ACCIDENT

Aircraft Type and Registration:	Reims Cessna F152, G-BHCP
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1979
Date & Time (UTC):	28 January 2006 at 1430 hrs
Location:	Meden Vale, Nottinghamshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose landing gear damaged and lower engine cowling distorted
Commander's Licence:	Commercial Pilot's Licence with Instrument and Instructor Ratings
Commander's Flying Experience:	1,500 hours (of which 700 were on type) Last 90 days - 100 hours Last 28 days - 25 hours
Information Source:	AAIB Field Investigation

Synopsis

After approximately 20 minutes of flight the engine rpm started to decrease, with the engine running unevenly and producing severe vibration prior to stopping. The pilot successfully landed the aircraft in a field, with no injury to the occupants. An engineering examination revealed that the No 4 cylinder had separated from the engine due to a fatigue crack that had originated from an external surface corrosion pit. A search of the Civil Aviation Authority's Mandatory Occurrence Reporting database revealed 23 similar events. The Bureau D'Enquetes et D'Analyses Pour La Securite De L'Aviation Civile (BEA) has reports of 34 similar events occurring in France. This AAIB report carries seven Safety Recommendations.

History of the flight

Approximately 20 minutes into the flight the instructor applied full power to initiate a climb. About 5 to 10 seconds after the application of power the rpm reduced and the engine began to run unevenly. The instructor applied carburettor heat and found that the engine rpm became erratic, accompanied by severe vibration. With the carburettor heat remaining applied he trimmed the aircraft for the best glide speed, transmitted a 'PAN' call on the departure airfield's frequency and started to look for a suitable field for an emergency landing when the propeller and vibration suddenly stopped. The instructor carried out the forced landing checks, which included briefing the student and transmitting a 'MAYDAY' call. The aircraft was successfully landed in a field about half a mile to the south-east of the village of Meden Vale,

causing damage to the nose landing gear and distortion of the lower engine cowling. Both the instructor and student, who were not injured, evacuated the aircraft safely.

Engineering and metallurgical examination

Inspection by the maintenance organisation revealed that the No 4 cylinder had completely separated from the engine in the area between the cooling fins and the cylinder-to-crankcase mounting flange (Figure 1). The pieces of the cylinder were sent to AAIB for detailed metallurgical examination. The metallurgical examination showed that corrosion had occurred on the outer surface of the cylinder which, over a period of time, had reduced the wall thickness and produced corrosion pits. These corrosion pits acted as stress raisers which, combined with the reduced cylinder wall thickness, allowed fatigue initiation and propagation. A fatigue crack initiated and propagated around approximately 36% of the cylinder's circumference prior to the final overload failure.

