INCIDENT

Aircraft Type and Registration:	Boeing 777-236, G-RAES
No & Type of Engines:	2 General Electric Co GE90-85B turbofan engines
Year of Manufacture:	1997 (Serial no: 27491)
Date & Time (UTC):	6 March 2015 at 1530 hrs
Location:	London Heathrow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 14 Passengers - 221
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	43 years
Commander's Flying Experience:	15,541 hours (of which 3,108 were on type) Last 90 days - 202 hours Last 28 days - 73 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional inquiries by the AAIB

Synopsis

The aircraft had taken off from London Heathrow Airport. During taxi, takeoff and initial climb, the crew felt unusually warm and noticed very low airflow from the flight deck vents. As the flight reached initial cruise level, all three crew members on the flight deck started to feel unwell and opened the cockpit door to improve ventilation. The decision was made to return to Heathrow with all three crew members on oxygen and the cockpit door closed.

An uneventful landing was carried out and it was found that debris in the conditioned air duct below the cockpit floor was almost completely blocking airflow to the flight deck. The source of the debris and how long it had been present could not be determined.

History of the flight

During taxi, takeoff and initial climb, the pilot and the two co-pilots noticed very low airflow from the various flight deck vents, and that the flight deck was becoming unusually warm but normal flight deck temperature control was having no effect. Passing 10,000 ft, they made a VHF radio call to MAINTROL (MAINTenance ConTROL) for technical support and any possible solutions to the airflow problem. Pressurisation and passenger cabin temperatures were normal; there were no EICAS (Engine Indicating and Crew Alerting System) or STATUS messages displayed and no smoke or fumes were detected.

All air conditioning pack, trim air and recirculation fan switches were cycled off/on one at a time and AIR COND RESET switch pressed, but the problem remained. As the flight continued at initial cruising level (FL 340), they began to feel slightly unwell. The symptoms included headache, nausea, light-headedness, a constant urge to take deep breaths and difficulty maintaining concentration. Each of the co-pilots made separate visits to the passenger cabin and noted an improvement in their condition whilst outside the flight deck. All the cabin crew felt normal. The crew reviewed the various unannunciated checklists, but none of them were relevant to their situation. A second call was made to MAINTROL with this new information, but they could not provide any solutions at that time. The crew decided to open the flight deck door temporarily in an attempt to lower the flight deck temperature and improve the air quality. They were also concerned that the cockpit electronics may not have been getting sufficient cooling due to the low airflow. Two cabin crew members were positioned by the open flight deck door at all times and the 'heavy' co-pilot remained on the flight deck for added security. In addition, the forward toilet was withdrawn from passenger use and the curtains drawn to prevent the passengers from seeing that the cockpit door was open.

The flight deck temperature reduced quite quickly, but the crew did not feel any noticeable improvement in their condition. Still feeling the symptoms, they decided that the operating co-pilot, who was Pilot Flying (PF), should don his oxygen mask and reduce the risk of any further pilot incapacitation. Within a few minutes he noted that most of his symptoms had disappeared. A third call was made to MAINTROL, but they still did not have any solutions other than what had already been tried. Their position was now north of Glasgow and they had been unable to resolve the situation.

With the flight deck door open and one pilot using his oxygen mask, they decided that they could not continue the flight. They planned to return to Heathrow with all three flight crew using their oxygen masks so that the flight deck door could be closed. A PAN PAN call was made to Air Traffic Control (ATC), with a request to jettison fuel and divert back to Heathrow. An immediate landing at the nearest suitable airport was considered, but they agreed that, with the use of oxygen masks and the flight deck door closed, the aircraft would be in a safe condition to return to its departure airport.

The commander then briefed the Cabin Service Director (CSD) using the company's "NITS" (Nature, Intention, Time, Special considerations) format. Once the cabin crew were briefed by the CSD, the pilot made an announcement to the passengers, informing them of their return to Heathrow. With these actions complete, the pilot and the heavy co-pilot donned their oxygen masks and the flight deck door was closed again for the remainder of the flight. The pilot believes the flight deck door had been open for a maximum of 15 to 20 minutes. With his oxygen mask on, he also noticed his symptoms were subsiding.

ATC vectored the aircraft out over the Irish Sea where approximately 28,000 kg of fuel was jettisoned and the flight continued on to Heathrow for a normal landing, during which the Airport Fire Service escorted the aircraft to the terminal as a precaution.

Engineering investigation

In normal operation, the Boeing 777 delivers air from the left air conditioning pack to the cockpit via two mufflers in the forward freight bay sidewall and thence into ducting feeding multiple outlets on the flight deck. There were no routine maintenance tasks to check the flight deck airflow although it was required to replace the recirculation air filters at every 'B' check (every 400 days). On G-RAES, this had last been done in September 2014.

The engineers tasked with investigating the crew reports of low airflow on G-RAES found that there was no airflow in the distribution ducting forward of panel P310 in the Main Equipment Centre underneath the flight deck. When the ducting was broken down for inspection a large amount of debris was found to be blocking the duct about 12 inches upstream from panel P310. The debris comprised wire, bubble wrap and insulation material. Further material was found in the general area when the ducting was borescoped and the blackened and brittle appearance of the debris suggested it had been there for some time.

A search of the technical records showed that, across the B777 fleet, pilot reports of low flight deck airflow existed but were sufficiently rare that it could be concluded that such problems were not endemic. The rectification actions had also been varied and it appeared that the only physical restriction found had been blocked filters.

However, on G-RAES there had been a pilot report of inadequate airflow from cockpit vents on 18 February 2015. Although it had been rectified by "cleaning restrictors", on 26 February another report was generated which complained of poor airflow through the flight deck vents and high temperatures. The recorded rectification action was that both flight deck temperature sensors were found contaminated and soiled and were causing the trim air valve to modulate to high temperatures. However, the engineer also added:

> *'Both sensors cleaned please report further, as this defect has history.'*

Two days later, on 28 February, a flight crew reported that:

> *'FYI, all puncalouvres (sic) valve in F/D have minimal airflow'*

The action taken was:

> *'Puncalouvres (sic) adjusted satis'*

The engineer involved later reported that he had found one of the punkah louvres to be misassembled.

Conclusion

The problems which afflicted the flight deck ventilation on G-RAES during February 2015 and led to the events on the incident flight were almost certainly caused by the migration of debris which had accumulated in the underfloor ducting from an unknown source at a time which could not be pinpointed.

The company's internal investigation identified two potential actions which could help prevent recurrences of a similar nature:

- Publicising the event throughout the airline to improve awareness
- Requesting the aircraft manufacturer clarify references in their Fault Isolation Manual (FIM) to airflow being 'satisfactory' or 'not satisfactory'.