ACCIDENT

Aircraft Type and Registration:	Schweizer 269D Configuration A (Schweizer 333), G-TAMA
No & Type of Engines:	1 Rolls Royce Allison 250-C20W turboshaft engine
Year of Manufacture:	2004
Date & Time (UTC):	4 February 2008 at 1455 hrs
Location:	Sheffield City Airport
Type of Flight:	Aerial Work
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Significant component and airframe damage
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	40 years
Commander's Flying Experience:	1,125 hours (of which 75 were on type) Last 90 days - 131 hours Last 28 days - 49 hours
Information Source:	AAIB Field Investigation

Synopsis

After landing on a post-maintenance flight, the helicopter suffered a seizure of the main rotor gearbox pinion outer bearing due to oil starvation. The main rotor gearbox had been replaced during the recent maintenance. It was determined that maintenance personnel had inadvertently caused metallic debris to enter the bearing oil supply gallery during their attempts to remove a blanking plug from the gearbox low oil pressure switch port, which had been overtightened.

History of the flight

The incident occurred after landing on a post-maintenance flight to check the tracking and balance of the main rotor. The engineer disembarked the helicopter with the rotors still running, leaving the pilot to shut down the aircraft. As she commenced the shutdown procedure, there was a loud 'bang' and the aircraft immediately began to shake severely, rocked violently and yawed 45 degrees nose left. She held the collective lever fully down, experiencing some difficulty as this required a large amount of force even with full friction applied. The throttle was closed and the fuel shutoff valve was selected off after the main rotor blades had come to a stop. The helicopter remained upright and the pilot was able to exit the aircraft normally.

Aircraft information

Background information

G-TAMA, Figure 1, was manufactured in 2004 and had completed 1,681 flying hours since new at the time of the incident. The helicopter, serial number 0051A, held a current EASA Certificate of Airworthiness valid until 12 June 2008. The incident occurred on the second post-maintenance flight after completion of an 800-hour scheduled maintenance check, during which the main rotor gearbox (MRGB) was replaced. The replacement gearbox, part number 269A5175-39 serial number S0030, was supplied by the helicopter manufacturer.

Figure 1
Photograph of G-TAMA

Aircraft description

General

The Schweizer 269D Configuration A, generically referred to as a Schweizer 333, is a three-seat helicopter powered by a single Allison 250-C20W turboshaft engine. It is equipped with a three-bladed main rotor with elastomeric lead-lag dampers and a conventional two-bladed tail rotor.

Power is transmitted from the engine to the main rotor and tail rotor via a 'Vee' belt, which drives a pulley on the rear of the MRGB. The pulley is attached to the MRGB input shaft and also drives the tail rotor driveshaft.

Main rotor gearbox (MRGB)

The two-part MRGB housing is manufactured from cast magnesium and is comprised of upper and lower housings. A pinion gear on the gearbox input shaft drives a ring gear, providing the required reduction gearing for the main rotor. The pinion gear is supported by inner and outer tapered roller bearings.

A pump within the gearbox provides pressurised oil for lubrication of the MRGB components. Oil is supplied to the pinion outer bearing via an oil gallery in the gearbox upper housing. The oil enters the bearing via an orifice in the bearing retainer, which must be aligned with the oil feed orifice in the gallery.

A low oil pressure warning switch is located in the oil gallery to the pinion outer bearing. The pressure switch port has a tapered thread to provide adequate sealing. Replacement gearboxes are supplied without a pressure switch installed and the port is blanked off with a threaded aluminium alloy plug, Figure 2.

The plug must be replaced with a pressure switch before installing the gearbox in the helicopter, although this is not mentioned in the maintenance manual procedure for MRGB removal and installation.

