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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: AIRCRAFT ENGINE CRANKSHAFT FAILURE

1. PURPOSE. This advisory circular provides information and suggests procedures to increase crankshaft service life and to minimize crankshaft failures.

2. GENERAL.

a. Although a high level of safety is provided in the design of engine crankshafts, failures do occur. Reports indicate that crankshaft failures can be attributed to:

(1) Material defects, which are few in number.

(2) Manufacturing defects that are minimal due to the application of quality control and inspection procedures employed by the manufacturers.

(3) Overheating caused by improper operating/maintenance techniques.

(4) Overstress due to improper operating techniques, out of balance condition, or undetected damage following an accident or incident.

b. Aircraft owners/operators and maintenance personnel have no control over material or manufacturing defects that cause crankshaft failures. However, with proper attention to engine operation and maintenance techniques, crankshaft failures related to overheating and overstress can be reduced.

3. OVERHEATING.

a. The following may cause crankshaft damage due to overheating:

(1) Bearing spin causes heat and refers to a connecting rod or crankshaft main bearing rotating in its mounting. Crankshaft damage is usually due to oil starvation.

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(2) Fillet ride creates heat and refers to a condition where the crankshaft rides a curved fillet area on a connecting rod, thrust, or main bearing. The condition occurs without presence of an oil film, and excessive heat is generated in a local area of the crankshaft. The condition usually develops from wear on engine parts.

(3) Engine oil overtemperature may result in improper lubrication by thinning of the oil. Improper operating techniques are most often the cause of oil overtemperature.

(4) Contaminated oil resulting in improper lubrication or oil starvation.

(5) Improper engine pre-oiling when new, overhauled, or after a long shutdown period.

(6) Overboost of supercharged engines contributes to overheating as well as overstress of parts.

b. Repair following any of those conditions should include inspection and consideration of crankshaft damage which could lead to complete crankshaft failure.

4. OVERSTRESS. Crankshafts are very susceptible to overstress. The original design of the crankshaft provides for normal loads; however, if additional vibratory stress or increased force are imposed, structural failure can be induced. Common causes of structural overload are:

a. A propeller out-of-balance or out-of-track condition.

b. A propeller strike resulting in sudden stoppage.

c. A liquid-lock that occurs when the combustion chamber is filled with fuel or oil and is usually encountered at initial start-up and is caused by overpriming or oil filling the cylinders during long periods of engine shutdown. As a result of liquid-lock, the piston, connecting rod, cylinder, and crankshaft suffer very high stress if any attempt is made to operate the engine.

d. A detuning of counterweights on balance weight-equipped crankshafts is a source of overstress for the crankshaft. Many engines are fitted with balance weights mounted on pins running in precision ground bushings as an integral part of the crankshaft. The counterweights are designed to position themselves by the inertia forces generated during crankshaft rotation and effectively absorb and dampen crankshaft vibration. If the counterweights are detuned (allowed to slam on mounts), the vibrations are not properly dampened and crankshaft failure can occur. Counterweight detuning can occur from rapid opening and closing of the throttle, excessive speed, excessive power, operating at high engine speed and low manifold pressure, and improper feathering procedures.

e. Overboost of supercharged engines applies high stress to the crankshaft.

f. Accident/incident damage. Special consideration should be given to crankshaft damage, if a propeller strike, severe vibration, or impact damage is involved.

g. Detonation or pre-ignition caused by improper fuel leaning procedures, excessive cylinder head temperatures, or improper ignition.

h. Operation at critical vibration conditions that may occur during a one cylinder-out situation or a restricted speed range.

5. RECOMMENDATIONS.

a. Operating procedures. Adhere to manufacturer's operating instructions and avoid overheating, detuning, liquid-lock, and overboost. Observe engine speed and power output limitations. Observe any special placards to avoid critical RPM.

b. Maintenance procedures.

(1) Maintenance personnel should consider crankshaft damage if a propeller strike, sudden stoppage, or liquid-lock occurs. Crankshaft damage should also be considered when repairing piston or connecting rod failure, gear train failure, loss of oil pressure, and other engine malfunctions and problems. Frequent checks of propeller track and balance will reduce undesired vibratory stress. Concern for proper quantity and quality of oil will aid in reducing friction heat. Proper rigging and operation of oil cooler and cowl flaps will reduce heating problems.

(2) The engine's worst enemy is contaminated oil that eventually clogs the engine oil passages resulting in oil starvation that starts the deteriorations of parts, creating overheating and crankshaft distress. Follow the manufacturer's recommendations for changing the oil. Keeping the engine oil clean will help increase engine life and reliability.

(3) Before starting an engine that is new, overhauled, or has been shutdown for a long period of time, particular attention should be given to pre-oiling, especially during cold weather. The pre-oiling procedure recommended by the engine manufacturer should be followed to preclude the operation of an engine without sufficient lubrication.

(4) Most crankshafts are nitrided to increase the bearing journal surface hardness. The removal of nitride during overhaul or repair of a crankshaft can result in a stress riser and eventual crankshaft failure.

Accordingly, particular attention should be given to the grinding limits recommended by the engine manufacturer.

(5) Present day aircraft engines designed with higher cylinder pressures for increased efficiency and horsepower require greater accuracy in ignition timing. Improper engine performance, burned pistons, failures of engine crankshafts, and engine failures have been traced directly to improperly timed ignition and inadequate ignition system inspection. The degree of accuracy necessary to correctly time the ignition can be obtained by following the recommended procedures provided by the manufacturer for each engine model.

(6) When an engine experiences an overspeed, an overboost, or a connecting rod failure, the crankshaft is subjected to abnormal stress levels. A detailed inspection may be necessary to locate possible crankshaft distress. The inspection should be accomplished in accordance with the engine manufacturer's recommendations.

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