Directorate General of Civil Aviation
India

Certification Issues on Advanced Composites

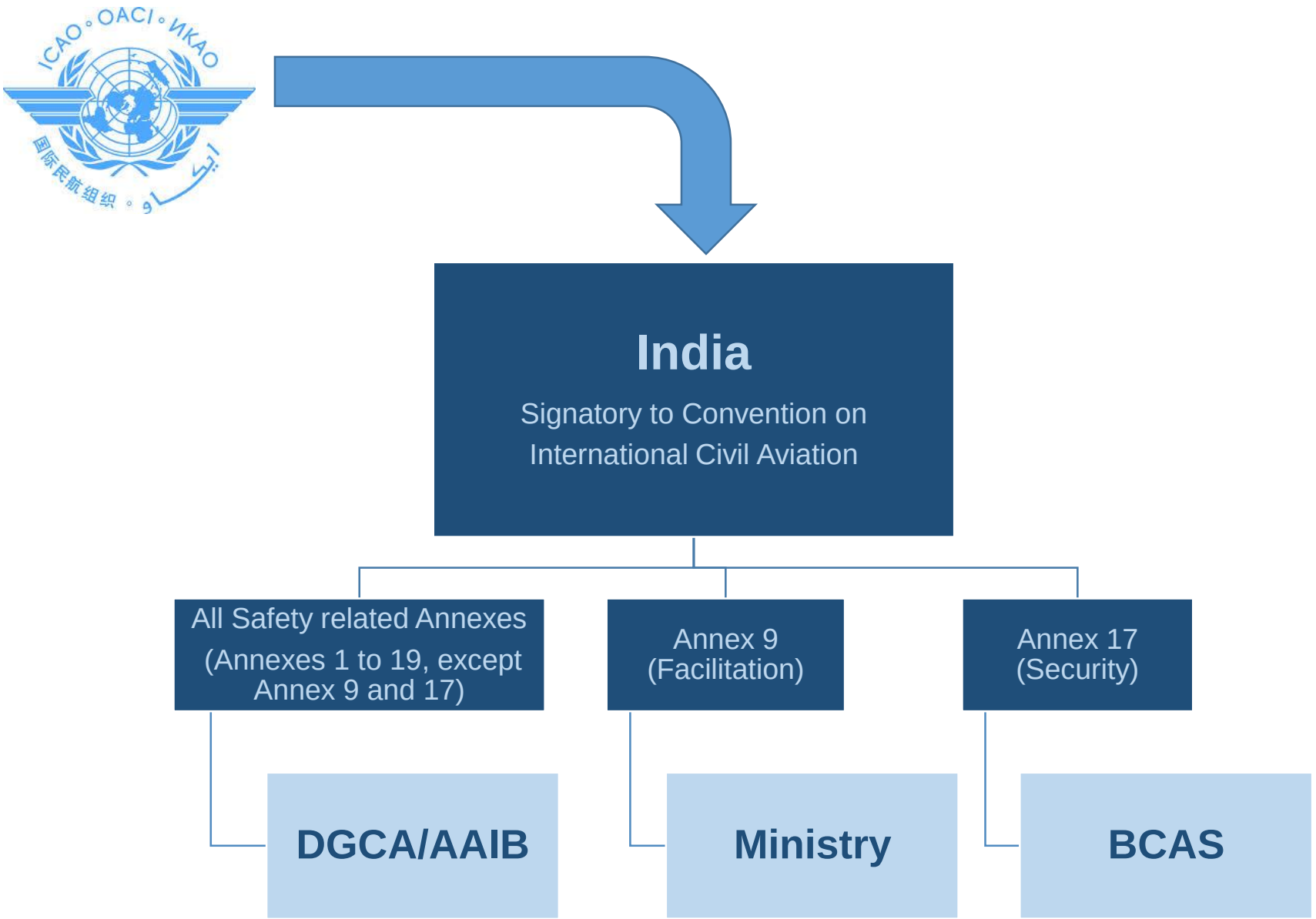
Outline

- Obligation
- Relevant legal framework
- Broad functions
- Type certification activities
- International cooperation with other countries on mutual acceptance of aeronautical products and parts
- Certification issues on advanced composite materials

Obligation

Obligation

- As a signatory to ICAO, India has obligation to implement and monitor laid down standards of ICAO for:
  - Operation of aircraft;
  - Licensing of personnel;
  - Licensing of civil aerodromes; and
  - Air transport operations


