INCIDENT

Aircraft Type and Registration:	DC-9-83(MD-83), G-GMJM
No & Type of Engines:	2 Pratt & Whitney JT8D-219 turbofan engines
Year of Manufacture:	1991
Date & Time (UTC):	26 January at approximately 0200 hrs
Location:	Cruise altitude over north west France
Type of Flight:	Public Transport
Persons on Board:	Crew - 7 Passengers - 167
Injuries:	Crew - none Passengers - none
Nature of Damage:	Minor to right engine jet pipe and right main landing gear door; damage to runway centreline lights on Runway 26L at London Gatwick Airport
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	35 years
Commander's Flying Experience:	8,418 hours (of which 2,181 hours were on type) Last 90 days - 221 hours Last 28 days - 75 hours
Information Source:	AAIB Field Investigation

The aircraft was operating a return charter flight from Manchester to Tenerife South. The takeoff from Manchester was flown using full power and with engine anti-icing selected 'ON '. Just prior to takeoff a cabin crew member stationed at the rear of the aircraft noticed that the noise from the engines appeared to sound slightly different to normal. He alerted the cabin supervisor via the interphone and she in turn decided to advise the commander. When she entered the flight deck however it was apparent that the aircraft was commencing its take-off run. Not wishing to distract the pilots she quickly returned to her seat. After takeoff the supervisor contacted the rear cabin to obtain an update on the situation and was told that the noise had ceased and all appeared normal. The outbound sector continued uneventfully and no further action was taken on the report.

The aircraft departed Tenerife South at 2155 hrs for the return sector to Manchester. During the initial climb, passing through FL 230, the commander reported that a slight high frequency vibration ("buzz"), lasting between 20 and 30 seconds, was felt through the rudder pedals and cabin altitude control wheel. The cabin crew at the rear of the aircraft also noticed a "loud noise and strange vibration" and reported the fact on the interphone to the cabin supervisor who in turn advised the commander. The flight deck crew checked all the aircraft systems but these showed no abnormal indications. The climb was therefore continued to a cruising level of FL 310 and the aircraft proceeded northbound. After informing the flight deck crew the supervisor visited the rear of the cabin to check on the vibration for herself. She reported back to the flight deck and confirmed the initial report. Furthermore throughout the flight she continued to keep the commander informed of conditions at the rear of the cabin.

The vibration through the altitude control wheel continued intermittently and the cabin crew stated that even though the vibration intensity reduced it was still present throughout the cruise. Unsure as to the source of the vibration the commander experimented with the thrust lever positions. This, however, was not conclusive.

At 0026 hrs, as the aircraft approached the Santiago area, the vibration through the rudder pedals re-occurred though this time it was of a much lower intensity. The commander checked with the cabin crew and they confirmed that they were experiencing vibration at the rear of the cabin. Instrument indications were normal, however, as a precaution, the commander requested a change of route to fly closer to the French coast in case an en route diversion became necessary.

After a discussion with the first officer the commander decided to disconnect the autothrottle and reduce power to approximately 1.5 engine pressure ratio (EPR) on each engine in turn to see if this had any effect on the vibration. Reduction of power on the left engine had no effect and this was returned to the normal power setting. The vibration ceased, however, when a power reduction to 1.5 EPR was made on the right engine. At the same time the commander also noticed a rapid drop in the right hydraulic quantity from 11 quarts to 6 quarts followed by a RIGHT HYDRAULIC PRESSURE LOW and RUDDER CONTROL MANUAL annunciation on the overhead panel. The abnormal check lists for HYDRAULIC QUANTITY LOW OR DROPPING and RUDDER CONTROL MANUAL were then carried out. The commander, who had earlier decided to go to the rear of the aircraft to listen for the vibration himself, decided now to remain on the flight deck but checked with the cabin staff at the rear to confirm that the vibration had ceased.

