## 1. Applicability

This AWB is applicable to piston engines installed in aircraft.

## 2. Introduction

The present Civil Aviation Safety Regulations permit on-condition maintenance programs, with no fixed time between overhauls (TBO), for piston engines in aircraft involved in private and aerial work operations. However, aircraft in charter and regular passenger transport (RPT) operations are required to follow TBOs, usually as recommended by the manufacturer or as approved in a system of maintenance. This AWB provides guidelines to CAR42M delegates/ authorized persons to develop a system of maintenance to extend the TBO of piston engines, also called Piston engine Life Development Program (PLDP).

## 3. Regulatory Framework

Federal Aviation Regulation (FAR) 33.19 specifies the durability requirements for piston engines; “Engine design and construction must minimize the development of an unsafe condition of the engine between overhaul periods”. Federal Aviation Administration (FAA) AC 33.19-1 further elaborates on the certification aspects of the piston engines. For piston engines, the “reciprocating system and structural parts have historically been designed to operate with safety factors large enough to ensure that operating stress levels are significantly below their relevant fatigue strengths or endurance limits. Under normal operating conditions these parts can be expected to have essentially infinite fatigue lives so the engine designer does not normally assign them a service life”. Hence unless explicitly specified as an airworthiness limitation, engine TBO can be extended based on demonstrated service experience that such extension will not lead to an unsafe condition between overhaul periods.

This AWB provides guidelines for a PLDP, consistent with the engine certification standards, that minimizes the development of an unsafe condition between overhaul periods. These guidelines also specify that the engine modification standards, repairs and maintenance practices used to demonstrate safe extended TBO periods are to be retained as part of the system of maintenance as long as the engines are operated under extended TBO.

The regulation under which a system of maintenance is approved, CAR42M, identifies the requirements, and among others CAR42M(3) states “ In deciding whether a system of maintenance adequately provides for the continued airworthiness of an aircraft, CASA or authorized person must have regard to…….manufacturers maintenance schedule….”. This implies that one can have regard to other aspects as well and the manufacturers schedule can be

varied when there is “compelling, detailed, objective evidence of a technical and scientific nature” to support the change. This AWB provides a procedure to collect such objective evidence in a controlled, sequential manner to provide a basis to extend the TBO of piston engines.

It is important to note that engines on a PLDP will need a more rigorous maintenance and reporting regime as detailed below, throughout the operating period.

A safety focused successful outcome for PLDP will require a system of maintenance that include the following elements detailed later in this AWB, in addition to what is required by the aircraft and engine manufacturers and any other CASA requirements;

- Engine entry (PLDP) requirements
- Engine condition monitoring
- Engine build standard
- Exhibit engines
- Reporting requirements
- PLDP management

## 4. Engine entry (PLDP) requirements

The TBO extension under PLDP is based on the premise that engines on an aircraft fleet with similar operational loads and environmental factors could be approved for extended TBO based on the documented evidence of safe operation. Hence it is important that as far as possible engines are selected based on the following criteria among others;

- The engines should be model specific and installed on single aircraft type and listed by serial numbers,
- Stage length of the operations shall be reviewed so that start stop cycles of the engines do not vary significantly across the engines.
- Considering the time required to complete PLDP, it is recommended that a fleet containing at least 10 engines with utilization of approximately 500 flight hours per year per engine be included in PLDP.
- The listed engines should have been operated by the specified operator for not less than 30 percent of the currently approved MTBO,
- The maintenance history, prior to entry, of the engines shall be reviewed to identify any maintenance actions that could alter the expected engine durability. This is to ensure that during tear down inspection, the findings are not adversely affected by the earlier maintenance actions, such as cylinder changes etc. It is recommended that the engines are condition monitored per Appendix A of this AWB

for at least 300 hours prior to MTBO before being inducted into PLDP to ensure satisfactory engine trend data.

- Engines operated on other aircraft makes or models have to be evaluated for eligibility.
- Engines that exceed the calendar time overhaul limits recommended by the manufacturer shall be excluded at any stage until overhauled.
- Engines that have experienced abnormal operating condition such as propeller strike, operation under high cylinder head temperature, oil system failure, etc. shall be excluded at any stage until overhauled.

## 5. Engine condition monitoring

During a PLDP, when engines are operated beyond the manufacturer's TBO, it is important that the continuing airworthiness of engines are assessed through condition monitoring program.