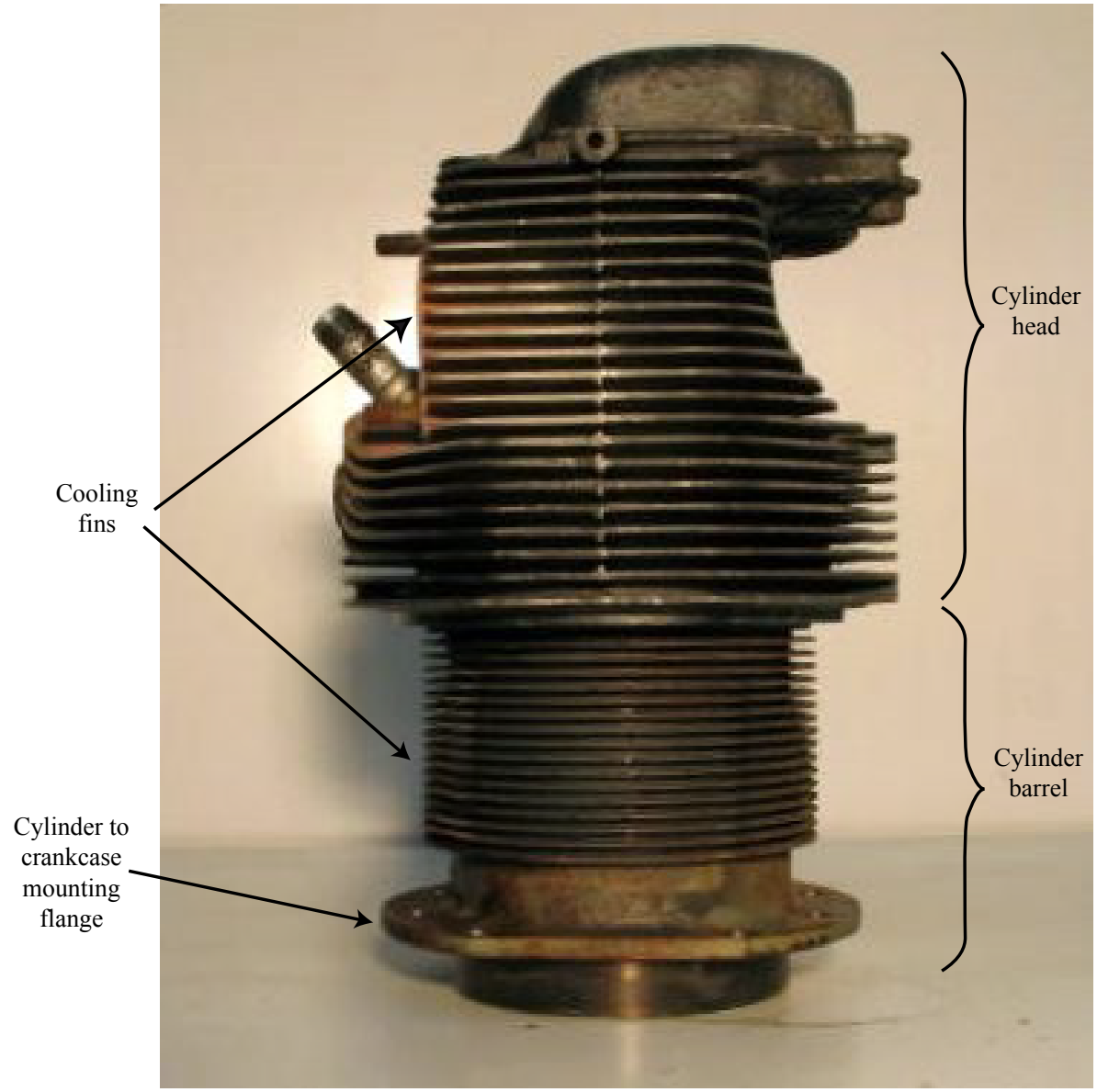

Figure 1

Lycoming 0-235 Series Engine Cylinder

Aircraft history

The aircraft had been on the UK register since it was manufactured and had been owned and operated by a number of individuals and flight training organisations. The previous owner/operator ceased operations in April 1998 and went into receivership. The aircraft was purchased at auction from the Official Receiver by the current owner at the beginning of 2005. It is understood that between April 1998 and January 2005 the aircraft was normally stored in the open but occasionally, for short periods, in a hangar. During this period the engine was occasionally ground run, although there is no written record of this. Only the current airframe and engine log books were with the aircraft when it was purchased by the individual who still owned it at the time of the accident. The previous owner/operator was no longer involved in aviation and his whereabouts, together with the missing log books, could not be established.

Engine history

The engine was manufactured in 1978 but it is not known if the failed No 4 cylinder was installed at that time as there were no records kept of the serial numbers of the cylinders fitted to the engine at manufacture. It is not known when the cylinder was manufactured as records were not kept of the cylinder serial numbers by the engine manufacturer.

In 1997 the engine was overhauled and given a new log book that started at 'zero hours'. It also contained an entry by the JAR 145-approved overhaul organisation which referred to one of their internal files, for the detail of the work that they had carried out. There was also a copy of the JAA Form One, the Authorised Release Certificate, which also referenced the overhaul organisation's internal file. The overhaul organisation had destroyed all their documentation relating to the overhaul in 1997, as allowed in JAR (EASA) 145.55 paragraph (c) (Appendix 1). None of the overhaul documentation had been supplied to the aircraft owner or operator by the approved overhaul organisation. It was noted that it is common practice for EASA/JAR Part-145 organisations to retain detailed worksheets and not to provide the originals or copies to aircraft owners or operators.

There was no indication in the new log book of the hours that the engine had run since it was manufactured in 1978 and no engine log books prior to the overhaul in 1997 were available. At the time of the accident the engine had completed 162 hours since the overhaul.

In August 2005, 80 hours since overhaul, the engine was found to have a low rpm at full power. As part of the remedial work carried out, all the cylinders were removed and honed, the valves removed, re-lapped and leak checked, and new piston rings fitted. In December 2005, 151 hours since overhaul, an oil leak was found around the base of the No 4 cylinder. The leak was traced to a split cylinder base seal, which was replaced.

