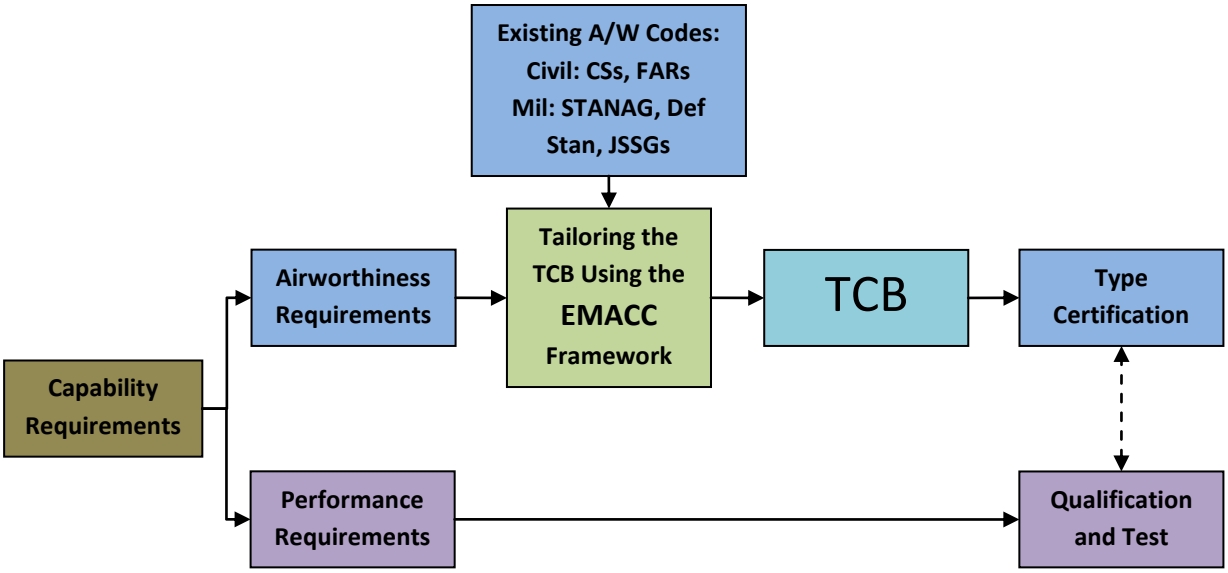
1 INTRODUCTION

A Generic Process showing the relationship between airworthiness certification and qualification[1] for Military Air System Type Entry into Service



It should be noted that the military process is distinct from the equivalent civil process. Unlike the civil certification process that starts with the Category of the aircraft, which in turn defines the Type Certification Basis (TCB) within a certification specification, the military certification process is defined by the military Airworthiness requirements which are determined by air system design, roles and missions. Thus the TCB is bespoke for each military type introduced to Service for a specific role, which requires it to be tailored to the air system design driven by the capability requirements.

1.1 Purpose of the guidebook

The European Military Airworthiness Certification Criteria (EMACC) contains a framework of certification criteria to assist in the determination of airworthiness for all manned and unmanned, fixed and rotary wing air systems. It is a foundation document to be used by the relevant National Military Aviation Authorities (NMAA) to define the air system's TCB. Its purpose is to enable a systematic, disciplined analysis of certification criteria in order to tailor a TCB for a specific air system. The process primarily comprises selecting applicable criteria and tailoring appropriate standards to define a TCB for new military air system programmes and major changes[2] to existing Air systems/aircraft. This guidebook describes the tailoring approach.

The primary objective in tailoring is to maintain the intent and context of the criteria. It is not an exercise intended to relax and/or degrade the criteria. Indeed, for military operations, tailoring may result in a more arduous certification basis. Where possible, it is recommended that a risk based approach to the evaluation of the potential impacts of the tailoring exercise is conducted.

Tailoring rules are as follows:

- Identify each criterion as either applicable or non-applicable, considering system or product complexity, type, data, and intended use. Document the rationale for identifying any criteria as non-applicable;

[1] Qualification is outside of the scope of this Guidebook but is included in this diagram to show that Qualification is a separate activity but can rely upon evidence from the certification process.
[2] Noting that minor changes to a type design are also required to conform to the TCB.

- Non-applicable criteria may not be deleted. However, if part of the criteria could be considered to be applicable or is modified then the applicable and non-applicable portions should be identified and any modifications that are made should be documented along with the rationale for doing so. It is recommended that the criteria are not modified directly , but in the event that a criterion is modified, it is essential that the intent and context is maintained;

- Supplement applicable criteria with specific measurable parameters, where appropriate (i.e., the supplement adds value to the definition of airworthiness requirements);

- Develop additional criteria, as appropriate, for any capabilities or systems (including the whole/complete system) not fully addressed by the criteria contained in this document.

1.2 Type-certification and type-certification basis

Type Certification is the process by which it is demonstrated that the design of a new or amended air system type complies with the airworthiness and environmental protection requirements applicable, in accordance with EMAR 21.A.17. After satisfactory completion of the process, the relevant NMAA may issue a Type Certificate (new or amended), or approve changes to an already certified air system type according to National regulation or procedures. A generic airworthiness certification process can be divided into the following phases:

- Establish and agree the TCB

- Propose and execute a Type Certification Programme

- Demonstrate compliance of the Type design with the TCB requirements

- NMAA scrutiny, reporting and issue of Military Type Certificate, or equivalent assurance

To achieve certification, the Project must undertake these phases to the satisfaction of the NMAA. In particular, the NMAA has to agree the established TCB. The TCB identifies the applicable requirements to which the air system manufacturer must show compliance. This includes any special conditions, exemptions, and equivalent safety findings that may be required[3]. It is intended that all applicable requirements for the many possible types and roles of military air systems are identified in the EMACC Handbook, which should be used to build the TCB by performing the tailoring process described in this Guidebook. The criteria included in the EMACC Handbook are written with the intent that an experienced engineer, trained in the specific technical area under consideration, should be able to interpret, tailor, apply, and evaluate a particular system's compliance with the criteria.

Examples of type-certification basis are provided in Annex A.

1.3 Type-Certification versus Qualification

Qualification is the process used by the contracting entity to establish compliance of a product with a set of performance and contractual requirements and is therefore outside of the scope of this Guidebook. However to avoid confusion it is beneficial to explain the differences between certification and qualification.

Generally, type-certification is a pre-requisite to qualification but these activities can be conducted in parallel. Type-certification can occur as soon as all airworthiness requirements have been adequately met. This may include some performance, availability, reliability and maintainability requirements which are aviation safety related. To achieve an appropriate release (entry into service) for military use and/or formal acceptance by military services it is usually necessary for the

[3] Special conditions usually refer to novel design features or unconventional use of the product; Equivalent Safety Findings dwell on materials that do not exist in already published Acceptable Means of Compliance (AMC); and exemptions commonly introduce deviations to existing requirements.

project to demonstrate compliance with both safety and capability requirements. These latter criteria are usually addressed by product qualification.

In some national organisational structures, the NMAA is not responsible for product qualification, and in these cases clear distinctions are made between type-certification and qualification. In order to ensure segregation between airworthiness aspects and contractual elements, some NMAAs may decide to conduct the certification process separately and independently from the qualification process. To achieve this, the NMAA may be organisationally separate from the entity responsible for project delivery, type acceptance and qualification. In this case, the certification activities are managed by Subject Matter Experts (SMEs) within the NMAA depending upon National organisational structures and responsibilities. However, it is possible, indeed desirable, that evidence from the certification activities should be reused for qualification purposes.

