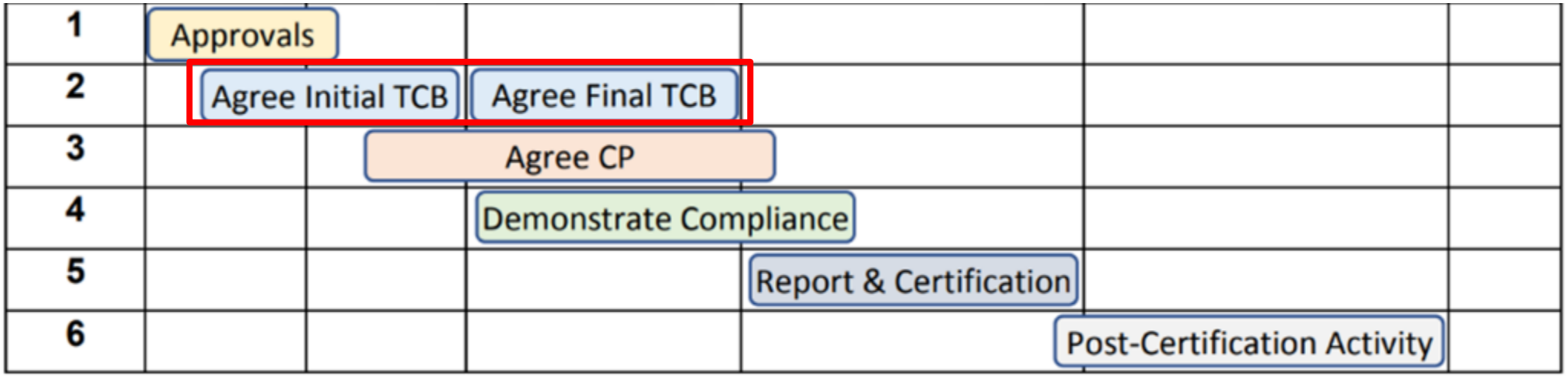
Military Air System Certification Process: Awareness Training Day 1- Phase 2 Type Certification Basis

MACP Phase 2 – Type Certification Basis

The Military Air System Certification Process (MACP)



What is a Type Certification Basis?

"*The agreed set of certification requirements, including airworthiness codes and Special Conditions, that are applicable to the Air System Type Design and will be demonstrated in the compliance activity in order to obtain a Military Type Certificate.*"

[Source: MAA02]

MAA02 MAA Master Glossary

Certification Specifications – What Are They?

"A Certification Specification for Airworthiness (hereafter referred to as 'Certification Specification') is a document, often referencing a number of associated design Standards, that comprises hundreds of Certification Requirements against which a designer must satisfactorily comply in order to establish a minimum level of Airworthiness for their Air System and thereby assure an Airworthiness Regulator to issue a Type Certificate."

[Source: MMAC]

Manual of Military Air System Certification (MMAC)
Chapter 1: Introduction
Para 7: Definitions

Military Air System Certification: Awareness Training Day 1

Key Certification Specifications

- DefStan 00-970 – UK MAA Benchmark Standard
- EASA Certification Specifications (CS): CS-22 – Sailplanes and Powered Sailplanes / CS-23 – Normal, Utility, Aerobatic and Commuter Aeroplanes / CS-25 – Large Aeroplanes / CS-27 – Small Rotorcraft / CS-29 – Large Rotorcraft… etc.
- US FAA governed: (14 CFR) Part 23 – 19 or less passengers, 19,000 lb or less MTOW / Part 25 – Transport aircraft / Part 27 – Normal Rotorcraft / Part 29 – Transport Rotorcraft
- UK CAA Specifications (Read across from EASA CS).
- US Department of Defense US-MIL-HDBK-516C

Def Stan 00-970 Part 05 – Subpart F (extract)

DEF STAN 00-970 Part 5 Issue 9

Requirement	Compliance	Guidance
SUBPART F - EQUIPMENT		
GENERAL		
CS 25.1301 Function and Installation	AMC 25.1301	INTENTIONALLY BLANK
UK25.1301a DELETED Issue 7	INTENTIONALLY BLANK	INTENTIONALLY BLANK
UK25.1301b DELETED Issue 7	INTENTIONALLY BLANK	INTENTIONALLY BLANK
UK25.1301c TEMPEST Requirements INTENTIONALLY BLANK Issue 7	INTENTIONALLY BLANK	For TEMPEST aspects of the design, refer to JSP440.
UK25.1301d Electromagnetic Compatibility Requirements Military specific EMC/EMI and bonding testing shall be performed. Issue 7	Air System EMC should comply with: (a) Defence Standard 59-411 "Electromagnetic Compatibility Parts 1-5" (latest edition) (b) Defence Standard 59-114 "Safety Principles for Electrical Circuits in Systems Incorporating Explosive Components" (latest edition)	INTENTIONALLY BLANK

EASA Easy Access Rules for Large Aeroplanes (CS25) (extract)

CS 25.1301 Function and installation

ED Decision 2008/006/R

(See AMC 25.1301)

(a) Each item of installed equipment must –

(1) Be of a kind and design appropriate to its intended function;

(2) Be labelled as to its identification, function, or operating limitations, or any applicable combination of these factors. (See AMC 25.1301(a)(2).)

(3) Be installed according to limitations specified for that equipment.

(b) Electrical wiring interconnection systems must meet the requirements of subpart H of this CS-25.

[Amdt 25/2]
[Amdt 25/5]

AMC 25.1301(a)(2) Function and installation

ED Decision 2008/006/R

When pipelines are marked for the purpose of distinguishing their functions, the markings should be such that the risk of confusion by maintenance or servicing personnel will be minimised. Distinction by means of colour markings alone is not acceptable. The use of alphabetic or numerical symbols will be acceptable if recognition depends upon reference to a master key and any relation between symbol and function is carefully avoided. Specification ISO.12 version 2ED 1987 gives acceptable graphical markings.

[Amdt 25/5]

Easy Access Rules for Large Aeroplanes (CS-25)

US MIL-HDBK-516C (extract)

Downloaded from http://www.everyspec.com

5.2.5 Environment design - sonic fatigue.

Criterion: Verify that the airframe structure (including cavities), equipment, and equipment provisions withstand the aeroacoustic loads and vibrations induced by the aeroacoustic environment for the air vehicle specified service life and usage without cracking or functional impairment.

