INCIDENT

Aircraft Type and Registration:	Dornier 328-100, G-BYML
No & Type of Engines:	2 Pratt &Witney PW-119B series turboprop engines
Year of Manufacture:	1996
Date & Time (UTC):	15 November 2005 at 2015 hrs
Location:	London (City) Airport, London
Type of Flight:	Public Transport
Persons on Board:	Crew - 2 Passengers - 20
Injuries:	Crew - Nil Passengers - Nil
Nature of Damage:	**S**moke in cabin
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	6,142 hours (of which 420 were on type) Last 90 days - 187 hours Last 28 days - 20 hours
Information Source:	AAIB Field Investigation

Summary

The aircraft was taxiing for takeoff at London (City) Airport when ATC informed the commander that their anti-collision lights were not illuminating. Shortly afterwards the flight crew identified that the associated circuit breaker 'popped' whenever the lights were selected ON. Meanwhile, the cabin attendants reported that the cabin was rapidly filling with smoke. An uneventful evacuation of the aircraft was carried out with no injuries to any of the crew or passengers. The investigation concluded that the crew experienced two unrelated faults and that the smoke in the cabin most probably resulted from leakage of oil from the left engine into the left Environmental Control System pack.

History of flight

On the day of the incident the crew had already operated three sectors between Dundee and London (City) Airport and were taxiing to holding point Charlie at London (City) for the final flight to Dundee; ATC advised them that their anti-collision lights were not illuminating. After confirming that the anti-collision lights switch in the cockpit was selected to ON the flight crew recycled the switch but the lights remained off. The aircraft held at holding point Charlie whilst the flight crew consulted the Minimum Equipment List, after which they advised ATC that they could still depart since the strobe lights were serviceable. ATC informed the crew that they were waiting to see if Terminal Control would accept them without anti-collision lights. Whilst awaiting further instructions the flight crew noticed that the circuit

breaker (CB) for the anti-collision lights had 'popped'; on resetting the CB it immediately popped again and the crew selected the anti-collision lights switch to OFF.

The cabin lights had been dimmed for takeoff and the cabin attendants were positioned in their allocated seats, 11A and 12A. Approximately four to five minutes after the pilots had noticed that the CB had popped, both attendants became aware of a smell of burning plastic. The No 1 attendant immediately used the inter-phone to inform the commander that '*there was a smell of burning in the cabin*', whilst the No 2 attendant walked to the front of the aircraft in an attempt to locate the source of the smell. Whilst doing so she noticed that there was smoke, or haze, blowing across the beams from the passenger reading lights. The attendant reported that the smoke seemed to be coming from the upper ventilation ducts located along the length of the cabin. The attendant immediately reported this to her colleague who told the commander that '*the cabin was filling up with smoke*'. The commander told the cabin attendant to '*stand by*', whilst he contacted ATC and requested an immediate return to the stand. In the meantime the No 2 attendant turned the cabin lights fully on and noticed that the cabin was now full of smoke, which appeared to be getting thicker. She again reported this to the No 1 attendant who told the commander '*we need to hurry up the cabin is really filling with smoke'*. The No 2 attendant now started to experience difficulty in breathing and went to the front of the aircraft to collect her Personal Breathing Equipment (PBE). However, before she could fit the PBE the commander gave the order, over the Public Address (PA) system, to evacuate the aircraft. He then commenced shutting down the aircraft and informed ATC '(*Callsign) we have smoke in the cabin, we are shutting down and evacuating the aircraft'*, this transmission was acknowledged by ATC.

At approximately 2015 hrs ATC activated the crash alarm and passed details of the Ground Incident to the fire service. The ATC controller estimates that the first appliance reached the aircraft approximately 30 to 45 seconds after the crash alarm had been activated. On arriving at the aircraft the Fire Officer informed ATC and the airport operations controller that the fire cover was now category 0[1]. A search team equipped with breathing apparatus and a thermal camera conducted a search of the aircraft and reported to the Fire Officer that there were no signs of excessive heat or smoke inside the aircraft.

Approximately 10 minutes after the initial call from the pilot, the Fire Officer informed the operations controller that he was downgrading the incident to a local standby. At about the same time the London Fire Brigade appliances reported that they were at the agreed rendezvous point and were informed that their assistance was not required. The airport fire appliances were stood down at approximately 2045 hrs once the operator's engineer and the Fire Officer were satisfied that the aircraft was safe to be towed to a stand.

In the absence of fire cover the runway had been closed for approximately 11 minutes during which the Tower Controller instructed one aircraft on approach to execute a go-around whilst the Radar Controller vectored other aircraft into a holding pattern until the runway re-opened.