Under future arrangements within the European military regulatory framework (see Section 2) work is underway to define the mechanisms and criteria for achieving Mutual Recognition between NMAAs. This would enable certification by one NMAA to be acknowledged as evidence of compliance with acceptable certification requirements for all Nations within the Military Airworthiness Authorities (MAWA) community. However, due to the immaturity of the process, mutual recognition and the level of involvement of pMS NMAAs in each other's certification projects is not discussed further within the Guidebook.

2 EUROPEAN MILITARY REGULATORY CONTEXT

The MAWA pMS Defence Ministers through the EDA Steering Board have declared[4]:

> **"…political support for national airworthiness authorities to develop and implement the EMARs. These requirements shall be developed in line with the Endorsed Roadmap[5] and with the Basic Framework Document established by the MAWA Forum."**

2.1 Harmonized framework

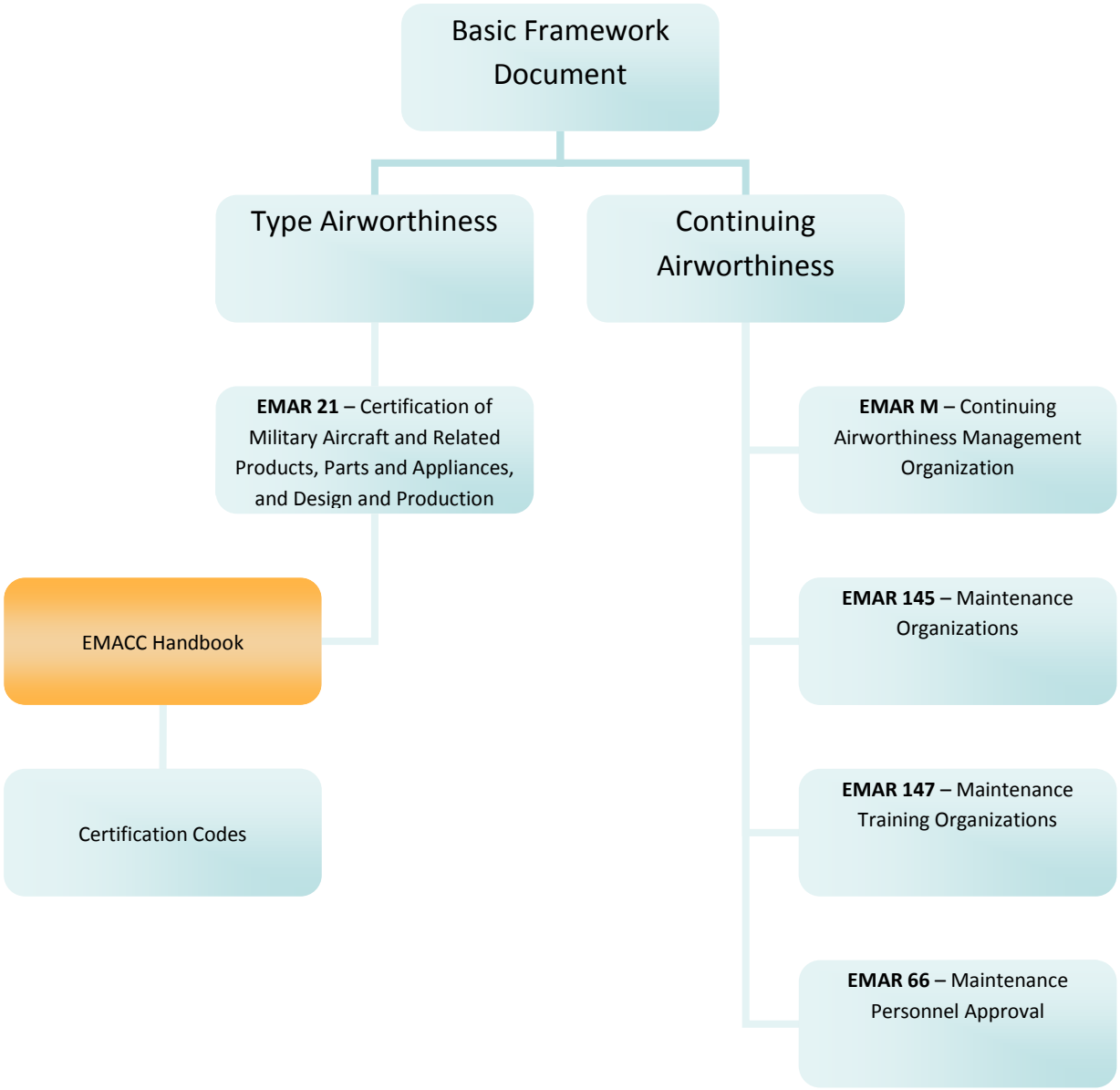
In accordance with the Basic Framework Document, the MAWA Forum is developing harmonised European Military Airworthiness Requirements (EMAR) for:

- Certification of military aircraft and related products, parts and appliances, and design and production organisations (EMAR 21)
- Requirements for Maintenance Organisations (EMAR 145)
- Military aircraft maintenance personnel approval (EMAR 66)
- Military aircraft maintenance training organisations (EMAR 147)
- Military continuing airworthiness management organisations (EMAR M)

In accordance with the Basic Framework Document[6], the pMS Authorities are committed to implement the EMARs as soon as practicable. Further, each Authority intends to withdraw the provision for regulations other than EMAR where the procedures established to check compliance of products, services, persons or organisations with EMAR are deemed to be satisfactory by the Authority concerned both technically and time-wise.

In addition the Basic Framework Document also states that each Authority shall adopt the structure of the whole set of future EMARs and adopt the existing EMARs as their sole regulation as soon as practicable. The Authorities do reserve the right not to fully apply the EMARs in certain circumstances for national reasons. However, in these instances the opportunities for recognition may be limited.

[4] EDA Doc No 2009/36 approved by the Steering Board on 17 November 2009 – "Defence Ministers' Political Declaration Regarding the Timely Development and Implementation of the European Military Airworthiness Requirements."
[5] EDA Doc No 2008/39 of 10 November 2008 on a "Roadmap on an EU-wide Forum for Military Airworthiness (MAWA)".
[6] BFD Ed 2.0 para 23.b – "Commitments of Authorities"



2.2 Certification Codes and standards referenced in the EMACC Handbook

To build the type-certification basis as defined in EMAR 21.A.17, NMAAs may rely on the EMACC document. The EMACC references several existing certification codes as source documents for detailed design and airworthiness standards, such as DEF STAN 00-970, US JSSGs, European Aviation Safety Agency (EASA) Certification Specification (CSs) and Standardization Agreements (STANAGS).

2.2.1 EASA CSs

Joint Aviation Requirements (JARs) were first issued in the 1970s by the Joint Aviation Authorities (JAA). They superseded all European Community Countries National Standards in 1992.

In 2003, JARs were replaced by EASA CSs. Currently, these include: CS-22 for sailplanes and powered sailplanes, CS-23 for normal, utility, acrobatic and commuter aeroplanes, CS-25 for large aeroplanes, CS-27 for small rotorcraft, CS-29 for large rotorcraft, CS-E for Engines, CS-P for propellers, CS-VLR for very light rotorcraft and CS-VLA for very light aeroplanes.

Since the issue of the JARs, many civil aircraft have been certified under JARs and CSs.

2.2.2 DEF STAN 00-970

DEF STAN 00-970 has been developed to define bespoke airworthiness requirements for various military air system types. The UK MAA Certification Division is responsible for the editing, publication and upkeep of the document on behalf of the UK MAA Executive Board (MEB). This document provides standards and guidance for the design of air system to meet airworthiness requirements for UK military operations.

2.2.3 STANAGS

When using STANAGs it is essential to determine the National ratification status that defines the level of agreement to their use.

