ACCIDENT

Aircraft Type and Registration:	DA 40 D Diamond Star, G-CCHD
No & Type of Engines:	1 Thielert TAE 125-02-99 piston engine
Year of Manufacture:	2003 (Serial no: D4.051)
Date & Time (UTC):	7 March 2015 at 1700 hrs
Location:	Approx 4 miles west of Shoreham Airport, West Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Rear fuselage partially detached, damage to right wing, propeller and nosewheel
Commander's Licence:	Private Pilot's Licence
Commander's Age:	28 years
Commander's Flying Experience:	126 hours (of which 31 were on type) Last 90 days - 4 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was climbing out after takeoff when the engine stopped at a height of about 1,100 ft. In the subsequent forced landing, three sheep were killed and the aircraft was badly damaged. It was found that a fuel injector and its unions had become loose and caused a total loss of fuel pressure. It could not be determined how the injector support and its securing screw had come undone as neither were recovered.

History of the flight

The purpose of the flight was to build the flying hours of the pilot, who was registered as a student at the flying school which owned the aircraft. Prior to departure from Shoreham, he performed all the required checks and completed the necessary paperwork before taxiing for takeoff on Runway 20.

During the initial climb the aircraft's performance and all indications appeared normal and, at a height of about 600 ft agl, the pilot executed a planned 90º climbing turn to the right. However as he reached approximately 1,000 ft, he sensed a slight reduction in engine noise and saw a drop to about 95% rpm from the full power selected. Although this appeared to correct itself, he commenced a precautionary wide turn to the right in anticipation that he might have to return to Shoreham. Upon reaching about 1,100 ft, he sensed another drop in noise which reduced to silence after a few seconds, with less

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than 2% engine rpm indicated. With the sea to his left and a built-up area below him, he steepened the right turn towards north and open ground whilst trying to restart the engine without success.

With only two suitable fields to choose from, he had to select one which contained a flock of sheep, since the other had power lines obstructing it. As he touched down in the muddy field the aircraft struck three of the sheep, killing them before it ran through the boundary fence and into another field containing trees. As the left wing struck one of the trees, the aircraft was spun through 90º anticlockwise before coming to a halt with the rear fuselage partially detached and the nosewheel collapsed.

The pilot shut down the aircraft and exited normally in time to warn a couple who had come to help to stay clear in case of fire (he recalled he had smelt burning during the descent). There was no fire and, whilst the couple called the emergency services, he called the flying club to advise them of his situation.

Engine examination

Engineers from the aircraft's maintainers arrived at the site and checked fluid levels and downloaded the data from the engine FADEC (Full Authority Digital Engine Control) unit. Although at first it visually appeared that nothing was wrong with the engine, the data for the accident flight showed a series of alerts for low fuel rail pressure. The next day, upon closer inspection, it was found that No 2 cylinder injector securing screw and injector support were missing, the injector itself was out of position by about 50 mm and the associated fuel pipe unions had loosened (Figure 1).

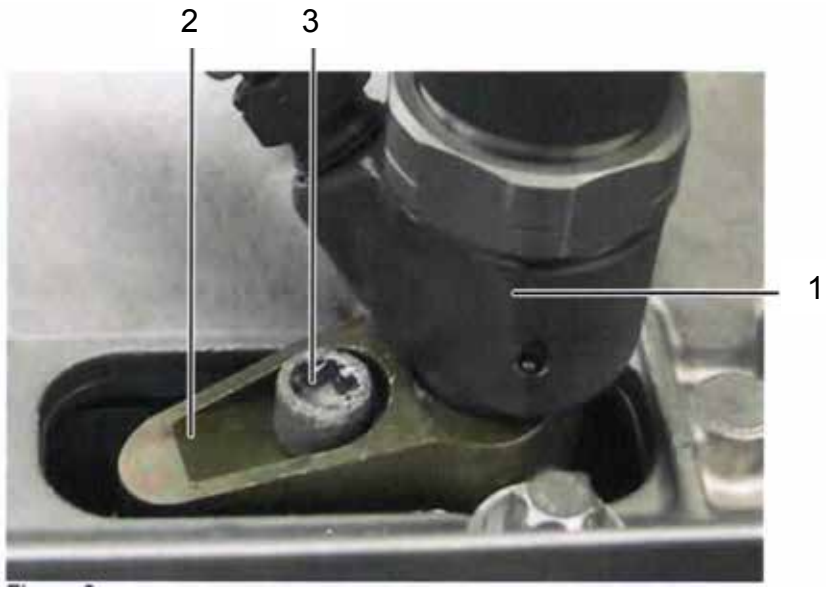

Figure 1

Photograph of intact assembly showing Injector (1), Injector Support (2) and Securing Screw (3).
(Photo courtesy Technify Motors)

