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## In-flight smoke, Boeing 777-200B, N795UA

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**Micro-summary: Cabin smoke in cruise prompts a diversion for this Boeing 777.**

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**Event Date: 2003-11-02 at 2215**

**Investigative Body: Aircraft Accident Investigation Board (AAIB), United Kingdom**

**Investigative Body's Web Site: <http://www.aaib.dft.gov/uk/>**

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## Boeing 777-200B, N795UA

<b>AAIB Bulletin No:</b> 8/2004	<b>Ref:</b> EW/G2003/11/24	<b>Category:</b> 1.1
<b>INCIDENT</b>		
<b>Aircraft Type and Registration:</b>	Boeing 777-200B, N795UA	
<b>No &amp; Type of Engines:</b>	2 Pratt & Whitney PW4090 turbofan engines	
<b>Year of Manufacture:</b>	1997	
<b>Date &amp; Time (UTC):</b>	2 November 2003 at 2215 hrs	
<b>Location:</b>	100 nm north-west of Glasgow, Scotland	
<b>Type of Flight:</b>	Public Transport (Passenger)	
<b>Persons on Board:</b>	Crew - 15	Passengers - 261
<b>Injuries:</b>	Crew - None	Passengers - None
<b>Nature of Damage:</b>	None	
<b>Commander's Licence:</b>	FAA Air Transport Pilot's Licence	
<b>Commander's Age:</b>	50 years	
<b>Commander's Flying Experience:</b>	14,793 hours (of which 1,781 were on type)	
	Last 90 days - 203 hours	
	Last 28 days - 75 hours	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot together with further investigations by the AAIB	

The aircraft was scheduled to fly from Frankfurt (Germany) to Washington (USA). After starting the engines, following the pushback off stand, the flight crew were presented with a 'PACK MODE L' message on the Engine Indication and Crew Alerting System (EICAS). This indicated that the left air conditioning pack was operating in the 'heat exchanger only' cooling mode as a result of one of a number of possible faults, including perhaps a failure in the left air cycle machine (ACM). The aircraft's departure was cancelled and engineering assistance was sought. It was discovered that the left ACM was defective and this was deactivated. The defect was deferred, in accordance with the operator's Minimum Equipment List (MEL), allowing the aircraft to operate with the remainder of its environmental systems providing the necessary air conditioning. The aircraft subsequently departed from Frankfurt four hours behind schedule.

Approximately one and a half hours into the flight, when the aircraft was 100 nm north-west of Glasgow (Scotland) at Flight Level (FL) 330, the cabin crew informed the flight crew that there was 'heavy smoke' in the cabin and that it was getting 'heavier'. In response to the commander's enquiry,

they confirmed that there were no flames. The relief pilot, who was on a rest break at the rear of the cabin at the time, stated that he was also aware of 'the smell of a hint of smoke'. The commander and co-pilot agreed to divert immediately and the commander instructed the cabin crew to "fight the fire". The commander then transmitted a MAYDAY call and ATC cleared the aircraft for a descent to FL100 and gave radar vectors for a diversion to Glasgow.

During the descent the relief pilot assisted the cabin crew in searching for the source of the smoke and any flames or hot spots. This involved removing some of the ceiling panelling in the rear galley so as to be able to look down the centreline of the cabin towards the area where the smoke had first appeared. No evidence of a fire was seen and by this stage the smoke was dissipating. The aircraft was levelled at FL100 and at about this time the flight crew noted a 'PACK MODE R' message on the EICAS. This indicated that there was a possible fault in the right air conditioning pack, similar to that which had previously occurred in the left air conditioning pack. There was also a very faint presence of smoke on the flight deck but the flight crew decided that it was insufficient to warrant the donning of oxygen masks. The redundancy in the aircraft's environmental systems meant that, despite failures in both the air conditioning packs, conditioned air continued to be supplied to the cabin and pressurisation was maintained.

The approach and landing at Glasgow were uneventful but the aircraft touched down about 28,000 lbs overweight, despite the crew jettisoning fuel, because of the need to terminate the jettisoning procedure before making the final approach to land. After the landing the aircraft was taxied on to stand accompanied by the Airport Fire Service. When the engines had been shut down, members of the fire service boarded the aircraft and confirmed that there were no signs of fire. The passengers were then disembarked without incident.

The aircraft interior and air conditioning system were subsequently checked for signs of heat damage but none was found. However, further engineering investigation did reveal that the right ACM was defective and, as a result, both it and the left ACM were replaced. The replacement of the left and right ACMs also required the respective re-heaters to be changed, since they had now both been fitted for over 4,000 hours. In addition, the right air conditioning pack 2<sup>nd</sup> stage turbine bypass valve was suspected to have seized in the closed position and a message indicated that the economy cooling valve in the right air conditioning pack was not in the commanded position. Consequently, both these components were also replaced. An overweight landing inspection was completed, but no faults were found.

The failures in the two ACMs were attributed to blockages in the condenser/reheater units in each air conditioning pack, both of which had been fitted since the aircraft was built. These blockages reduced the efficiency of the water separation process allowing excessive amounts of moisture to enter the first turbine stage of the ACMs where the air temperature is significantly reduced. As a result, water was able to collect on the turbine blades, and freeze, causing an imbalance in the rotating machinery. This imbalance led to the failure of the ACMs' air bearings and this was the probable source of the smoke in the cabin.

The aircraft manufacturer has identified the blockage and deterioration of the condenser/reheaters units as being the result of particulates, moisture or oil adhering to the inlet surfaces of the heat exchangers, depending on the aircraft's operating environment. The potential for units to become blocked, and the effect on the ACMs, was described in a Service Letter which was issued by the aircraft manufacturer in September 2001. The Service Letter also informed operators of a 'Pack Flow Restriction Test Procedure' that could be used to monitor the health of the air conditioning pack condenser/reheater. The Service Letter advised that the test procedure could be performed as a health check, at the operator's discretion, or as a troubleshooting tool. This procedure was added to the Aircraft Maintenance Manual and Fault Isolation Manual.

To address the problem of blockages in condenser/reheater units, the supplier introduced a modification which involved the application of a coating to the inlet surfaces of the heat exchangers. This modification was described in a Service Bulletin, published in May 2001, which also included the option for older units to be returned to the manufacturer for the coating to be applied.

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The operator concluded that it was likely that both sets of reheater/condenser had become blocked almost simultaneously, because they had been fitted to the aircraft for the same length of time. Since this incident the operator has taken the following actions: all reheater/condenser units fitted to their Boeing 777 fleet have been cleaned; a modification programme has been instigated to add corrosion protection to the core of the units because corrosion can also be a source of blockage; and a maintenance programme has been established to clean reheater/condensers at 30 month intervals.