NATO STANAG 4671 Edition 1: Unmanned Air Vehicle (UAV) System Airworthiness Requirements (USARs) was issued by the NATO Standardization Agency on 3 September 2009. The STANAG was derived from EASA CS-23 requirements supplemented with the following Unmanned Air Systems (UAS) airworthiness and safety documents:

Title	Date
JAA Eurocontrol UAV Task Force – Final Report	05/2004
Airworthiness standard for Unmanned aerial vehicles, RAI-UAV - Ente Nazionale Aviazone Civile – (Italy)	1999
Design standards UAV - Civil Aviation Safety Authority (Australia)	05/2000
Design and airworthiness requirements for UAV systems – DEF STAN 00-970 Part 9 (UK MOD)	05/2002
USICO (Unmanned Safety Issues for Civil Operations)– WP 2400 – Certification review item (CRI) “stall demonstration”	01/2004

The aim of the STANAG was to establish a baseline set of airworthiness standards in relation to the design and construction of military UAS. The USAR objectives enable UAS to reach a level of airworthiness design equivalent to manned general aviation aircraft, which are allowed to fly in all classes of airspace (A to G) under VFR and IFR. It is applicable to fixed-wing military UAS with a maximum take-off weight between 150kg and 20, 000kg.

The lower level limit of MTOW is common to EASA Basic Regulation for entitlement to a Type Certificate. The higher level limit was proposed[7] as the maximum acceptable MTOW at which the CS-23 could be used as a working basis for the certification of UAS. Small military UAS, with MTOW below 150kg, are not considered for certification; thus no appropriate code exists. Operations are currently limited to restricted areas, usually above closed (military) ranges or active operational areas, although STANAG 4671 was developed for UAS flight in non-segregated airspace.

Although NATO STANAG 4671 was derived from EASA CS-23 (ex: JAR 23), the following differences should be considered in its use:

- CS-23 paragraphs relative to some specific aircraft configurations have been removed, for example: aircraft equipped with skis, amphibian aircraft and seaplanes.
- CS-23 paragraphs or requirements relative to a specific aircraft category have been removed, such as utility, aerobatic and commuter aircraft.

[7] JAA-EUROCONTROL UAV Task Force report, May 2004.

- CS-23 paragraphs or requirements obviously not adapted to UAS have been removed, for instance, CS 23.785 seats, berths, litters, safety belts and shoulder harness and CS 23.1415 ditching equipment

- Some USAR paragraphs have been fully created in order to take into account the special features of UAS, and the complex systems usually found on UAS that are not typically installed on CS23 category aircraft: USAR1613 Command and control data link loss strategy, USAR1883 Command and control of multiple UAV and automatic take-off & landing systems.

3 THE EMACC DOCUMENT

3.1 Harmonised Text

The EMACC Handbook, consists of high level harmonised criteria that were developed taking due cognisance of all the referenced certification codes and information sources (eg EASA CS, Def-Stan 00-970 and STANAG). The harmonised text was created to allow National Military Airworthiness Authorities the flexibility to interpret the most appropriate approach. Therefore, harmonised criteria were generated which were deliberately not prescriptive, such that they do not become a standardised mandate and cannot be used as a "surrogate TCB" instead of certification requirements from accepted standards. In most cases, the harmonised criteria defined rely on explicit and implicit associated processes, procedures and policies to achieve a complete expression of the intent and expectation of the criteria.

In order to maximise the value provided by the EMACC handbook, for criteria with significant variances in intent between the referenced information sources, a key intent statement for the criterion was captured, together with potential considerations that needed to be taken into account for airworthiness and safety. In so doing, balanced and agreed harmonised criteria were agreed that would not prejudice and/or inhibit individual pMS tailoring.

The EMACC Handbook was based on the MIL-HDBK-516B structure. Given the way MIL-HDBK-516B evolved (based on experience of incidents / failures over time), significant overlap was observed between individual sections. The EMACC Handbook, therefore rationalised this structure, for example through merger of MIL-HDBK-516B criteria, addition of new criteria or through removal of extant criteria. In rationalising, every effort was made to ensure the EMACC Handbook remained as succinct as possible without losing any of the original intent of the US/European information sources. In order to achieve this, the Handbook includes:

- Section level introductions that clearly define and bound the scope of each section within the EMACC Handbook.
- A traceability matrix that links the EMACC Handbook structure to the original MIL-HDBK-516B structure.

3.2 Presentation of the EMACC Criteria

The EMACC framework is based on MIL-HDBK-516B[8] in order to establish all possible applicable airworthiness certification criteria for military air systems. These criteria are not intended for direct inclusion in the type-certification basis; rather, they are high-level and qualitative by nature. For detailed requirements in a TCB, a standard and AMC must be identified for each criterion to provide quantitative measures of compliance with airworthiness and safety requirements. To facilitate identification of relevant, appropriate requirements for each criterion the EMACC proposes several compliance standards, usually including numerical values. These standards define the certification requirements for inclusion in the TCB.

6.1.3.5.2 The air vehicle shall not exhibit unsafe limit cycle oscillations, unbounded oscillations, unsafe triggering mechanisms during mode transitions, or unsafe sudden/steep gain changes. Consideration should be given to:

a. High gain conditions;
b. All possible air vehicle configurations;
c. Controls fixed and controls free stability;
d. Configuration changes/transitions;
e. Pilot workload and the ability of the air vehicle in the military role;
f. The entire ground and flight envelope.

Airworthiness certification criterion

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A Appendix C.3.7, C.3.8	Def-Stan 00-970 Reference:	00-970 P1 2.16 00-970 P1 2.17.28 00-970 P1 2.17.31 00-970 P1 2.21.4 00-970 P1 2.21.8 00-970 P1 2.22.7
		STANAG Reference:	
FAA Doc:		EASA CS Reference:	CS 23.321-459 CS 25.321-459 CS 27.321-427 CS 29.321-427

Airworthiness standards

When considering tailoring, it is important to remember that it is the airworthiness standards to be included in the TCB that are "tailored", not the criteria in the EMACC; these are non-negotiable as they provide the framework for analysis of airworthiness requirements to ensure completeness and consistency of the tailored TCB. Standards, however, are usually associated with levels of safety (CS-25 does not have the same safety target as CS-23). As a result, for the same given airworthiness criterion, the standards for a fighter air system may differ significantly from those required for a tanker aircraft.

[8] MIL-HDBK-516B is a document controlled by the US Air Force that establishes the criteria only. MIL-HDBK-516B Change 1 was then introduced with additions from the US Navy. Last, the MIL-HDBK-516B Expanded proposes the criteria from MIL-HDBK-516B with standards and methods of compliance added.

It should be noted that the EMACC handbook does not yet include sub-system sections for HUMS and DAS equipment, as no appropriate standards could be harmonised; it is intended that these will be included in a subsequent EMACC handbook update. Validation of criteria against CS25 has been undertaken, and is accounted for in the EMACC Handbook