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The injector had been removed and replaced on 24 February 2015 in order to rectify a leak from its injector seal. The spares invoice for this task indicates that, in addition to a new sealing ring, the injector securing screw was also replaced as required by Technify Repair Manual RM-02-02 Chapter 73-10.05 Issue 3.

The same section of the manual, revised in July 2014, also specified the following:

> *'Note:*
> *Before a third injector change – the Repair of the Thread for Injector Attachment must be done. Refer to Chapter 73-10.10'*

The repair involved insertion of a helicoil insert into the female thread.

The manufacturer has advised that this requirement arose from a case that occurred earlier in 2014 in which an Italian registered DA 40 suffered an engine failure and subsequent successful forced landing. Like G-CCHD, the FADEC data showed a loss of rail pressure occurring at the moment of failure. Physical examination revealed that an injector was similarly displaced and the screw and support were also displaced but were still present. Investigation by the Italian Authorities and the manufacturer showed that the thread in the aluminium cylinder head had stripped.

The manufacturer decided that the corrective action would be to do the thread repair at the third injector change, hence the revision of Chapter 73-10.05. It was not felt necessary to issue a Service Bulletin or similar to highlight this change and it was noted that Chapter 73-10.10 did not refer to the third injector change requirement and remained dated December 2013.

The maintenance company stated that the staff involved in G-CCHD's injector removal on 24 February 2015 were aware of the repair requirement, but were using the engine log book to ascertain how many times the injector had been changed. However, the log book was not used to record how many times the injector had been removed and refitted. Such an action could occur several times for processes such as cleaning, sealing ring replacement or for the scheduled 900-hour timing chain replacement but would be entered on work sheets. All staff have now been instructed to make a record in the engine log book every time an injector is disturbed.

Discussion

The cause of the loss of engine power on G-CCHD was the loss of fuel pressure due to a loose fuel injector. After the accident, the maintainer inserted a new screw into No 2 female thread and was able to torque it up to the required value; therefore, it is unlikely that the thread in the cylinder head was stripped. In addition to the screw and injector support, the copper injector seal was also found to be missing.

In their report into the previous Italian incident, the engine manufacturer provided three scenarios which it considered could cause a fuel injector to come loose:

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1. The presence of fluid at the base of the thread which could expand with temperature and cause stripping of the thread. Fluid had been found at the bottom of all four threads (which were also damaged) of the engine involved in the Italian incident and this, according to the manufacturer, was the most probable reason for the failure in that case.

2. The screw was either overtorqued or undertorqued by the mechanic. Overtorquing would risk stripping the thread in the aluminium cylinder head whilst undertorquing could result in the screw working loose. The type of screw used requires a specific tightening method and failure to observe the correct sequence could result in either of the above.

3. The screw was not renewed at its last removal/replacement[1].

The maintainer's paperwork records that a new screw had been requisitioned for the injector removal on 24 February 2015 and the hole should have been cleaned before it was inserted. The missing copper injector seal was unusual because it should have been present and the injector did not come completely out of its housing. The manufacturer ran tests without a seal present and believes that the high temperatures from leaking gas may have been sufficient to compromise the self-locking feature of the screw.

Therefore it could not be determined why the screw had apparently become loose and neither it, the injector support nor the seal were recovered. At the time of the accident, the aircraft had flown 8 hours and 40 minutes in over 13 flights since the injector seal replacement.

Footnote

[1] The screw is of a 'Torque-to-Yield' type which must not be re-used after removal. The method of torquing is to tighten to a set torque and then perform two separate 90º turn operations. The manufacturer also advises that the screws have a self-locking feature which is destroyed when they are undone.

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