AIRWORTHINESS BULLETIN

TCM Continental & Lycoming Engines: Failure of Weld Repaired Crankcases

AWB 85-015 **Issue** : 1
Date : 19 April 2013

1. Applicability

Any TCM Continental or Lycoming horizontally-opposed engine crankcase which has been weld-repaired in the region of the cylinder retention studs.

2. Purpose

To alert operators, repairers and maintainers to problems with weld repaired crankcases and provide recommendations to detect potential catastrophic engine failures.

3. Background

Reports of failures and cracking of weld-repaired crankcases in the region of the cylinder retention studs continue to be received by CASA and are attributed to inadequate welding repairs. Limited welding repairs to certain crankcases may be permitted by the engine manufacturer under FAA or CASA approved schemes used by appropriately NAA approved specialist repair organisations.

Figure 1 - Failure of a weld-repaired crankcase. Note crack from the cylinder base stud.

Factors such as inadequate pre-weld crack detection and cleaning, poor welding technique including the use of incorrect filler rod material and improper heat treatment prior to and following welding will result in an overall degradation of the parent crankcase material itself, including repaired areas that are weaker or softer than specification.

Basic failure mechanism

Weaker or softer crankcase material in the region of the cylinder retention studs can result loss of stud torque due to the stud partially pulling out of the case and/or via crankcase cracking in the stud retention hole (See Figure 1).

This partial release of a cylinder tie-down stud or through-bolt results in insufficient installation tension and the stud or bolt which then becomes sensitive to combustion pulses which alternatively stretch and release the stud or bolt each time the cylinder fires. Under such conditions, fatigue cracking is soon initiated and failure can shortly follow. Fatigue cracking and failure of one stud or through-bolt can also lead to fatigue cracking and failure of the remaining cylinder hold down fasteners for that cylinder and, has been demonstrated, can eventually result in separation of the cylinder from the case.

Accident and incident investigation results

An analysis of crankcase failures and cylinder separation shows that weaknesses in weld repairs in the cylinder hold down stud region usually become apparent during the first 500 hours of engine operation. CASA AD/LYC/88 and AD/CON/59 - both now cancelled - mandated a torque check on cylinder hold-down nuts for all weld-repaired cases after the initial engine assembly test run and for all engines with less than 500 hours flight time. Loose nuts were to be identified in the log book and re-checked at 50 to 75 flight hours later and any weld-repaired case with nuts which continued to move during the second check-torque required immediate removal from service.

The attached facsimile of FAA AC 43-16, Alert No 130 relating to Lycoming engines recommended continual torque checks every 25 to 50 hours flight time (depending on the type of engine operation) until the engine reached 500 hours flight time. FAA AC 43-16, Alert No 130 also mentions two accidents; each involving an in-flight loss of power due to separation of one of the cylinders from the crankcase. One of the two accidents resulted in a fatality and the other in a serious injury.

“In each case, metallurgical examination revealed extensive fatigue cracking of several studs which were fitted to the released cylinder. Also, in each case fatigue cracking initiated at or near one of the stud holes on the crankcase cylinder mounting deck. Metallographic sections through the holes associated with these crack initiation sites revealed that extensive weld repair had been performed. Records show that both cases were weld-repaired approximately 300 hours previous to the accidents. In one of the cases, the welded area was much softer than the base area”.

4. References

1. U.S. FAA publication: General Aviation Alerts, AC 43-16, Alert No 130 of May 1989 - Separation of Cylinder from the Crankcase. (Attached as a facsimile of the original document).

2. Teledyne Continental Motors Service Bulletin M90-17.

3. ECI Service Instruction (SI) No. 02-1

4. CASA SDR database.

5. Recommendations

1. All welding repairs on crankcases should be carried out strictly in accordance with NAA approved procedures and documented in the Approved Release Certificate which should identify the repairs and include reference to the approved process used.

2. After assembling an engine crankcase with weld repairs in the cylinder hold down area, consider implementing a torque check on cylinder hold-down nuts following the test run and again at 50 to 75 flight hours later. Consider removing from service any weld-repaired case with nuts which continue to move during the second check-torque.