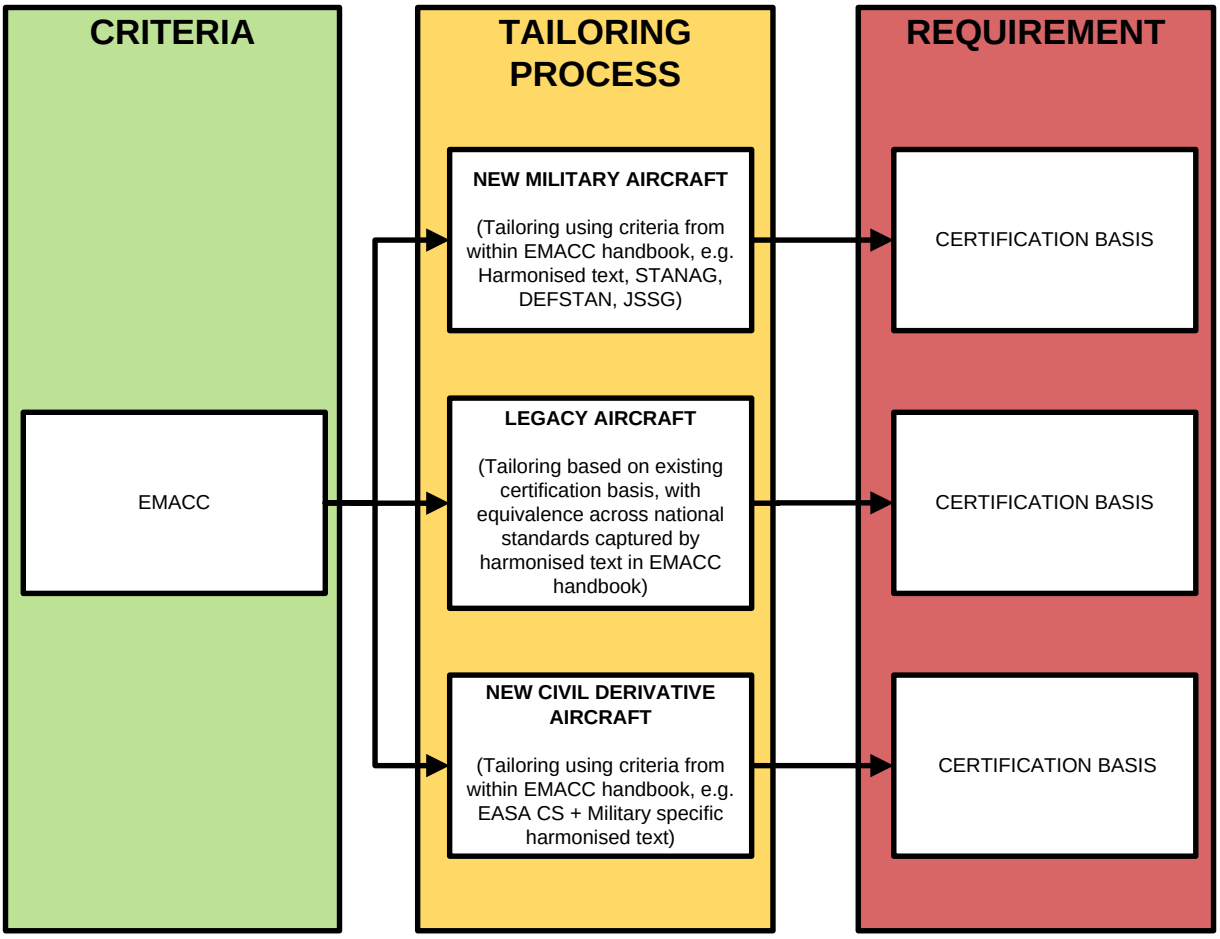
3.3 EMACC specific requirements

With the exception of Def Stan 00-970 Part 7 - Rotorcraft there is no certification code specific to the type-certification of individual military air roles, such as combat air, ISTAR, Tankers, etc. As a consequence, to adopt a total safety approach for all military applicable types, the EMACC introduces criteria dedicated to specific military equipment in chapter 17.

4 PROCESS - TAILORING THE TCB USING THE EMACC

The TCB tailoring process described in this guidebook focuses on the certification aspects for new air system types, or major changes[9] to type designs. As described above, the resulting outputs can be used as part of the qualification process, although this is not considered below.

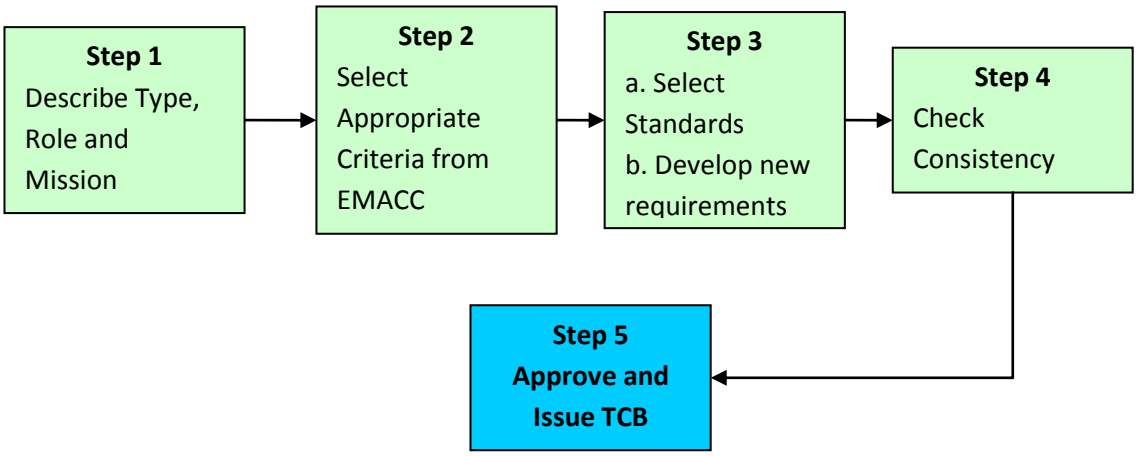
The objective of the tailoring process is to set appropriate airworthiness standards for certification according to the air system's general design, role(s) and mission(s).



There are 5 main steps of the TCB tailoring process as follows:

- **Step 1:** Describe the general design, role(s) and mission(s) for the Air system/aircraft ;
  - **Step 2**: Select and document applicable criteria from the EMACC;
  - **Step 3**: Define certification requirements (The TCB)
    - **Step 3a**: Select and document appropriate "Standards" referenced within the EMACC to produce the "Requirements".
    - **Step 3b**: Identify new standards, if considered appropriate, or develop bespoke new requirements as necessary for new or innovative technology.
  - **Step 4**: Carry out a consistency check of selected standards to ensure that they are not contradictory.
  - **Step 5**: Approve and Issue the TCB (in accordance with pMS Regulation)

[9] Noting that minor changes to a type design are also required to conform to the TCB.


Step 1
Describe Type, Role and Mission
Step 2
Select Appropriate Criteria from EMACC
Step 3
a. Select Standards
b. Develop new requirements
Step 4
Check Consistency
Step 5
Approve and Issue TCB

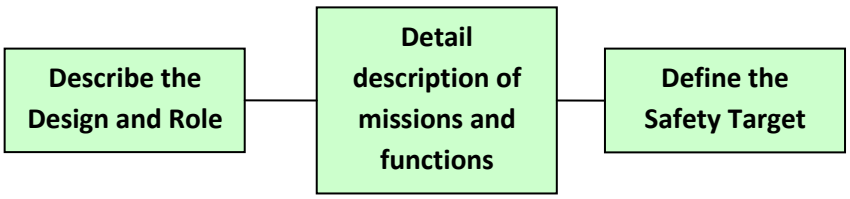
4.1 Step 1: Describe the Design, Role(s) and Mission(s)

The TCB tailoring process starts from a basic knowledge of the air system capability requirements, which drive the design, role(s) and mission(s) of the air system. Once top level design configuration concepts are determined, the TCB may be developed and approved to provide a tailored set of criteria, bespoke to the design, against which compliance will be assessed using appropriate standards.

For the NMAA, the objective of Step 1 is to understand the air system design and main role(s)/mission(s) in order to establish the essential technical considerations that will impact selection of appropriate certification requirements. This should be achieved through NMAA procedures that will normally include detailed technical briefing in order to fully understand the design, including new used technologies and any unique or unconventional features or intended unconventional usage of the air system. It is often the case, that at the early stages, the design may not be set and will continue to be further refined throughout the development phase. It is possible that the certification basis may not be finalised until the final air system configuration has been determined. Nevertheless, the fact that the design may not be "frozen" should not prevent early engagement with the NMAA to begin develop and tailor the TCB; indeed, it is essential as part of the airworthiness strategy that work to develop the TCB is started as early as possible within the development phase so as to inform major procurement decisions.

