Title: Piston Engine Overhaul Periods for Aircraft Holding an EASA Certificate of Airworthiness

Advisory Memoranda are provided for information purposes only and must not be misconstrued as formally adopted Acceptable Means of Compliance (AMC) or as Guidance Material (GM).

1. Introduction

This Advisory Memorandum provides guidance to those preparing Aircraft Maintenance Programmes (AMP) for piston engine aeroplanes, below 2,730 kg Maximum Take Off Mass (MTOM), for approval by the IAA. It outlines the IAA policy in respect of extensions to the recommended overhaul periods (operating time and calendar time) for piston engines installed on aircraft, other than complex motor-powered aircraft, subject to EASA regulations. Where an owner/operator wishes to continue to operate their piston engine beyond the recommended overhaul interval, the AMP must include details of the inspections which are to be carried out to allow continued operation.

Instructions for continuing airworthiness containing overhaul intervals for components, typically referred to as Time Between Overhauls (TBO), must be considered when developing the AMP. The owner or operator must consider the operational environment in which the aircraft is used and the types of operating activity the aircraft is involved in, when determining if a TBO extension is appropriate. Any decision taken to differ from the manufacturer's recommendation shall be recorded in the Aircraft's continuing airworthiness record system (logbook) or AMP.

TBO values established by the Design Approval Holder (DAH) are normally defined in terms of calendar time and/or operating flying hours/cycles/landings, whichever occurs first.

The owner or operator may propose extended intervals for overhauling piston engines (TBO^E from now on) compared to those TBOs recommended by the engine DAH (hereinafter referred to as TBO^R). This Memorandum outlines the maximum extensions which would normally be considered for approval. In exceptional circumstances, the IAA may consider permitting extensions beyond that which is outlined below.

2. Extending the overhaul interval of piston engines

To extend the overhaul interval compared to the one established by the DAH, the following should be observed:

a) Inspection standards and tests conditions as well as pass-fail criteria should be stated before the component is inspected and be based on the components' typical parameters provided by the DAH in the form of manuals. These standards, conditions, and criteria should be considered part of the AMP. Guidance is given in Appendix 1 to this Memorandum as to what inspection items should be considered.

b) At the TBO^R, the component should be inspected in accordance with the maintenance data referred to in the AMP.

c) All component parts identified by the DAH for replacement at TBO^R which are accessible during the inspection should be individually inspected and replaced if necessary.

d) The results of the inspection should be included in the continuing airworthiness record system and should be conclusive. A copy of the inspection results should be provided to the aircraft owner.

e) Airworthiness Directives affecting the component and required to be completed at the time of the overhaul should be completed not later than TBO^R.

f) If, during the course of operating beyond the engine DAH's TBO^R, the engine experiences a mechanical failure or inspection requirement necessitating full or significant partial engine disassembly, the engine should be overhauled.

Examples of activities requiring significant disassembly include propeller strike/shock load inspections and crankshaft replacements for wear-related issues. Defects requiring replacement of individual cylinder and piston assemblies, and oil pump (where such work does not involve the removal /replacement of individual gears) are not included in the category of maintenance necessitating overhaul.

g) If the inspection is satisfactory and there is no reason to believe that the engine will not function as intended (e.g. consideration of past occurrences affecting the individual aircraft), the TBO^E will be reflected in the AMP (refer to paragraph h) together with any additional maintenance action identified as necessary so that the engine functions as intended until that time. As a minimum, another conclusive inspection should be programmed when 50% of the extended interval $\left(\frac{TBO^E - TBO^R}{2}\right)$ is reached or annually, whichever occurs first.

h) TBO^E should not exceed 20% of TBO^R in calendar time or operating hours, whichever comes first.

i) No further TBO extension should be allowed except for components fitted on privately operated aircraft with a MTOM of 2,730 kg or below, for which there is no limit on the number of extensions (20% of TBO^R each) when conditions a) to g) are similarly met. In this case, at the time of the third TBO extension, the fact that the aircraft is privately operated should be stated in the aircraft's continuing airworthiness records (e.g. aircraft logbook). The components affected should also be identified.

j) The IAA may permit further extensions for components fitted to other aircraft on a case-by-case basis.

k) TBO extensions can be considered for the components affected by the operation of the aircraft in highly corrosive environment or installed on aircraft used for towing provided that the inspections/checks of the components are performed at intervals of 25 % of the extended interval $\left(\frac{TBO^E - TBO^R}{4}\right)$. In these cases, for the extension of the engine's TBO, in addition to the measures defined by Appendix I to this Memorandum, a boroscope inspection and/or an oil spectrographic analysis should be part of the inspection. The limitation on the number of extensions is dictated by the type of operations e.g. private or commercial operations/aerial works.

