TECHNICAL REPORT IN-021/2002

DATA SUMMARY

LOCALIZACIÓN/*LOCATION*
Fecha y hora/*Date and time* Monday, 8 April 2003; 16:59 h local time
Lugar/*Site* En route Madrid (MAD)-Jerez (XRY)

AERONAVE/*AIRCRAFT*
Matrícula/*Registration* EC-EXT
Tipo y modelo/*Type and model* Mc-Donnell Douglas DC-9-87 (s/n 49837)
MOTORES/*ENGINES*
Tipo y modelo/*Type and model* Pratt & Whitney JT8D-217C
Número/*Number* 2

TRIPULACIÓN/*CREW*
Piloto al mando/*Pilot in command*
Edad/*Age* Not available
Licencia/*Licence* Airline Transport Pilot (ATPL)
Total horas de vuelo/*Total flight hours* 13081 h

LESIONES/*INJURIES*	**Muertos**/*Fatal*	**Graves**/*Serious*	**Leves**/*Minor*
Tripulación/*Crew*			6
Pasajeros/*Passengers*			89
Otras personas/*Third persons*			

DAÑOS/*DAMAGES*
Aeronave/*Aircraft* Minor. Copilot windshield broken
Otros daños/*Third parties* None

DATOS DEL VUELO/*FLIGHT DATA*
Tipo de Operación/*Operation* Domestic scheduled passenger transportation
Fase del Vuelo/*Phase of flight* En route

1.- FACTUAL INFORMATION

1.1.- Description of the event.

The aircraft was in a scheduled passenger flight between the airports of Madrid and Jerez de la Frontera (Cádiz). When established in cruise level, at 27000 ft, the right hand windshield (also called copilot o CM-2 windshield, P/N 5912290-506) shattered, at the time that smoke was seen on the right upper corner of the crystal pane. An unpleasant smell of combustion was noticed in the cockpit.

The flight crew donned their oxygen emergency masks and declared emergency on the radio. An emergency descent was carried out up to 14000 ft, after which the aircraft returned to Madrid and landed there uneventfully, without damage to persons or further damage to the aircraft.

1.2.- Description of the windshield heater system.

The windshield panels are composed of three layers (panes) of glass that bond together to make one unit. A clear vinyl laminate is between the outer and inner panes and the central pane. Both vinyl laminates contain electrically conductive metal oxide.

The three windshields (left, right and central) have an anti-ice system that prevents icing from forming outside the windshield. There is also an anti-fog system that precludes fog from accumulating inside the three windshields, the two clearview windows, and the two upper windows (eyebrow).

In the anti-ice system, the electrical current goes to the oxide in the outer laminate, located between the exterior crystal pane and the central crystal pane. There is a temperature sensor in that laminate operates the windshield anti-ice system on and off.

The anti-fog system operation is similar, except that the thermal switch is on the windshield inner surface and electrical power goes to the oxide in the inner vinyl laminate located between the inner and the central crystal panes.

In both cases, current goes to the resistances that convert it into heat to deice or defog the windshield through electrical connectors kept together by a plastic material part (see in Figure 1 the type of connectors located in each windshield and windows).

The anti-icing electrical current is controlled by means of the cockpit switch WINDSHIELD ANTI-ICE. When it is moved to “ON”, current is applied to the temperature controller of every windshield. They apply gradually power to every windshield until reaching 1500 w in 4 min. to avoid thermal shock to the crystal. Afterwards, the thermal sensors command the controllers to send more or less electrical power to the conductive laminates to keep the exterior side of the windshield between 105º y 125º F (40º y 52º C).

There is currently a maintenance task in the “Maintenance Planning Data” (MPD) every 72 FH that says “Check of cockpit windows for condition and operation”

1.3.- Inspection of the system.

After the incident, the maintenance personnel of the operator disassembled and discarded the damaged windshield and inspected the area. It was determined that the cause of the unpleasant smell, smoke and, eventually, the breakage of the crystal was the overheating of the parts of bakelite in which the electrical connections were located, due to a high consumption of the heating resistances of the windshield.

They also replaced the thermal controllers of the windshield. Afterwards, the characteristic smell was not noticed again, and there was no further malfunction of the windshield of the aircraft.

However, the exact cause of the high consumption of the resistances could not be determined. Using information provided by the aircraft manufacturer, it was concluded that the incident could be due in ultimate term to one or more loose (i.e., with a torque less than the nominal specified) electrical connections at the upper right corner of the first officer’s windshield. It is possible that a loose connection condition altered the impedance of the windshield sensing system and demanded more heat be applied to the anti-ice heater layer located between the inner pane and the central pane. Under those circumstances, according to the manufacturer, the most likely source of the reported smoke was an over current in the outer vinyl layer with the resultant pyrolization (chemical decomposition due to the heat effect) of portions of the laminate material and the overheating of the molded “plastic” connector that makes the electrical connections to the windshield heaters and sensing systems.