To begin the TCB tailoring process, before analysing the EMACC framework to identify detailed design criteria, the NMAA should establish the following:

- The air system concept design and intended main role(s);
- The air system detail description of and missions/functionalities;
- The safety objective.



4.1.1 The Military Air System Design and Role

As previously stated, the military certification process begins with the definition of capability requirements. The primary considerations for selecting applicable tailored certification requirements, therefore, will be based upon defining the main role of the air system; typically, these may include the following:

> **Combat aircraft:** The main roles of combat aircraft are air defence, such as air-to-air combat, and/or kinetic effects on the ground. Generally, these are fast and highly manoeuvrable, although unmanned variants may not be. These air systems are usually equipped with a variety of weapon systems, including bombs, guns, cannons, rockets and guided missiles.

Military transport aircraft: Military transport aircraft are primarily used to transport troops and materiel. Cargo can be attached to pallets, which are easily loaded, secured for flight, and quickly unloaded for delivery. Cargo also may be discharged by air-drop, eliminating the need for landing. Also included in this category are air tankers used for Air-to-Air Refuelling (AAR).

ISTAR - Reconnaissance and surveillance aircraft: ISTAR aircraft are primarily used to gather intelligence. They are equipped with cameras, radar and other sensors for battlefield and/or airspace surveillance, maritime patrol and targeting. These types usually include modified civil aircraft designs, although the role is increasingly being undertaken by UAS.

4.1.2 Military Air system specific design and functionalities/missions

The top level definition of Design and Role is essential, but not sufficient to tailor criteria in the EMACC. The Project must also clearly define specific design and missions/functionalities of the air system for the NMAA to consider. A list of main military air system design characteristics and functionalities/missions can be derived from the air system specification and any Statement of Operating Intent and Usage (SOIU) that forms part of the design data, including the Design usage Spectrum. The initial list of design and role features may not be exhaustive, and NMAA's are likely to amend or enhance the air system certification basic type description matrix for individual projects[10].

The matrix should provide a high-level description, but the importance of Step 1 being completed in sufficient detail to inform the tailoring process should not be overlooked. By maintaining a single basic description as the focal point for consideration of tailored EMACC criteria and standards, the NMAA will be better able to ensure consistency when selecting a mix of requirements from differing certification specifications. Furthermore, the description matrix should be treated as a "living document" to be updated and mature as the development phase progresses:

- This description is not frozen, and should be updated in the light of on-going experience;
- The principle of the list is intended to be similar to a database management system; enabling the description to provide the system with keywords to select (semi-automatically) appropriate and applicable airworthiness standards.
- The semi-automatic selection should always be supplemented by further SME analysis in the relevant technical fields to confirm (by adding, modifying or removing) the definitive applicable airworthiness standards.

4.1.3 The safety objective

The NMAA should clearly define the safety objective to be achieved throughout the Certification process. This will often be set according to National regulation or procedures. However, it should always be borne in mind that existing airworthiness standards may include differing safety levels, and care should be taken when mixing standards from different certification codes to ensure consistency; the default safety target for the code will often be implicit within a detailed requirement. For example:

- CS-25: In case of a civil transport aircraft a catastrophic failure must be extremely improbable at the system level, and is generally interpreted to be less at the aircraft level.

[10] A completed example of the Air System Certification Basic Description is included in Section 5.

- CS-23: For Normal, Utility, Aerobatic, and Commuter Category Airplanes, implies an expected level of safety at the system and aircraft level.
- FAR23 (AC 23.1309-1D) gives additional information but has varying safety objectives according to the class of the airplane.
- UAS: STANAG 4671 is derived from EASA CS-23. The corresponding AMC.1309 (b) refers to US standards such as USAR.1309 and AC 23.1309-1C. Consequently it is considered that the level of safety is equivalent to CS-23.
- Military Aircraft: according to DEF STAN 00-970 part 1, there are two levels of safety:
    - For combat air types;
    - For air support fixed- and rotary-wing types.

It should be noted that there is a further military distinction between combat air and air support types, and in comparison with civil aircraft, when considering that the safety target may be decreased during a mission for military purposes. Such a dual safety approach may be implemented for the certification of a single aircraft with several purposes (i.e. combat + support).

4.2 Step 2: Selection of applicable criteria from the EMACC

Step 2 comprises the selection of applicable criteria from the EMACC. The EMACC framework should be analysed in a systematic way with each criterion evaluated for applicability to the design description established in Step 1[11]. Selection of each criterion should be justified fully using NMAA procedure for documenting the TCB, such as using Military/Certification Review Items (M/CRIs). In particular, it is essential to document the rationale for all criteria deemed not applicable to the certification basis. Typically this could be a statement regarding configuration of the aircraft systems (e.g., — criterion x.xx is not applicable as this aircraft has no propellers). It is important to ensure that criteria should not be modified. If a portion of a considered criterion applies, and a portion does not apply, the applicable portion should be included in the TCB and justification for the non-applicable portion should be provided (such as store separation characteristics for aircraft that may carry but don't jettison stores).

It is important to note that the EMACC Handbook refers to certification specifications and standards at a fixed amendment state, which is detailed in the Handbook. Users will need to consider the impact of subsequent changes during the tailoring process to ensure that an appropriate reference status is established. The EMACC Handbook will be periodically updated through review and cross-checking of the referenced documents; users should always refer to the current version. Where a conflict exists between the reference documents and the EMACC Handbook then it should be brought to the attention of the Sponsor.

A Tailored TCB Airworthiness Certification Criteria document, similar to the table below, should be produced to record the rationale for each EMACC criteria.

Paragraph Number	Certification Criteria	Applicable (Y/N)	Rationale for Non-Applicable Criteria	Standard
XX.X.X	Each criteria transposed from the EMACC	Y or N - Identify each criterion as either applicable or non-applicable, considering system or product complexity, type, data, and intended use	Describe fully the rationale used to justify removal of the criteria from the tailored TCB	Step 3 - Define the standards to be used from the sources referenced in the EMACC; modification of specified requirements; appropriate other requirements considered; or development of new criteria as special conditions or equivalent safety findings

[11] For example: life support criteria will be N/A for an unmanned air vehicle (UAV)

4.3 Step 3: Define Certification Requirements to produce the tailored TCB

The objective in Step 3 is to convert the high-level certification criteria selected as applicable to the TCB in Step 2, into detailed design and airworthiness requirements such as those specified in accepted certification codes referenced in the EMACC.

4.3.1 Step 3a: Selection of appropriate Standards from certification codes referenced within the EMACC Requirements

The initial Step 3a requires analysis of the different standards to define what best suits the selected criteria. For example, for the same given airworthiness criteria from the EMACC, the standards for a fighter aircraft may be significantly different than those required for a transport aircraft.

Primary Certification Code. In most cases, practicable application of the tailoring process using the EMACC will require selection of a Primary Certification Code (PCC) for the Project. For example:

- For a civil derivative airliner used in the military Air Transport role, the applicable civil certification specification (e.g. CS25) could be selected as the PCC.
- For a fast-jet fighter aircraft, Def Stan 00-970 or JSSG 2006 might be considered the most appropriate PCC depending on the origin of the Design Organisation (DO).
- For unmanned air support or combat air vehicles, STANAG 4671 or Def Stan 00-970 Part 9 might be considered as the PCC.

Careful selection of the PCC should simplify analysis of the EMACC framework, as the default standard associated with each criteria will initially be sourced from the PCC. Only where it is considered that the PCC requirement does not adequately address consideration of the system or product complexity, type, data, and intended use should an alternative requirement be needed from a different code, or by developing a bespoke requirement in Step 3b. The association of a default standard from the PCC to each applicable criterion is an important step to ensure the consistency and the completeness of the type-certification basis.