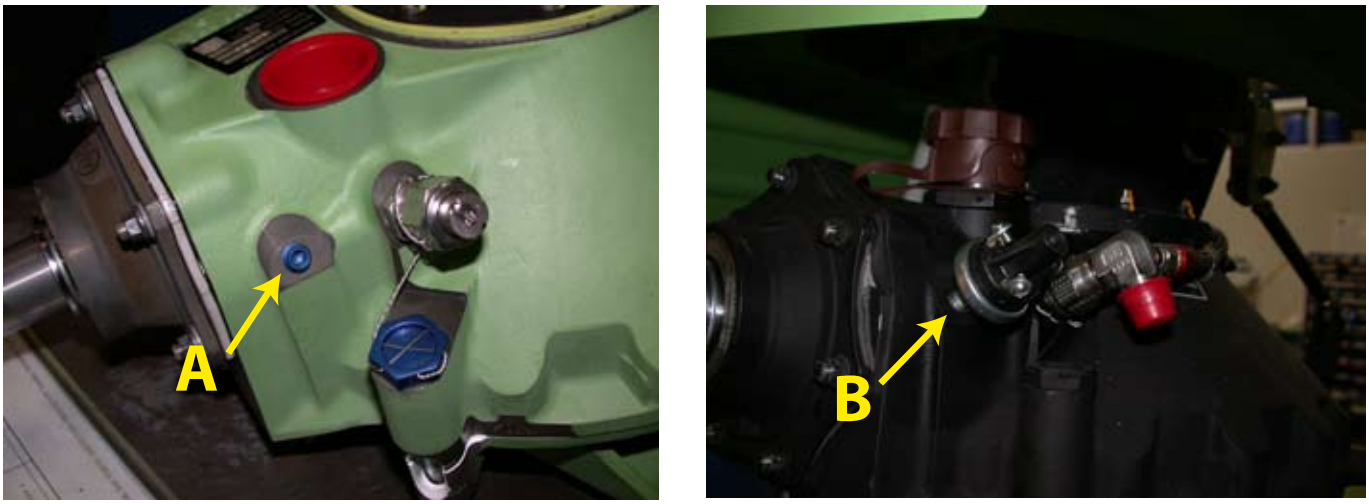

Figure 2

Photographs showing MRGB with blanking plug ('A') and low oil pressure switch ('B') installed

Note: gearbox on left has not yet been painted

Aircraft examination

General

Various components and parts of the airframe structure were damaged as a result of the abnormal loads experienced in the incident. The main rotor lead-lag dampers had failed and the tail rotor driveshaft exhibited a torsional overload failure consistent with the tail rotor driving against a restriction at the front of the driveshaft.

MRGB damage

The MRGB input shaft was found to be binding intermittently and felt rough when rotated by hand. The pinion outer bearing was badly damaged from apparent oil starvation and subsequent overheating (Figure 3). The bearing cage had fractured and the rollers exhibited a dull grey coloration, with some having partially melted. The bearing retention nut and washer were intact and correctly located. The oil feed orifice in the bearing retainer was correctly aligned with the oil gallery orifice and was free of obstruction. Some ferrous debris was found in the bearing oil drain passage. No other defects were reportedly found within the MRGB which could have restricted or blocked the oil supply to the pinion outer bearing.

Examination of the bearing oil supply gallery revealed the presence of oil, small shiny chips of non-ferrous debris and a single fragment of ferrous debris (Figure 4). This fragment, which measured approximately 3 mm in length with a diameter tapering from approximately 0.8 mm to 2.5 mm at its widest, was found to have a machined threaded/spiral finish closely resembling the tip of a stud extractor bit.