Other cases of Lycoming O-235 series engine cylinder failures

The CAA Mandatory Occurrence Reporting (MOR) and AAIB Accident databases were searched for similar occurrences involving the failure of a cylinder from a Lycoming O-235 series engine. The CAA database revealed 24 occurrences (Table 1) (which includes the one that is the subject of this report), seven of which have been the subject of an investigation by an accident investigation organisation (six by the AAIB and one by the BFU, the German equivalent of the AAIB). The 17 occurrences that were not investigated by an accident investigation organisation either resulted in a safe landing or were found during maintenance. Seven of the cylinders

Date	Aircraft Type	Type of flight	Incident/ Accident	Cylinder No	Cylinder part no	Location and type of failure	Metallurgical examination	Comments
Jun-77	Robin 400	Private	Accident	No 4	N/K	Circumferencial crack between 3rd and 4th cooling fins	N/K	AAIB investigation Bulletin 8/77 - file destroyed
Mar-82	Cessna 152	N/A	On maintenance	No 1	LW 11633	Circumferencial crack approximately halfway down the cylinder barrel	No	MOR
Oct-84	Cessna 152	Training with instructor	Incident	No 4	N/K	Not known	No	MOR missing from CAA archives
Apr-85	Cessna 152	N/K	Incident	N/K	N/K	Cracked cylinder to crankcase flange	No	MOR missing from CAA archives
Oct-88	Cessna 152	N/K	Incident	N/K	N/K	Radial failure of the cylinder barrel adjacent to the bottom cooling fin	No	MOR unreadable on CAA microfich
Mar-89	Cessna 152	Training with instructor	Incident	No 4	LW 11633	Circumferential crack between 2nd and 3rd cooling fins	No	MOR
May-89	Cessna 152	Training with instructor	Incident	No 3	LW 11633	Circumferential crack near the top of the cylinder barrel	No	MOR
Apr-90	Slingsby T67	Training with instructor	Incident	No 4	N/K	Circumferential crack at the mid section of the cylinder barrel originating from a corrosion pit	Yes	MOR. AAIB metallurgical examination file destroyed
Jun-90	Cessna 152	Training with instructor	Accident	No 4	N/K	Circumferential crack at the mid section of the cylinder barrel originating from a corrosion pit	Yes	AAIB investigation Bulletin 12/91 - file destroyed
Sep-90	Jodel DR 220	Private	Incident	No 3	N/K	The cylinder head had separated in the area of the combustion point	No	MOR
Aug-91	Cessna 152	Private	Accident	No 1	N/K	Circumferential fatigue failure in the cylinder to crankcase flange area	No	German accident investigation
Jan-92	Cessna 152	Training with instructor	Incident	No 4	N/K	Circumferential crack in cylinder barrel in the area of the cylinder head barrel joint	No	MOR
Mar-92	Cessna 152	Private	Incident	No 1	LW 11633	N/K	No	MOR
May-92	Cessna 152	N/K	Incident	No 1	N/K	Crack in the area of the cooling fins of the cylinder barrel	No	No MOR submitted
Aug-92	Cessna 152	Training with instructor	Incident	No 4	N/K	Cylinder detached - nothing further known	No	MOR
Mar-95	Cessna 152	Training with instructor	Incident	No 3	N/K	Circumferential crack in the area of the lower cooling fins	No	MOR
Aug-95	Pipe PA-38	Training with instructor	Incident	No 1	N/K	Cylinder failure in the area of the head to barrel joint	No	MOR
Sep-95	Robin 2112	Private	Incident	No 4	LW 11633	Cylinder head failure in the area of the lower cooling fins	No	MOR

Table 1

UK incidents/accidents that have resulted from
a cylinder failure on a Lycoming 0-235 series engine

Sep-97	Robin 400	Training with instructor	Incident	No 4	N/K	Cylinder barrel cracked between the mounting flange and the cooling fins	No	MOR
Jul-01	Robin 200	Training solo	Accident	No 4	LW 16703	Circumferential fatigue crack originating from a corrosion pit in the area between the cylinder to crankcase flange and the cooling fins	Yes	AAIB investigation Bulletin 4/02
Oct-02	Cessna 152	Training	Incident	No 3	LW 11633	Circumferential fatigue crack originating from a corrosion pit in the area between the cylinder to crankcase flange and the cooling fins	No	MOR
Jan-03	Piper PA-38	Training with instructor	Incident	No 4	LW 11633	Circumferential fatigue crack originating from a corrosion pit in the area between the cylinder to crankcase flange and the cooling fins	No	MOR
Apr-05	Cessna 152	Training with instructor	Accident	No 4	LW 16703	Circumferential fatigue crack originating from a corrosion pit in the area between the cylinder to crankcase flange and the cooling fins	Yes	AAIB investigation Bulletin 7/05
Jan-06	Cessna 152	Training with instructor	Accident	No 4	LW 16703	Circumferential fatigue crack originating from a corrosion pit in the area between the cylinder to crankcase flange and the cooling fins	Yes	AAIB investigation

Table 1 (Cont)

UK incidents/accidents that have resulted from
a cylinder failure on a Lycoming 0-235 series engine

were part number LW 11633 and three were part number LW 16703; for the remaining 14, the part numbers are not known. The difference between the two cylinders is that part number LW 16703 has a shot-peened outer surface whereas part number LW 11633 has not. Unfortunately the reports on some of these 'non-investigated' occurrences omitted a number of relevant facts, which included the engine hours, the cylinder part number, the origin, type and exact location of the cylinder failure and the type of flight being undertaken.

