Aircraft Forensic Engineering

The Defence Science and Technology Organisation (DSTO) is the Australian Government’s lead agency charged with applying science and technology to protect and defend Australia and its national interests. DSTO delivers expert, impartial advice and innovative solutions for Defence and other elements of national security.

Overview

One of the most important aspects underpinning the structural integrity and economic operation of aircraft (fixed wing and rotary) is the need for a highly experienced and expert capability which can provide correct diagnoses of defects and failures in aircraft components and systems. The DSTO’s Aircraft Forensic Engineering section is the centre of excellence in aircraft defect and failure analysis for the Australian Defence Force (ADF), and in support to other government-related agencies and industries.

Aircraft Forensic Engineering is the largest group of scientific and technical aircraft failure specialists in Australia. These specialists provide the ADF with an essential independent forensic capability for engineering and scientific analysis into the causes of accidents and major incidents, failures or deterioration of metallic and non-metallic structural components, engines, systems and equipment. This extends to aviation support equipment including aircraft and airfield ground support equipment, aircraft common spares, and aeronautical life support equipment.

In addition, the capabilities within Aircraft Forensic Engineering extend to providing support to non-aviation investigations related to Land and Maritime Systems.

Primary capabilities

Aircraft Forensic Engineering has, collectively, hundreds of years of experience investigating the behaviour of specialised materials used in the aeronautical industry. These materials can exhibit deterioration and damage as a result of manufacture, maintenance, or operational service.

Aircraft Forensic Engineering’s capabilities for investigating problems include:

- On-site accident and major incident investigation and laboratory support;
- Structural integrity defect analysis;
- Quantitative assessments of damage accumulation, including determination of fatigue crack growth rate;
- Corrosion damage assessment;
- Composite material fracture analysis;
- Aircraft wiring and systems investigations;
- Determination of metallographic structure, hardness, tensile properties, fatigue life and fracture toughness;
- Metallurgical examination and investigation of engineering materials, processes and components;
- Chemical investigations of contaminated equipment;
- Failure modes and effects analysis (FMEA) and oxygen hazards and fire risk analysis (OHFRA);
- Specialist scientific advice and recommendations for corrective and preventative actions;
- On-site problem solving and consultation.
Aircraft Forensic Engineering in practice

Among the areas of expertise developed by Aircraft Forensic Engineering are quantitative fractography, composite material fracture analysis, aircraft wiring and systems, and oxygen systems and components.

**Quantitative fractography**

Providing world expertise in this area, quantitative fractography involves ‘reading’ the microscopic markings on fracture surfaces and then relating these to the service history of the component – thereby determining the crack growth rate. In many cases this has led to the development of an inspection program that enables critical aircraft parts to continue in service. With information on rates of crack growth, the useful life of a cracked component may be extended for many more flight hours with significant economic benefit.

**Composite material fracture analysis**

Composite materials are increasingly being used in the construction and maintenance of modern aircraft. The analysis of fractures in composite structures is essential for the understanding and identification of the mechanisms and causes of defects and failures in these structures. With new ADF acquisitions such as the C130J, full composite Tiger and MRH Helicopters, and future aircraft such as the Joint Strike Fighter and UAVs, Aircraft Forensic Engineering provides the ADF a unique and essential capability to undertake complex failure investigations of defects and failures in composite aircraft structures.

**Aircraft wiring and systems**

Maintaining reliable electrical wiring and systems on aircraft fleets is a major issue for fleet owners worldwide, particularly for ageing aircraft. Aircraft Forensic Engineering is the ADF’s lead scientific arm in the assessment and advice on ageing wiring issues, and has worked together with the ADF to provide key advice on managing aircraft wiring now and into the future.

**Aircraft oxygen systems and components**

The safe design, development and operation of aircraft oxygen systems and components, requires special knowledge of materials, design, testing, manufacturing, operation and maintenance practices. Through experience, knowledge and training, Aircraft Forensic Engineering have developed a capability that covers a wide range of aircraft oxygen system and component investigations that include: oxygen hazards and fire risk analysis (OHFRA), failure modes and effects analysis (FMEA), contaminant analysis; investigations of oxygen fires, and liquid dry breathing oxygen analysis.

**Facilities and equipment**

Aircraft Forensic Engineering’s world-class laboratories, equipment and related facilities include:

- High-resolution digital photography;
- Modern scanning electron microscopes and x-ray energy analysis systems;
- Precision optical measuring equipment with surface profiling capability;
- Modern microscopes with precision motorised stages and advanced colour digital imaging systems – digitally linked to desktop computers with image enhancement and measuring programs;
- Computer-enhanced digital quantitative imaging facility;
- Dimensional metrology facility;
- Advanced non-destructive inspection facilities;
- Mechanical testing;
- Facilities specialising in petroleum, oils and lubricants, analytical chemistry and corrosion;
- Access to modern finite element, computational fluid and impact dynamics analyses;
- Access to chemical instrumentation including fourier transform infrared spectroscopy and chromatography-mass spectrometry.

**Further information**

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