Advisory Circular AC43-5

Engine and propeller overhaul and testing

Revision 2
15 April 2016

General

Civil Aviation Authority Advisory Circulars contain information about standards, practices, and procedures that the Director has found to be an Acceptable Means of Compliance (AMC) with the associated rule.

An AMC is not intended to be the only means of compliance with a rule, and consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices, or procedures are found to be acceptable they will be added to the appropriate Advisory Circular.

An Advisory Circular may also include guidance material (GM) to facilitate compliance with the rule requirements. Guidance material must not be regarded as an acceptable means of compliance.

Purpose

This Advisory Circular provides methods acceptable to the Director for showing compliance with the general maintenance rules set out in Part 43 - General Maintenance Rules in respect to acceptable techniques, methods, and practices in relation to piston engine and propeller inspection and testing, and with the operator maintenance requirements in Part 91 – *General Operating and Flight Rules.*

Related Rules

This Advisory Circular relates specifically to Civil Aviation Rule Part 43 and Rule 91.603(e) and (f).

Change Notice

Subject to “Memorandum for Technical Cooperation” between the CAA of Mongolia and New Zealand on mutual cooperation in implementation of Assembly Resolution A29-3: Global Rule Harmonization, 29th ICAO Assembly, 1992, which urges States to promote global harmonization of national rules, dated 6th of May, 1999, Mongolian Civil Aviation Safety Regulation has been reconciled to the Civil Aviation Regulation of New Zealand.

Amendment 164 of Annex 1 to the Chicago Convention on International Civil Aviation urges flight crew members, ATC personnel and aircraft maintenance engineers to comply with the language proficiency requirements; and

Under Article 14 of the Civil Aviation Law of Mongolia 1999, “Use of foreign language in civil aviation” the AC has been released in English version only, in order to prevent any mistranslation and misuse of the aviation safety related documents.

This AC43-5 was developed based on NZ AC43-5 revision 2, dated on 18 December 2007.

Table of Contents

Introduction

The objective of Part 43 is to establish, for all aircraft, the minimum standard of maintenance considered necessary to ensure the continued validity of their Airworthiness Certificate. Part 43 also requires that all aircraft are maintained to a standard that assures safe operation.

This is achieved by prescribing—

- the minimum standard of maintenance required for aircraft
- the minimum standards for the performance of maintenance
- the persons whom may certify maintenance
- the manner in which maintenance is to be recorded and certified

The provision of enhanced maintenance practices is a recognised method of maximising the useable service of a component or product as detailed in AC43-4. In Mongolia the CAA has identified inspections for engines and propellers that provide for such maintenance beyond the recommendations of the manufacturers. The CAA approach is not suggesting an inadequacy with the manufacturer's recommendations but specifically addressing the airworthiness issues rather than the economics and serviceability issues important to a manufacturer.

It should be stressed that these maintenance procedures are not intended to provide a freedom to run until failure. The validity of the concept relies on the inspections providing warning of impending failure. There are some items in engines and propellers that cannot be adequately inspected other than by stripping and the action of stripping the engine or propeller provides an opportunity to overhaul the product. Operators must consider this when requiring the completion of any inspections.

This advisory circular provides acceptable methods, techniques, and practices for the maintenance and testing of piston engines and propellers, beyond the recommended TBO.

Where reference is made to technical data, including manufacturer's instructions, that data is to be the current issue or revision.

Overhaul procedures

This advisory circular contains information relating to the overhaul of engines and propellers, including their associated accessories.

The overhaul of engines and propellers must be performed in accordance with the relevant manufacturer's instructions. Overhaul, in relation to an aircraft or aircraft

component, means to perform a major work operation which involves dismantling and complete testing to specification and renewal of operational life.

The refitting of partial life components during this maintenance does not constitute an overhaul. Such work on an engine or propeller is only a repair and the component should not be released as overhauled.

When fitted to aircraft used on air transport operations the time between overhaul (TBO) of an engine or propeller must be that recommended by the manufacturer. Other periods may be prescribed in the operator's maintenance manual if accepted by the Director.