***Standard* (Army and Air Force)**:

a. All aeroacoustic loads sources associated with the air vehicle and its usage are identified.
b. The airframe is designed such that an uncertainty factor of +3.5 dB is applied on the predicted aeroacoustic sound pressure levels.
c. The airframe is designed for fatigue life such that a factor of 2.0 is applied on the exposure time derived from the air vehicle specified service life and usage.

***Standard* (Navy)**: The aircraft and its components are designed to withstand, without cracking or functional impairment, loads resulting from vibratory sources and hot surface flow; engine, propeller, prop-rotor, and main or tail rotor passage frequency and pressure loads; power lift systems; cavity noise, blast pressures and recoil forces due to gun and rocket firing; buffeting forces; unbalances of rotating components; structural response to gusts and airfield and ship landing surfaces; exhaust turbulence noise and temperatures during operations in close proximity to shipboard catapult systems, jet blast deflectors and other air vehicles operating in close proximity; and acoustic/sonic loadings due to auxiliary power units, motors and pumps. Natural frequencies are separated from predominate main and tail rotor frequencies, and other driving sources such as gearboxes, shafting, engines, auxiliary power units.

***Method of Compliance* (Army and Air Force)**: Verification methods include analyses and tests. The following compliance instruments are applicable in addressing the standards:

a. Predictions of the near field aeroacoustic loads and fatigue life encompassing the air vehicles service life and usage and the identified aeroacoustic load sources.
b. Wind tunnel, jet models which define acoustic levels.
c. Component acoustic fatigue tests based on fatigue life predictions.
d. Ground and flight aeroacoustic measurements from full scale test aircraft including internal noise measurements.

***Method of Compliance* (Navy)**: Verification methods include analyses, wind tunnel testing, review of documentation component fatigue testing, airframe and component ground vibration testing, and powered ground testing including operations of engines, while opening and closing doors and compartments and when in close proximity to other parked and/or operating air vehicles; and flight testing throughout the full range of flight and ground operations, including gunfire and stores or cargo release. Transducers are utilized to record the operational acoustic and vibration environments.

References: (Navy/Air Force fixed wing) JSSG-2006: A.3.5, A.3.5.1, A.3.6, A.3.3.8, A.3.3.9, A.4.5, A.4.6, A.4.8 and A.4.9

(Army rotary wing) ADS-10-SP, ADS-24 (cancelled), ADS-27-SP, ADS-29 (cancelled), ADS-51, ADS-64-SP (inactive), AR-70-62

(Navy rotary wing) As identified in the AVPS Addendum for the respective air vehicle and/or AR-56, AR-89, MIL-D-23222

14 CFR23, 25, 27, 29

STANAG 4671: USAR 321

Establishing the TCB – New Type Design

Selection of applicable Certification Specification and Version/Amendment;

Clear statement on which versions of the selected specifications will be applied;

Identification of areas that may require a Military Certification Review Item (MCRI).

Manual of Military Air System Certification (MMAC)
Chapter 2: Certification Of Air System Type Designs (MRP Part 21 Subpart B) And The Military Air System Certification Process (MACP)
Phase 2 - Establish and Agree the TCB

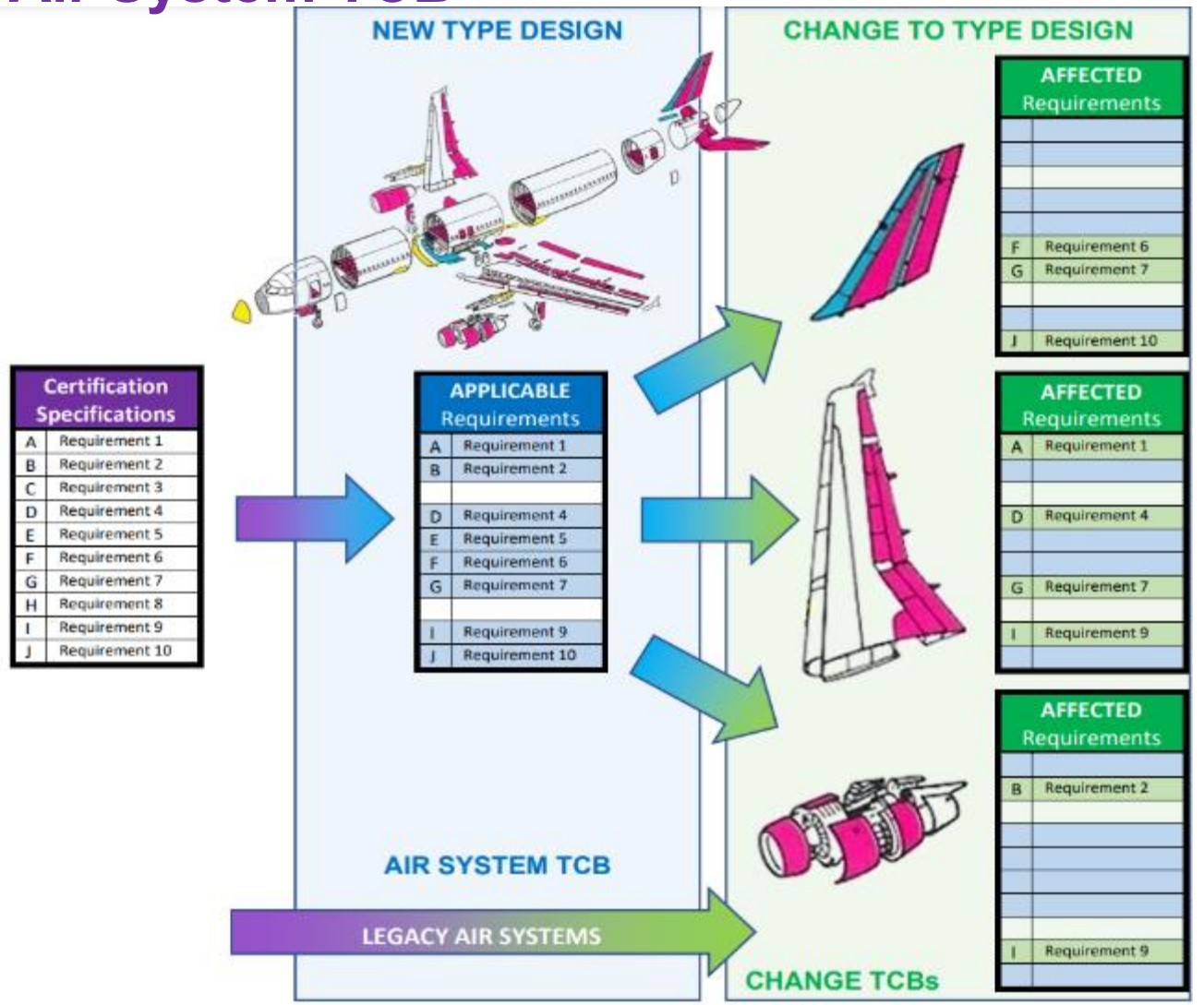
Establishing the TCB – Change to Type Design

