

Aircraft Certification – Including Modifications

Learning Outcomes

By the end of this session delegates will be able to:

- Discuss the Type Certification process which is used to assure acceptable Airworthiness levels
- To explain the relationship between a Type Certificate and a Certificate of Airworthiness
- Explain the differences between certification and validation
- State what would be considered a modification
- Describe the differences between Minor and Major changes
- Identify the certification basis which is to be used for changed products
- Describe the change approval process
- Identify the documentation which may be required to support the certification of the change
- Discuss ETSOs (European Technical Standard Order)

Statutory Responsibility of NAA

- Under the Civil Aviation Act the CAA is required to be satisfied with the fitness of an aircraft to fly.
- NAA Air Navigation Order/Law permits CAA to issue a Certificate of Airworthiness for a specific aircraft.

Statutory Responsibility of CAA

Two stage process:

- Type certification
 - The process of establishing that the generic type design meets applicable design and safety requirements
- Certificate of airworthiness issue
 - Recognises that an individual aircraft meets any additional (e.g. operational) requirements and is physically airworthy

What Is Airworthiness ?

ICAO Annex 8 – Airworthiness of Aircraft

“When in compliance with the comprehensive and detailed airworthiness codes established, adopted or accepted by a Contracting State for the class of aircraft, engine or propeller under consideration.”

Why Have an Airworthiness Code?

- To have an acceptable standard against which a design can be assessed – both domestic and foreign Authorities
- In order to learn from others and to prevent repeating mistakes / learn by experience
- Consistency
- Example of codes raised to satisfy ICAO Annex 8
 - CS 25 (EASA)
 - JAR 25 – European (pre-EASA)
 - AP25 / NGLS-3 - Russian
 - BCAR Section D - UK

Where We Are Today

EASA has held legal responsibility for all (non-Annex II) European certification / validation activity - although a significant portion undertaken by the National Airworthiness Authorities (NAA's)

Annex II aircraft that are still individual NAA's legal responsibility, e.g:

- Homebuilt aircraft / Micro lights
- Aircraft engaged in military, police, customs or similar services

The Certification Process

EASA Internal Working Procedure Type Certification

- Application – from an approved organization
- Establish Certification Team
- Establish Certification Basis
- Conduct Investigation
- Type Certificate Recommendation by the Team to EASA
- EASA Issues an EASA Type Certificate

The Certification Process

Application

- ❑ Application to EASA
- ❑ EASA review eligibility – 21A.13 & 21A.14
- ❑ EU Organization with a Part 21 subpart J approval.
 - ❑ Non-EU Organization supported by a recognized NAA

The Certification Team

Structure

Performance

Systems

Flight Test

Avionics

.....

Certification Basis

Elements

- Certification Specification 25 (CS25)
- Special Conditions
- Exemptions
- Equivalent Safety Findings
- Environmental Standards
- Reversions (derivative aircraft only)

Certification Specification 25 (CS25)

Binding in Basic Regulation (EC)

216/2008

**Amendment standard at date of application
- Part 21A.17**

Certification Basis - Special Conditions

Special Conditions – 21A.16b

- Special Conditions developed when the design
- To introduce pending formal policy /
- To address novel features
 - A380 two stage slide – to address gear collapse conditions – “slide availability” warning