Where the manufacturer recommends a variation in TBO up to a specified maximum, any conditions or recommendations for reaching this maximum must be observed. If an air transport operator wishes to increase the TBO of an engine or propeller, then a suitable programme must be agreed by the Director. This is an escalation programme.

A piston engine that is being, or has been, operated in either fixed wing agricultural aircraft or military aircraft for all or part of its life since new, or last overhaul, must be overhauled before use on an air transport aircraft.

To meet the requirements of rule 43.53(3)(ii), a type certificated engine which has been operated on any aircraft issued with a special category airworthiness certificate is not to be fitted to an aircraft for which a standard or restricted airworthiness certificate is required without the approval of the Director.

All engine accessories are to be considered part of the engine for determining their overhaul period, unless otherwise specified in the manufacturer's instructions or approved by the Director.

Part 91 – Operation considerations

Piston engines installed in aircraft not used for hire or reward may be maintained in accordance with these procedures rather than overhauled at fixed periods provided that the engine meets certain conditions.

Propellers installed in aircraft not used on air operations may be maintained in accordance with these procedures with respect to the calendar requirement provided that the propeller meets certain conditions.

The validity of enhanced maintenance relies on inspections providing adequate warning of impending failure.

In the case of propellers, an Australian CASA study in 1997 indicated the following costs associated with running propellers on condition versus complying fully with manufacturer's recommendations. The study examined three types of programme:

- full manufacturer's
- manufacturer's without a calendar TBO but regular inspection
- manufacturer's without a calendar TBO and no inspection

The programmes assumed a five year calendar time overhaul and flying hour overhauls of 1000, 2000, and 3000 hours.

The Mongolian experience has indicated that a regular inspection is preferred and so the third type of programme is not considered acceptable. The results of the other programmes were:

- 1000 hours TBO—

➢ the full manufacturer's programme is as cost effective as *on condition* maintenance if an operator is operating greater than 200 flying hours per year

➢ the manufacturer's programme without a calendar based TBO applied but with regular inspections is more cost effective if an operator is operating less than 200 flying hours per year

- 2000 hours TBO—

➢ the full manufacturer's programme is as cost effective as on condition maintenance if an operator is operating greater than 350 flying hours per year

➢ the manufacturer's programme without a calendar based TBO applied but with regular inspections is more cost effective if an operator is operating less than 350 flying hours per year

- 3000 hours TBO—

➢ the full manufacturer's programme is as cost effective as on condition maintenance if an operator is operating greater than 500 flying hours per year

➢ the manufacturer's programme without a calendar based TBO applied but with regular inspections is more cost effective if an operator is operating less than 500 flying hours per year

When electing to run beyond the recommended TBO the operator should assess their economic advantage of doing so.

Engines

The engine must be inspected by a licensed aircraft maintenance engineer (LAME) with an appropriate rating.

Inspection requirement

In addition to the requirements of Part 91.605(a)(3) or (4), the inspection should also be carried out as prescribed below:

- at -

➢ the TBO recommended by the manufacturer in terms of operating hours

➢ each 100 hours thereafter

- at -

➢ the calendar period recommended by the manufacturer, if prescribed, or ten years since initial build or last overhaul

➢ each twelve month period thereafter

Any finite life limitations imposed on the engine and its components or accessories by the manufacturer in the Maintenance and Overhaul Manual, Service Bulletins, or Service Letters, or by the CAA in an Airworthiness Directive, must be complied with. Finite life limitations are limitations that require the removal and replacement of the component, or part, and are normally found in the Airworthiness Limitation section of the aircraft maintenance manual or Instructions for Continued Airworthiness.

Condition inspection – piston engines

External condition

The engine should be examined externally for obvious faults which would make it unacceptable for further use, including:

- cracked crankcases
- excessive end float in the propeller shaft
- overheating
- corrosion

Internal condition

Significant information concerning the internal condition of an engine may be obtained from an examination of the oil filters and magnetic plugs for contamination by metallic particles.

Oil consumption

Since the oil consumption of an engine may have increased toward the end of its normal overhaul period, an accurate check of the consumption over the last ten hours would show whether the engine is likely to satisfactorily continue in service beyond the maximum TBO recommended by the manufacturer.