On 19 April 2005 a Cessna 152, registration G BHFC, was involved in an accident due to an engine failure near Hardwick Airfield in Norfolk (AAIB Bulletin 7/05). The report concluded that the most likely cause of the Lycoming O-235-L2C engine stoppage was the failure of the No 4 cylinder due to fatigue cracking around the base of the cylinder, which initiated from corrosion pitting. This allowed the upper part of the cylinder to break free. As part of this investigation into the accident to G-BHCP, the failed cylinder parts from G-BHFC were subjected to a detailed metallurgical examination. This examination confirmed that the failure was by a fatigue crack mechanism that had originated from an area of corrosion that was located in the area between the barrel cooling fins and the cylinder to crankcase mounting flange (Figure 1). The fatigue crack had propagated around approximately 30% of the cylinder's circumference prior to the final overload failure.

Up to October 1998, 15 cases of cylinder failure on Lycoming O-235 series engines had been reported to the Direction Generale De L'Aviation Civile (DGAC) in France. This number of cylinder failures prompted the DGAC to issue Airworthiness Directive 1998-225(A) (see the next paragraph), with Revision 6 being issued on 27 December 2000. By November 2003 a total of 34 cases of cylinder failure had been reported (Table 2).

Service Instruction and Airworthiness Directive

During the late 1990s Lycoming, the engine manufacturer, became aware of a number of O-235 cylinder barrel failures in Europe. As a result, there was a change in the preparation and painting of cylinders and engines shipped overseas, and shot-peening was introduced for O-235 cylinders.

On 26 January 2001 Lycoming issued Service Instruction (SI) No 1504, applicable to O-235 series engines operating under the Direction Generale de l'Aviation Civile (DGAC) in France. The reason for the SI was given as follows:

> *'The French DGAC has reported a significant number (of failures) of O-235 cylinder barrels in France. These failures have initiated from corrosion pits at the base of the cylinder. For O-235 engines operated under its authority, the French DGAC has issued AD (Airworthiness directive) 1998-225(a) which requires periodic inspection of the cylinder barrels for cracks.*
>
> *Since it is not possible to determine the depth of pitting or the point at which corrosion will initiate a crack, Textron Lycoming recommends replacement of cylinders affected by AD 1998-225(a) with new cylinder assemblies which offer improved corrosion resistance. O-235 engines and cylinder kits shipped from the factory after the 1st September 2000 incorporate these new cylinder assemblies.'*

The 'improved corrosion resistance' is understood to comprise zinc chromate treatment and shot-peening, although the latter assists fatigue resistance only.

Reference to the DGAC AD 1998-225(A) suggests that

the 'significant number' (20 in France up to May 2000) of cylinder failures included engines with a wide variety of calendar age and flying hours but all, generally, with failures in a similar area to that experienced by G-BHCP. The AD also inferred that the absence of significant corrosion was not a guarantee that cracks were not present and thus required that all new, or overhauled, engines should be subjected to a technique of applying white developer spray to the cylinder barrels, with the cooling baffles removed, and then running the engine in this condition. The purpose was to highlight any oil leakage through a cracked cylinder. Various further steps were detailed should such leakage be detected or suspected and the procedure was to be repeated every 50 flying hours. On overhauled engines, an additional visual inspection for oil leaks, with baffles installed, was required to be performed at 20-hour intervals.

With the formation of EASA in 2003 this DGAC AD was withdrawn and has not been re-issued by the EASA.

Requirements for maintenance record entry and retention - UK ANO & EASA Part 145

In the United Kingdom, the Air Navigation Order (ANO) 2005 Section 1, Part 3 paragraph 22, Part 7 paragraph 91 and Schedule 6 specify the requirements for maintenance records, maintenance entries and their retention.

Section 1 Part 3 paragraph 22 requires that any document which is incorporated by reference in a Log Book shall be deemed to be part of the Log Book and requires that every Log Book shall be preserved by the operator of an aircraft until a date two years after the aircraft or component has been destroyed, or has been permanently withdrawn from use.

Section 1 Part 7 paragraph 91 requires that an operator of an aircraft preserves any document or record, and that if they cease to be the operator of the aircraft shall continue to preserve the document or record as if they had not ceased to be the operator. In the event of the operator's death the duty to preserve the document or record shall fall upon their personal representative.

CAA Airworthiness Notice No.12 Appendix 61 ('Appendix 2' to this AAIB report), titled 'Retention of Records - Post Incident and Accident Investigation' summarises the requirement for the retention of records.

