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Issued by the Commercial Aviation Association of South Africa. P.O. Box 45, Rand Airport, 1419. Phone 34-2516

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Our Ref: 38/700

22 July 1981.

AERO ENGINES INVOLVED IN PROPELLER STRIKE ACCIDENTS

RECOMMENDED PRACTICE

Introduction:

Manufacturers of General Aviation aero engines are vague in respect of action that should be taken when an engine is involved in a propeller strike accident. The Directorate of Civil Aviation refers to recommendations and instructions by the manufacturers and, therefore, offers no concrete guidelines either.

As in most instances a claim exists under an insurance policy, the decision whether or to what extent to carry out an inspection of the affected engine becomes one of compensation. On numerous occasions this leads to conflict of opinions between the maintenance engineer/organisation on the one side and the assessor/underwriter on the other side, with a confused aircraft owner in between.

The Executive Committee of AMOSA discussed the matter with senior staff members of the Directorate and with experienced engine repair and overhaul personnel and has agreed on the following recommended practice which it asks all Members to follow. If a Member disagrees with the recommendation, he is urged to communicate his objections or comments to the Association forthwith.

Appliance:

The recommended practice applies only to General Aircraft aero engines manufactured by either AVCO Lycoming or Teledyne Continental.

Manufacturers' Guidance:

Lycoming's Service Letter No. 163A of 25 August 1972 states:-

"Conditions which surround accidents are many and varied; therefore, the circumstances of the accident cannot, in our opinion, be used to predict the extent of engine damage or assure its future reliability.

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Therefore, in matters of this kind, the severity of damage to the propeller and suddenness of the stoppage must be the two factors on which to base judgment as to whether inspection of the engine is required. For example, it is generally accepted that minor propeller damage of less than the four inches at the blade tip will not cause latent internal damage and the engine can be continued in service with reasonable assurance of trouble free operation.

However, Avco Lycoming must take the position that in the case of sudden engine stoppage, the safest procedure is to remove and disassemble the engine and inspect completely the reciprocating parts. Any decision to operate an engine which was involved in a sudden stoppage without such inspection must be the responsibility of the agency returning the aircraft to service".

Teledyne Continental Motors Service Bulletin M71-5 (Rolls-Royce No. T-202 of 27 January 1972) reads:-

"It is impossible to predict if any internal damage was incurred and the extent of damage by relating to such things as forward speed, engine RPM, type of surface upon which the propeller impacted, etc.

The most vulnerable areas where damage might occur as a result of such accidents is the crankshaft propeller flange, the crankshaft counter-weight blades and the crankcase bearing webs.

1. The crankshaft can be inspected with the engine assembled for propeller flange runout and for cracks on the backside of the flange at the radius to the shaft.

2. Crankshaft counterweight blades can be superficially inspected by removing one or more cylinders. However, the limited access afforded by this method does not permit a positive determination.

3. Cracks in the crankcase bearing webs can only be discovered by complete engine disassembly.

We must, therefore, take the position that the only sure method of inspecting for possible internal damage is complete engine disassembly and magnetic particle inspection of the crankshaft, gears and connecting rods, and zyglo inspection of the crankcase. Owners electing any inspection procedure other than complete disassembly must accept the attendant risks".

Both Manufacturers stress that the safest and surest procedure is to remove and disassemble the engine and inspect the reciprocating parts completely and thoroughly and that owners electing any lesser inspection procedure must accept the attendant risk and that return to service must be the responsibility of the person signing the aircraft out.

Criteria to be considered:

In deciding whether to carry out a complete inspection or to be satisfied with a partial examination, one has to ask oneself three questions, namely:-

1. When to carry out a shockload inspection.
2. What to inspect for during a shockload inspection.
3. Which parts to replace during a shockload inspection.

When to inspect:

This must be divided again into three separate parts, namely:-

(a) Visual damage to the propeller blades.

(b) The information from the operator regarding the circumstances under which the accident occurred.

(c) What type of engine is involved.

Visual damage:

As stated in the Avco Lycoming Service Letter, it is generally accepted that minor propeller damage of less than 102 mm (4") from the blade tip will not cause latent internal damage.

Information:

The aforegoing is of little value if one does not know the power setting of the engine (RPM) during impact, as experience has shown that internal damage in the engine occurs more often during prop strike at low engine power settings, even when less than 102 mm of the blade tip is damaged, than in the case of a prop strike at high power settings where the inertia of the crankshaft takes effect with less likelihood of damage.

Type of engine:

The design features of a Lycoming and Continental crankshaft are totally different and have to be considered when deciding whether a shockload is necessary or not.