The maximum extensions which will normally be approved for engines fitted to Irish registered aircraft are as follows:

Operation Category	Permitted TBO^{E}
Private Operations (e.g. Non- Commercial Air Transport/Commercial Operations)	There is no limit on the number of extensions.
Commercial Operations	One extension (TBO^{E}) permitted (see para (h))
Towing activity	TBO^{E} (see para (k)) – number of extensions as detailed in type of operation detailed above e.g. Private or Commercial Operations
Commercial Air Transport	No extension normally permitted

This table is for easy reference only, read all accompanying notes to ensure this Notice may be applied to a particular engine.

l) Based on the results of the inspection mentioned in paragraph b, the AMP amendment containing the extended TBO should be approved by the competent authority.

m) An engine with an extended TBO should not be installed on a different aircraft unless agreed by the competent authority of the Member State of registry.

3. Other Considerations

1. Provision for TBO extensions must be included in an Aircraft's Maintenance Programme for it to be used.

2. The TBO for an engine may be affected by the incorporation (or non-incorporation) of certain manufacturers' modifications, or operating environment therefore caution should be exercised in determining the normal TBO.

3. The concept of allowing engines to run beyond the manufacturer's recommended TBOs depends upon it being possible to assess the condition of the engine by prescribed

inspections carried out at defined intervals. It is not the intention to provide a freedom to run the engine until it fails.

4. This Advisory Memorandum gives guidance regarding the extension of recommended overhaul periods on the basis of the effect on airworthiness alone. The economics of operation has not been considered, whereas this may have been considered by the manufacturer when establishing the recommended overhaul periods. Aircraft owners/operators must make their own decisions with regards to overhaul periods based on the operation of the aircraft, environmental effects and economical considerations. Unless satisfied that the engine remains in an airworthy condition, the owner/operator should have the engine overhauled.

5. Preserve engines with low utilisation in accordance with manufacturer's recommendations. For guidance purposes, engines not operated for more than 1 month should be considered for preservation measures.

4. Approval from the IAA

AMPs to be approved by the IAA should be submitted to AWSD, Irish Aviation Authority, 11-12 D'Olier Street, Dublin 2 or awsd@iaa.ie .

IAA approval of an AMP for an aircraft does not absolve the owner from responsibility for any maintenance recommendation not fully complied with.

1 Appendix I

Maintenance Requirements for Piston Engine Operation beyond Manufacturers' Recommended Time Between Overhaul (TBO)

This appendix provides criteria on the inspection items needed for the extension of TBO^R of a piston engine. It is recommended that these items be carried out annually on any engine which is operating beyond TBO^R.

A piston engine that has reached the end of its DAH recommended overhaul interval may be expected to have suffered some wear to cylinders, pistons, valves, bearings and other moving parts, but an engine that has been carefully operated and maintained may still be in a condition suitable for a further period of service.

1. Many factors affect the wear that takes place in an engine. The most important of these include: the efficiency of the air intake filter; the techniques used in engine handling, particularly during starting; the quality of the fuel and oil used in the engine; and the conditions under which the aircraft is housed when not in use. Conditions of operation are also relevant; the length of flights; the atmospheric conditions during flight and on the ground; and the type of flying undertaken. Many of these factors are outside the duties of the maintenance personnel, but meticulous compliance with the approved maintenance programme and any instructions provided in the form of service bulletins or DAH's recommendations will undoubtedly help to prolong the life of an engine.

2. The inspections and tests that may be necessary to assess the condition of an engine are detailed in the following paragraphs. Alternative inspections/tests that would provide equivalent information or findings may be proposed.

3. Inspection and maintenance

A number of items included in the normal scheduled maintenance of an engine may be repeated to determine the condition of an engine at the end of its normal overhaul period, and additional inspections may also be specified.

3.1 External condition

The engine should be examined externally for obvious defects such as a cracked crankcase, excessive play in the propeller shaft, overheating and corrosion, which would make it unacceptable for further use. Special attention should be drawn to the cables, plugs, connectors and sensors of engines equipped with electronic control systems regarding improper mounting, shaving, worn contacts, and other kind of damage. Worn or damaged parts have to be repaired/replaced according to the Design Approval Holder's (DAH) instructions. External tubes and houses should be checked and if necessary replaced in accordance with the DAH's instructions.

3.2 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 metal particle contamination. These checks may be sufficient to show that serious wear or breakdown has taken place and that the engine is unacceptable for further service.

3.3 Oil consumption

Since the oil consumption of an engine may have increased towards the end of its normal overhaul period, an accurate check of the consumption over the last 10 flying hours would show whether it is likely to exceed the maximum recommended consumption defined by the DAH, if the overhaul period were to be extended.

