Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Aviation Occurrence Report – 200506834
Final

Engine failure – 93 km east of Adelaide Airport, SA
23 December 2005
VH-OAE
British Aerospace Plc 3201, Jetstream

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Postal address: PO Box 967, Civic Square ACT 2608

Office location: 15 Mort Street, Canberra City, Australian Capital Territory

Telephone: 1800 621 372; from overseas + 61 2 6274 6590

Accident and serious incident notification: 1800 011 034 (24 hours)

Facsimile: 02 6274 6474; from overseas + 61 2 6274 6474

E-mail: atsbinfo@atsb.gov.au

Internet: www.atsb.gov.au

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Australian Transport Safety Bureau
PO Box 967, Civic Square ACT 2608 Australia
www.atsb.gov.au

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Honeywell USA for figure 1.

Abstract

On 23 December 2005 at about 1745 South Australian Summer Time, a British Aerospace Plc, J32, Jetstream aircraft was being operated on a scheduled passenger service from Mt Gambier to Adelaide in South Australia. The crew reported that during cruise flight at flight level (FL) 120 and in a shallow right turn, about 93 km east of Adelaide, the right engine briefly surged twice and then stopped.

After landing at Adelaide, the TPE331-12UHR-702H engine, serial number P66397C, was removed from the aircraft and forwarded to the manufacturer in the US for failure examination. The report of that engine examination indicated that the P/N 3103589-1 gear had a separated section of one gear tooth and several other damaged teeth. A metallurgical examination of the damaged components and the metal fragments found in the gearbox showed that there had been significant heavy wear of the mating surfaces of the spur gear teeth of both gears. The report further stated that experience had shown that the mating of a new or different gear, and a worn gear can accelerate tooth wear and lead to tooth fatigue cracking. In this instance the smearing of the separated surfaces and the damage sustained by the components precluded an assessment of whether the failure was due to fatigue. The report also indicated that, 'In the absence of an identified fatigue origin, there is also the possibility that a foreign object may have entered the gear mesh and overloaded a tooth'.

The engine manufacturer advised that they have submitted a Publication Change Request (PCR 029601) to the Inspection and Repair Manual 72-IR-15 specifically requiring an inspection for wear of the P/N 3103590-2 gear. That change is expected to be issued in late 2007.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Australian Government Department of Transport and Regional Services. ATSB investigations are independent of regulatory, operator or other external bodies.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the Transport Safety Investigation Act 2003 and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au.

FACTUAL INFORMATION

On 23 December 2005 at about 1745 South Australian Summer Time[1], a British Aerospace Plc, J32, Jetstream aircraft was being operated on a scheduled passenger service from Mt Gambier to Adelaide, South Australia. The crew reported that during cruise flight at flight level (FL) 120 and in a shallow right turn, about 93 km east of Adelaide, the right engine briefly surged twice and then stopped.

The crew initially carried out the operator's standard *Engine failure in flight* memory checks before shutting-down and securing the engine in accordance with the aircraft's quick reference handbook (QRH). The crew notified air traffic control of the engine problem and a clearance was received for a direct track to Adelaide Airport. The crew also requested and were approved to descend to 10,000 ft to prevent any possible pressurisation problems that may have resulted from the loss of power from the engine. During the occurrence, another company pilot who was on board the aircraft as a passenger, relayed timely information from the crew to the passengers about the situation in an attempt to allay any concerns.

Prior to the top of descent the crew attempted an Auto and a Manual restart of the stopped engine in accordance with the procedures listed in the QRH. During these attempts, the engine would rotate and the propeller would unfeather but the engine would not start. The aircraft landed at Adelaide at 1850.

The TPE331-12UHR-702H engine, serial number P66397C, was removed from the aircraft and forwarded to the manufacturer in the US for failure examination. That examination was carried out with the assistance of a member of the US National Transportation Safety Board (NTSB) at the request of the Australian Transport Safety Bureau, and a report was provided.

The operator had purchased the engine from the manufacturer in November 2005. Prior to purchase, in October 2005, the engine had undergone a scheduled continuous airworthiness maintenance (CAM) inspection. The manufacturer reported that during the CAM inspection a gear, part number (P/N) 3103589-1, and bearing, P/N 3103585-1, from the reduction gearbox were replaced with new items. The gear had been replaced due to wear on the spur gear teeth[2]. The gear, P/N 3103590-2, which was part of the P/N 3103598-2 assembly (figure 1), was inspected and refitted to the assembly. That gear had been in the engine since manufacture.

The engine was fitted to the occurrence aircraft on 20 December 2005. At the time of fitment, the engine had completed a total of 6,242 hours and 7,987 cycles since new. The engine had completed a further 15.65 hours and 17 cycles up until the time of the failure.