- All engines shall be on a condition monitoring program starting at least 300 hours prior to reaching MTBO.
- Condition monitoring shall be performed per Appendix A of this AWB and a trend of the recorded parameters created and analysed.

## 6. Engine build standard

Some of the service bulletins (SB) issued by the manufacturers improve engine durability, and hence the PLDP should specify the build standard required, taking into account the period of TBO extension.

- The build standard of the engine including service bulletins to be incorporated, use of PMA parts, parts replacement policy, use of repaired major parts such as crank case etc. must be specified.
- Modification standards of the accessories/components shall be specified.
- All acceptable supplementary type certificates (STCs) and CAR35 modifications shall be specified.
- Acceptable repairs, shall be specified for all components, including crank shaft, crank cases, cylinders, gears, accessories etc.
- The build standard shall be reviewed during the evaluation of exhibit engines

## 7. Exhibit engines

Exhibit engines are engines nominated to demonstrate safe operation under TBO extension and are subjected to detailed inspection and strip report during overhaul. The PLDP relies on documented evidence that the engines can continue to operate safely to the approved TBO extension.

- Two exhibit engines along with accessories/ components where applicable shall be evaluated for each provisional extension period in coordination with CAR 42M delegate.
- Reports per paragraph 8 shall be reviewed to evaluate the suitability as exhibit engine.
- A detailed condition (strip) report identifying reason for rejection, repair and rework of each component shall be prepared by the overhaul agency, taking into account any reports per paragraph 8. The strip report will include comparison of the limits and clearances of exhibit engines in relation to the acceptable limits specified by the manufacturer. Separate strip reports shall be prepared for components/ accessories for which TBO extension is sought.
- In situations where the components (magnetos, turbo chargers, injectors etc) have been changed during the extension period, TBO extension for components should be evaluated independently from that of the engine. Approved TBO of any component shall not be more than that for the engine.
- The registered operator is to ensure that any advice based on the strip report given by the overhaul agency is available to the CAR42M delegate/authorized person for action as required.
- Experience with similar PLDP programs on similar engines and latest service and durability information from other sources including those from the manufacturers shall be considered while evaluating the exhibit engines as basis for TBO extensions.
- In situation where one of the two exhibit engines fail to meet the acceptance criteria, an additional exhibit engine can be nominated after evaluating the reasons for failure. The failure of two exhibit engines to meet the acceptance criteria should result in the termination of PLDP.

## 8. Reporting requirements

Close monitoring of the continuing airworthiness of the engines during PLDP is critical to ensure satisfactory outcomes. Noted below are some of the critical reporting requirements.

- The PLDP shall be reviewed on a continuous basis and corrective actions taken as required, taking into account the operational experience.
- All major defects and safety incidents related to the engines on PLDP shall be assessed by the registered operator to ensure that the system of maintenance is still appropriate for the engines.
- Any significant findings during engine condition monitoring per paragraph 5 and corrective actions, if any, shall be reviewed by the registered operator.
- All major maintenance action such as replacement of cylinders shall be reviewed by the registered operator.

- All instances of metal in the oil system shall be reported.
- Strip reports on engines and components are to be reviewed at regular intervals as part of continuing monitoring after the termination of PLDP.
- **Additional reporting requirements.** All significant events including approval of each stage of TBO extension, major defects, and factors that adversely affect engines meeting the extended TBO shall be reported to CASA local office within 4 working days. These reporting requirements by the industry CAR42M delegate/ authorized person are in addition to what are required per the present regulations.

## 9. PLDP management

A satisfactory outcome of PLDP requires careful evaluation at various stages and diligent management involving close consultation between operator and CAR 42M delegate. All components (magnetos, turbo chargers, etc.) listed in the engine type certificate data sheet (TCDS) can be included in the TBO extension program. Strip reports of the components may be evaluated independent of the engine and separate TBO extension approved for components different from that for engine. At no stage shall, the TBO of a component be more than that for the engine.

9.1 The PLDP specific to the nominated engines and elaborating on the elements included in this AWB shall be documented in a system of maintenance approved under CAR 42M.

9.2 Two engines that meet the entry requirements per paragraph 4 shall be removed at MTBO as exhibit engines and condition evaluated per paragraph 7.