Certification Basis – Exemptions

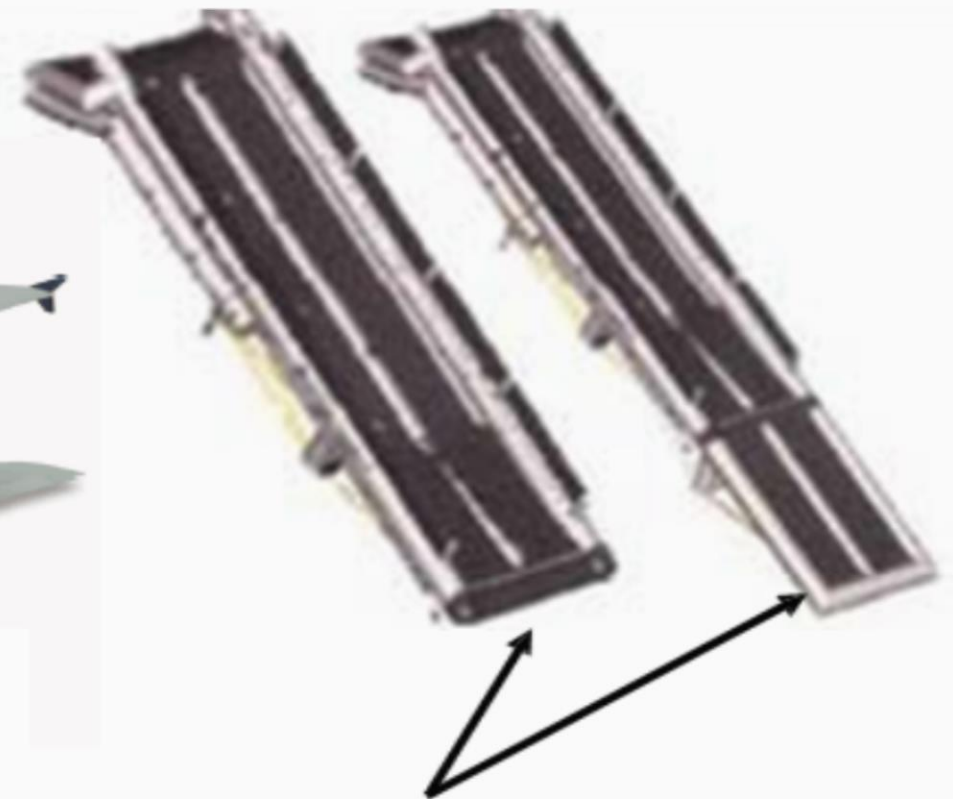
Exemptions

- **Granted where compliance with specified requirements cannot be justified**
- **Used mainly on Derivative Aircraft - Change Product**
Rule (CPR) 21A.101

Example

- **B777 - PDOS - power door opening system – flex hoses – compliance with JAR 25.1183(a) fire resistant criterion**

Certification Basis Special Conditions A380 Slide



Variable slide length dependent on
aircraft on ground attitude

Certification Basis – Exemptions

Exemptions

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Product

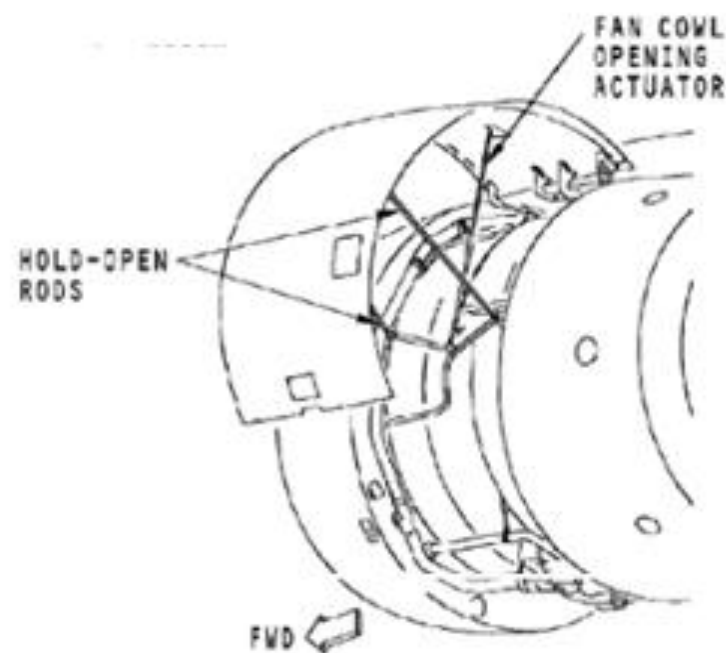
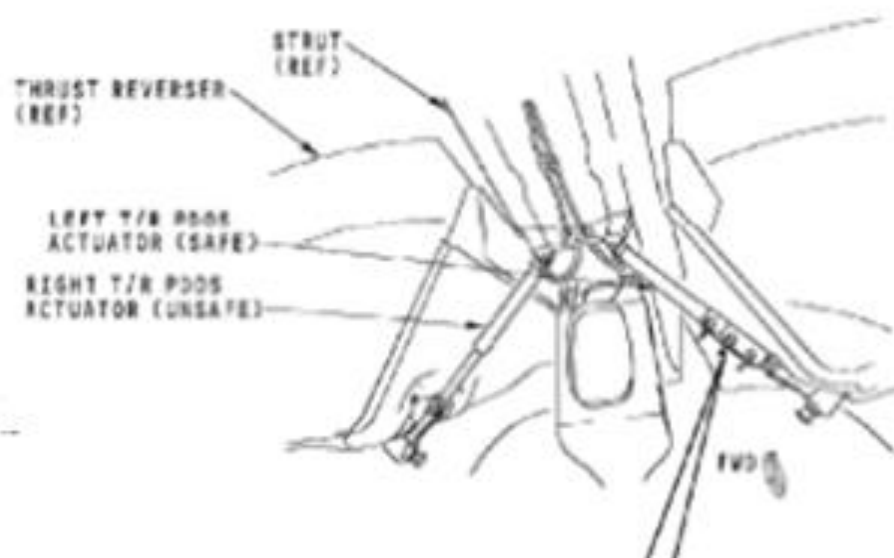
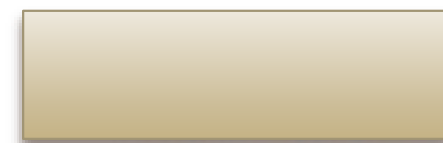
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Example