3.4 Compression check

Piston ring or cylinder wear, or poor valve sealing could, in addition to increasing oil consumption, result in a significant loss of power. A cylinder compression check should be carried out in accordance with the DAH's instructions. The usual method of checking engine compression is the differential pressure test. In this test a regulated air supply (normally 560 kPa (80 lbf/in^2)) is applied to each cylinder in turn and a pressure gauge is used to record the actual air pressure in the cylinder. Since some leakage will normally occur, cylinder pressure will usually be less than the supply pressure and the difference will be an indication of the condition of the piston rings and valves. By listening for escaping air at the carburettor intake, exhaust and crankcase breather, a defective component may be located. It is usually recommended that the differential pressure test is carried out as soon as possible after running the engine.

4. Power output of aeroplane engines

The power developed by an aeroplane engine after initial installation is established in the form of a reference engine speed, which is recorded in the appropriate logbook so that a comparison can be made during subsequent power checks. The reference engine speed is the observed engine speed obtained using specified power settings and conditions corrected, by means of graphs supplied by the engine DAH, to the figure which would be obtained at standard sea-level atmospheric temperature and pressure; changes in humidity do not produce large changes of power and are ignored for the purpose of establishing a reference engine speed or subsequently checking engine power. Power checks should be corrected in the same way.

4.1 Power checks

The majority of light aeroplane piston engines are air-cooled and rely on an adequate flow of air for proper cooling of the cylinders. This condition can only be obtained during flight and ground runs should therefore be as brief as possible. Cooling can be assisted by facing the aircraft into wind, but high wind conditions must be avoided when making power checks, as they will significantly affect the results obtained. Before running the engine at high power the normal operating temperatures should be obtained (not the minimum temperatures specified for operation) and during the test careful watch should be kept on oil and cylinder temperatures to prevent the appropriate limitations being exceeded.

4.1.1 Normally-aspirated engines are tested at full throttle and, where a controllable-pitch propeller is fitted, with fully fine pitch selected. The changes in barometric pressure affecting engine power are considered to be balanced by changes in propeller load, so that only temperature correction is necessary. This correction factor may be obtained from a graph supplied by the engine DAH (if not provided by the DAH, Leaflet 70-70 Piston Engine Overhaul – Correcting Engine Test Results of CAA UK CAP 562 could be used). The observed full throttle speed multiplied by the correction factor will give the corrected speed.

4.1.2 Although normally-aspirated engines are often fitted with variable-pitch propellers, the engine speed obtained at full throttle is usually less than the governed speed and the propeller remains in fully fine pitch. With supercharged engines, however, the propeller is usually governed to a constant speed at high power settings and small changes in power will not affect engine speed. The power of a supercharged engine is, therefore, checked by establishing a reference speed at prescribed power settings.

a) Since a supercharged engine is run at a specified manifold pressure regardless of the atmospheric pressure, corrections must be made for both temperature and pressure variations from the standard atmosphere.

b) The procedure is to run the engine until normal operating temperatures are obtained, open up to maximum take-off manifold pressure, decrease power until a fall in engine speed occurs (denoting that the propeller blades are on their fine pitch stops), then throttle back to the manifold pressure prescribed by the DAH and observe the engine speed obtained.

c) The correction factor to be applied to the observed engine speed of a supercharged engine may be obtained from graphs supplied by the engine DAH.

4.1.3 Although the engine speed obtained during a check of engine power is corrected as necessary for atmospheric temperature and pressure, no correction is made for humidity, ambient wind conditions or instrument errors and, consequently, the corrected engine speed is seldom exactly equal to the reference speed even if the engine condition is unchanged. However, engine power may usually be considered satisfactory if the corrected speed obtained during a power check is within 3 % of the reference speed.

4.1.4 If it is not possible to assess power deterioration by means of a power check (e.g. due to fitting a different propeller), a rate-of-climb flight test should be carried out.

5. Power loss

If the power check (paragraph 4) or normal engine operation reveal an unacceptable loss of power or rough running, it may be possible to rectify this by carrying out certain normal servicing operations or by replacement of components or equipment. The replacement of spark plugs, resetting of tappets or magneto contact breaker points, or other adjustments to the ignition or carburation systems, are all operations that may result in smoother running and improve engine power.

6. Servicing

If the engine proves to be suitable for further service, a number of servicing operations will normally be due in accordance with the approved maintenance programme. Unless carried out previously (paragraph 6), these operations should be completed before the engine is returned to service.

7. Logbook entries

A record of the checks made, and any rectification or servicing work, must be entered and certified in the engine logbook before the engine is released to service for its recommended or extended service life. The logbook entry made should also specify any restriction on further use (e.g. May not be used for Commercial Air Transport).

8. Maintenance programme amendments

The aircraft maintenance programme should reflect the provisions for TBO extension and the additional maintenance tasks required with their periodicity to operate the aircraft engine beyond its recommended overhaul period.