The treatment under EASA is slightly different. EASA Part-145 details the requirements for the approval of aircraft maintenance organisations. Part-145.A.55 (Appendix 1) states that approved maintenance organisations must record all details of work carried out in an acceptable form and that they must provide a copy of Certificates of Release to Service and a copy of any data used for work carried out. It also states that these organisations must retain a copy of all detailed maintenance records and any associated data for two years from the date the aircraft or component to which the work relates was released from the organisation. There is, however, no requirement to keep documents that are referenced in a Log Book to be deemed to be part of that Log Book and required to be preserved by the operator of an aircraft until a date two years after the aircraft or component has been destroyed, or has been permanently withdrawn from use.

Requirements for maintenance record entry and retention - EASA Part M Section M.A.305

From September 2008 all aircraft, except those specified in Annex II to Regulation (EC) No. 1592/200, not involved in commercial air transport will be required to comply with EASA Part M Section M.A.305 (Appendix 3).

Date	Aircraft Type	Type of flight	Incident/ Accident	Cylinder No	Cylinder part no	Location and type of failure	Metallurgical examination	Comments
08/11/1995	GROB 115	N/K	Incident	3	N/K	N/K	?	
01/09/1996	DR400	Private	Accident	1	LW 18289	N/K	?	Sent to Lycoming for investigation
10/02/1997	DR400	Ferry Positioning	Incident	N/K	LW 16704	Initiation in the blending radius of the flange on an outside corrosion pitting	Yes	29 bench marks over a 22mm length from 12mm of the origin
08/04/1997	DR300	Private	Incident	4	LW 16704	Initiation in the blending radius of the flange on an outside corrosion pitting	Yes	30 bench marks over a 20mm length from 16mm of the origin
21/06/1997	C 152	N/K	Incident	4	LW 16704	N/K	?	Sent to Lycoming for investigation
28/06/1997	DR400	Private	Incident	N/K	N/K	N/K	?	
06/07/1997	DR300	Training with Instructor	Incident	3	LW 16704	Initiation between the 11th and the 12th cooling fins	Yes	Corrosion in all the area (cylinder and fins)
09/02/1998	DR400	Training with Instructor	Accident	2	LW 16703	Initiation the flange in a very corroded area	Yes	Initiation from external corrosion pitting
28/04/1998	DR400	Private	Incident	3	LW 16703	N/K	?	Sent to Lycoming for investigation
Mar-98	DR400	N/A	Incident	2	LW 16703	Initiation the flange in a very corroded area	Yes	Maintenance
09/05/1998	DR400	N/A	Incident	4	LW 16704	N/K	?	Maintenance Initiation from external corrosion pitting
24/05/1998	DR300	Private	Incident	3	N/K	Two initiation points both located in the flange in very corroded areas	Yes	
20/06/1998	DR315	N/A	Incident	1	LW 16704	Initiation the flange in a very corroded area	Yes	Found on pre-flight
02/08/1998	GROB 115	N/K	Incident	2	N/K	N/K	?	
24/10/1998	C 152	Training with Instructor	Incident	3	LW 18289	Initiation in the blending radius of the flange on an outside corrosion pitting	Yes	Initiation from external corrosion pitting
02/03/199	DR315	N/A	Incident	3	LW 16704	Initiation from corrosion pits in mounting flange	?	Maintenance
16/04/1999	DR300	N/A	Incident	4	N/K	N/K	?	Maintenance
03/07/1999	DR400	Private	Incident	3	N/K	N/K	?	Sent to Lycoming for investigation
10/01/2000	DR400	N/A	Incident	4	LW 16703	Initiation in the flange in a very corroded area	Yes	Maintenance

Table 2

French occurrences that have resulted from a cylinder failure
on a Lycoming 0-235 series engine

22/03/2000	DR400	Training with Instructor	Incident	2	LW 16703	Initiation in the flange in a very corroded area	Yes	
29/04/2000	DR400	Private	Accident	4	N/K	Initiation in the blending radius of the flange on an outside corrosion pitting	Yes	
12/05/2000	DR400	N/A	Incident	3	N/K	N/K	?	Maintenance
24/06/2000	DR400	N/K	Incident	3	N/K	N/K	?	Maintenance
30/06/2000	DR400	N/K	Incident	1	N/K	N/K	?	Maintenance
19/07/2000	DR400	Private	Incident	4	N/K	N/K	?	
27/07/2000	DR300	N/K	Incident	1	N/K	N/K	?	Maintenance
04/08/2000	DR400	N/K	Incident	4	N/K	N/K	?	
22/08/2000	DR300	N/K	Incident	2	N/K	N/K	?	
20/12/2000	DR300	N/K	Incident	4	N/K	N/K	?	
02/03/2001	DR400	Private	Incident	4	LW 16703	Initiation from corrosion pits in mounting flange area	?	
05/03/2001	DR400	N/K	Incident	2	N/K	N/K	?	
14/05/2001	DR400	N/K	Incident	4	N/K	N/K	?	
09/06/2003	N/K	N/A	Incident	N/K	N/K	N/K	?	Maintenance
17/11/2003	DR400	N/K	Incident	2	N/K	Initiation in the blending radius of the flange on an outside corrosion pitting	Yes	

Table 2 (Cont)

French occurrences that have resulted from a cylinder failure
on a Lycoming 0-235 series engine

This section (‘*Aircraft Continuing Airworthiness Record System’*) specifies those documents that are required to be retained, how long they have to be retained and who is responsible for retaining them. There is no statement in this section requiring that documents to which reference is made in a log book, or component record card, form part of that log book or record card and be retained until a date two years after the aircraft or component has been destroyed or permanently withdrawn from use.