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Certification Basis – Exemptions

B777 PDOS



Certification Basis – Elect To Comply

Elect to Comply

- Mature NPA (Draft requirement) ready for incorporation into the CS but not yet formalised
 - e.g. NPA 25D-327 Graphical exit signs as an alternative to red exit signs for pax
- Often harmonises the requirements (FAR/EASA)
- Subject to a request from the applicant
- Once used, forms part of the formal certification basis (i.e. is not optional when designing changes after Type Certification)

Certification Basis – Equivalent Safety Findings

Equivalent Safety Findings

- Non-Identified
- Alternative MOC not feasible
- Acceptability justified on the basis that the design is “equivalently safe” based on other compensating factors

Example

- Passenger numbers versus number of exits

Certification Basis – Environmental Standards

Environmental Standards

- Noise
- Emissions
 - Fuel
 - Exhaust
- ICAO Annex 16 (JAA) and FAR 36 Requirements (FAA)

Certification Basis - Reversions

Earlier requirement but not prior to existing type certification basis – only derivative aircraft.

Example

- Boeing JAR 25.562 Change 13 – 16g dynamic seat testing

Documenting the Process - CRIs

Certification Review Items

List of CRIs constitutes the basis of approval for the aircraft.

- **CRI A-01 “top level” Type Certification Basis CRI**

Each CRI will record :-

- A summary of the issue
- Applicant position
- Authority Position
- Conclusion

Documenting the Process - CAIs

Certification Action Items

- Used to document the level of involvement of the team in the certification programme
- List of CAIs constitutes the Certification programme

Each CAI will document :-

- A summary of the issue
- A specific Applicant Action i.e. to provide results of a specific test / enable the NAA to witness tests etc.
- Authority Position
- Conclusion

Documenting the Process

Managing the process

- PCM keeps administrative control of both CRIs and CAIs
- Closure of all CRIs and CAIs nominally indicates completion of the investigation activity.
- Compliance Checklist / Statements of Compliance
- Post TC Procedures agreed

Final Phase Checklist

- Used to track the end phase activity
- Set milestones to be addressed - CMR/AFM/MRB

Conducting the Investigation

Team find compliance with Certification Basis by:

- Technical Familiarisation
- Review and Approval of Technical Documents
 - Desktop review
 - Certification meetings at the manufacturer
- Witness Ground Tests (e.g. Structural/HIRF)
- Flight Test programme

Communication

Project Certification Manager to EASA:

- PCM Meetings (Aiding Standardization)
- All CRIs and CAIs sent to EASA for standardization and endorsement
- Final Phase agreed with EASA
- Presentation of the process and results to EASA for acceptance, by PCM

The Type Certificate

Issued by EASA under EU Law

- On the basis of the recommendation from Responsible Party (EASA /JAA /NAA Team.)
- States that the Type Design definition meets the certification basis
- Is a generic acceptance of the Type Design
- Provides basis for ongoing acceptance for an individual aircraft, via a Certificate of Airworthiness

Validation - A Route to Type Certification

- Applicable for non-EU designed aircraft
- Requires High Level Bilateral Agreement
- Based on prior Certification by “domestic” NAA to known code of requirements
- Same generic process but concentrate efforts on:
 - requirement differences – (SRD – amendment pairs)
 - current safety issues
 - new and novel technology
- Rely as far as possible on the compliance finding by domestic NAA
 - Requires documented working arrangement defining processes to be used and responsibilities of both authorities

Certification vs Validation

A380 EASA (JAA) are the certification authority
FAA are the Validation (foreign Authority).

B787 FAA are the Certifying Authority
EASA are the Validating (foreign) Authority

Certification

- Domestic Authority
- Responsibility
- Compliance finding
- Responsibility for
- Airworthiness with
- High work load

▪ Validation

- Design responsibility
- Authority (EA)
- Compliance finding
- as possible
- usually to areas of
- Less resource

The Certificate of Airworthiness

- Individual Aircraft
- Meets Type Design
- Modifications Approved
 - Customer needs / Requirements
 - Operational Role
- For Used Aircraft...
 - Repairs Approved?
 - AD Compliance?