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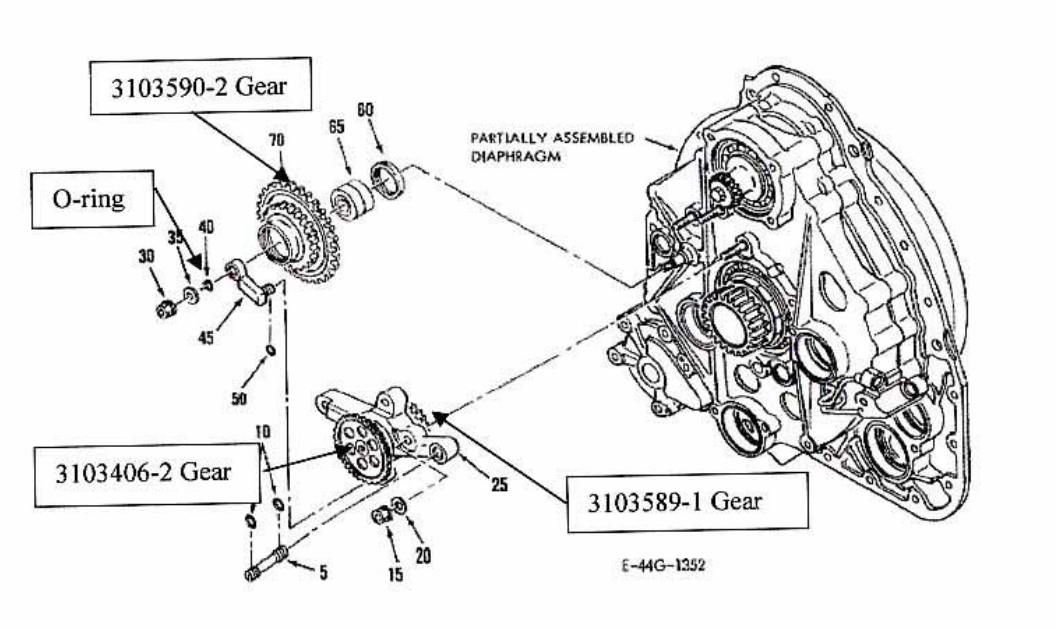
1 The 24-hour clock is used in this report to describe the local time of day, South Australian Summer Time (SAST), as particular events occurred. South Australian Summer Time was Coordinated Universal Time (UTC) + 10 hours 30 mins.

2 Spur gear teeth are radial, uniformly spaced around the gears outer periphery and parallel to the shaft axis; ASM International, Materials Information Society Handbook, Volume II.

Figure 1: Diagram showing relationship between the gears



The report of the engine examination indicated that the P/N 3103589-1 gear had a separated section of one gear tooth and several other damaged teeth. The splined shaft that connected that gear to the P/N 3103406-2 gear had evidence of bent splines. The P/N 3103590-2 gear that meshed with the P/N 3103589-1 gear was missing all of its teeth. None of the bearings exhibited any pre-existing wear or evidence of any damage from oil starvation and all jets that supplied oil to the affected components were unobstructed. There was no wear or damage noted to the gearbox pressure oil pump. The scavenge pump had been contaminated with material from the worn gears. The gearbox oil filter impending bypass indicator had not operated during the incident.

During the examination, it was noted that the 'O' ring that sealed the oil jet supply (figure 1, item 45) to the bearing (figure 1, item 65) in the P/N 3103590-2 gear was incorrectly positioned between the jet and the bearing instead of under the washer as required (figure 1, item 35). The report indicated that there was no evidence of any oil starvation to that bearing and the incorrect placement of the seal was not considered to be a factor in the occurrence.

A metallurgical examination of the damaged components and the metal fragments found in the gearbox showed that there had been significant wear of the mating surfaces of the [spur] gear teeth of both gears. The report further stated that experience had shown that the mating of a new or a different gear, and a worn gear can accelerate tooth wear and lead to tooth fatigue cracking. In this instance, the smearing of the separated surfaces and the damage sustained by the components prevented an assessment of whether the failure was due to fatigue.

The report also indicated that, 'In the absence of an identified fatigue origin, there is also the possibility that a foreign object may have entered the gear mesh and overloaded a tooth'.

The engine manufacturer required a spectrometric oil and filter analysis program (SOAP)[3] to monitor an engine's in-service condition and to reduce the possibility of a premature mechanical failure. That program monitored the type and quantity of deposits in the engine oil and oil filters over a specified period. A trending feature within that program could highlight an engine with a rapidly increasing filter 'weight' and indicate that further maintenance action was required. A high filter weight quantity of carbon steel in a sample could indicate a problem with a gear assembly. In November 2000, the engine manufacturer issued Alert Service Bulletin TPE331-A79-0034[4] that changed the SOAP interval periodicity to a fixed 100+/- 20 engine hours to minimise variability. On 24 June 2005, CASA issued AD/TPE 331/62[5] that required Australian compliance with that Alert SB.

The engine had not had a SOAP sample carried out on the oil as it had only completed 16.1 hours in service since engine installation. The last sample had been carried out on 15 November 2004, prior to the CAM servicing. That sample and the one prior to that on 6 November 2004 were considered to be normal. The next SOAP sample was required to be completed at 6,342 (+/-20) engine hours.

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3 Service Information Letter – P331-97 - THE HONEYWELL SPECTROMETRIC OIL AND FILTER ANALYSIS PROGRAM FOR ALL TPE331 ENGINES EXCEPT -14GR/HR ENGINES; Revision 10, Apr 5/02.

4 Honeywell Alert Service Bulletin – TPE331-A79-0034 - OIL DISTRIBUTION – DECREASED TIME INTERVAL BETWEEN SPECTROMETRIC OIL (AND FILTER) ANALYSIS PROGRAM (SOAP) SAMPLING; Revision 4, Apr 5/02.

5 CASA AD/TPE331/62, Reduction Gear and Shaft Assembly, superseded CASA's original requirement, AD/TPE331.55, on 24 Jun 2004.

ANALYSIS

The engine failure was due to the separation of the gear teeth on the P/N 3103590-2 gear and the subsequent related damage to the P/N 3103589-1 gear.

It is likely that the P/N 3103590-2 gear teeth separated as a result of accelerated tooth wear due to the mating of new and worn components leading to fatigue failure and the subsequent loss of one or more teeth from that gear. However, the possibility of the damage having occurred from a foreign object could not be discounted.

SAFETY ACTION

The engine manufacturer advised that it has submitted a Publication Change Request (PCR 029601) to the Inspection and Repair Manual 72-IR-15 specifically requiring an inspection for wear of the P/N 3103590-2 gear. That change is expected to be issued in late 2007.