CEMILAC AND MILITARY AIRWORTHINESS IN INDIA

Kanchan Biswas* and K. Tamil Mani**

Abstract

Besides the performance excellences, airworthiness and safety are the major concerns in Aviation. The operational needs and the varying environmental conditions demand strict control over all facets of design, manufacture, operation and maintenance of aircraft. The acceptable levels of safety and reliability necessitate an independent Regulatory Assurance System to anticipate potential failures, assess deviations in design and manufacture, simulate operational demand and evaluate and certify the design. Centre for Military Airworthiness and Certification (CEMILAC) has been entrusted this responsibility for the military aircraft of Defence Forces. CEMILAC, with its 14 Regional Centres have been providing airworthiness and certification of military aircraft, aero engines and airborne systems for the past fifty years.

Airworthiness and Certification

‘Airworthiness’ in simplified term means ‘Fitness to Fly’. It is the ‘Continued capability of an aircraft to perform satisfactorily and fulfill mission requirements throughout its specified life, in the prevailing environments with acceptable levels of safety and reliability’. ‘Certification’ on the other hand is the procedure, which provides the possibility of making certain that any aircraft, whether civil or military has an acceptable level of safety for a given future utilisation within the defined flight load spectrum for a specific period.

The major considerations in airworthiness certification are

- Flight safety - Assessment of risk associated with flight
- Assured life - Both theoretical and experimental determination of life through fatigue and endurance testing
- Redundancy Management - to improve system reliability
- Protection - against deterioration due to life cycle environment

To be airworthy, the design must meet Airworthiness requirements which are to ensure safety and reliability during design, manufacture and maintenance. The airworthiness certification is issued by airworthiness regulatory bodies based on satisfactory design evaluations, analyses, simulations and ground and flight tests. While certification is mainly associated with ab-initio development activity, continued airworthiness applies to airworthiness assurances through out the service life of the developed, bought out or license manufactured aircraft. The total airworthiness function is shown in Fig.1.

Airworthiness Philosophy

The basic philosophy is that an impartial body belonging neither to manufacturer nor to operators evaluates the design from safety and performance angle. The design requirements are evolved such a way that safety and reliability are ensured. All airworthiness standards, military or civil, whether that of USA, Europe or Russia, have a common point of reference, is that an inverse relation should exist between probability of occurrence of an event and the degree of hazard inherent in its effect.

Civil and Military Airworthiness

A fundamental difference between Civil and Military airworthiness lies in the fact that military aircraft design quite often precedes the development of well-matured technology. To get slight edge over the adversaries, military aircraft development uses technologies, which are yet to be proven to the maturity level acceptable for civil application. Thus, the basic tenet of airworthiness for civil

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aircraft is passenger comfort and safety. For military aircraft design on the other hand, completion of mission task is given priority while safety levels are set as agreed between manufacturer and user.

For comparison, safety levels are defined as fatalities per ton kilometer of transportation for civil aircraft while for military fighter aircraft, it is the number of accidents per 10,000 hours of flight.

**Airworthy Aircraft**

An aircraft is said to be really airworthy when,

a. Its type has been designed to meet the applicable Certification standards.
b. It has been manufactured by an approved Organization.
c. It has been maintained by approved people as per applicable directives.
d. As a result of (c) no significant defect has been found.

**Airworthiness Certification Process**

Certification is a process of evaluation and documentation of compliance of a product that it meets the stipulated requirements of the specification and is declared safe to fly by the competent authority. Certifying methodology and expertise required for assuring airworthiness demands thorough examination of all technical details right from the drawing board through fabrication process to flight test and evaluation for uncompromised safety, reliability and consistency in the performance of flying machines. Airworthiness certification encompasses early conceptual work through the detailed writing of technical specification to final evaluation of the aircraft.

Certification is an assurance to the users in the form of a declaration that the product conforms to the stipulations as defined in specification. The terms certification and airworthiness are closely related. While certification is clear assurance for a product type, airworthiness is an explicit declaration that the product item is certified to be airworthy, with limitation as applicable. A product that is certified need not be Airworthy, unless declared as also airworthy. The certification methodology is explained by the block diagram shown at Fig.2.

It is also necessary to differentiate between the terminologies of ‘Clearances’ and ‘Certification’. In a system of concurrent certification viz, the action to eventually certify the aircraft along with progress of the design/development activity, an element of work/stage is ‘cleared’ by the certification authority and the work then progresses to the next element. Such a procedure is necessary if the programme is a major one, like an aircraft development.