Previous Safety Recommendations

In 2000, following an in-flight engine run-down on a BN2B Islander aircraft caused by a crankshaft failure, the AAIB made the following Safety Recommendation:

Safety Recommendation 2001-028

In order that maintenance records may be of enhanced use to post incident and accident investigations, it is recommended that the CAA promote amendment of JAR 145.55 to increase the minimum period for the retention of maintenance records from two to five years.

The CAA response to this safety recommendation was:-

‘The CAA partially accepts this recommendation. Whilst it is accepted that JAR 145.55 requires that maintenance records be kept for a minimum of two years, the operator of an aircraft is bound by more stringent requirements of the Air Navigation Order 2000, Article 17 or JAR OPS 1.920. In this respect, the requirement is that operators keep log books/maintenance records until 24 or 12 months after the aeroplane has been permanently withdrawn from service. The CAA thus considers that current requirements adequately address the subject of maintenance record retention.

Further, to promulgate to industry its responsibility in respect of document retention, the CAA will issue an appendix to Airworthiness Notice 12. This appendix will be included in the October 2001 revision of Airworthiness Notice.’ This was issued in October 2001.’

In 2001, following a fatal accident to a Hughes 269 helicopter the AAIB made the following safety recommendation:-

Safety Recommendation 2001-088

The CAA should conduct a review of JAR 145.55 with the aim of proposing to the JAA the improved harmonisation of maintenance document retention time requirements with those specified in the ANO, so that maintenance Worksheets and component Certificates of Release that are referred to in airframe, engine and propeller Log Books and component log cards are retained until the aircraft, engine, propeller or component has been destroyed or scrapped.

The CAA response to this safety recommendation was:

‘The CAA does not accept this recommendation. The CAA recently published Airworthiness Notice 12 Appendix 61 (Retention of records – Post Incident and Accident Investigations) in which maintenance organisations and aircraft operators were reminded of their responsibilities in relation to the content and retention of maintenance records. The Notice makes the clear distinction between those records to be kept by a JAR 145 approved organisation maintaining aircraft used for Commercial Air transport (CAT), and the records that are required to be retained for non

commercial air transport as described in the Air Navigation Order Article 17. A copy of the records raised by the maintenance organisation should be supplied to the aircraft operator/owner, for retention as part of the aircraft record. In all cases, the operator/owner is required to retain aircraft records. In the case of aircraft operated for CAT, records must be kept until one year after the aircraft is destroyed or permanently withdrawn. In the case of aircraft operated for non-CAT, records must be kept until two years after the aircraft is destroyed or permanently withdrawn.'

Analysis

Retention requirements for maintenance documentation

During this investigation the AAIB could not obtain the records of the engine overhaul that occurred in 1997, which were referred to in the engine log book (CAP 398). They had been destroyed by the JAR (now EASA) approved overhaul organisation as allowed by the two-year rule stated in JAR (now EASA) Part 145. What is not specified in EASA Part 145 is that, where any document is incorporated 'by reference' in a log book, it shall be deemed to be part of that log book and retained for two years after the item to which the log book refers has been destroyed or has been permanently withdrawn from use. CAA Airworthiness Notice No. 12, Appendix 61, titled 'Retention of Records – Post Incident and Accident Investigations', paragraphs 4 and 6 do not make reference to the retention requirements when documents are incorporated 'by reference' in a log book, although there is a note to this effect after paragraph 5.

Operators of UK-registered aircraft are required to comply with the ANO, which requires them to keep such records for a period of two years after their aircraft have been permanently withdrawn from service, whereas maintenance organisations generally comply with the EASA Part 145.A.55 requirement, which only requires them to keep records for a minimum of two years after the aircraft, or component, has been released after maintenance work.

It was found during this, and previous, investigations to be common practice for approved maintenance and overhaul organisations to retain the detailed paperwork associated with the work carried out and referring to it by a file or job number in the associated log book or component record card. The organisation would then destroy this detailed paperwork two years after the date the work was completed.