4.3.2 Step 3b: Selection or development of new appropriate standards to define the Tailored TCB requirements

Using knowledge of the design, role(s) and mission(s) described at Step 1, where no appropriate standard exists in the PCC or any alternative Code referenced in the EMACC, it could be considered necessary to do one of the following:

- Select an alternative appropriate standard not documented in the EMACC[12]
- modify a standard from the PCC
- modify a standard from an alternative Code
- develop a new requirement; or
- define the scope for equivalent safety findings

[12] Use of alternative standards not currently referenced in the source certification Codes could be considered by MAWA TF4 for introduction at subsequent updates of the EMACC.

4.3.3 Documenting Development of the TCB Requirements

The rationale for selecting requirements from the PCC, alternative referenced Codes or developing new requirement should be document in accordance with NMAA regulation or procedures (such as in a M/CRI[13]) for incorporation into the type-certification basis of the air system. Documentation should be included to account for the following outcomes, among others, from Steps 3a and 3b:

- Integration of new equipment for military purposes (ex: adding new troop seats transportation or different mission systems in a Civil Derivative Aircraft (CDA));
- Specific military operations such as those requiring night vision devices or AAR;
- Degradation of the previously defined safety level;
- New concept of design not yet taken into account by the NMAA, which might lead to an alternative standard or Special Condition being incorporated as a new reference in EMACC;
- Change to an existing airworthiness standard in EMACC, for which there is no existing method of compliance;
- Need to clarify an existing airworthiness standard in EMACC to ensure understanding of the method of compliance for the avoidance of doubt;
- Deviation to an airworthiness standard in EMACC;
- Special conditions, for exportation or for compliance to standards outside the EMACC perimeter (such as NATO);

[13] An CRI illustrative example is provided in Annex B of the guidebook.

4.4 Step 4: Carry out a consistency check of selected standards to ensure that they are not contradictory **and** that all requirements are identified and formulated in a way that makes them unambiguous, verifiable and realistic.

Once all EMACC topics have been addressed, it is important for the NMAA to carry out a consistency check at the aircraft level to ensure that the tailoring of standards has maintained a coherent level of safety in terms of the safety target defined in Step 1, in particular where requirements may overlap. Step 4 relies on consideration by suitably qualified and experienced SMEs using the best available knowledge.

The tailored TCB will be used to establish the project certification programme, which would include consideration of the most appropriate Means of Compliance (MoC) that need to be demonstrated in order to show compliance to each of the requirements. Early consideration of the most appropriate MoC is important particularly for new requirements that have been introduced.

4.5 Step 5: Approve and Issue the TCB.

Approval of the TCB should be carried out in accordance with National procedures and Regulations. The Approval and Issue arrangements should be detailed in the Certification Plan.

5 EXAMPLES - TAILORING THE TCB USING THE EMACC

(Chapter 5 is intended to include examples of specific use of the EMACC Handbook to tailor a TCB. The following illustrative examples are included in the interim until examples from pMS use of the Handbook are available)

5.1 Step 1: Describe the Design, Role(s) and Mission(s)

Example 1.1 – Compiling an air system certification basic type description matrix

The CASA CN-235 is a civil/military aircraft modified for a transport/support role. The air system was initially first certified by the Spanish military airworthiness authority on 19th Nov 1986 and FAA civil certification was granted on 3rd Dec 1986 to US Code of Federal Regulations, Title 14, Part 25 (FAR 25), effective from 1 Feb 1965, including all amendments from 25-1 to 25-59, 25-61 and 25.62. The aircraft is to be modified for maritime patrol purposes, which mainly consists of:

- Integration of a Tactical System (operator consoles, search radar, FLIR/EO turret, AIS and Datalink);
- Installation of bubble windows;
- Fitting of weapons under the wing (torpedoes and underwater bombs);
- Upgrade of the Flight management system.

Although the applicable airworthiness standard is FAR25, it may be considered similar to CS-25 (with some variants), which can be considered as the PCC.

In Step 1 of tailoring in accordance with the EMACC, an air system certification basic type description matrix may look as follows:

AIR SYSTEM CERTIFICATION BASIC TYPE DESCRITPION			
Features of the Air System Design, Mission, Function			**Description**
Engines	Number		2
	Location		Underwing Pods
	Type	Jet	No
		Propeller	Yes
	APU		
Operational Limitations	Limit Speeds	VMO/MMO	232 Knots
		V Stall	
	Altitude		25,000 ft
	Range		2871 Km
	Cargo Load		5,000 Kg
	MTOW		15,800 Kg
Cockpit/Flight Deck	Crew Number		2
	Equipment	Surveillance	Yes
		SAR	Yes
		Weapons	Yes
		Scientific	No
Cabin	Max Occupancy		5
	Equipment	Surveillance	Yes
		SAR	Yes
		Weapons	Yes
		Scientific	No
Military Equipment	Ejection Seat		No
	Weapon Systems		Yes
	Tanker		No
	Carrier-based		No

AIR SYSTEM CERTIFICATION BASIC TYPE DESCRITPION			
Features of the Air System Design, Mission, Function			Description
	ECM		No
Missions	Number/Mix		10
	EW		Yes
	AAR (Receive or Dispense)		No
	Surveillance		Yes
	SAR		Yes
	Air-to-Air		No
	Ground Attack		Yes
	Scientific		No
	Air Drop		No
	Air Transport		No
	Civil Transport		No
Other Design Features	Civil ATM/ATC		No
	ETOPS		Yes
	CAT I, II, III Approach		No
	Fly by wire		No

Criteria: *"EMACC 5.1.11 - The airframe, although it may be damaged in emergency landing conditions on land or water, shall be designed to protect personnel during crash landings."*

Rationale: Prior to use of the chart, the CS 25.561 (General – Emergency landing conditions) & 25.562 (Emergency landing dynamic conditions) would be automatically selected as the PCC. But, since the purpose of the modified aircraft does not include the civil transport, the DEF STAN 00-970 Part 1 Sec 4 4.22 (CRASH LANDING, DITCHING AND PRECAUTIONARY ALIGHTING ON WATER) should be considered more appropriate than the CS 25.561 & 25.562 according to aircraft classification.

5.2 Step 2: Selection of applicable criteria from the EMACC

Example 2.1 – Electromagnetic Environmental Testing

"EMACC 13.2.1 - All systems and sub-systems on the air vehicle shall be mutually electro-magnetically compatible."

US Cross References		European Cross References	
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-464, section 5.2	*Def-Stan 00-970 Reference:*	00-970 6.1.41 00-970 6.6.10.3 S9 L1011
		STANAG Reference:	4671.867 4671.685(e) 4671.1431(g) 4671.U1481(b) 4671.U1605 4671.U1717
FAA Doc:		*EASA CS Reference:*	CS 23.1431(b) CS 25.1431(c) CS 29.1431(b) CS 23.C5 287b(2)(iii) CS 23.1301 CS 25.1301 CS 27.1301 CS 29.1301
Comments:	No equivalent para. CS 27.1431. AMC refers to CS23/25/27/20.1301 - EMC covered by this para. No equivalent to MIL-STD-464 looked into.		

Paragraph Number	Certification Criteria	Applicable (Y/N)	Rationale for Non-Applicable Criteria	Standard
13.2.1	All systems and sub-systems on the air vehicle shall be mutually electro-magnetically compatible.	Y	-	Intra-system EMC is required at the aircraft level to demonstrate that equipment and subsystems are capable of providing safety of flight in conjunction with other equipment and subsystems which are required to operate concurrently.
13.2.5	If protection from the effects of an electro-magnetic pulse is required, the appropriate level of protection and associated acceptance criteria are to be established.	N	EMP Protection not required for mission	

Example 2.2 – CDA with no pressurization system.