9.3 On satisfactory completion of exhibit engine requirements a Provisional TBO (PTBO) shall be approved subject to the condition that both engines on a twin-engine aircraft shall not be on PTBO.

9.4 The extensions shall be in steps of 100 flight hours or 10 percent of the manufacturers TBO which ever is less.

9.5 All engines on TBO extension shall be condition monitored per paragraph 5 at intervals of 100 flight hours or 10 percent of the manufacturers TBO which ever is less. The monitoring will start at least 300 flight hours prior to the engine reaching MTBO.

9.6 Any of the nominated engines removed after the start of PLDP, exhibit engines or otherwise, shall be reassembled to conform to the build standard specified per paragraph 6.

9.7 Two engines that reach PTBO limit shall be removed as exhibit engines and the procedure per paragraphs 9.3 to 9.7 repeated. At no stage shall the PTBO of the engines exceed 125 percent of the MTBO.

9.8 A comprehensive review of PLDP shall be made following its termination.

9.9 The review per paragraph 9.8 will evaluate paragraph 9.5 requirements and specify an engine condition monitoring interval, not more than 100 flight hours for engines operating on TBO extension.

9.10 The review will also specify an engine build standard for engines on TBO extension.

9.11 The review will evaluate the reporting requirements per paragraph 8 and identify the elements to be continued as long as the engines are operated on extended TBO.

9.12 The system of maintenance per paragraph 9.1 shall be reviewed at intervals not exceeding 3 years taking into consideration the reports received per paragraph.

## 10. Re-validation of existing PLDP

Some PLDP approved earlier under “DA 288” programs and systems of maintenance can be reviewed under the guidelines set forth in this AWB and re-approved as necessary. Having demonstrated safe operations in the past, there is no justifiable need to again have exhibit engines and strip reports to substantiate TBO extension. However it is important that the present arrangements are documented and a system for regular review incorporated. Accordingly, the revalidated PLDP for operators already on TBO extension will include among others, requirements per paragraphs 9.9 through 9.12, leaving aside the process of establishing of the extended TBO itself.

## 11. Conclusion

The registered operator must have the appropriate infrastructure and commitment to ensure a high level of operational safety associated with an enhanced maintenance program which includes engine build standard to improve durability.

**Abbreviations**

AWB – Airworthiness Bulletin
CAR35- Civil Aviation Regulation 35
ETBO – Extended TBO
FAA – Federal Aviation Administration
FAR – Federal Aviation Regulation
MDR – Major Defect Report
MTBO – Manufacturers TBO
PLDP – Piston-engine Life development program
PMA – Parts Manufacturing Approval
PTBO- Provisional TBO
STC – Supplemental Type Certificate
TCDS – Type Certificate Data Sheet.

## Appendix A - Engine condition monitoring for PLDP

This Appendix provides guidelines for the parameters to be used for condition monitoring of engines on PLDP and installed on aircraft.

The parameters and the conditions under which they are to be recorded shall be altered as required for engines installed on rotorcraft. Engine specific details including additional maintenance actions where required are to be included in the system of maintenance at the start of PLDP.

### A1. Calibration

All instruments used for the following measurements shall be calibrated at intervals specified by the manufacturer

### A2. Engine performance

Carry out static engine run and record the following parameters on CASA piston engine condition report form 728. All aircraft maintenance manual and flight manual limitations are to be followed during the engine runs.

The engine parameters to be recorded include;

- Take off power per the flight manual
- Oil pressure at idle and at take off power
- Oil temperature at idle and at take off power
- Cylinder head or exhaust gas temperature at take off power

- Fuel pressure/flow at take off power
- Ambient temperature and altitude

Trends in the engine performance parameters are to be created and analysed per paragraph 5 of this AWB

### A3. Cylinder leak check

Cylinder leak check shall be carried out per the procedure published by the manufacturers or CASA AAC 6-32 Amdt.1.

### A4. Oil system checks

Replace the oil filter and inspect the removed filter, oil pressure screen and if applicable oil suction screen for metal particles and other debris.

Replace engine oil at intervals recommended by the manufacturer and record oil consumption.

### A5. Turbocharger and controller checks

Turbocharger and controller where applicable shall be checked and adjusted per the manufacturers recommendations.

### A6. Engine operation and condition

Engine and propeller operation during performance checks shall be smooth and no fuel and oil leaks.

**Enquiries:**

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