POST Type Certification Activities

- Modification Approval
 - TC Holder
 - STC
- Service Bulletins
- Flight Manuals
- Airworthiness Directives
 - AMOC
- Continued Airworthiness
 - Accidents / Incidents
 - Product Improvements

Embraer ERJ 170

EASA VALIDATION
20 February 2004



Summary of Certification of Large Aircraft

- Airworthiness
- Type Certification Process
- Certification or Validation
- Type Certificate v Certificate of Airworthiness

Certification of Modifications (changes)

What is a Modification?

- A change made to an aircraft; including its components, systems, engines, radios, instruments, furnishings, flight manual etc
- Changes can be either physical or to paperwork

Change classification

‘Major’ is further sub-classified in Part 21A.101 as:

- Substantial (e.g. [for helicopters] number/configuration of rotors, all metal to all composite aircraft)
- Significant (e.g. comprehensive avionics upgrade including EFIS, SVS, data recorders & ELTs, additional engine, type of landing gear, no. of rotor blades)
- Not Significant (e.g. cameras, EMS installations, cargo hoists)
- These classifications dictate the applicable requirements ...

Certification Basis for change

Identification of Certification Basis for changed products

[Part 21.A101]:

- Comply with latest requirements, except where the change is non-significant and not introducing new or novel features
- Otherwise, by derogation, default to the certification basis in force at original Type Certification

(Changed Product Rule)

Appendix 1 to GM 21A.101 Examples

Figure 1. Table of examples of changes for Small Aeroplanes:

The following are examples of substantial changes:

Description of change	Is there a Change to the General Configuration? 21A.101(b)(1)(i)	Is there a Change to the Principles of Construction? 21A.101(b)(1)(i)	Have the assumptions used for Certification been invalidated? 21A.101(b)(1)(ii)	Notes
Change in wing location (tandem, forward, canard, high/low)	Yes	No	Yes	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable requirements is required.
Fixed wing to tilt wing	Yes	Yes	Yes	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable requirements is required.
Increase in the number of engines from one to two	Yes	Yes	Yes	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable requirements is required.
Replacement of piston or turbo-prop engines with turbojet or turbofan engines	Yes	Yes	Yes	Proposed change in design is so extensive that a substantially complete investigation of compliance with the applicable requirements is required.

Summary of Certification of Modifications

- What would be considered a modification?
- What are the differences between Minor and Major changes?
- How do you identify the certification basis which is to be used for changed products?
- Describe the change approval process
 - What documentation may be required to support the certification of a change?

Appendix 1 - Guidance information

- Aspects to be covered during design investigations
- Aspects to be covered during flight test assessments

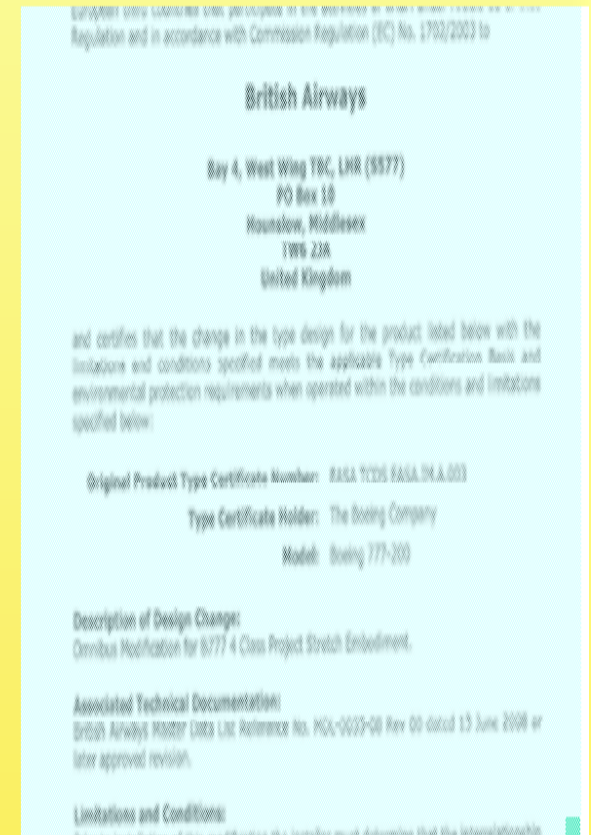
Finally

When all the documentation has been accepted by the “Investigating Authority” - i.e.

the EASA or CAA Team - the change can be 'approved'

[Note: Under the EASA system, technical approval results in a

Technical Visa . Only when this is processed by EASA in Köln is the change legally approved]