Criteria: *"EMACC 8.2.4 - Ensure that the air vehicle normal and emergency pressurization requirements are met and are indicated or monitored to ensure Safety of Flight."*

Rationale: Considering a propeller-driven transport aircraft, intended to be used for military purposes, with a MTOW less than 19 000 lb and a number of cabin crew less than 19. The aircraft is intended to fly at a maximum altitude of 10 000 feet. The aircraft was initially civil type-certified following CS-23 (previously JAR 23) EASA regulation. Since the maximum altitude will never be more than 10 000 feet, the aircraft is designed for flight without any pressurization system. Consequently, the CS 23.365, CS23.841 & CS 23.843 requirements will be considered as non-applicable. Moreover, even is the aircraft is intended for military use, the DEF-STAN 00-970 P1 6.14 will also be considered not applicable.

5.3 Step 3: Define Certification Requirements to produce the tailored TCB

Example 3.1 – Selecting requirements from the PCC:

As an example, for a manned civil transport airplane, considering criterion 5.4.1:

"EMACC 5.4.1 - 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."

US Cross References		European Cross References	
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.12 Damage Tolerance, pg 398 JSSG-2006: A.4.12 Damage Tolerance, pg 400 (for compliance development)	*Def-Stan 00-970 Reference:*	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
		STANAG Reference:	4671 305 4671 570 4671 572 4671 573 4671 575
FAA Doc:	14CFR reference: 23.571, 23.572, 23.573; 25.571; 27.571; 29.571.	*EASA CS Reference:*	CS 23.571 CS 23.572 CS 23.573 CS 23.575 CS 25.571 CS 27.571 CS 29.571

The airworthiness standard CS-25 might be selected. In particular, requirement CS 25.571 should be selected for inclusion in the TCB, assuming that there is no specific military operation which could jeopardize this requirement.

Criteria: *"EMACC 13.1.2 - All non-flight-critical equipments shall be identified and shown: 1. To comply with all electromagnetic environmental effects requirements that are appropriate for the particular equipment, including lightning susceptibility; this includes both radiated and susceptibility requirements; 2. To not adversely affect the safe operation of flight critical equipment."*

Rationale: Considering a UAS where a new video camera system has been installed in order to transmit real time video to a ground station: the system comprises an analogue camera, a converter, a modem, a transmitter and an antenna. The system is classified as non-flight-critical. According to EMACC, airworthiness code STANAG 4671 could be selected. Furthermore, the intent of the STANAG is "to correspond as closely as practicable to a comparable minimum level of

airworthiness for fixed-wing aircraft as embodied in documents such as 14 CFR1 Part 23 and EASA2 CS-23 (from which it is derived), whilst recognizing that there are certain unique features of UAS that require particular additional requirements or subparts." Consequently, select the appropriate standards as follows: STANAG 4671.867, 4671.685(e), 4671.1431(g), 4671.U1481, 4671.U1605, 4671.U1717.

Example 3.2 – Selecting from the civil PCC requirements that might have a similar military standard, which would not affect the level of safety

Criteria: *"5.4.1 - 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."*

Rationale: Without reference to the Air System Certification Basic Type Description CS 25.571 (Damage tolerance and fatigue evaluation of structure) would be automatically selected. But, since the purpose of the modified aircraft does not include civil transport, DEF STAN 00-970 Part 1 Sec 3 3.2 (FATIGUE) might be considered more appropriate than the CS 25.571 according to the aircraft classification. However, DEF STAN 00-970 Part 1 Sec 3.0.2 clearly states that the relevant requirement is intended to provide information similar to that contained in JAR 25 Section C, which may mean that the choice of DEF STAN in lieu of CS-25 (previously JAR25), would have no major consequence on the certification process.

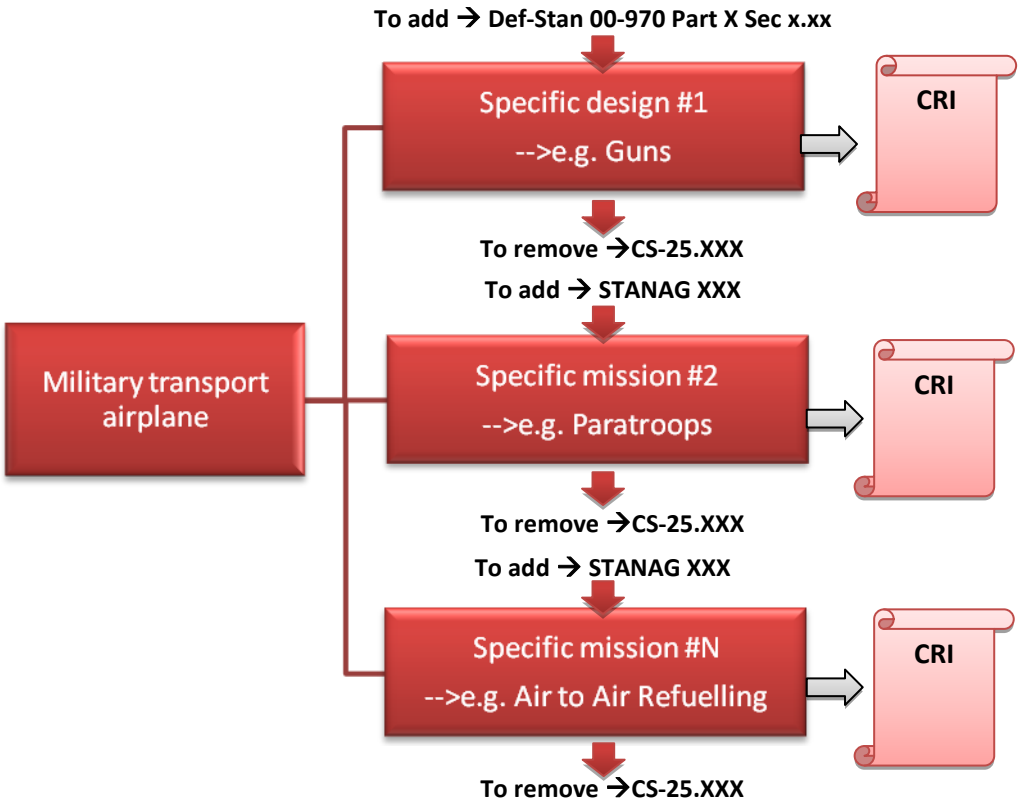
Example 3.3 – Selecting requirements from a military PCC

Criteria: *"EMACC 13.1.2 - All non-flight-critical equipments shall be identified and shown: 1. To comply with all electromagnetic environmental effects requirements that are appropriate for the particular equipment, including lightning susceptibility; this includes both radiated and susceptibility requirements; 2. To not adversely affect the safe operation of flight critical equipment."*

Rationale: Considering a major change installed on a fighter, the tailoring process would select the appropriate DEFSTAN 00-970 parts 4.27.23 to 4.27.40, 6.1.4, 6.1.41, 6.2.58, 6.6.54. Note: On some current fighter, the MIL-STD-461 was used for certification, directly or by cross reference. If this were the case, justification for using an alternative standard would need to be documented iaw Step 3b.

Example 3.4 – Selecting alternative military standards to those identified in a civil PCC and documenting relevant changes in an CRI

A general approach for civil modified transport aircraft using CS25 as the PCC may be as follows:



5.4 Step 4: Carry out a consistency check of selected standards to ensure that they are not contradictory **and** that all requirements are identified and formulated in a way that makes them unambiguous, verifiable and realistic..

Example 4.1 – the Testing flammability

Criteria: *"EMACC 8.4.14 - Air vehicle interior finishes and materials shall deter combustion and any toxic by-products of combustion shall be at acceptable levels."*

Rationale: If other compliance methods than the ones provided in CS-25 AMC are used, it can invalid the results or should be subject to discussion with the NMAA.