Figure 3

Photograph showing damage to MRGB pinion outer bearing

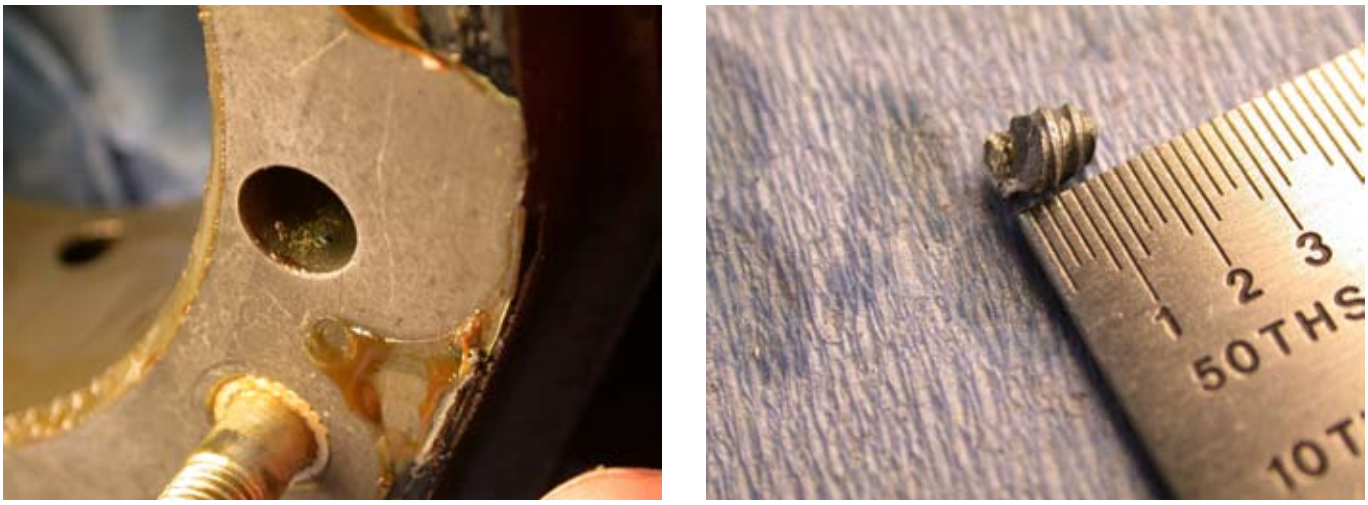

Figure 4

Photographs showing metallic debris in pinion bearing oil gallery (left) and close-up view of ferrous fragment (right)

Recent maintenance activity

The helicopter had recently completed an 800-hour scheduled maintenance check, performed at the operators' maintenance facility at its main base at Sheffield City Airport. One of the tasks completed was the replacement of the MRGB.

The maintenance personnel involved in this task were interviewed by the AAIB. They reported having great difficulty removing the blanking plug from the pressure switch port in the pinion rear bearing oil gallery, which had been installed too tightly. Attempts to undo it with an 'Allen' key were unsuccessful and only served to damage the soft alloy plug. An attempt was then made to remove it with a stud extractor tool, but this also proved unsuccessful when the tool bit broke as it was being screwed into the plug. Finally, the plug was drilled at various points round its circumference to weaken it, after which it was possible to undo it. Care was taken to avoid debris entering the oil gallery.

Examination of metallic debris

The ferrous fragment and broken stud extractor bit were subjected to forensic examination.

When offered up to each other under a visual microscope, the fragment and broken tool bit were found to be a close geomteric match, however, an exact fracture match was not possible as some material was missing from the tool bit and the fracture surface of the fragment had been destroyed by mechanical damage.

An Energy Dispersive X-ray analysis was performed to compare the material of the fragment against that of the broken tool bit. The results showed the fragment to be a low alloy steel containing chromium with lesser amounts of manganese, molybdenum and silicon. The broken tool bit was found to be of a similar material. The surface of the fragment was also contaminated with what appeared to be an aluminium-copper alloy.

Additional information

Manufacturer's MRGB assembly procedure

On reviewing its procedure for assembling the MRGB, the helicopter manufacturer found that it contained no instruction to install the blanking plug in the low oil pressure switch port and therefore no torque value was specified for the plug. It is also noteworthy that the MRGB is painted after the blanking plug has been installed.

Maintenance organisation and personnel

The organisation that had performed the maintenance is an EASA-145 approved maintenance organisation and is approved to perform base and line maintenance on Schweizer 269-series helicopters.

The maintenance personnel who carried out the task of replacing the MRGB were qualified to carry out the task and had performed it on a number of previous occasions.

Discussion

The evidence suggests that the fragment removed from the gearbox was probably the tip of the broken stud extractor tool, indicating that the blanking plug was breached in the attempts to remove it. The non-ferrous debris in the oil gallery appeared to be shavings or chips from the damaged aluminium alloy plug.

The damage to the MRGB outer pinion bearing is consistent with the effects of oil starvation. It could not be determined whether this was caused by the ferrous fragment or the non-ferrous debris in the oil gallery, but the latter seems more likely as the smaller, lighter aluminium alloy chips would be have been more easily carried by the oil to a location where they could cause a restriction in the bearing oil supply.

The maintenance personnel had resorted to using unconventional methods to remove the blanking plug as they were unable to do so using normal tools because it had been installed too tightly. This is a common problem when installing plugs into tapered threads. A significant contributory factor is the lack of an instruction for installing the plug in the manufacturer's procedure for MRGB assembly. There is therefore scope for variation in how tightly the plug is tightened, depending on who installs it. Additionally, painting over the plug may make it more difficult to remove due to the adhesive effect of the paint.

Safety action

This incident is unlikely to have occurred had the blanking plug not been overtightened, as unconventional methods used to remove it would not have been necessary. If such methods are used, metallic debris may enter the MRGB oil supply and cause gearbox seizure, as this incident demonstrated. Had the helicopter been airborne at the time, the seizure of the pinion outer bearing may have had catastrophic consequences.

In response to this incident, the manufacturer has stated that they are in the process of revising their gearbox build documents to reflect a maximum torque to be applied to the blanking plug prior to shipping.