By now the aircraft was under the control of Brest ATC. The commander informed them that the aircraft was under reduced power and requested a descent to FL 280. High frequency radio contact was then attempted with the company engineers and operations for advice. Reception however was poor and as the weather in northern France was marginal, with low cloud and strong winds, the commander elected to continue towards the UK. (With a failure of the right hydraulic system the commander was committed to lower the landing gear by gravity using the alternate system. Once locked down the gear could not be retracted. Any diversion, with the gear locked down, made after an attempted approach in marginal conditions would have had a detrimental effect on fuel consumption which could have caused further problems for the crew.)

As the weather at Manchester and at other airfields in the Midlands was also deteriorating, with the surface wind close to the aircraft's crosswind limits, the commander decided to divert to London Gatwick. He advised the cabin supervisor of this and also asked to be informed on any re-occurrence of vibrations felt in the rear of the cabin.

Further examination of the right hydraulic system indicated that the quantity had now increased to 9 quarts and an attempt was made to re-pressurise the system using the electric auxiliary pump. Hydraulic quantity however rapidly reduced on pump selection confirming a leak in the right hydraulic system.

The aircraft was now under the control of London ATC. The commander declared a state of URGENCY (PAN) and informed London as to the nature of the problem. He also advised that following landing gear extension the aircraft would have a very limited diversion capability and was really committed to a landing at Gatwick. He also advised that after landing he would need engineering assistance to vacate the runway. These messages were relayed to Gatwick where the emergency services were alerted. The commander also briefed the cabin supervisor and made a PA to the passengers informing them of the situation.

The aircraft was radar vectored towards the MAYFIELD HOLD where the slats, flaps and landing gear where lowered (Final approach flap was restricted to 28° to cater for the possibility of a right engine failure or precautionary shutdown during the approach). The commander re-briefed Gatwick ATC that after landing the aircraft would need assistance to vacate the runway and informed them that as they would be landing with the landing gear doors in the extended position sparks would be seen beneath the aircraft during the landing run as the landing gear doors made contact with the runway surface.

The weather conditions at Gatwick for the approach were surface wind 260°/15 kt gusting to 38 kt, visibility 20 km with broken cloud at 2,500 and 3,500 feet. The commander decided, because of the strong surface wind and turbulence, to use the right engine normally even though this caused the vibration to return even more noticeably during the later stages of the approach. As the approach continued the aircraft experienced considerable windshear with a marked loss of airspeed. The commander reported that in his opinion recovery from this situation, which required almost go-around thrust, would have been difficult if not impossible had the aircraft made the approach on one engine.

The aircraft landed without further incident. The right landing gear door however, suffered minor damage to its sacrificial rubbing strip, when it contacted several runway centreline lights.

Flight Recorders

Following the incident the Cockpit Voice Recorder (CVR) and the Flight Data Recorder (FDR) were removed from the aircraft and replayed successfully. The CVR recording was found to contain no useful information as aircraft power had been on, with the CVR circuit breakers left in, whilst the aircraft was on the ground for longer than the 30 minutes duration of the recorder

FDR data from the incident flight was analysed using the manufacturer's nominal calibration dataand showed that eighteen minutes after take off, at an altitude of 23,000 feet, the EPRs were reduced to 1.4 for a 15 second period before restoration to 2.0. Coincident with the reduction in EPRs was the introduction of noise transients onto the values recorded for No 2 engine fuel flow and N1, the transients continued after the EPRs were increased to 2.0. Despite these transients it was possible to determine that for the same EPR the average values for fuel flow and N1 on the No 2 engine matched those of the No 1 engine for the rest of the flight. No significant noise was visible on any of the other recorded parameters.

On reaching an altitude of 31,000 feet the aircraft levelled and commenced the cruise with EPRs between 1.8 and 1.9. Two further effects were evident once the aircraft was established in the cruise, oscillations in EPR and in altitude. The EPRs oscillated over a range of 4% with a cycle period of 12 seconds, the oscillations occurred in bursts with a period between bursts of 7 minutes. Both engines were affected equally although the oscillations in the No.1 Engine lagged those in the No 2 engine by approximately 90°. Values for fuel flow and N1 on the No 1 engine varied in sympathy with the changes in EPR as did the variations of 0.006g in longitudinal acceleration. Oscillations in altitude were also observed, these had a range of 200 feet with periods of 7 minutes.