3. Identify weld-repaired engines using technical documentation, visual inspection and/or engine case stampings. For those engines which have had an approved weld repair in the cylinder hold down area with less than 500 hours flight time, consider carrying out a torque check on all cylinder hold-down nuts within the next 100 hours of operation. Identify loose cylinder hold-down nuts in the aircraft engine log book and re-check at 50 to 75 flight hours later. Consider removing from service any weld-repaired case with nuts which continue to move during the second check-torque.

4. If one of the nuts fitted to a main through-stud or bolt is found to be loose, immediately consider that a main bearing may have moved and check the crankshaft main bearing clearance. (For example in accordance with Lycoming Service Bulletin (SB) No 272) in conjunction with the nut/stud replacement. (Reference: Lycoming Service Instruction (SI), No 1112).

5. Note that engine vibration and crankcase oil leaks and oil weeping from the crankcase, particularly in the cylinder base-to-case area, may be a symptom of cylinder studs releasing and crankcase cracking.

6. Use current manufacturer’s data for crankcase inspection criteria, such as torque values and nut tightening procedures.

6. 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:

Airworthiness & Engineering Branch
Civil Aviation Safety Authority
GPO Box 2005, Canberra, ACT, 2601

Attachment:
FAA AC 43 16
Alert No. 130

Reproduced below is the text of an article titled "Separation of Cylinder from the Crankcase" taken from the U.S. FAA publication: General Aviation Alerts, AC 43-16, Alert No 130 of May 1989.

Separation of the Cylinder from the Crankcase

"This applies to Textron Lycoming horizontally-opposed engines that have been weld repaired around or near the crankcase cylinder mounting decks. Note: If it is not known if these areas have been weld repaired, it is recommended that the following inspection and checks be performed.

Two accidents, each involving an in-flight loss of power on Lycoming I0-540-K1 powered Ted Smith Aerostar 600 (Piper PA-60) aircraft were experienced due to separation of one of the cylinders from the crankcase. One of the two accidents resulted in a fatality and the other in a serious injury.

In each case, metallurgical examination revealed extensive fatigue cracking of several studs which were fitted to the released cylinder. Also, in each case fatigue cracking initiated at or near one of the stud holes on the crankcase cylinder mounting deck. Metallographic sections through the holes associated with these crack initiation sites revealed that extensive weld repair had been performed. Records show that both cases were weld-repaired approximately 300 hours previous to the accidents. In one of the cases, the welded area was much softer than the base area.

There may currently be Lycoming crankcases in service that have been weld repaired in the cylinder mounting deck areas in which the weld areas have not been properly rehardened. The presence of this softer material may cause partial release of the torque on the adjacent stud and the insufficient torque can initiate fatigue cracking of the stud. Fatigue cracking of one stud can lead to cracking of additional studs and can eventually result in separation of the cylinder from the case.

It is therefore recommended that the following be performed on the applicable engines cited above: Using a torque wrench, check the torque on the hold-down nuts that are fitted to all the cylinder studs (i.e. the short studs and the long, thru studs), every 25 to 50 hours depending on type of usage (i.e. frequency and extent of high power operations including possible overspeed / over boost), until 500 hours have been accumulated since the weld repair work was done. This may require removal of cylinder baffles for accessibility. Also, inspect for cracks and signs of oil leakage.

If a loose nut is detected, continue checking the torque on the remaining nuts fitted to that cylinder; and if one of the nuts fitted to a thru stud was found to be loose, check the crankshaft main bearing clearance in accordance with Lycoming Service Bulletin (SB) No 272, latest revision, in conjunction with the nut/stud replacement. (Reference: Lycoming Service Instruction (SI), No 1112, latest revision.)

Lycoming SI No. 1029, latest revision, and the Direct Drive Reduction Gear Drive Overhaul Manuals provide tightening procedures and the torque values for the various size hold-down nuts and studs.

Other conditions which may indicate a problem with cylinder stud cracking are engine vibration and oil leakage. Appropriate action, which may include the above recommendations, is advised.

Note: For the purposes of this alert, the above service documents may be pertinent to other engine models in addition to those specified.