The Continental engine has a smaller outside diameter crankshaft flange than the Lycoming engine, but is thicker than the Lycoming engine. This means that the Continental crankshaft is more rigid but as a result, will crack easier during impact. The Lycoming shaft being bigger in flange diameter and thinner, will bend easier. Therefore, the allowable bent or run-out of the Continental crankshaft flange is 0.005" whilst the allowable bent on the Lycoming flange is 0.018" before straightening and flange (skimming). (Avco Lycoming Service Bulletin No. 201B of 20 February 1976 refers.)

.th other words all three factors under heading "When" have to be onsidered before a decision is made by the A.M.E. as to shockload .n engine or not.

What to inspect:

No definite guidelines are available and various workshops have their own ideas. Again, the make of engine involved must be considered:-

(a) In the case of Avco Lycoming engines, experience has shown that - also keeping the aforegoing in mind - the following is sufficient:-

Dismantle the engine but leave the pistons in the cylinders as the piston rings are not disturbed. Then remove the crankshaft assembly and gear train as these parts will have to be magnafluxed in accordance with Lycoming Service Instruction No. 1285 of 5 October 1973; various amperages are required for different parts. Remember that Lycoming parts are magnafluxed only in the circular way. Next, visually check the crankcase and check bearing alignment. Finally, inspect and/or repair the crankshaft in accordance with Avco Lycoming Service Bulletin No. 201B. The engine may then be assembled again.

(b) In the case of Continental engines, the pistons must be removed from the cylinders, as the oil scraper rings are disturbed by removing the cylinders. Here also the crankshaft and gear train must be magnafluxed both in radial and axial directions as specified by the Continental Overhaul Manual. Since the beginning of 1981, the crankshafts on the IO-360 and IO-520 series must furthermore be ultra-sonically tested for cracks as described by Continental Service Bulletin No. M81-2 of 14 January 1981. The crankcase must be dye-checked especially on the front main bearing saddle pods, after which the bearing line bore must be checked. The engine may then be re-assembled.

Which parts to replace:

Here again opinions differ as to which parts should be replaced and this also depends on the make of engine involved:-

For the Continental engine the accepted rule is:-

1. All gaskets and hoses and locking devices.
2. All main bearings.
3. All conrod bearings.
4. All conrod bolts.
5. All conrod nuts.
6. All counterweight washers and circlips where applicable.
7. All piston rings.

For the Lycoming engines, the same parts should be replaced except for the piston rings as these are not disturbed.

Final Responsibility:

The final responsibility whether to return an engine to service without a complete inspection remains with the maintenance engineer/ organisation signing the Certificate of Safety and/or the logbooks. With other words, it is to be left entirely to the expertise and experience of the A.M.E./A.M.O. licensed in the category "C" for the particular engine, whether a complete or partial inspection should be carried out.

In those instances where, on the advice of an assessor the underwriters only wanted a partial inspection, but the owner, rightly or wrongly, insisted on a complete inspection or otherwise an undertaking that the underwriters would accept full responsibility if something goes wrong at a later stage attributable to the prop strike, often the underwriters change their minds completely and full shockload inspections were carried out even if not warranted. As said, the final decision should remain with the responsible engineer or maintenance organisation and in everybody's interest, it is recommended that the task is given to reputable organisations having the staff with the required expertise or to individuals having the expertise, the experience and the necessary equipment and literature.

Is a test bench run necessary?

With modern aero engines for General Aviation, the extensive running of engines on a test bench with inadequate cooling is considered to do more harm than good, while the checking of proper operation and for oil leaks can just as well be done when installed in an airframe.

However, a run-in procedure is still desired. The various overhaul manuals provide for test runs, and manufacturers also provide guidance by means of Service Bulletins, e.g. Rolls-Royce Service Bulletin No. T-210 (TCM M72-3) deals with engine run-in after a top overhaul of one or more cylinders in which a run-in procedure in two ten-minute increments is recommended, the first not to exceed 1200 rpm and the second not to exceed 1500 rpm, with a cooling-off period in between, followed by a very brief run-up to check full power performance and then to take-off using full power and fly around the airport for one hour at 75% power (refer to the Service Bulletin for the full procedure to be followed).

Therefore, a test-bench run is not considered necessary following an inspection of an aero engine involved in a propeller strike accident.

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W A R N I N G: This Recommended Practice serves as a guidance only and does not supersede any instruction or recommendation issued by the manufacturer or the Directorate of Civil Aviation.

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The information is provided only for the purpose of giving guidance where instructions and recommendations are not clear and where differences of opinion exist between the A.M.E./A.M.O, the assessor, the owner and/or the underwriter.