Following the incident the commander consulted with the company Chief Pilot and, since the flight crew had not been exposed to any fumes, it was decided that they would operate the spare aircraft on the flight to Dundee. It was also arranged that another cabin attendant would be allocated to this flight; she was already at the airport

Footnote

[1] Category 0 means that there is no fire cover available.

but had not been on the incident aircraft. The two cabin attendants who had been exposed to the smoke were given the option of remaining at London; however, they elected to fly back, as passengers, to Dundee where they were based. They subsequently consulted their GP who advised them to take a few days off work. Neither of the cabin crew required any further medical treatment. The spare aircraft subsequently departed London (City) Airport at 2136 hrs.

Aircraft evacuation

On hearing the command to evacuate the aircraft the cabin attendants immediately opened the front and rear doors and instructed the passengers to leave the aircraft. A few individuals initially tried to retrieve items from the lockers and one passenger started to open the emergency exit adjacent to seat 9A. Another passenger tried to push past the attendant at the front door, who was holding the passengers back until the propeller stopped rotating. Nevertheless, an orderly evacuation was carried out and the attendants escorted the passengers safely away from the aircraft. The cabin crew reported that the passengers remained calm throughout the incident and none of them required medical treatment.

CAA advice on actions following a smoke/fumes incident

Flight Operations Department Communication 21/2002 recommends:

Operators should ensure that flight and cabin crews are advised as to the post-flight actions required following a smoke/fumes incident. These actions should include:

a) A Commander's review of the in-flight incident. This should include consultation with the flight and cabin crew;

b) A determination as to whether any crew member felt unwell, or whether their performance was adversely affected; and

c) The requirement for a crew member who felt unwell, or felt their performance was affected, not to operate as a member of the crew until he/she has been assessed as fit by a medical practitioner and the crew member feels fit to operate.

The instructions to flight and cabin crews should be detailed in the Operations Manual.

Whilst the commander and Operator instinctively complied with these recommendations, at the time of the incident there were no instructions in the Operator's Operations Manual concerning the actions to be taken following a smoke/fumes incident. However, the Operator has since taken action to include appropriate instructions in their Operations Manual.

CAA advice on the operation of circuit breakers

Flight Operations Department Communication 7/1999 recommends:

In-flight operational use of CBs will usually involve the action of resetting a circuit breaker which has tripped because of an electrical overload or fault. Clearly, the re-establishment of electrical power to a circuit which is at fault does involve, however slight, an element of risk. Accordingly, flight crews should be advised not to attempt to reset CBs in flight for other than essential services and, even then, only when it is allowed by the aircraft flight manual and there is clearly no associated condition of smoke or fumes. A second reset should not be attempted.

In this instance the flight crew elected to re-set the CB since they were still on the ground, although, strictly speaking, the aircraft was classified as being 'in flight'.

Description of air conditioning system

The aircraft air conditioning system uses engine bleed air to supply conditioned air to the passenger cabin and cockpit. Bleed air from the engines is supplied to two identical Environmental Control System (ECS) packs and the bleed air from each engine can be selected on and off by a flow control and shut-off valve. The right hand (RH) pack normally receives bleed air from the right engine and supplies all the conditioned air for the cockpit with any excess flow added to the air from the left hand (LH) pack for the passenger cabin. The engine bleed airlines from each engine are also connected by a cross-bleed line equipped with a cross-bleed valve, which can be opened by the pilots to enable both ECS packs to be supplied with air from one engine. Conditioned air is supplied through ducting to floor and ceiling outlets in the passenger cabin and cockpit; additionally each passenger seat position is supplied with conditioned air through an adjustable outlet. The flight crew can control the engine bleed air via switches mounted on the ECS control panel. The operating status of the ECS is indicated by lights on the ECS control panel and messages and synoptics on the Engine Indicating and Crew Alerting System (EICAS).

The possibility of oil contamination of the ECS was first identified in 1995 and can be caused when oil leaks from the engine main bearings and contaminates the compressor air flow before it enters the ECS through the compressor bleed valves. Some of the potential causes for this include over filling the engine oil tanks, deteriorated engine seals and starting or stopping the engines with the engine bleed air selected ON. A customer information letter was issued on 8 December 2000 highlighting the possible causes of bleed air contamination and the procedures to clear the contamination once it has occurred.