Identification of affected certification requirements from the existing TCB in order to develop a TCB for the design change;

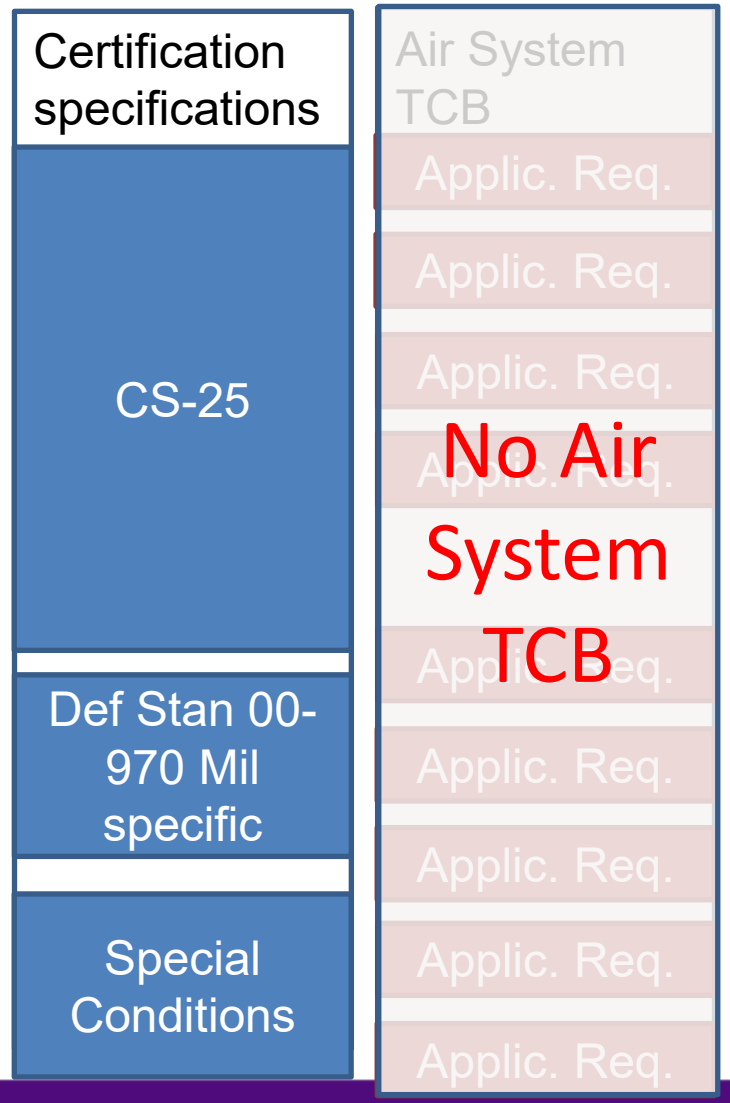
Consideration of Changed Product Rule (CPR) if applicable.

New Platform Air System TCB

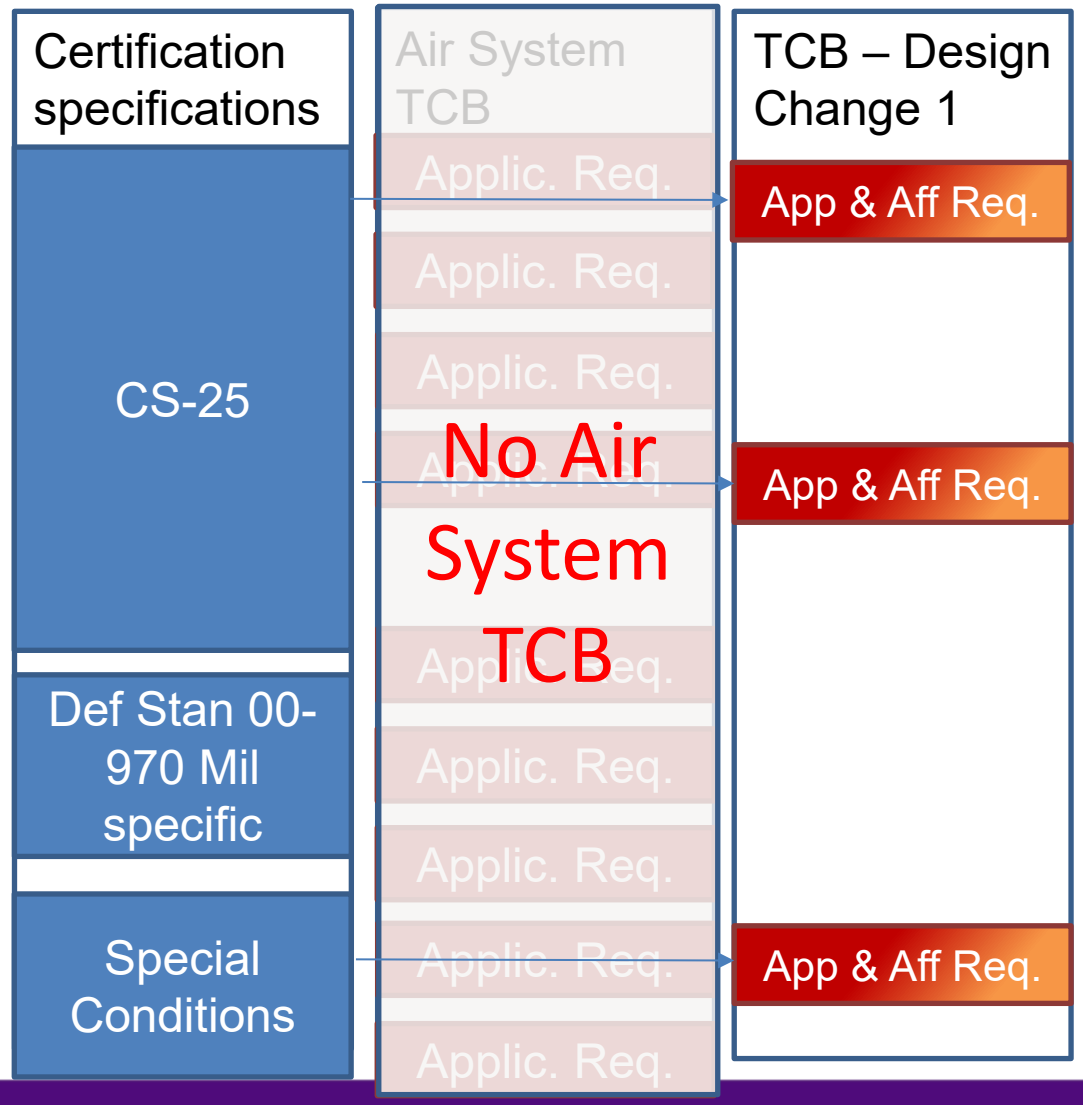
Certification specifications	Air System TCB	Type Design Change
CS-25	Applic. Req.	Affected Req.
	Applic. Req.	
	Applic. Req.	Affected Req.
	Applic. Req.	Affected Req.
		Applic. Req.
	Applic. Req.	Affected Req.
Def Stan 00-970 Mil specific	Applic. Req.	
	Applic. Req.	Affected Req.
Special Conditions	Applic. Req.	Affected Req.
	Applic. Req.	