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AVCO LYCOMING DIVISION
WILLIAMSPORT, PENNSYLVANIA 17701

Service Bulletin

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DATE: June 20, 1980

Service Bulletin No. 201C
(Supersedes Service Bulletin No. 201B)
Engineering Aspects are
FAA (DER) Approved

SUBJECT: Inspection and Straightening of Bent Crankshaft Flanges

MODELS AFFECTED: All Avco Lycoming direct drive aircraft engines.

TIME OF COMPLIANCE: Before resuming operation with any engine involved in sudden stoppage.

Engines subjected to sudden stoppage must be inspected to detect damage which can affect continued safe operation.

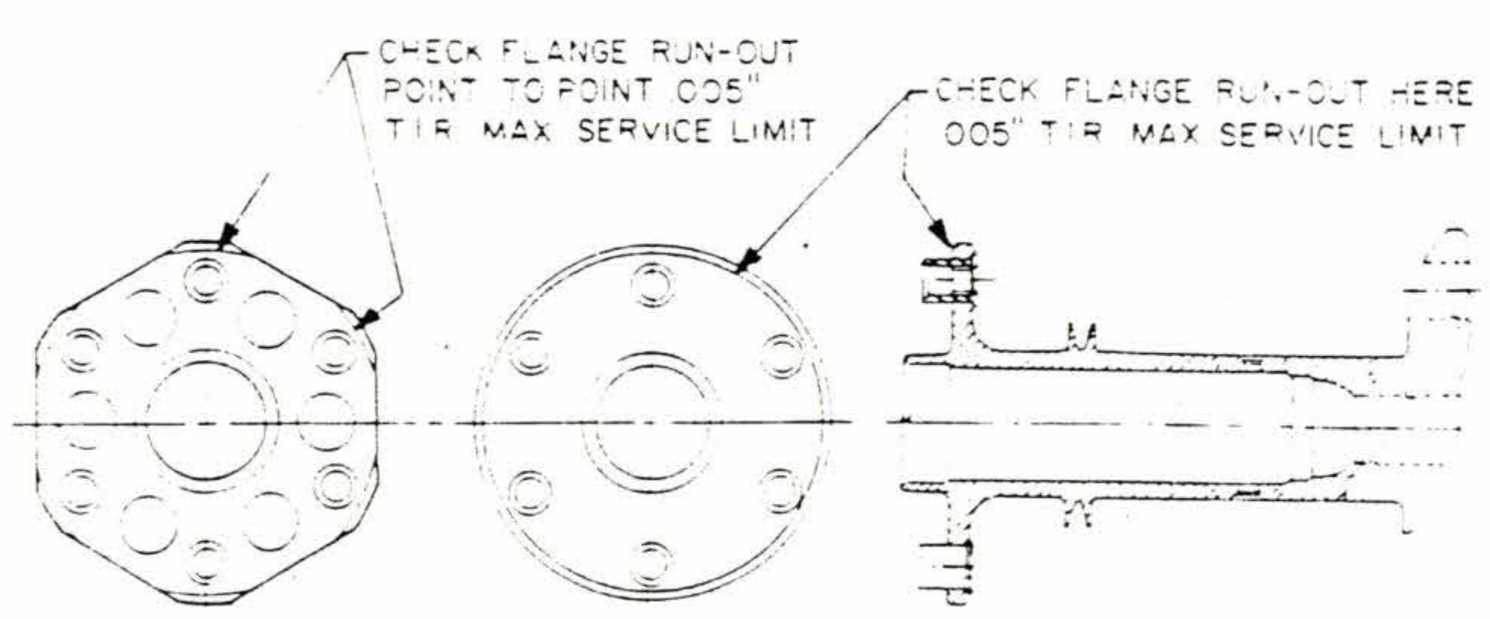
After removing the propeller and starter ring gear support, gauge the flange thickness and compare with dimension listed in the chart at right. This will determine minimum. Check run-out of the propeller flange with a dial indicator at the location shown in the illustration. If run-out exceeds .005 inch total indicator reading remove the crankshaft and inspect both structurally and dimensionally as described in the Direct Drive Overhaul Manual, Avco Lycoming publication no. 60294-7 and Table of Limits, SSP-1776.

Crankshaft flanges with .018 inch or less run-out may be straightened by bending or by facing the front surface of the flange to restore maximum run-out to within .005 inch. Thickness of the flange must not be less than that shown in the following chart.

Flange Thickness

Manufacturing	Min. Permissible
.195/.205	.190
.270 ± .010	.255
.380 ± .010	.365
.440 ± .010	.425

If desired, crankshafts may be returned to Avco Lycoming for inspection and reconditioning. For additional information pertinent to sudden engine stoppage, see latest edition of Service Letter L163.



Section Thru Front of Crankshaft Showing Area for Flange Measurement

NOTE: Revision "C" revises text and chart.