Engineering investigation

Debrief

The company engineer entered the aircraft within 10 minutes of the incident and was not aware of any signs of smoke or smells. Before the crew departed on the spare aircraft the company engineer received a quick debrief from the pilot informing him of the problem with the anti-collision lights and reports of some smoke in the cabin. The engineer's understanding was that there where only wisps of smoke from the overhead ducting, accompanied by a bad smell; consequently, the investigation initially focused on the anti-collision lights electrical system. It was a further 14 hours before the engineer became fully aware of the extent of the smoke in the cabin and was informed that the cabin crew had provided statements to the company.

Anti-collision lights

Seats 10A to 5A were removed and several of the cabin floor panels were lifted in order for a limited inspection to be carried out on the cable looms, air conditioning pipes and aircraft structure. There was no evidence of burning, over heating or signs of smoke damage. With electrical power applied to the aircraft the anti-collision lights CB 'popped' whenever the lights switch was selected ON; however there was no evidence of smoke or signs of overheating of the electrical cables and components. The anti-collision lights power supply, which is located outside the pressure cabin, was replaced and the anti-collision lights operated normally.

The engineering documentation revealed that the anti-collision lights power supply had been replaced at Edinburgh on the day prior to the incident and had

been fitted on this aircraft for a total of 2.55 flying hours before the failure was noticed. The power supply had previously been removed from another aircraft on 8 August 2004 for the same fault, and following repair was reissued to the operator on 14 December 2004. It then remained in their stores until being fitted to G-BYML on 14 November 2005. The power supply unit has since been returned to the overhauler for further investigation and repair.

Engine and Air Conditioning System

There were no warning messages on the EICAS to indicate that there had been a problem with either the engine or the air conditioning system. Extensive ground runs were carried out with all the electrical equipment and the air conditioning system operating with no evidence of smoke or bad smells in the cockpit or the cabin. The ground cooling fan, recirculation fan and avionic fan were operated and found to be serviceable. The engine oil levels were checked and found to be at "ADD 1 ½" mark, which was considered to be normal. The air conditioning pipes from the air conditioning packs were removed and there was no evidence of oil having leaked out of the engines into the ECS pack. The aircraft was subsequently flown, without passengers, for 1.47 hours on a training flight and closely monitored for a further 20 flying hours with no repetition of smoke or smells in the cabin. The engine oil consumption was also closely monitored during this period and was assessed by the company as being normal. Moreover, since this incident the operator has not reported any further incidents of smoke in the cabin on any of their aircraft.

Possible causes of smoke in the cabin

Anti-collision lights

With the anti-collision lights power supply unit located outside of the pressure vessel, and no evidence of smoke or overheated cables under the cabin floor, it is unlikely that the anti-collision electrical system was the source of the smoke.

Engine

The engine manufacturer has stated that leakage across two of the four main bearing carbon seals in the engine can cause smoke and unusual smells in the cockpit. However, this would result in an increase in oil consumption and, since the problem could not fix itself, there would be repeated occurrences of smoke in the cabin. Given that the oil consumption was normal and there have been no repeated occurrences of smoke in the cockpit, it is considered unlikely that failure of a main bearing carbon seal was the cause of the smoke in the cockpit.

Environmental Conditioning System

Despite the lack of oil residue in the pipelines, the description given by the cabin attendants of the bad smell and the smoke coming out of the cabin ventilation vents strongly indicates that the ECS pack had become contaminated with oil. With the ECS cross-bleed valve selected CLOSED, its normal position, it is likely that the oil came from the left hand engine, which only feeds conditioned air to the passenger cabin. However, the engineering investigation could not identify the circumstances that led to oil entering the ECS and the operator has reported no further incidents of smoke in the cabin.

Discussion

The evidence strongly suggests that the flight crew were presented with two unrelated faults and it is most likely that the source of the smoke was leakage of oil from the left hand engine bleed system into the LH ECS. The cabin attendants' description of the amount of smoke in

the cabin was at variance with the observations of the fire crew and the operator's engineer shortly after the evacuation when there was no evidence of smoke, or bad smells in the cabin. It is possible that with the lights dimmed for takeoff, and the smoke blowing across the passenger reading lights, that the smoke appeared to be much thicker than it actually was. Nevertheless, the timing of the two unrelated events, and the concerns of the cabin attendants that the cabin was rapidly filling with smoke, was sufficient for the commander to order the evacuation of the aircraft. Communication between the commander and cabin attendants was effective and the attendants took timely action in making the decision to don their PBE, and they subsequently carried out a swift and safe evacuation of the aircraft. ATC also displayed a good level of communication in bringing the pilots attention to the failed anti-collision lights and instigating the aircraft ground incident plan. The Airport Fire Service and the London Fire Brigade responded promptly with the result that the incident was down-graded quickly to local standby and the runway was closed for only 11 minutes.