Legacy Platform – Design Change TCB

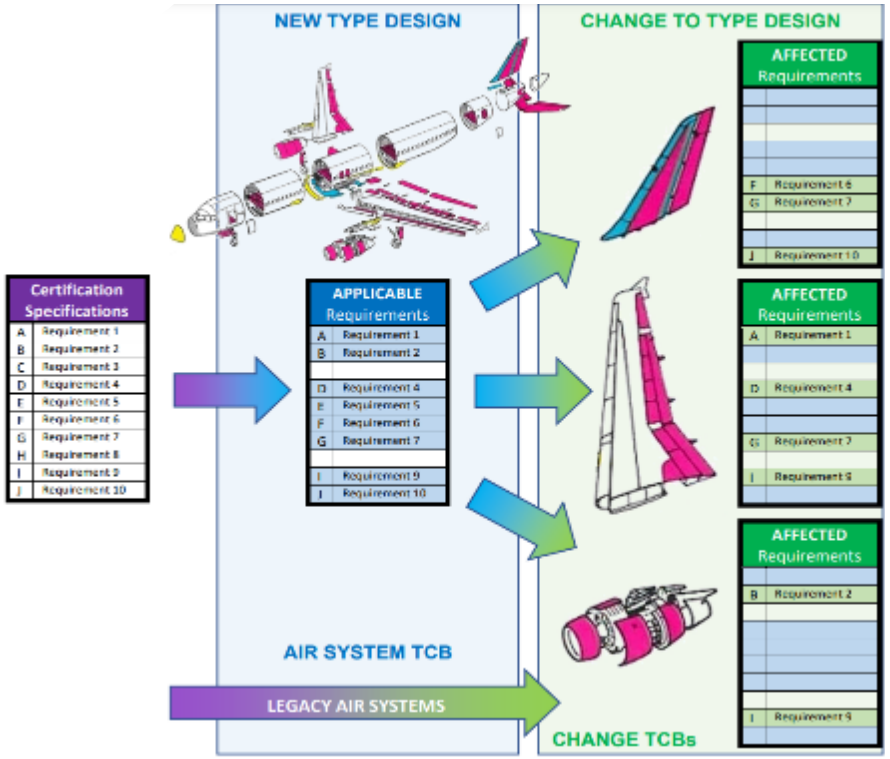


Legacy Platform – Design Change TCB



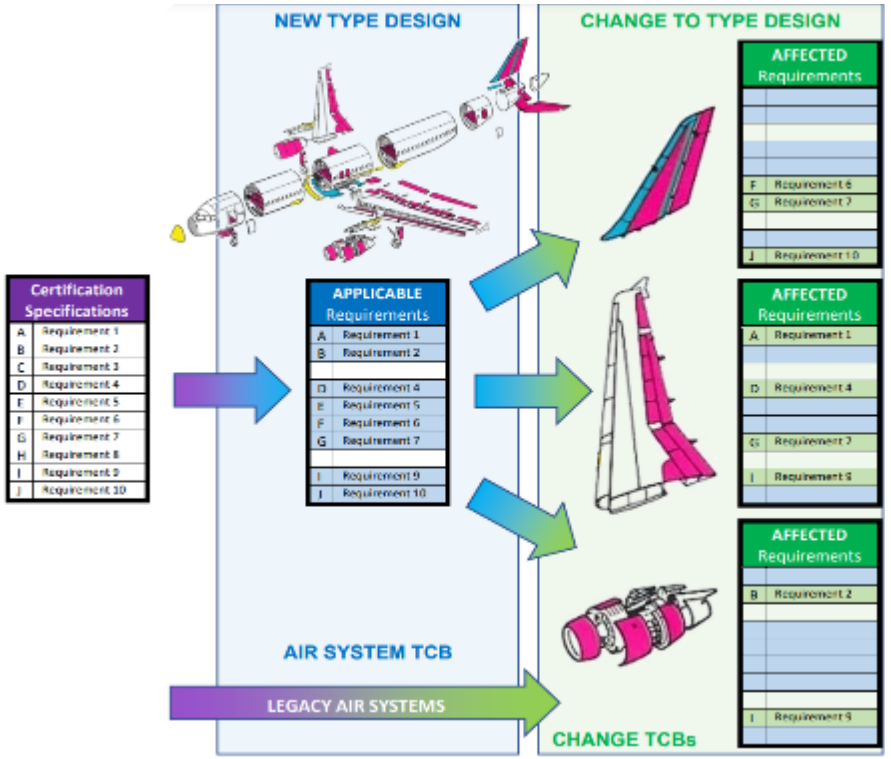
Legacy Platform – Design Change TCB

Certification specifications	Air System TCB	TCB – Design Change 1	TCB - Design Change 2
CS-25	Applic. Req.	App & Aff Req.	App & Aff Req.
	Applic. Req.		
	Applic. Req.		
	No Air System TCB	Added to ADCC	App & Aff Req.
	Applic. Req.		
Def Stan 00-970 Mil specific	Applic. Req.		
	Applic. Req.		App & Aff Req.
Special Conditions	Applic. Req.	App & Aff Req.	
	Applic. Req.		