Compression check

Piston ring and cylinder wear, and poor valve sealing, could, in addition to increasing oil consumption, result in a significant loss of power. Cylinder compression tests and leak rate tests are methods of determining, without major disassembly, the standard of sealing provided by the valves and piston rings.

Ground power checks

Each person carrying out an inspection, for the purpose of allowing a piston engine to remain in service beyond the manufacturer's recommended TBO, must run the engine to determine satisfactory performance in accordance with the manufacturer's limitations.

Propellers

A propeller is under four loads during operation:

- thrust
- torque
- centrifugal
- aerodynamic forces

The majority of propellers used are designed such that they cannot be considered redundant structures in which partial failure can be tolerated. Despite this, the life limitations have not generally been considered necessary because the control the manufacturer exercises over the vibrational characteristics of a particular engine-propeller configuration under each of the four types of load. These characteristics often determine the operating limitations for propellers that avoid the critical vibration environments. When operated within the limitations the deterioration and wear associated with normal operation play a larger factor in the life of a propeller.

Operators should note that operation outside the limitations in the higher stress environments can lead to premature blade failure. The operation in the higher stress areas can be caused by incorrectly maintained propellers or by inaccurate tachometers.

The effect of the operational deterioration of a propeller is not predictable and the life limitations imposed by a manufacturer are based around averages – average damage, average utilisation, average maintenance.

Propellers have three critical areas:

- the blade retention area
- the blade tips
- the mid blade for large blades.

The US and Mongolian experience is that most failures occur in the blade tip area and most originate from mechanical damage in the form of nicks, dents, and cracks. This damage is easily detected through regular inspections by operators – pre-flights – and engineers – scheduled inspections.

For scheduled inspections, the propeller must be inspected by a licensed aircraft maintenance engineer (LAME) with an appropriate rating.

Inspection requirement

The inspection requirements are based around retaining the TBO period in hours but enabling the calendar period to be extended until this hour limitation is reached. There are two reasons for this requirement. Firstly, the manufacturer's data on average usage is considered appropriate to set an operating hour limit. Secondly, many general aviation aircraft in Mongolia do not operate a high enough number of hours to reach the TBO during the calendar period.

Propellers inspection requirements are:

- overhaul at the TBO recommended by the manufacturer in terms of operating hours
- inspection in accordance with Manufacturer's Maintenance Manual and this advisory circular each five years

Any finite life limitations imposed on the propeller and its components or accessories by the manufacturer in the Maintenance and Overhaul Manual, Service Bulletins, or Service Letters, or by the CAA in an Airworthiness Directive, must be complied with. Finite life limitations are limitations that require the removal and replacement of the component, or part, and are normally found in the Airworthiness Limitation section of the aircraft maintenance manual or Instructions for Continued Airworthiness.

Condition inspection – propellers

Variable pitch propellers

The propeller is to be inspected to determine that it is in a safe condition to continue in service. The inspection should include:

- dismantling the propeller sufficiently to enable visual inspection of critical areas, including the-

➢ hub

➢ hub spider

➢ blade bearings and races

➢ blade roots for corrosion and general condition

- renewal of all seals and gaskets
- checking the condition of de-icer boots if fitted
- dressing of the blades as necessary to remove any nicks, damage or corrosion - application of protective coatings as necessary
- blade dimensions within the manufacturer's service limits
- assembly of the propeller in accordance with the manufacturer's instructions
- balance in accordance with the manufacturer's instructions.

Fixed Pitch propellers

- for metal propellers, a visual inspection of the hub and blades for corrosion, nicks and damage, especially to the blade leading edges and thrust faces.
- for wooden/composite propellers, a visual inspection of the hub and blades for delamination, damage to the leading edges and thrust faces and crushing of the hub by the mounting plates
- dressing of the blades as necessary to remove any nicks, damage or corrosion. Application of protective coatings as necessary
- blade dimensions within the manufacturer's service limits
- balance in accordance with the manufacturer's instructions

Documentation

The details of the inspections performed and the test results obtained should be entered in the appropriate log book and the release to service certified. Entries regarding the performance measurements taken should include, as applicable:

- idle rpm

- maximum rpm
- manifold pressure
- engine temperatures
- fuel flow
- ambient temperature and pressure
- calculated thrust or power