A large increase in the transients on the fuel flow values occurred 1 hour and 50 minutes into the flight and 30 minutes later, whilst the EPRs were being independently varied, the No 2 engine hydraulic pressure failed. The No 2 engine EPR was reduced to 1.5, 2 hours and 50 minutes after takeoff and remained at this setting until the start of the descent one hour later. During the descent, with EPRs set to 1.0, the transients on the fuel flow parameter reduced to a low level. On the approach both engines responded similarly producing peak EPR demands of 1.7 at 180 feet agl. The fuel flow and N1 transducers, common to both the engine indicating and flight recording systems, were tested after the incident and found to be serviceable although their operation under vibration could not be verified. The recorded altitude parameter is sourced from the aircraft's No 2 Air Data Computer.

Data from previous flights was analysed for evidence of oscillations in EPR and altitude. Flights during the previous 20 hours showed oscillations in both altitude and EPR, although those in EPR were not as marked as on the incident flight. No oscillations in EPR were evident in flights 200 flying hours, 20 days calendar time, beforehand, however the oscillations in altitude were similar to those on the incident flight. The same was true for flights 1,700 flying hours, six months calendar time prior to the incident. Data recorded on the FDR after the aircraft had returned to service showed no further oscillations in EPR, however, the oscillations in altitude continued.

Engineering Information

Engine Vibration

Examination of the aircraft after landing revealed that the tailcone from the right engine was missing and an hydraulic pipe in the rudder circuit supplied by the No 2 system had fractured.

The tailcone was found at Barcombe, near Lewes, Sussex, and metallurgical analysis showed that the primary mechanism resulting in the failure of its attachments was long term very high cycle low stress fatigue induced by vibration or noise.

The No 2 engine was returned to a Pratt & Whitney powerplant centre where a strip examination determined that a No 6 bearing carbon seal had failed, leading to a redistribution of air cooling flow around the high pressure compressor (HPC) shaft. The increased flow past the HPC shaft carried an oil mist which caused a build-up of carbon deposits on the inner shaft wall. This reduced the clearance between the HPC centre shaft and the low pressure turbine (LPT) shaft and eventually led to local contact and overheating between the two shafts. The local heating of the LPT shaft caused the shaft to twist slightly and the resulting loss of concentricity finally caused heavy engine vibration, leading to the loss of the tailcone and the fracture of the hydraulic pipe.

Rudder Oscillation

After the hydraulic pipe had been replaced an hydraulic rig was connected to the aircraft to functionally check the integrity and operation of the repaired system. Whilst hydraulic power was connected a powerful rudder oscillation was noticed which the maintenance personnel present considered would have been violent enough to cause the aircraft damage, if it had been on jacks. The oscillations had an amplitude of about 3 inches at the rudder trailing edge, and a frequency of 6 to 10 hertz. Subsequent examination showed that all four rivets in each of the two rudder dampers had sheared. The rudder dampers were fitted primarily to prevent wind loads from causing the unrestrained rudder from impacting against its stops whilst parked. Both rudder dampers and the rudder power control package were changed, but the oscillations were still present

Five other MD-80 series aircraft were examined in the UK and 5 of the 10 sets of rivets were found to have failed; the failure mechanisms involving combinations of fatigue, corrosion and shear.

Advice from Douglas Aircraft indicated that the rudder power control package need not be replaced, and that provided the rivet holes were not elongated, the rudder dampers could be re-installed. Douglas say that the problem appeared to coincide with the incorporation of Service Bulletin 27-301 (which removed a rudder pressure restrictor and improved the surface finish of the rudder actuator cylinder barrel bores), and that they knew of 42 cases at that time involving only MD-80 series aircraft. No in-flight occurrences of the problem had been reported.

During the course of the AAIB enquiries the status of the problem was elevated by Douglas Aircraft and a series of flight tests were defined to determine whether the rivets are failing as a result of flight buffeting, thereby preventing the dampers from restraining the oscillations. The tests now await the availability of a suitable aircraft, and their results, and the cause of the oscillations, will be reported when the information becomes available.