Legacy Platform – Design Change TCB

Certification specifications	Air System TCB	TCB – Design Change 1	TCB - Design Change 2
CS-25	Applic. Req.	App & Aff Req.	App & Aff Req.
	Applic. Req.		
	Applic. Req.		
	No Air System TCB	Added to ADCC	Added to ADCC
	Applic. Req.		
Def Stan 00-970 Mil specific	Applic. Req.		
	Applic. Req.		App & Aff Req.
Special Conditions	Applic. Req.	App & Aff Req.	
	Applic. Req.		



Changed Product Rule

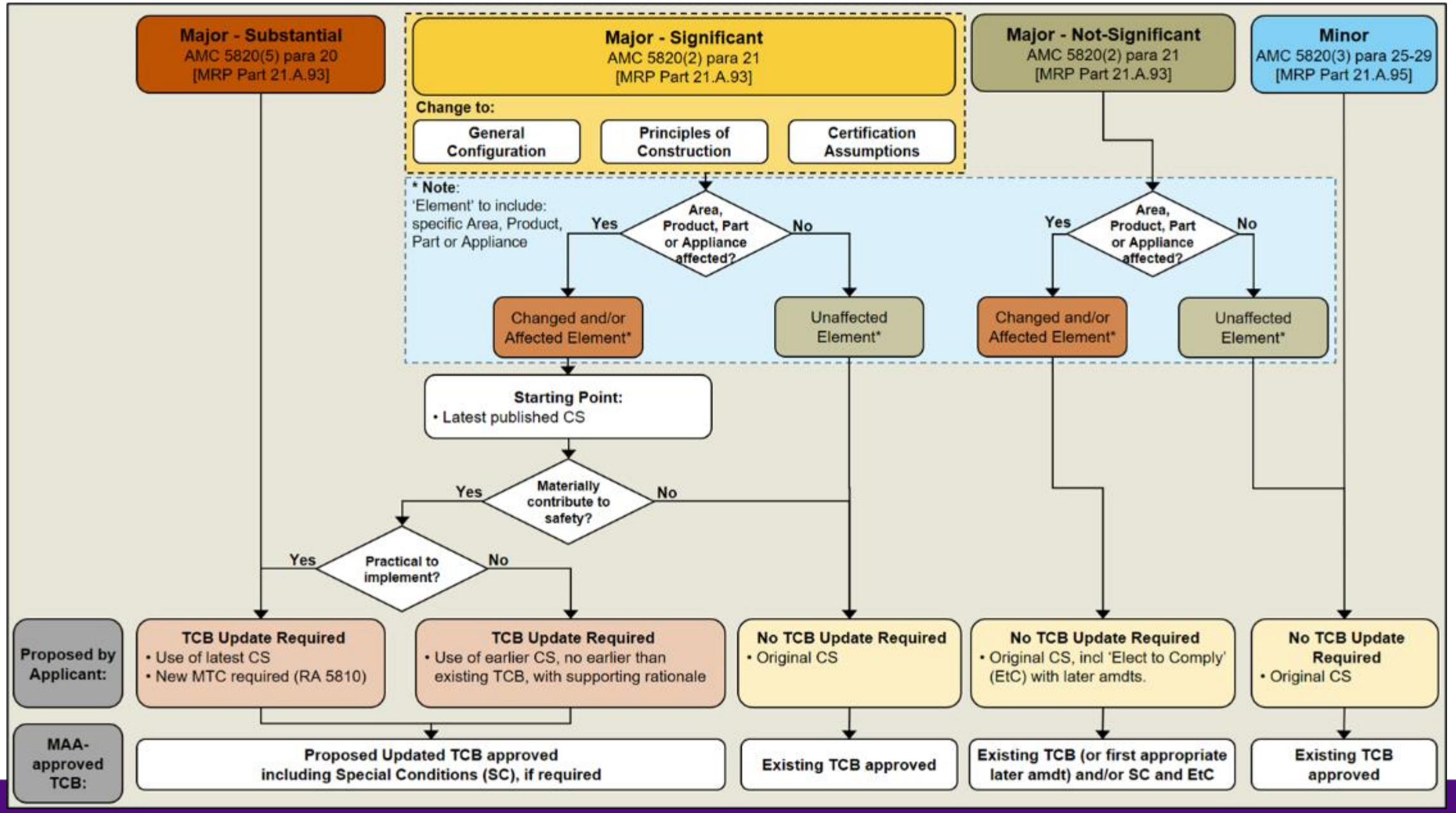
Application of Changed Product Rule (CPR) determines whether a Major, not significant change to the Type Design could comply with an earlier amendment of the certification specification and not the current specification.

It can be used when:

- An area, system, part or appliance is not affected by the change.
- Compliance with the latest amendment for a Significant change does not contribute materially to the level of safety.
- Compliance with the latest amendment would be impractical.

AET Tool 8T:
TCB Generation Guidance

Military Air System Certification: Awareness Training Day 1


Major - Substantial
AMC 5820(5) para 20
[MRP Part 21.A.93]
Major - Significant
AMC 5820(2) para 21
[MRP Part 21.A.93]
Change to:
General Configuration
Principles of Construction
Certification Assumptions
Major - Not-Significant
AMC 5820(2) para 21
[MRP Part 21.A.93]
Minor
AMC 5820(3) para 25-29
[MRP Part 21.A.95]
* Note:
'Element' to include:
specific Area, Product, Part or Appliance
Area, Product, Part or Appliance affected?
Yes
No
Changed and/or Affected Element*
Unaffected Element*
Starting Point:
• Latest published CS
Materially contribute to safety?
Practical to implement?
Proposed by Applicant:
TCB Update Required
• Use of latest CS
• New MTC required (RA 5810)
TCB Update Required
• Use of earlier CS, no earlier than existing TCB, with supporting rationale
No TCB Update Required
• Original CS
No TCB Update Required
• Original CS, incl 'Elect to Comply' (EtC) with later amdts.
No TCB Update Required
• Original CS
MAA-approved TCB:
Proposed Updated TCB approved including Special Conditions (SC), if required
Existing TCB approved
Existing TCB (or first appropriate later amdt) and/or SC and EtC
Existing TCB approved

Changed Product Rule Example

King Air 350ER Avenger introduced for Fleet Air Arm Observer Training. Instructor and student training stations fitted in the cabin on seat rails certified to 6G forward deceleration for accidents.

At the time of certification the requirement for crashworthiness specified 9G deceleration.