The applicable torque information of the screws that attach the connector to the windshield is listed in the “Standard Wiring Practices Manual”, that says “flatten the lock washer”.

1.4.- Previous maintenance record.

On 7-April-2002 a flight crew of this aircraft reported that they noticed an “irritant” smell in the cockpit that was thought to come from the left air conditioning pack. This pack was left inoperative.

The crew of the next flight on the same day noticed that the unpleasant smoke still remained during the flight. On the ground, the air conditioning system was operated for 30 min on the right hand pack only and no smell could be reproduced. The left pack was again left inoperative.

The aircraft was released for service and the next day the subject incident happened, with presence of the smell noticed previously, smoke in the cockpit and breakage of the right hand windshield.

1.5 In-service experience of the system.

The manufacturer of the aircraft informed that this event had happened other times. Their safety information system database had 18 similar events recorded, and the Boeing’s FAA Service Difficulty Reports database (which goes back to 1973) showed 80 similar incidents. The failure modes were all similar, i.e., windshield arced and subsequently cracked, after which the crew followed published procedures and maintenance removed/replaced the windshield, temperature controller, transformer, etc.

The windshields or the components of the windshield anti-ice system do not have life limits. They are replaced “on condition”, i.e., when they have failed or malfunctioned or when the windshield is no longer transparent.

No evidence was found that, even though similar events have happened in the past, any airworthiness directive was issued related to the anti-ice or anti-fog systems of the windshields of the MD-87.

Aside from possible cockpit smoke and odor considerations, the manufacturer does not consider the cracking of the outer pane or evidence of charring/arcing to be a threat to the airplane due to the windshield fail safe (multi-ply) construction, and because the arcing occurs outside the pressurized area.

Therefore, according to the manufacturer, the hazards associated to and incorrect torque applied to the screws that ended in the loosening of any connector would be possible overheating in the outer laminate layer, and associated overheating of the molded “plastic” connector that makes the electrical connections to the windshield heaters and sensing systems. Such overheating would likely produce an acrid odor and could produce a small quantity of smoke. Since the failure of the anti-ice heater occurs outside the pressure vessel, there is no hazard to the airplane and the “smoke” would dissipate as soon as the electrical power is removed or the conductive layer´s constituents have been consumed.

However, besides the manufacturer’s opinion, it should be considered that the overheating of the plastic connectors pose an actual fire hazard on the aircraft because they are located in the inner face of the windshield and, therefore, inside the pressurized area. Those parts are installed inside the primary field of vision of the pilots, and it could be argued that their overheating with smoke generation should in principle be easily detected by the crew.

Another factor to be taken into account when evaluating the hazard to the aircraft due to this type of failure is the fact that a broken windshield difficulties the vision of a pilot (if the RH or LH windshield broke) or both pilots (if the central windshield broke). This situation would have especial influence during landing. However, the probability of two windshields breaking during the same flight is very remote, because the thermal sensors, the resistances, the

transformers and the temperature controllers are independent for each of the three windshields.

Paragraph FAR 25.775 e) of the airworthiness requirements FAR-25, under which is certified the aircraft, require that “the windshields panels in front of the pilots must be arranged so that, assuming the loss of vision through any one panel, one or more panels remain available for use by a pilot seated at a pilot station to permit continued safe flight and landing.”

Additionally, even in the case that a common cause, for example hail, should impair the pilot’s vision through the three windshields, the lateral clearview windows can be opened and could be used by the pilots to help their vision during landing with the cabin not pressurized, in compliance with paragraph FAR 25.773 b)2) “Pilot compartment view”.

2.- CONCLUSION

The incident was produced probably due to a malfunctioning of the anti-ice protection system of the right hand or first officer windshield that caused a high electrical consumption for which the system was not designed.

That high electrical current eventually ended raising the temperature of the plastic connector until smoke and acrid odor were produced, and of the anti-ice system resistance until the outer crystal pane of the windshield cracked and broke.

Although the ultimate cause of the malfunction of the system could not be determined, it is possible that it was due to the loosening of one or more connectors of the thermal sensor.

Despite the facts that there was a history of previous similar breakages of windshields in the fleet, and there were two squawks of acrid odor in the cockpit the previous day of the incident, the maintenance personnel was not able to find the cause of the overheating and to repair it before releasing the aircraft for service again.

