AWB 51-1 Issue 1, Aircraft Fabric Coverings

Aircraft Fabric Coverings

AWB 51-1 Issue 1, 25 December 2001

Applicability

All references to aircraft in this Airworthiness Bulletin (AWB) are references to fabric-covered aircraft only.

Purpose

This purpose of this AWB is to outline and define the airworthiness requirements for fabric coverings used as alternate approved materials and processes.

Background

Before the 1960's the majority of Australia's aircraft originated (in design) from the United Kingdom (UK), with most aircraft structures fabric covered in organic mediums such as cotton or Irish linen. In the early 1960's an influx of aircraft from the United States of America (USA) occurred, with the majority of these aircraft being an all-metal construction. However, many aircraft types imported from the USA aircraft adopted a fabric material, which utilised new man-made fabrics, which was an inorganic fabric that used a different application process to that of the organic materials used by UK aircraft.

Unlike the UK aircraft that generally had a composite airframe consisting of wood and metal structures, USA aircraft incorporated a predominately all-metal structural frame that was covered by the synthetic fabric, comprising either polyester or glass fibre.

Unfortunately the natural fabric covering materials and processes has problems not associated with synthetic fabrics. Greater flammability, degeneration due to exposure to mildew and fungus, difficulty in application and greater susceptibility to the ultraviolet (UV) rays, all combining to ensure a fabric replacement interval of 10 to 20 years. Because of this many of these aircraft were recovered using the new synthetic materials.

However, synthetic fabrics also have an inherent maintenance concern, since their resilience can lead to replacement intervals far greater than those of natural fabrics, ensuring greater intervals between adequate airframe structural inspection schedules. Structural deterioration could go undetected for many years causing a slow decline of the aircraft's structural integrity. Timely inspection of airframe structures is of equal importance to wooden or composite airframes as it is to metal structures. Extensive examination of any structure requires the complete removal of the fabric for adequate and comprehensive inspection, regardless of fabric type.

Recommendations

Fabric Replacement

The replacement of a fabric, including covering of an flying surface, is regarded as a major repair and should be performed by an appropriately authorised Civil Aviation Regulation (CAR) 30 organisation employing either a Licenced Aircraft Maintenance Engineer (LAME) or a Maintenance Authority (MA) holder having airframe group 4 privileges.

The selection of fabric type (and associated processes) can depend on many factors. These may include

- If the fabric replacement differs from the fabric detailed in the aircraft's Type Certificate (TC), then a Supplemental Type Certificate (STC) or Engineering Order (EO)[i].
- Availability of fabric and it's associated chemicals, tapes, cords, threads, etc.
- Skill of the maintainer in the chosen material and process.
- Type of operation the aircraft is involved in (agricultural, high speed/aerobatics, glider).
- Availability of suitably calibrated tools and equipment.

Synthetic fabric manufacturers have gained STC approval for many aircraft types. Although the STC is issued in another country, these are accepted by CASA provided they originate from a recognised National Airworthiness Authority (NAA). A copy of the STC should be forward to CASA Area Office responsible for the aircraft's files for attachment of the STC to the aircraft's file at the completion and certification of the recovering process.

Many aircraft maintenance manuals have limited information regarding the recovering process required on the aircraft, with most manuals referring to stitching patterns and special covering techniques unique to the aircraft. If recovering an aircraft using Grade A cotton an approved document for application guidance, in conjunction with aircraft's maintenance manual, is the Federal Aviation Administration's (FAA) Advisory Circular (AC) 43.13-1B and the UK Airworthiness leaflet 2-8. These documents outline all acceptable techniques for a range of practices, from doping and repairs to inspection.

Should an alternate material be chosen to cover an aircraft, and then the materials and procedures should be detailed in the STC. This includes, but is not limited to, items such as chemicals (paint and dopes), stitching threads, finishing and lacing tapes, fabric attaching hardware (rivets, PK screws & clips), inspection rings, drain grommets and material. Failure to comply with all aspects of the STC, including materials and methods, will void the STC, making the repair un-approved.

Equipment

The equipment requirements for performing fabric work are minimal. However, several items are required to be calibrated prior to use to ensure to compliance to instructions covered in either the STC or aircraft maintenance manual. If utilising one of the synthetic materials that require heat for fabric shrinkage, then the heat source (generally an household iron) must be checked for its various temperature settings.

Storage

If using an organic material such as cotton, then the certain environmental conditions must be met. This includes a working room temperature of (typically) 16 to 21°C and a minimum relative humidity of 70%. Storage of fabric should be in clean dry areas away from direct sunlight with an average temperature of 20°C. These conditions must be continually monitored during the recovering process, with the monitoring equipment calibrated for accuracy.