However, the seat rails were only designed for 6G:

- Because the rails were only designed for 6G, designing the stations to 9G **did not contribute materially to the level of safety**.
- Furthermore, it was **impractical** to change the baseline aircraft and increase crashworthiness to 9G.
- Therefore CPR could be used to comply with previous amendment.
- Stations were designed and certified to 6G.

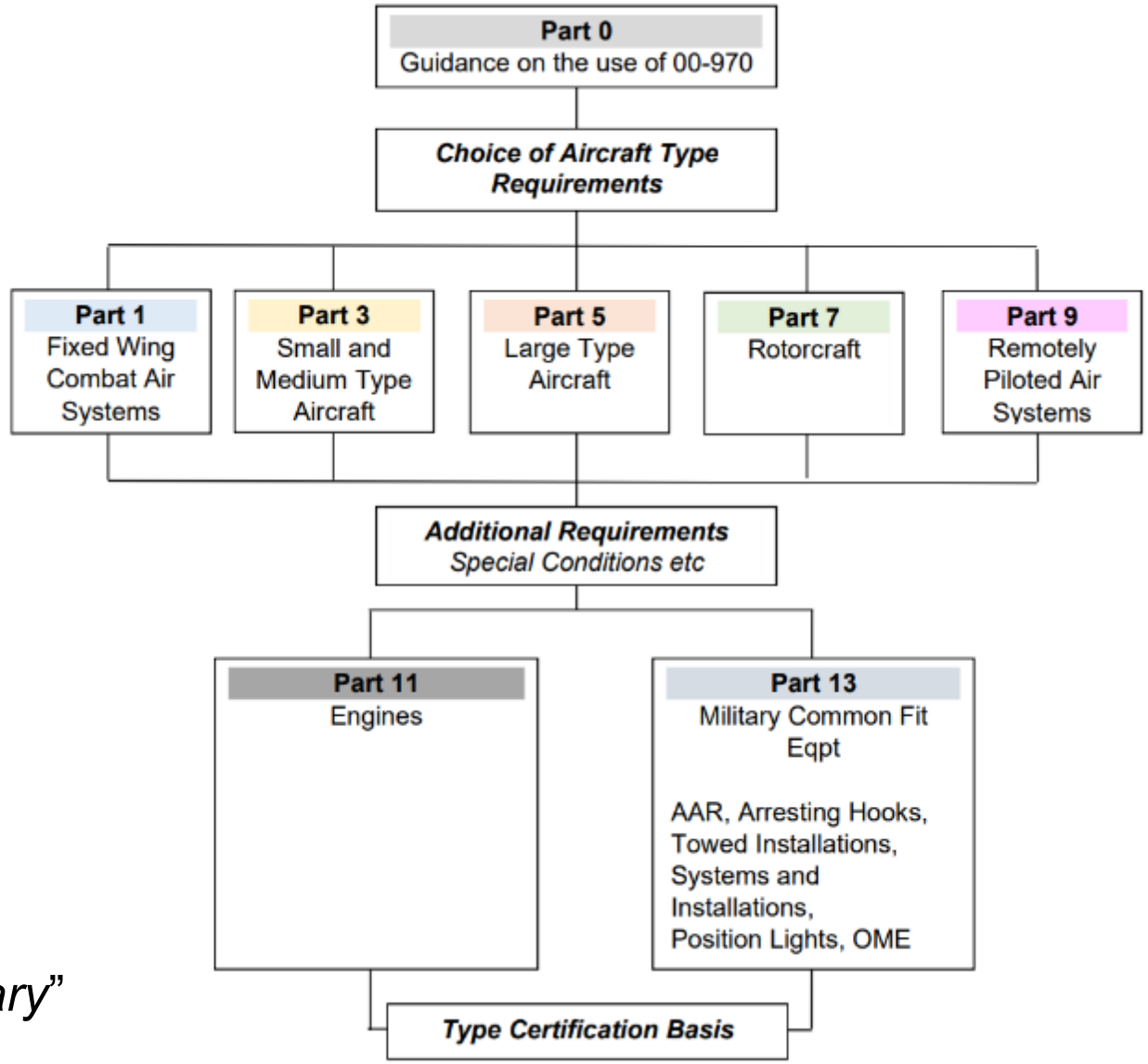
Defence Standard 00-970

The MAA benchmark Certification Specification is Def Stan 00-970

It is composed of multiple Parts.

It refers to civil airworthiness requirements where appropriate, adding military specific requirements as needed.

"as civil as possible, as military as necessary"



Atlas

The platform is a large transport aircraft, powered by four turboprop engines, with an MTOW of 137, 500 kg.

Designed to carry a 25 tonne payload over 2,000 nm.

Which Part of DS 00-970 is not applicable?

Tutor

The Tutor is a light training aircraft, used for basic flying training.

Carries 2 crew, student and instructor.

MTOW 990 kg.

Which Part of DS 00-970 is not applicable?

SW-4 Solo

The Solo is a rotary Unmanned Air System (UAS).

Has the capability to carry a safety pilot.

Powered by a single turboshaft engine.

Has an MTOW of 1,800 kg.

Can carry utility payloads (cameras, reconnaissance).

Which Part of DS 00-970 is not applicable?

Alternative Certification Specifications

EASA CS: European Union Aviation Safety Agency Certification Specifications

FAA FAR: US Federal Aviation Administration Federal Aviation Regulations

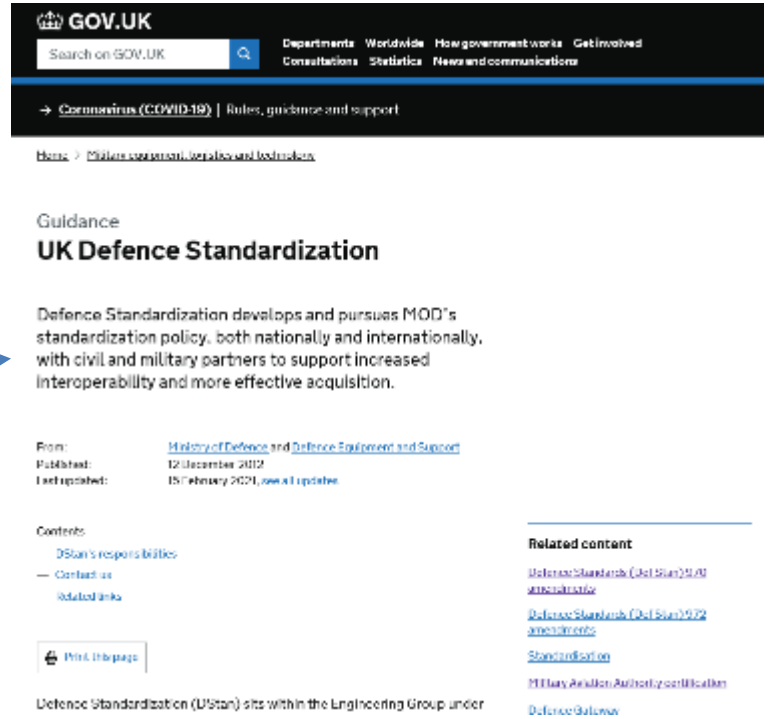
MIL-HDBK-516C: US Department of Defense (DoD) Handbook Airworthiness Certification Criteria

Where to Find Def Stan 00-970

Def Stan 00-970 can be accessed through either DStan or StanMIS.