It is important for specific maintenance records to be accessible, particularly after an incident or accident. The absence of relevant records in such investigations undermines the prime reason for requiring maintenance records to be kept at all. In view of this the following Safety Recommendations are made:

Safety Recommendation 2007-089

It is recommended that the Civil Aviation Authority amend the title of Airworthiness Notice No.12, Appendix 61 to 'Retention of Records' to reflect the requirement stated within the Notice to retain records at all times, not just after an incident or accident.

Safety Recommendation 2007-090

It is recommended that the Civil Aviation Authority amend Airworthiness Notice No.12, Appendix 61 to reflect, throughout Appendix 61, the requirement to retain maintenance and overhaul records for two years after the aircraft, engine, propeller or component has

been destroyed or permanently removed from service, where reference is made to those records in the log books or component record cards.

Safety Recommendation 2007-091

It is recommended that the European Aviation Safety Agency (EASA) amend EASA Part 145 (and Part M as necessary) to require that maintenance and overhaul records that are referred to in airframe, engine and propeller log books, and component record cards, are deemed to be part of that log book or record card and are retained until the aircraft, engine, propeller or component has been destroyed or permanently removed from service.

Safety Recommendation 2007-092

It is recommended that the European Aviation Safety Agency (EASA) should amend EASA Part 145 (and Part M as necessary) to require that all EASA Part 145 approved organisations supply the aircraft operator with the records associated with work that they perform on an aircraft, engine, propeller or component.

Safety Recommendation 2007-093

It is recommended that, to enable aircraft operators to fulfil the requirements of the Air Navigation Order and EASA Part M, the Civil Aviation Authority review the requirements for, and monitoring of, EASA Part 145 approved organisations providing the aircraft operator with the records associated with work that they perform on an aircraft, engine, propeller or component.

Occurrences resulting from cylinder failure

As noted earlier in this report, Tables 1 and 2 list the known occurrences that have occurred in the UK and France which have been the result of a complete or partial separation of a cylinder from a Lycoming O-235 series engine caused by a fatigue crack propagating from an external corrosion pit. The majority of aircraft in the UK that are fitted with the O-235 series engine are operated in the pilot training role and all but two of the accidents since 1977 have occurred whilst being operated in that environment. In the UK there have been no recent fatal accidents resulting from a cylinder failure on a Lycoming O-235 series engine.

Cylinder inspection

Following a number of occurrences of Lycoming O-235 series engine cylinder failures in France, attributed to fatigue initiating from external corrosion pitting, the Direction Generale de l'Aviation Civile (DGAC) issued Airworthiness Directive (AD) 1998-225(A), that mandated regular inspections of these cylinders. With the formation of the European Aviation Safety Agency (EASA) in 2003 this AD was withdrawn and has not subsequently been re-issued by the EASA.

Safety Recommendation 2007-094

It is recommended that the European Aviation Safety Agency review the Airworthiness Directive 1998-225(A) R6 issued by Direction Generale de l'Aviation Civile (DGAC) in France with a view to issuing an EASA Airworthiness Directive to cover this area of concern.

Following the occurrence of cylinder failures in France, the engine manufacturer issued Service Instruction (SI) No 1504 which introduced a replacement cylinder for the O-235 series engines, with improved corrosion resistance. All new O-235 series engine cylinders delivered from the engine manufacture since 2000 are of the improved corrosion resistance type.

Safety Recommendation 2007-095

It is recommended that the Federal Aviation Administration review the continued airworthiness of cylinders manufactured prior to the year 2000 that are fitted to Lycoming O-235 series engines.

APPENDICES

145.A.55 Maintenance records

(a) The organisation shall record all details of maintenance work carried out. As a minimum, the organisation shall retain records necessary to prove that all requirements have been met for issuance of the certificate of release to service, including subcontractor's release documents.

(b) The organisation shall provide a copy of each certificate of release to service to the aircraft operator, together with a copy of any specific approved repair/modification data used for repairs/modifications carried out.

(c) The organisation shall retain a copy of all detailed maintenance records and any associated maintenance data for two years from the date the aircraft or component to which the work relates was released from the organisation.

1. Records under this paragraph shall be stored in a safe way with regard to fire, flood and theft.
2. Computer backup discs, tapes etc. shall be stored in a different location from that containing the working discs, tapes etc., in an environment that ensures they remain in good condition.
3. Where an organisation approved under this Part terminates its operation, all retained maintenance records covering the last two years shall be distributed to the last owner or customer of the respective aircraft or component or shall be stored as specified by the competent authority.

Appendix 1

EASA Part-145.A.55 Maintenance Records

Airworthiness Notice No. 12, Appendix 61

Issue 4

29 September 2006

Retention of Records - Post Incident and Accident Investigations

1 During an investigation into an engine failure resulting in an air turn back and emergency landing, the record keeping and retention of record period was found to be inadequate and incomplete. Considerable difficulty was experienced during the investigation in tracing the maintenance actions taken during the overhaul of the engine crankshaft which was identified as the cause of the engine failure.