It is probable that if they would have had information on the previous similar events, especially whether some of them were associated to characteristic odor in the cockpit, the incident could have been prevented.

3.- SAFETY RECOMMENDATIONS

Although the failure that produced the incident is not considered by the manufacturer as a serious or immediate threat to the airworthiness of the aircraft, the background of similar events (up to 80 recorded in the FAA data base) makes it convenient to recommend that the corresponding information on causes and effects of the breakages of the windshield be provided to the operators. The current inspection of the MPD “Check of cockpit windows for condition and operation” every 72 FH was not enough to detect the possibility of a malfunction in the windshield anti-ice system.

REC 11-03: It is recommended to Boeing that submits to the operators of aircraft MD-87 a maintenance letter to inform them about the possibility of the in-flight cracking and break of the windshields due to malfunctions of the heating system, about the initial symptoms that precede the breakage, and about the measures to be taken in that respect.

Boeing response (ref. 17696, 18 April 2003): At the time of approval of this report, the manufacturer has informed that they are already planning to issue a Service Letter to advise DC-9/MD-80/MD-90/717 operators of the typical causes of cracked windshields and the symptoms that may accompany or precede windshield cracking. The applicable operational procedures for the “heritage Douglas Aircraft models” are currently being reviewed, and it is planned to re-write the procedures to be more complete and consistent.

Additionally, in order to reduce the possibility of improper windshield heater wiring connections, the manufacturer has also informed that revisions are being made to the Aircraft Maintenance Manual (AMM) to add a note to the appropriate sections to refer mechanics to the Standard Wiring Practices Manual (SWPM) for information regarding correct attachment of the wires to the terminal strip in the cockpit overhead and at the windshield.

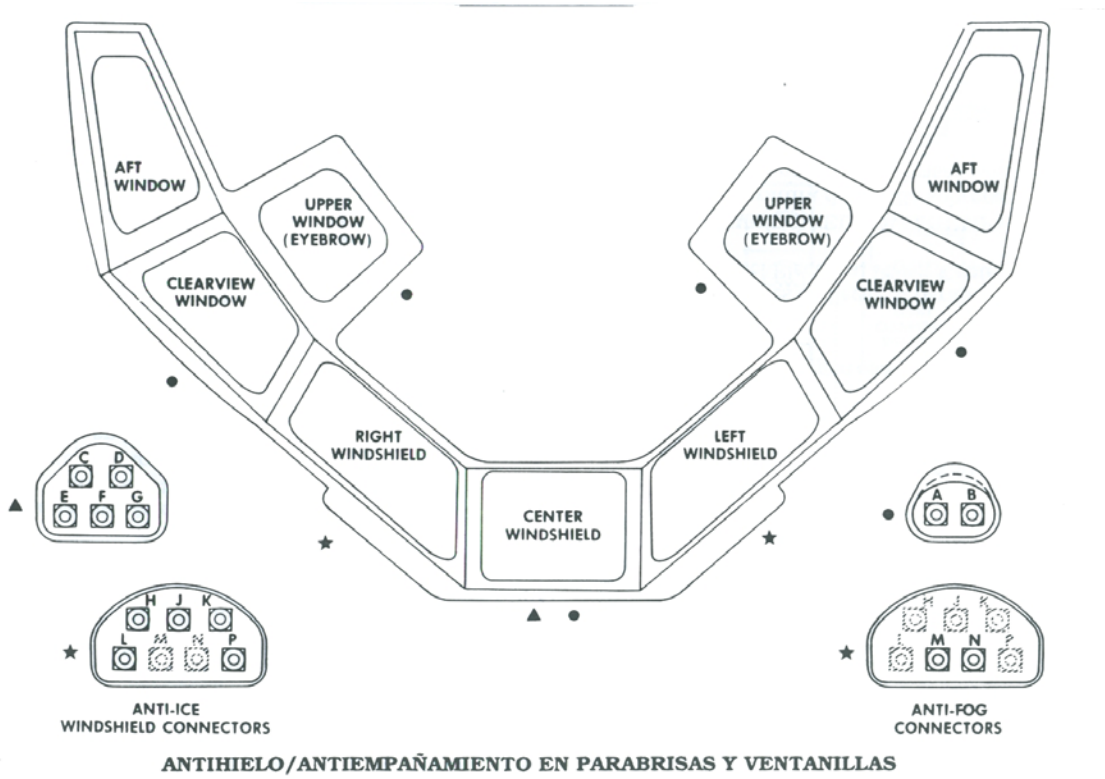

Figure 1