ANNEX A: Type Certification Basis Examples

A – Template

The Type Certification Basis should be described in a consistent format following EMACC Handbook framework section and sub-section headings. It should be structured according to the following basic template:

Overall Basis of Certification. Description of the Primary Certification Code (including version number) against which the whole aircraft is certified. This forms the default certification code for all systems, sub-systems and elements not specifically covered in the later sections.

Exceptions. Detail, using the system and sub-system breakdown in the EMACC Handbook, elements of the design that are certified to alternative agreed standards or codes

Special Conditions. Detail, using the system and sub-system breakdown in the EMACC Handbook, elements for which a bespoke certification specification has been developed for the project. These may also be detailed within CRIs.

Elect to Comply Items. Where a later version of the PCC or alternative standard used elsewhere has been used for certification with agreement of the NMAA, these should be documented here.

Equivalent Safety Findings. Specify where it is not possible to certify against an accepted standard, and agreement has been reached to provide a safety argument to demonstrate an equivalent level of safety has been achieved.

B – Military Aircraft Example

(It is intended to include a military TCB when available to provide an illustrative example)

C – Civil Aircraft Example

…

3 - 14 CFR Section 21.29 and the following sections of Part 25 of the FAR as amended by amendments 25-1 through 25-54:

- FAR 25.2 FAR 25.777(g) FAR 25.1309(a),(b)
- FAR 25.107(d)(e) FAR 25.781 FAR 25.1331(a)(3)
- FAR 25.125 FAR 25.785(g) FAR 25.1353(c)(6)
- FAR 25.201(d) FAR 25.787(a) FAR 25.1401(b)
- FAR 25.331(c) FAR 25.803(c)(7) FAR 25.1401(f)
- FAR 25.351(a)(1) FAR 25.809(j) FAR 25.1411(a)(2)
- FAR 25.361 FAR 25.903(a) FAR 25.1415
- FAR 25.491 FAR 25.901 FAR 25.1438
- FAR 25.511(b)(c) FAR 25.905(a) FAR 25.1501
- FAR 25.571(b)(6),(e)(2) FAR 25.994 FAR 25.1513
- FAR 25.613 FAR 25.1013 FAR 25.1521(b)(c)
- FAR 25.615 FAR 25.1015 FAR 25.1547(c)

- FAR 25.621 FAR 25.1019 FAR 25.1549
- FAR 25.631 FAR 25.1093(b)(1),(b)(2) FAR 25.1583(a)(4)
- FAR 25.671(c)(1) FAR 25.1141(f)(2) FAR 25.1583(1)
- FAR 25.693 FAR 25.1303(b)(4) FAR 25.1585(a)
- FAR 25.773(b)(2) FAR 25.1305(c)(6)(7) FAR 25.1587(a)
- FAR 25.777(e)
- Item (1), (2), and (3) above have been examined and found to be equivalent to Part 25 of the FAR through Amendment 25-54.

4 - FAA Special Conditions for ATCPS dated July 11, 1985 (FAR 25.904, Amendment 25-62 for the ATR42-320)

5 - SFAR 27, Amendments 1 thru 5

6 - FAR 36, Amendments 1 thru 12 for the ATR42-200 and -300 (Amendments 1 thru 15 for the ATR42-320)

7 - FAA Exemption No. NM 104 regarding 25.571 (e) (2), granted April 19, 1984 (Propeller debris)

8 - In addition voluntary compliance with FAR 25.832, Amendment 25-56 has been demonstrated.

9 - A finding of regulatory adequacy pursuant to the "Noise Control Act of 1972"

10 - FAA findings of Equivalent safety for the following rules:

- FAR 25.773(b)(2)
- FAR 25.807 (c) and (d)
- FAR 25.865

11 - Compliance with the following optional requirements has been established

- Ice protection provisions JAR 25.1419.
- Structural Provisions for ditching: JAR 25.801 (a)(b)(c)(d)(e)

12 - Compliance with the following optional requirements has been established:

- Ditching Provisions JAR 25.1411 (a)(b)(d)(e)(f)(g)(1) and JAR 25.1415 (a)(b)(c)(d)(e)
- When requested by the operational rules, the life rafts must be installed in accordance with the locations defined in document 421.054/92, issue 5.

13 - For precision approach and landing, the applicable technical requirements are complemented by JAR AWO - Subpart 2 Type Certificate No. A53EU, issued October 25, 1985, amended August 25, 1988.

...

Date of application for Type Certificate: XX February 20YY.

ANNEX B: CRI Illustrative Example

Project:		**MCRI-NO:**
Subject:	Title of subject	
Applicable Regulation Ref.:	Reference to involved regulation	**Issue No:**
Referenced Documents	Reference to any associated document	**Date:**
Advisory Material/ Policy Ref.:		**MCRI Status:**
Other applicable Requirements:		
Primary responsible:	Primary panel involved in the discussion	**Next Action**
Secondary responsible:	Other panel may be involved in the discussion	**MCRI Agreement target:**

Statement of Issue:

Description of the subject which necessitates an adapted Military TCB

Discussion:

Record of the discussion leading to a proposed adapted Military TCB with associated Military Special Conditions (certification requirement) and associated Interpretative Material and/or Acceptable Means of Compliance.

Proposed Aircraft Military Special condition :

Proposed adapted Military TCB.

NMAA Position:

NMAA SMEs trace their positions along the discussion with the Applicant to define the Military Special Conditions and associated Interpretative Material and/or Acceptable Means of Compliance.

Conclusion: NMAA provides position (agreement, rejection, request for adaptation)

Appendix: Glossary and Acronyms

Glossary

Military Special Condition:

The form of words that will be part of the military requirement is described. This is the only element that appears in the TCB.

Interpretative Military Material

The interpretation of the Military Special Condition requirement is established during the CRI discussion and is provided for completeness to ensure mutual understanding of the requirement between the applicant and the MAA. It will not be part of the TCB.

Military Acceptable Means of Compliance

AMC would be established during the CRI discussion; guidance material would be documented for AMC to demonstrate compliance to the Military Special Condition requirement.

Legacy Aircraft

Legacy aircraft are aircraft that are already in military service and have been previously certified (either formally or not).

Acronyms

AAR	Air-to-Air Refueling
AMC	Acceptable Means of Compliance
CDA	Civil Derivative Aircraft
CS	Certification Specification
DAS	Defensive Aids Systems/Suite
DEF STAN	Defence Standard
DO	Design Organisation
EASA	European Aviation Safety Agency
EMACC	European Military Airworthiness Certification Criteria
EMAR	European Military Airworthiness Requirements
EMC	Electromagnetic Compatibility
EMP	Electromagnetic Pulse
FAR	Federal Aviation Regulations
FLIR/EO	Forward Looking InfraRed
HUMS	Health Usage and Monitoring System
ISTAR	Intelligence, Surveillance, Target Acquisition, and Reconnaissance
JAA	Joint Aviation Authorities
JAR	Joint Aviation Requirements
JSSG	Joint Service Specification Guide
MAA	Military Aviation Authority
MAWA	Military Airworthiness Authorities
NMAA	National Military Aviation Authorities
M/CRI	Military/Certification Review Items
MIL-HDBK	Military Handbook
MoC	Means of Compliance
PCC	Primary Certification Code
pMS	participating Member States
SME	Subject Matter Expert
SOIU	Statement of Operating Intent and Usage

STANAGS	Standardization Agreements
TCB	Type Certification Basis
UAS	Unmanned Air Systems
UAV	Unmanned Air Vehicle
USAR	Unmanned Air Vehicle (UAV) System Airworthiness Requirements (USARs)