2 Aircraft operators and maintenance organisations are reminded of their responsibility to retain adequate and complete maintenance records as specified and referenced in the following paragraphs for the periods listed.

3 The requirements for retention of maintenance records for EASA aircraft operated for Commercial Air Transport or Non-Commercial Air Transport are identified in Part M M.A. 305 and M.A. 306. For non-EASA aircraft the retention periods are those specified in the Air Navigation Order 2005 (as amended).

4 Part-145 approved maintenance organisations need only retain a copy of all detailed maintenance records for two years from the date the aircraft or aircraft component was released from the Part-145 organisation (Part 145.A.55). If contracted to keep records on behalf of the Operator then the retention period will be that required by Part M M.A. 305 and M.A. 306.

5 The requirements for retention of records for all other aircraft registered in the United Kingdom should be as defined in the Air Navigation Order 2005 (as amended) Article 22. This requires the Operator of the aircraft to keep Aircraft, Engine and Propeller Log Books. The Log Books must include particulars as specified in the ANO Schedule 6 which include:

- Paragraph 1(e). Particulars of all maintenance work carried out on the aircraft or its equipment.
- Paragraph 1(g). Particulars of any overhauls, repairs, replacements and modifications relating to the aircraft.

Also note that any document which is incorporated by reference in a log book shall be part of the log book and it is the duty of the Operator to keep the above records. Every Log Book shall be preserved by the Operator of the aircraft until 2 years after the aircraft has been destroyed or has been permanently withdrawn from use.

6 Consequently, if a Part-145 approved maintenance organisation carries out work (overhaul, inspection, repair, modification or replacements) on an aircraft NOT operated in accordance with JAR-OPS, then the record retention requirements are as required by the Air Navigation Order.

Appendix 2

CAA Airworthiness Notice No 12, Appendix 61

M.A.305 Aircraft continuing airworthiness record system

(a) At the completion of any maintenance, the associated M.A.801 certificate of release to service shall be entered in the aircraft continuing airworthiness records. Each entry shall be made as soon as practicable but in no event more than 30 days after the day of maintenance action.

(b) The aircraft continuing airworthiness records shall consist of, as appropriate, an aircraft logbook, engine logbook(s) or engine module log cards, propeller logbook(s) and log cards, for any service life limited component and the operator's technical log.

(c) The aircraft type and registration mark, the date, together with total flight time and/or flight cycles and/or landings, as appropriate, shall be entered in the aircraft logbooks.

(d) The aircraft continuing airworthiness records shall contain the current:

1. status of airworthiness directives and measures mandated by the competent authority in immediate reaction to a safety problem;
2. status of modifications and repairs;
3. status of compliance with maintenance programme;
4. status of service life limited components;
5. mass and balance report;
6. list of deferred maintenance.

(e) In addition to the authorised release document, EASA Form 1 or equivalent, the following information relevant to any component installed shall be entered in the appropriate engine or propeller logbook, engine module or service life limited component log card:

1. identification of the component, and;
2. the type, serial number and registration of the aircraft to which the particular component has been fitted, along with the reference to the installation and removal of the component, and;
3. the particular component accumulated total flight time and/or flight cycles and/or landings and/or calendar time, as appropriate, and;
4. the current paragraph (d) information applicable to the component.

(f) The person responsible for the management of continuing airworthiness tasks pursuant to M.A. Subpart B, shall control the records as detailed in this paragraph and present the records to the competent authority upon request.

(g) All entries made in the aircraft continuing airworthiness records shall be clear and accurate. When it is necessary to correct an entry, the correction shall be made in a manner that clearly shows the original entry.

(h) An owner or operator shall ensure that a system has been established to keep the following records for the periods specified:

1. all detailed maintenance records in respect of the aircraft and any life-limited component fitted thereto, at least 24 months after the aircraft or component was permanently withdrawn from service, and;
2. the total time and flight cycles as appropriate, of the aircraft and all life-limited components, at least 12 months after the aircraft or component has been permanently withdrawn from service, and;
3. the time and flight cycles as appropriate, since last scheduled maintenance of the component subjected to a service life limit, at least until the component scheduled maintenance has been superseded by another scheduled maintenance of equivalent work scope and detail, and;
4. the current status of compliance with maintenance programme such that compliance with the approved aircraft maintenance programme can be established, at least until the aircraft or component scheduled maintenance has been superseded by other scheduled maintenance of equivalent work scope and detail, and;
5. the current status of airworthiness directives applicable to the aircraft and components, at least 12 months after the aircraft or component has been permanently withdrawn from service, and;
6. details of current modifications and repairs to the aircraft, engine(s), propeller(s) and any other component vital to flight safety, at least 12 months after they have been permanently withdrawn from service.

Appendix 3

EASA Part M Section M.A.305