Examples of aspects needing to be covered by design investigation of changes

System safety assessment

- Hazard Analysis
 - FMEA
- Structural aspects, including the airframe manufacturers input, if required
 - Static (and Dynamic) strength
 - Flight loads
 - Crash Loads
 - Fatigue
 - Flutter
 - Vibration
 - Weight and Balance

Examples of aspects needing to be covered by design investigation of changes

- General restraint and protection of occupants
 - Passengers and Equipment Operators
 - Head and body strike
 - Medical Evacuees
 - Restraint harnesses
 - EM effects caused by aircraft equipment on Heart Monitors etc
- Protection of pilot
 - Struck by Camera Booms
 - Ambulance installations
 - Vomit screens

Examples of aspects needing to be covered by design investigation of changes

- Venting of gases
 - Ambulance installations
 - Entonox
 - Oxygen
- Fume protection
 - Fuel vs electrical/avionics
 - Oxygen vs oil, fuel, grease
- Protection from contamination
 - Oxygen Systems
 - Fuel, oil, hydraulic
 - Drinking Water
- Flammability
 - Furnishings

Aspects covered during the Flight Test Assessment

- Performance
 - Take Off
 - Climb
 - Engine Out
 - Vne
 - Pressure errors
- Handling
 - Stability
 - Controllability
 - Stall spin (if fixed wing)
 - Wake turbulence
 - Vibration
 - Flutter
- Cockpit ergonomics
- EMC

European Technical Standard Order

A Technical Standard Order (*TSO*) is a minimum performance standard issued by the Civil Aviation Authority for specified materials, parts, processes, and appliances used on civil *aircraft*.

What is a TSO or ETSO?

- Addressed by Part 21 SubPart O, European Technical Standard Order Authorization
- An ETSO (EU) or TSO (US) states that the part meets a minimum performance standard. It approves the design and production of the part or appliance
- It may meet a given SAE or NAS specification or, for avionic equipment, an RTCA or EUROCAE MOPS (Minimum Operational Performance Spec). These specifications are usually part of the (E)TSO

ETSO Purpose

(E)TSO approval is most useful for stand alone 'common user' items.

Logically loses validity for more complex equipment which is unique to a specific installation, for example flight deck seats, escape slides.

FAA practice is generally to TSO everything that is eligible. Suits US industry culture.

European approach is more flexible. Authorities do not insist on (E)TSO and aircraft manufacturers are generally agreeable (or feel obliged) to include complete equipment qualification within the type certificate definition.

ETSO Benefits

Clarifies the responsibilities for continued airworthiness (failures, malfunctions, defects) of the equipment.

Removes the necessity for the technical re-evaluation of the equipment (by certification authority) for every project

Equipment item may include more than basic ETSO capability

Examples:

- An aircraft seat may include features (not required to satisfy basic ETSO requirements) including motorized functions with computer control, and installation of other items such as IFE, lights etc
- An enhanced TAWS meeting TSO C151c may contain obstacle database, geometric altitude, RAAS etc
- None of this is covered by the ETSO authorisation

ETSO

ETSO granted when equipment shown to meet
Minimum

Operational Performance Specification
(MOPS)

Note: MINIMUM

- e.g. ETSO-C123b Cockpit Voice Recorder
Systems complies with EUROCAE ED-112

An ETSO does not infer any approval to
fit to an aircraft and will not necessarily
ensure the equipment's suitability for all
applications.

Equipment general qualification considerations

CS-ETSO Subpart A references ED-12 ,ED-14 and ED-80 but the individual ETSO does not always specify the particular environmental test category or software/hardware levels.

The extent is up to the equipment manufacturer; the test levels are declared in the **DDP** upon completion of the qualification test.

The installing DOA must determine the suitability of the equipment's development/qualification for the proposed aircraft application.

ETSO Deviations

Non-compliances with the ETSO standard must be recorded as deviations – even if the equipment complies with later standards than those prescribed by the ETSO.

Deviations are acceptable only if an equivalent level of safety can be demonstrated by the applicant.

Deviation requests are subject to an EASA/NAA consultation process prior to acceptance.

Accepted and rejected deviations are published by EASA

ETSO Limitations

The design or performance limitations of the equipment which limit its application will be explicitly recorded in the DDP (and on the certificate).

E.g. may limit the equipment's use to certain aircraft types or environmental conditions.

These limitations may be those declared by the manufacturer (ETSO holder) or identified during the authorization process..

Ignore them at your risk!

DDP

Declaration of Design and Performance (DDP)

Declares:

- . Compliance with the minimum performance requirements
- . Software and environmental qualification
- . Limitations
- . Deviations
- . Functions not covered by the ETSO