**Airworthiness Analysis and Verification**

The various tools used for ensuring airworthiness requirements along with the objectives are listed in Table-1.

**Military Airworthiness In India**

Military Airworthiness started in India with the formation of Resident Technical Office at Bangalore in 1958.

<table>
<thead>
<tr>
<th>Table-1</th>
<th><strong>Objectives</strong></th>
<th><strong>Airworthiness Tools</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acceptable levels of performance and handling qualities</td>
<td>Aerodynamic configuration, handling and flying qualities analysis</td>
</tr>
<tr>
<td>2</td>
<td>Safe operation through out the life</td>
<td>Airframe structure and construction</td>
</tr>
<tr>
<td>3</td>
<td>Acceptable levels of reliability of aircraft and systems</td>
<td>Reliability analysis, (FMECA, FTA)</td>
</tr>
<tr>
<td>4</td>
<td>Establish durability levels of airframe and systems</td>
<td>Fatigue, endurance, ageing and life tests</td>
</tr>
<tr>
<td>5</td>
<td>Ensure electrical power available</td>
<td>Electrical load analysis</td>
</tr>
<tr>
<td>6</td>
<td>LRU certification</td>
<td>Qualification test of LRU</td>
</tr>
<tr>
<td>7</td>
<td>System integration</td>
<td>Rig integration tests</td>
</tr>
<tr>
<td>8</td>
<td>System safety</td>
<td>Safety and Hazard Analysis</td>
</tr>
<tr>
<td>9</td>
<td>Establish interchangeability and maintainability</td>
<td>Design for maintenance programmes and schedules</td>
</tr>
<tr>
<td>10</td>
<td>Ground evaluation</td>
<td>Interface ground test on aircraft</td>
</tr>
<tr>
<td>11</td>
<td>EMI/EMC</td>
<td>Qualitative/quantitative EMI/EMC test on complete aircraft</td>
</tr>
<tr>
<td>12</td>
<td>Reduce pilot workload, increase in safety and comfort</td>
<td>Human Engineering and ergonomics</td>
</tr>
</tbody>
</table>
CEMILAC (Centre for Military Airworthiness and Certification) was established in 1995 to consolidate certification work. Within one decade CEMILAC has become one of DRDO’s significant agencies vested with the responsibility of Airworthiness and Certification of Military Aircraft and airborne stores. CEMILAC with its corporate office at Bangalore has 14 arms called Regional Centres for Military Airworthiness (RCMA) spread all over the country, each with a unique core competence for speedy and more effective airworthiness assurance functions. CEMILAC is headed by a Chief Executive and the heads of the RCMA are designated as Regional Directors.

**RCMAs and Their Core Competence**

Each Regional Centre has a specific Core Competence in Design Evaluation and Certification as given below:

**a) Aircraft Group**
- RCMA (Aircraft) - Ab-initio designed Aircraft, Systems and UAV
- RCMA (Helicopters) - Ab-initio designed Helicopters
- RCMA (Kanpur) - Military Transport Aircraft and Parachutes
- RCMA (Nasik) - Russian Fighters and their Upgrades
- RCMA (Chandigarh) - Overhaul of Russian Helicopters and Transport Aircraft

**b) System Group**
- RCMA (Lucknow) - Accessories for Aircraft and aero-engines
- RCMA (Air Armament) - Air Armament Stores
- RCMA (Korwa) - Inertial Navigation, Flight Data Recorder
- RCMA (Hyderabad) - Avionic equipment for aircraft and engines
- RCMA (Missiles) - Aircraft mounted missile

**c) Propulsion and Materials Group**
- RCMA (Engines) - Certification of aero engine of western origin
- RCMA (Materials) - Certification of aerospace materials
- RCMA (Foundry and Forge) - Certification of Castings, forgings, elastomers, FOL
- RCMA (Koraput) - Certification of aero engines of Russian origin

**CEMILAC Spectrum of Activities**

CEMILAC certification activities ranges from ab-initio developed aircraft and systems to continued airworthiness of bought out and license built aircraft and systems. Some of the special thrust areas are discussed in the subsequent paragraph.

- **Life Extension studies**: CEMILAC has been instrumental in life evaluation studies for aircraft, helicopters, aero engines and accessories to fully exploit their life potential to enhance operational use. Based on very systematic and scientific studies, technical lives of many frontline aircraft, helicopters, aero engines, rotors and parachutes have been extended resulting in huge foreign exchange savings.