More guidance can be found on the relevant .gov.uk website.

[UK Defence Standardization - gov.uk]



Non-UK CS:

[EASA Easy Access Rules – easa.europa.eu]

[FAR – faa.gov]

Military Configuration, Role and Environment

When procuring new military platforms, particularly when they are civilian derivatives, the TAA must also be mindful that the SOI may not be aligned with the design assumptions of the original design.

King Air 350ER Air Taxi

Avenger

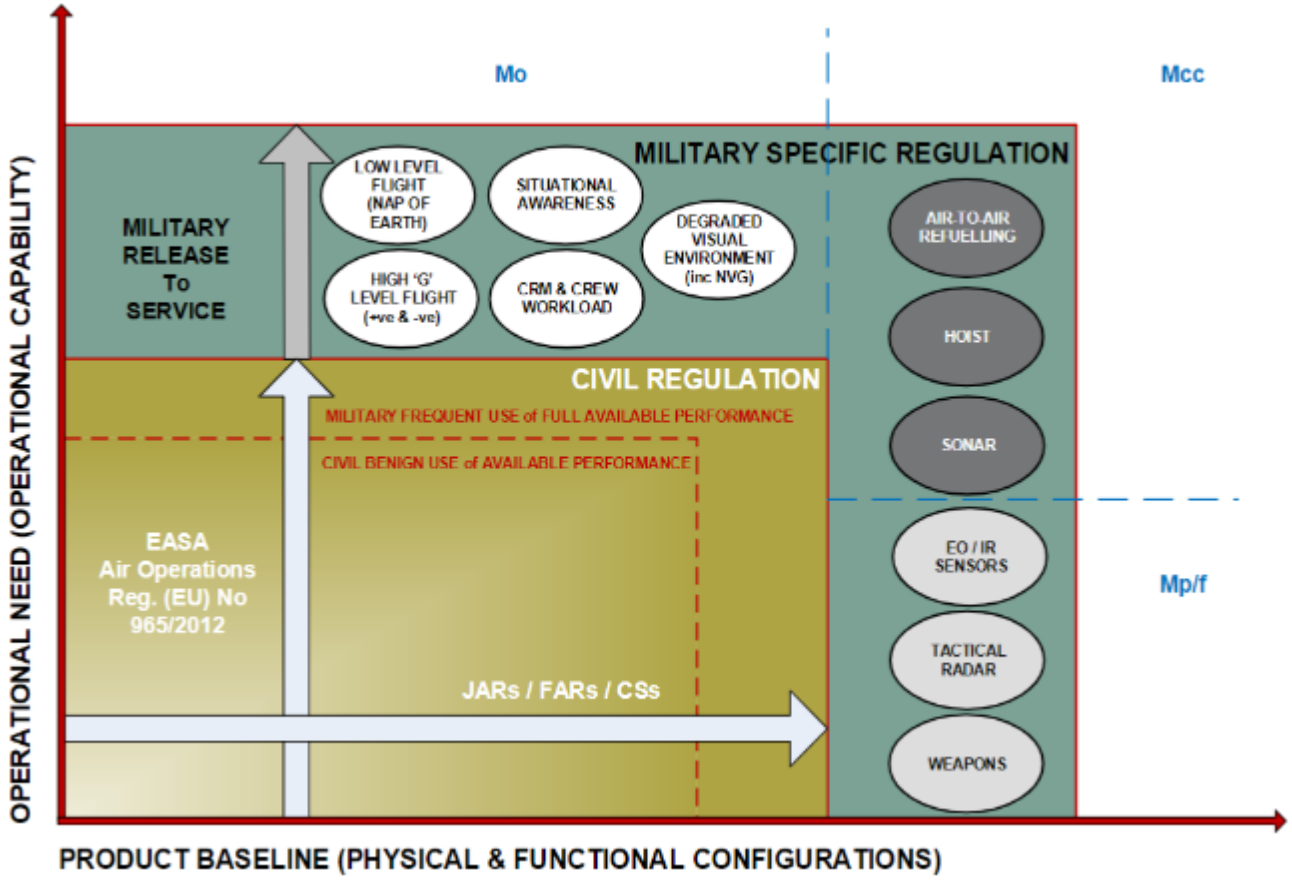
Shadow

Military Configuration, Role and Environment

A framework is used to determine differences between military and civil applications.

It is split into the following areas:

- Configuration:
  - *Functional. e.g. Air to Air Refueling*
  - *Physical e.g., Mission Systems, use of varied materials.*
- Role:
  - *Operational E.g., Search and rescue, formation flying*



Def Stan 00-970 Part 0 via Defence Gateway

Intended Military Configuration, Role and Environment

The TAA should identify:

- Changes to the air system configuration that will affect air system handling and existing platform systems.
- Changes to the air system usage that may fall outside the design assumptions for the original platform and its systems.

The TAA should also investigate if there is proposed change in the use of an in-service platform.

Military Requirements

A military delta is the difference between the certification requirements that are acceptable for a civil platform and a military platform.

Additional requirements are identified in Def Stan 00-970 as UK requirements.

For example:

Landing Gear		
CS25.721 General	See AMC 25.963(d)	INTENTIONALLY BLANK
UK25.721d Ground Clearance With the exception of arresting hooks and tail bumpers if fitted, there shall be a positive ground clearance of all parts of the Air System, including all control surfaces in the most adverse position with all external stores, on a smooth hard surface in all practicable take-off and landing attitudes, with the maximum undercarriage closure and tyre compression including any combination of burst tyres and total collapse of the shock absorber.	INTENTIONALLY BLANK	INTENTIONALLY BLANK

Military Requirements

For example:

- With limited exceptions, civil aircraft have a far lesser requirement for operating with doors open than military aircraft. UK25.785a places additional requirements on the platform to enable the attachment of crew harnesses.

