Australian Government
Civil Aviation Safety Authority

AIRWORTHINESS BULLETIN

Propeller Strike Guidelines

AWB 61-011 **Issue** : 1
Date : 22 September 2014

1. Effectivity

All Australian registered aircraft fitted with reciprocating engines which have had a propeller strike.

2. Purpose

To provide a set of guiding principles which have been identified as having either a direct or indirect influence on the determination of continuing airworthiness for a piston engine anytime a propeller strike incident has occurred.

3. References

- Civil Aviation Regulations (CAR) 1988 Division 9 – Maintenance releases
- Civil Aviation Safety Regulations (CASR) 1998 – Regulation 21.007A
- Australian Airworthiness Directive AD/LYC/89
- FAA Special Airworthiness Information Bulletin NE-06-32R1
- Lycoming Service Bulletin No. 533B
- Teledyne Continental Motors Service Bulletin SB96-11B
- McCauley Governors Service Bulletin 215C
- Slick Magneto Maintenance and Overhaul Manual
- Federal Aviation Administration (FAA) Advisory Circular AC-43.13-1B Chapter 8. Engines, fuel, exhaust and propellers.

Note: An incomplete review of the information provided in this AWB can cause errors. It is strongly recommended that all supporting information is read to assure a complete understanding of the issue being addressed.

4. Definitions

Responsible persons: For the purposes of this AWB, responsible persons are those persons identified in CAR (1988) regulation 47(1), with respect to the affected aircraft:

- The holder of the certificate of registration;
- The operator;
- A flight crew member;
- An authorised person engaged in the maintenance of the aircraft.

Minor Propeller Damage: means damage of such a kind where repair can be accomplished in accordance with the propeller manufacturers published instructions without removal of the propeller or its major components, for example; minor dressing of the blades.

Major Propeller Damage: means damage of such a kind that cannot be categorised as minor propeller damage.

Propeller Strike: For the purposes of this AWB, this definition is an amalgam of the various definitions published by the FAA and major engine and propeller manufacturers.

a) Any incident, whether or not the engine is operating, that requires repair to the propeller other than minor propeller damage.

b) Any incident during engine operation in which the propeller impacts a solid object which causes a drop in RPM and also requires structural repair of the propeller (incidents requiring only minor propeller damage repair are not included). This is not restricted to propeller strikes against the ground, and although the propeller may continue to rotate, damage to the engine may result, possibly progressing to engine failure.

c) A sudden RPM drop while impacting water, tall grass, or similar non-solid medium, where propeller damage is not normally incurred.

d) Any propeller strike occurring at taxi speeds and during touch-and-go operations, involving any propeller tip-to-ground contact.

e) Any situation where an aircraft is stationary and the landing gear collapses causing one or more blades to be bent or substantially damaged, or where a hangar door (or other object) strikes the propeller blade. These cases should be handled as a sudden engine stoppage because of potentially severe side loadings on the crankshaft propeller flange, front bearing, and seal.

Engine System: means all the rotating and reciprocating parts of the engine, including the gearbox (if applicable), and all driven accessories (propeller governor, distributors, magnetos, pumps, etc.).

5. Background

A maintenance release is issued to an aircraft by an authorised person under the requirements of Division 9 of CAR 1988. One of the requirements of Division 9, specifically CAR 47(1)(a)(ii), is that a Maintenance Release ceases to be in force if a responsible person becomes aware of major damage or a major defect with the aircraft.

Following a propeller strike, there can be legitimate concern as to whether major damage or a major defect of the propeller and engine system exists or is likely to develop. The answer to this critical question can only be answered by a thorough assessment of the facts and data by responsible persons and not through speculation or hope.

Assessing whether an engine system is indeed airworthy and fit for continued service following a propeller strike is open to interpretation. Typically, this decision has been left to a responsible Licenced Aircraft Maintenance Engineer (LAME) with a lack of clear guidance. The LAME is placed in a situation that requires the use of their own judgement. In practical terms, this has the potential to lead to the introduction of preventable safety related latent conditions that could lead to an increased likelihood of serious incidents.

Historically, the common practice following a propeller strike was to use a dial-indicator to check the concentricity of the engine crankshaft flange in conjunction with a Non Destructive Inspection (NDI) of the flange area for cracks. The prime objective of this method was to negate the need to perform engine tear-down inspections. Unfortunately this practice does not address the potential transmission of adverse loads, for example; loading of the crankshaft main bearing journal to a condition that leads to a crack.

In other words, the propeller strike can be a precursor to a catastrophic failure later in the engine's life as the full extent of any damage may not become immediately apparent. The loads induced during a propeller strike can set up a series of microscopic stress fractures within various engine components that, over time, will accelerate fatigue with ultimate failure occurring without warning under otherwise benign conditions.

In recent times the major engine manufacturers and FAA have taken a more conservative approach by expanding the definition and circumstances which qualify as a propeller strike event.