- **Midlife Upgrades**: Midlife upgrades have become reality for almost all the fleet world over. These upgrades include integration of new weapon system, avionics, EW systems and store management and weapon aiming algorithms. CEMILAC has successfully certified the airworthiness of both hardware and software upgrades on indigenously designed, license produced as well as bought out Aircraft and Helicopters which have greatly enhanced the operational effectiveness of these platforms.

- **Indigenous development of airborne materials and stores**: CEMILAC has acted as catalyst for indigenisation of aircraft raw materials, airborne equipment and general stores as well as Aviation fuel, oil and lubricants. Based on rigorous and thorough evaluations, more than 3000 items have been accorded airworthiness approvals by CEMILAC. This has greatly helped indigenous development programmes besides providing help to maintain the operational readiness of the fleet.

- **Approval of design firms and test houses**: CEMILAC has approved design firms for specific areas of design based on the experience and past record of activities. Similarly CEMILAC has also approves test houses for material and other tests of indigenously developed items. Based on the assessment made by the expert committee set up by CEMILAC, more than 70 design firms have already been approved. They cover
wide ranges like Aerodynamics and CFD Analysis, Structural Design and Analysis, Avionics, Electrical and Instruments, Software Verification and Validations, Development of hardware with embedded software etc. These approvals has greatly eased the development process as the main design agencies can outsource design and testing activities to these houses and concentrate on major design and integration activities.

CEMILAC Spectrum of activities is shown in Fig.3.

CEMILAC Achievement

In the last few decades India has taken a big stride in the field of design, development and production of military and civil aircraft and stores. With modest beginning in the fifties CEMILAC has expanded its horizon to certify the most complex and digital fly-by-wire aircraft development programme. The expanding horizon is shown in Fig.4.

CEMILAC Certification Record

CEMILAC during its existence has certified as per the procedure outlined in Min of Defence document DDPMAS-2002, the following aircraft programmes:

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Certification Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hindustan Trainer : HT-2</td>
<td>Aug 1951</td>
</tr>
<tr>
<td>Pushpak</td>
<td>Sep 1958</td>
</tr>
<tr>
<td>Kiran Mark I</td>
<td>Sep 1964</td>
</tr>
<tr>
<td>HF-24</td>
<td>Apr 1970</td>
</tr>
<tr>
<td>Kiran Mark II</td>
<td>Jun 1976</td>
</tr>
<tr>
<td>HPT-32</td>
<td>Jan 1977</td>
</tr>
<tr>
<td>Ajeet Trainer</td>
<td>Sep 1982</td>
</tr>
<tr>
<td>HTT-34</td>
<td>Jul 1984</td>
</tr>
<tr>
<td>ALH</td>
<td>Aug 1982</td>
</tr>
<tr>
<td>LCA</td>
<td>Jan 2001</td>
</tr>
<tr>
<td>IJT</td>
<td>Mar 2003</td>
</tr>
</tbody>
</table>

CEMILAC Certification for Foreign Developer/User

CEMILAC also certifies airborne product specially developed by foreign vendors for use by Indian Defence. These include airborne equipment, Line Replaceable Unit (LRU) and aero engines. Sometimes a developed system has been upgraded/modified to suit Indian requirements. Some of the recent examples of CEMILAC certification of product developed abroad are the certification of AL-55I engine developed by M/s Turbomeca, France for powering the Advanced Light Helicopter (ALH).

Similarly, while buying the ALH, procurement authorities of Ecuador, South America, has requested CEMILAC as the agency for the certification of ALH as per the SOP released by the Ecuador procurement authority.

Conclusion

Airworthiness encompasses early conceptual work of writing detailed technical specifications to final evaluation to assure the required performance, reliability and safety. CEMILAC is organized for sharing of the expertise on airworthiness assurance amongst designers, manufacturers, Certification and operating personnel. Based on five decades of experience CEMILAC has emerged as the major accelerator for design and development of indigenous aircraft, aero engines and airborne stores.

CEMILAC mission is that the customer receives aircraft and systems as safe as the state-of-art permits. Through systematic design evaluations, CEMILAC assures the user the demonstrated performance of the developed aircraft. For the existing fleet, CEMILAC also ensures continued airworthiness through out the operation life of the fleet.

CEMILAC vision is that it will instill global standard of Safety, Reliability and Performance in Indian Military Airborne Systems through Excellence in Airworthiness Certifications.

References

2. Kanchan Biswas., "An Introduction to Aircraft Airworthiness".
Fig. 1 Airworthiness Functions

Fig. 2 Certification Methodology
Fig. 3 CEMILAC Spectrum of Activities

Fig. 4 CEMILAC Experience