India
Signatory to Convention on International Civil Aviation
All Safety related Annexes (Annexes 1 to 19, except Annex 9 and 17)
Annex 9 (Facilitation)
Annex 17 (Security)
DGCA/AAIB
Ministry
BCAS

Relevant Legal Framework

Relevant Legal Framework

- Primary Aviation Legislation
  - Aircraft Act, 1934 - empowers Central Government to make rules to implement the provisions of Chicago Convention & its Annexes
- Specific Operating Regulations
  - Aircraft Rules, 1937
  - Aircraft (Demolition of obstructions caused by Buildings and Trees etc.) Rules, 1994
  - Aircraft (Carriage of Dangerous Goods) Rules, 2003
  - Aircraft (Investigation of Accidents and Incidents) Rules, 2012
  - Civil Aviation Requirements (CARs)
  - Aeronautical Information Circulars (AICs)
  - Advisory Circulars

Broad Functions

Functions

Regulatory

- Registration of aircraft
- Issuance of certificates of airworthiness
- Grant of air operator's permit
- Approval of training institutes for pilots and engineers
- Licensing of aerodromes
- Certification of CNS/ATM facilities
- Type certification and validation of aeronautical products
- ITSO authorization to parts & appliances
- Amendment to Aircraft Act/Rules

Licensing of Personnel

- Pilots: PPL, CPL, ATPL
- Aircraft maintenance engineers
- Flight engineers

Functions

Safety Oversight

- Surveillance
- Regulatory Audit
- Surveillance of Foreign Airlines
- Spot Checks

Accident Investigation

- Investigation of all incidents and serious incidents on aircraft less than 2250 kg
- Monitoring accident/serious incident investigations recommendations and their follow-up

Environmental Regulations

- Keeping check on aircraft noise and engine emissions
- Collaborating with other environmental authorities

Functions

International Cooperation

- ICAO, regional civil aviation bodies (EC, COSCAP-SA), different countries (bilateral), training institutes, others (USTDA)

Advisory/ Coordination

- Advice to Government on air transport, air services agreements, ICAO matters
- All technical matters relating to civil aviation
- Coordination with various departments including Air Force

Type Certification Activities

Type Certification Regulations

- Domain directorate: Aircraft Engineering Directorate
- Regulations on type certification aspects:
  - Rule 49 of the Aircraft Rules, 1937
  - CAR 21 – Type certification/ITSO Authorisation
  - CAR Section 6, Series A, Part I – Type Validation
  - CAR Section 6, Series A, Part II – Type Acceptance of Foreign Aeronautical Product
- Certification requirements acceptable to DGCA
  - FAR/CS Part 23, 25, 27, 29, 31, 33 & 35

Type Certificates Issued

Hansa-3

- Two seat all-composite trainer aircraft
- Certification basis: Part 23 using JAR VLA
- AUW: 750 kgs
- Single engine, single pilot
- Category: Normal

Type Certificates Issued

Dhruv Helicopter

- 12 seats
- Certification basis: Part 29
- AUW: 5500 Kgs
- Twin engine, two pilots
- Category: Transport
- 60% advanced composites used

Acceptance of Type Certificate & Supplemental Type Certificate

- Aeroplane
  - Transport category (Part 25) 82
  - Normal/commuter category (Part 23) 63
- Rotorcraft
  - Transport category (Part 29) 21
  - Normal category (Part 27) 42
- Projects in hand
  - Embraer 190LR
  - Embraer 550
  - A320 NEO
  - Max Pax
  - PW 1100G engine

ITSO Authorisations

- Life raft
  - Four person GA
- Aircraft Ni-Cd battery
  - 53 Ah for B737
  - 23 Ah for A320
- LODA issued by FAA on both the articles
- Projects in hand
  - Aircraft Ni-Cd battery (52 Ah for Learjet 85)
  - Standby magnetic compass
  - Position lights (LED)
  - Aircraft tyres

International Cooperation with Other Countries

International Cooperation with Other Countries

Russia (2001/ 2005)	Bilateral agreement followed by Implementation Procedures (IP) under the Bilateral Agreement on reciprocal acceptance of aeronautical Products, Parts and appliances
Israel (2007)	'Technical Arrangement' for the acceptance of airworthiness and environmental approval of civil aeronautical products
Chile (2007)	'Technical Arrangement on airworthiness' for the acceptance of airworthiness and environmental approval of civil aeronautical products