CS 25.785 Seats, Berths, Safety Belts and Harnesses	AMC 25.785	INTENTIONALLY BLANK
UK25.785a Open Doors in Flight, Crew Restraint Structural attachment points shall be provided for the attachment of crew harness configurations when operations require crew members to stand near an open door in flight. Issue 7	INTENTIONALLY BLANK	INTENTIONALLY BLANK

Tailoring the TCB

TAA is responsible for selection of **appropriate** Airworthiness requirements from the Certification Specification, in order to build the proposed TCB for MAA approval. This is known as ‘tailoring’.

Tailoring permits a TAA to establish a TCB for a new platform or in-service design change which is relevant and minimises the verification and validation effort associated with proving compliance with the TCB requirements.

The Certification Log

- **AET Tool 8N forms part of the TCB.**
- The Certification Log lists all of the applicable Certification Specification Requirements and goes on to detail Means of Compliance and Levels of Involvement (Covered in Phase 3).
- It's completion is mandatory in order to receive a Military Type Certificate (MTC).
- The Certification Log is a component of the Military Type Certification Basis (TCB), which must be agreed with the Military Aviation Authority (MAA).

Phase 2

1	2	3	4	5	6	7	8
Certification Specification							
Unique ID	Subpart	Certification Specification	Amendment / Issue	CS Paragraph	Heading	Requirement	Existing Agreements

Phase 2

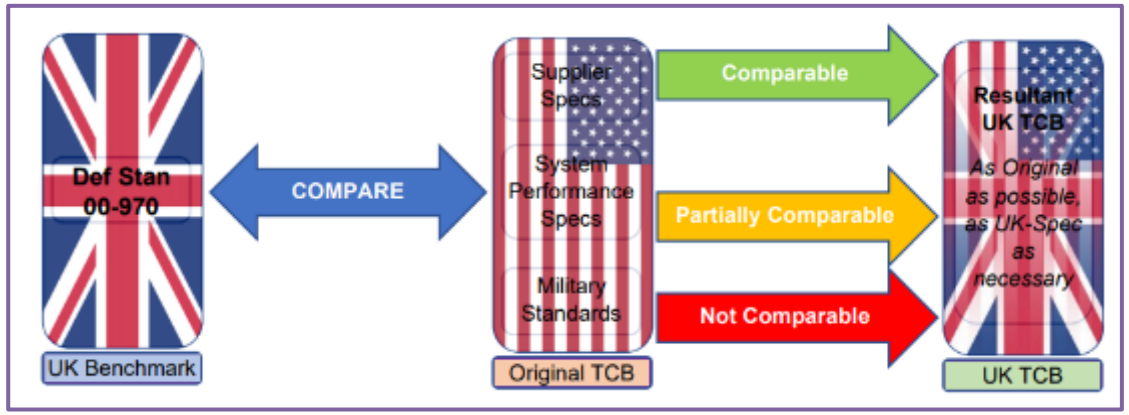
9	10	11	12	13	14	15
Type Certification Basis						
Applicability	Applicability Justification	Affected	Affected Justification	AMC	Regulatory Compliance MCRI No	Regulatory Compliance MCRI Status

AET Tool 8N: Certification Log

TCB Benchmarking

Benchmarking:

- permits the use of certification evidence from other (accepted) Regulators
- reduces the effort required to certify a new military platform for the UK.



Through benchmarking, a TAA needs to demonstrate that the original Air System's TCB:

- is appropriate
- it delivers a level of safety that is consistent with the intent of Def Stan 00-970.

Examples of when benchmarking might be appropriate include military air systems which are:

- derivatives of civilian aircraft
- designed or developed using an alternative Certification Specification.

Manual of Military Air System Certification (MMAC) Chapter 5: Certification Credit within the MACP

TCB Approval Requirements

A 2* Director Air is required to approve and propose the TCB for a new air system.

TAA approves subsequent changes to the TCB.

The MAA will agree the TCB and changes in writing.

Phase 2 Inputs and Outputs

Inputs:

- New Type Design
  - Certification Specification: Def Stan 00-970 is the benchmark Certification Specification, but other specifications or standards may be proposed
  - MCRIs (Military Certification Review Items) if required
- Change to existing Type Design
  - Identification of affected certification requirements

Outputs:

- Initial TCB (Type Certification Basis): Submitted by the TAA and Agreed by the MAA

Phase 2 Type Certification Basis Awareness Refresher

The Awareness Course covered:

- What is a Type Certification Basis?
- Establishing the TCB – New Type Design
- Establishing the TCB – Change to Type Design
- Certification Specifications – What Are They?
- Changed Product Rule
- Defence Standard 00-970 - What is it and where to find it
- Alternative Certification Specifications
- Military Configuration and Usage
- Military Requirements – Military Deltas
- Military Usage v Design Assumptions
- Tailoring the TCB
- The Certification Log
- TCB Benchmarking
- TCB Approval Requirements

Break

Activity:
Phase 2 – Syndicate Exercises
00-970 TCB Tailoring

Identifying 00-970 Parts for the Type Certification Basis

Summary Exercise - Brief

You are the Certification Manager for the King Air 200 multi-engine training platform.

The platform is a 60's design but has a MTC.

The aircraft is certified to Def Stan 00-970.

The DT is planning a mid-life upgrade.

Key design changes are:

- A glass cockpit (replace analogue with digital displays)
- Uprated engines with conformal fuel tanks
- Modern avionics and communications suite.

All design changes have been installed on similar civil platforms.

The design changes will result in a change of designation from TMk1 to TMk2.

……..Your task is to assist your TAA in certifying this project.

Phase 2 Syndicate Exercise – Tailoring the TCB

Phase 2 Part A – Tailor the Type Certification Basis

- Select the appropriate Parts of Def Stan 00-970 which apply to this Design Change; discard the rest.
- Place the systems under the appropriate Parts.

Phase 2 Part B – Allocate systems to Subparts of Def Stan 00-970

- Align the systems listed with the appropriate sub-part(s) of Def Stan 00-970 Part X

Phase 2 Part C – Airworthiness Requirements Selection

- Align the requirements with the design change feature(s)

End of Day