6. Recommendations

a) Following any propeller strike event, the responsible persons should establish whether the Maintenance Release issued under CAR 43 should cease to be in force as per CAR 47(1).

b) Responsible persons should use the Assessment Guidelines in paragraph 7. below and any other appropriate data to establish whether major damage of the propeller and engine system exists or is likely to develop.

7. Assessment Guidelines

The following points identify potential damage conditions and provide corrective action recommendations for aircraft piston engine systems that have had a propeller strike.

NOTE: The possibility also exists that there may be damage to the aircraft structure, controls instrumentation and other components which will require separate and different considerations.

a) Damage to the engine system following a propeller strike is primarily caused by two forces which can act independently or in combination.

i) ***Impact forces,*** as a direct consequence of the collision, whether the engine is operating or not. Impact forces tend to bend the crankshaft flange, overload crankcase bearing saddles and indent bearings.

ii) ***Inertial forces,*** induced by the change in motion of rotating parts of an operating engine system, as a consequence of the collision. Inertial forces tend to crack internal gears and drive shafts, damage accessories and indent bearings.

In cases where the engine is running these forces will interact and can have a compounding effect with the contribution in inertial forces increasing exponentially with the rate of change in motion (e.g. sudden RPM drop).

Ultimately, the forces induced during a propeller strike must be dissipated. The resultant energy will typically find paths throughout the engine system and even the engine mounts and adjoining structure.

b) The apparent “severity” of damage to a propeller or the circumstances of the event should not be the only criterion for deciding whether an engine system requires disassembly and inspection of the rotating parts. There is no real relationship between the extent of visible damage and the type of inspection that has to be done to the engine system.

c) Some of the determining factors and conditions which should be included as part of any propeller strike event assessment, include;

i) Engine Data

(1) Engine speed, (RPM)

(2) Aircraft ground speed

(3) Engine response, (RPM change)

(4) Engine Design Data, (supercharged engine, crankshaft vibration dampers, etc.)

ii) Propeller Data

(1) Type of propeller, (material, configuration etc.)

(2) Location and size of damage

(3) Single or multiple blade damage

(4) Direction in which the blades are bent

(5) Propeller hub and control system damage

iii) Impacted Object

(1) Object description

(2) Mass and rigidity

(3) Damage and potential energy absorption.

The more comprehensive and precise this data is the better the understanding of the circumstances surrounding the event can be. In many cases the pilot report is the only information source and in the absence of key information an accurate determination cannot be made.

For example;

(1) Single propeller blade damage may indicate either low propeller speed or sudden engine stoppage therefore, the assessment needs to be inclusive of the aircraft and engine speed data, direction and extent of blade damage and propeller strike object data.

(2) Backward bending of multiple propeller blades indicates forward aircraft speed with potential physical damage to the engine and mount structure due to impact loads.

(3) Because of the wide range of objects a propeller can strike, damage to the strike object, its mass, rigidity and movement may indicate that a significant part of the impact energy has not been transmitted to the engine however; this needs to be assessed in conjunction with the propeller damage and engine deceleration data.

d) Where the engine and driven accessory manufacturers publish a set of requirements to be adhered to whenever a propeller strike occurs, these should be followed to assure the continuing airworthiness of the individual aeronautical products.

e) Any accessory gear-drive devices not covered by such manufacturers data should be inspected for conformity to the original part limits with respect to concentricity, straightness and run-out, followed by inspection using a suitable NDI method to verify serviceability.

f) Due to the abnormally high loads which can be inflicted during a propeller strike, particularly close attention may need to be given to specific component parts, in addition to the normal shop manual requirements. For example;

i) Flyweight assembly components, idler gear and drive gear of the governor.

ii) Inertia sensitive parts of magnetos, such as the distributor block gear.

iii) Forward crankcase bearing support and adjacent structure.

iv) Crankshaft counterweight assemblies.

NOTE: For the information of the Maintenance Repair Organisation (MRO) the component should be tagged to indicate that it has been involved in a propeller strike event.

g) The actions recommended by this AWB, like many other situations in aviation, require some degree of judgment on the part of the pilot, Licenced Aircraft Maintenance Engineer (LAME) and Maintenance Repair Organisation (MRO), as well as good communication between all parties.

Careful consideration of all factors related to the propeller strike need to be undertaken prior to making a final determination on maintenance requirements. If there is any doubt about the airworthiness and integrity of an engine system, the only safe recourse is to perform a detailed internal inspection of the related components. Even though such inspections may find no damage, the consequences of undetected damage from a propeller strike can otherwise be catastrophic.

If a detailed assessment per the recommendations of this AWB finds that no further maintenance action is deemed necessary, a log entry should still be made with the reasons for the determination clearly recorded.

8. Enquiries

Enquiries with regard to the content of this Airworthiness Bulletin should be made via the direct link e-mail address:

AirworthinessBulletin@casa.gov.au

or in writing, to:

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