Fabric Testing

Regardless of the type of fabric used to cover an aircraft, fabric will deteriorate in service, with various areas deteriorating at different rates. These variable rates depend on type of operation, storage/parking area of aircraft, type of fabric material, water, chemical and oil contamination, UV rays, etc. Although some aircraft manufacturers impose an arbitrary replacement life on fabric, fabric replacement on most aircraft is considered to be 'on condition'. All aircraft fabrics must conform to various standards for continued airworthiness and is measured in tensile strength. In lieu of the aircraft or fabric manufacturer setting a minimum tensile strength for a fabric, the minimum accepted standard for aircraft fabric is 70% of new tensile (undoped)

strength. Other variable that may determine acceptable fabric strength is the aircraft's wing loading, the aircraft's engine horsepower rating and the aircraft's never-exceed speed (Vne).

Testing of an aircraft's fabric covering can be achieved by using a variety of methods, including a portable, calibrated fabric tester. These testers consist of a penetrating cone and plunger housed within a sleeve assembly and indicate in either colour or numbered bands. Testing should be repeated at various positions on the aircraft's surface, with the lowest reading obtained (other than in an isolated repairable area) being considered representative of the condition of the aircraft's fabric. All punctures produced by the tester should be repaired in accordance with approved data.

NOTE: The test should not be made through double layers of fabric

Other areas that should be closely inspected for integrity are rib lacing and stitching, chafing areas such as longerons and ribs, envelope stitching, fabric cemented joints, drain grommets, inspection access points and areas where pipes, cables and airframe structures penetrate the fabric. The integrity of all these components has equal importance to make-up of the final fabric covering process. The minimum required tensile strength of the fabric is also conveyed to other materials of the fabric process such as rib lacing and thread.

NOTE: Razorback glass fabric does not have to be tested for tensile strength.

The inspection and testing of the fabric should not be confused with the deterioration of the dopes or sealers that cover the fabric. Depending on the covering system chosen, many of the chemical coatings can be restored by a chemical rejuvenation process. However, the tensile strength of the underlying fabric is the determining factor to whether the rejuvenation process should be attempted.

Certification

All recovering and repairs must be recorded in the aircraft logbook and signed for by an appropriately qualified person in accordance with the Certificate of Approval holders manual.

Fabric Terminology

Dacron®	Registered trade name for polyester fibres made by E.I. DuPont de Nemours & Company. Poly-Fiber® (and all it's other pseudonyms) is Dacron material.
Ceconite®	Registered trade name for a fabric woven from polyester fibres and covering process. Application is with nitrate and butyrate dopes.
Stits Fabric	Generic name for a fabric covering process developed by Mr. Ray Stits. Purchased by Poly-Fiber Inc in 1993 and renamed Stits Poly-Fiber.
Poly-Fiber®[ii]	Registered trade name for a fabric woven from polyester fibre. A Poly-Fiber Inc material and process. Application is with Poly-Fiber® products.
Irish Linen	A strong fabric made from flax.
Grade-A Cotton	A high-grade, long staple cotton cloth with 80 threads per inch in both warp and fill directions. Used in covering aircraft structures.
Razorback®	Registered trade name for a glass fibre fabric and covering process.

Superflite®	Registered trade name for a fabric woven from polyester fibres and covering process.
Madapolam	A bleached cotton fabric with a soft finish used in covering wooden surfaces. Complies with British Standard (BS) F114.

Bibliography

FAA Advisory Circular 43.13B

Ceconite Procedure Manual 101

UK CAA Civil Aircraft Airworthiness leaflet 2-8 Fabric Covering

FAA Technical Standard Order TSO-C15d

Joint Aviation Authorities JTSO C15d

Poly-Fiber® Manual

Aircraft Maintenance and Repair - Delp/Bent/McKinley

Aviation Technician Integrated Training Program - Dale Crane

CASA Civil Aviation Regulations 1988 and 1998

CASA Advisory Circular AC21.15 (0)

i - If the aircraft's TC requires a fabric to a Technical Standard Order (TSO), then any other alternate fabric that meets the same TSO is acceptable. FAA TSO-C15c & JAA JTSO-C15d refers to aircraft fabric and FAA TSO-C14b refers to gliders, ultra lights, etc.

ii - Poly-Fiber® and Ceconite® are two distinctive processes and are covered by different STC's. Mixing of materials and chemicals, including processes and application methods, voids the STC, making the repair un-approved.