International Cooperation with Other Countries

Brazil (2011)	'Memorandum of Understanding (MoU)' followed by Implementation Procedures (IP) under the MoU on reciprocal acceptance of aeronautical Products, Parts and appliances
USA (2011)	'Executive Agreement' under Bilateral Aviation Safety Agreement (BASA) followed by Implementation Procedures of Airworthiness (IPA) on mutual acceptance of TSOd articles

International Cooperation with Other Countries (in Progress)

EASA (2010 onwards)

- EASA certification team familiarized with DGCA rules/ regulations/certification procedures, and also on DHRUV helicopter systems
- Certification plan developed by EASA consisted of VIII phases, of which phase I thru' V have been completed and phase VI is in progress
- In phase VII of the programme, Working Arrangement (WA) will be finalized, and subsequently signed between EASA and DGCA

Certification Issues on Advanced Composite Materials

Issue of Data Equivalence

- Data equivalence is typically evaluated for data sets that differ due to changes in manufacturing or material processing like:
  - Minor changes in constituents or constituent manufacturing processes
  - Identical materials processed by different component manufacturers
  - Identical materials processed at different locations of the same manufacturer
  - Slight changes in processing parameters, etc.
- Any of above changes require establishment of design allowables

Issue of Data Equivalence

- Further, design allowables need to be established for each batch of the material with large number of coupon level samples for each batch to be tested
- Means of regulatory compliance along with Equivalent Level of Safety (ELoS) during certification of composites where proviso of material equivalency as given in CMH-17 not utilized for establishment of design allowables
- Example - Type acceptance of B787

Continued Airworthiness of Composites

- Acceptable procedures/methodologies used for repair/ modification of aircraft composite structure to ensure continued airworthiness
- Example: B787 modification
- Steel battery casing provided with vent fastened to fuselage to allow escape of hot vapours into atmosphere
- No evidence shown as to how modifications catered for regulatory substantiation in respect of following conditions:
  - Possibility of delamination of involved portion of fuselage composite structure during drilling process
  - Ovalty of hole
  - Oversized hole

Continued Airworthiness of Composites

- Modification carried out in open conditions and not in factory and under controlled environment
- Means of regulatory compliance along with Equivalent Level of Safety (ELoS) under such circumstances in the absence of any supporting analysis and factors need to be considered

Engine Certification Issues

- Pure Power PW1100G engine fitted on A320 NEO aircraft has composite fan case having small thermal expansion rate and fan blades of Al-alloy having large thermal expansion rate
- Above combination increases fan tip clearance at higher altitudes and low temperature conditions causing degraded fan efficiency
- Although honeycomb thermal conforming liner used on the inner side of case to overcome this condition, how its continued performance during in-service substantiated by the OEM and accepted during type certification

Engine Certification Issues

- Leap engine being fitted on A320 NEO/ B737-NG max has composite fan blade, composite fan case, and composite stator guide vanes (SGV)
- Fan blades and SGVs expected to encounter bird strike/ FOD. As such, material has to be of higher impact resistance
- Fan case is required to have containment capability. As such, the material should be capable of higher energy absorption
- To what level OEM has carried out or propose to carry out analysis and tests to demonstrate the substantiation criteria and acceptance by the regulator without any ELoS

Rotorcraft Certification Issues

- One of the concerns is excessive tail rotor vibration due in-service delamination of tail rotor blade
- Need to know level of demonstration by OEM and acceptance by regulator on the following:
  - Ultimate load capacity including consideration of manufacturing and impact damages
  - Growth rate of damages that may occur from fatigue, corrosion, intrinsic defects or damage from discreet sources expected in-service
  - Effect of environmental conditions viz. strength degradation due to high temperature and moisture and material variability
  - Substantiation of bonded joints
  - Delamination due to torsional and bending stresses
- Example: Type acceptance of Bell 407GX

Other Design Related Issues

- Procedure adopted to define Repairable Damage Limits (RDL) and Allowable Damage Limits (ADL) at design stage
- In case of adhesion failure (separation) in the primary composite structures, effectiveness of bonding towards lighting protection
- Ensuring structural integrity of primary structure when subjected to different kinds of in-service damages
- Apart from coupon level tests, any sub-component/component level tests to demonstrate damage tolerance and fatigue life
- Substantiation of crashworthiness of composite structure by test or analysis so that same level of protection as provided by a conventional metal transport aircraft is maintained

Thank you