

CIAIAC

Comisión de Investigación
de Accidentes e Incidentes
de Aviación Civil

Preliminary report

A-32/2008

**Accident involving McDonnell Douglas
DC-9-82 (MD-82) aircraft, registration EC-
HFP, operated by Spanair, at Madrid-
Barajas Airport on 20 August 2008**

DATA SUMMARY

LOCATION

Date and time	Wednesday, 20 August 2008; 14:24 local time ¹
Site	Madrid-Barajas Airport. Madrid (Spain)

AIRCRAFT

Registration	EC-HFP
Type and model	McDonnell Douglas DC-9-82 (MD-82)
Operator	Spanair

Engines

Type and model	Pratt & Whitney JT8D-219
Number	2

CREW	Pilot in command	Co-pilot
Age	39	36
License	Airline Transport Pilot License ATPL (A)	Commercial Pilot License CPL (A)
Total flight hours	8476 ²	1276 ²
Flight hours on the type	5776	1054

INJURIES	Fatal	Serious	Minor/None
Crew	6		
Passengers	148	18	
Third persons			

DAMAGE

Aircraft	Destroyed
Other damage	12 Ha area burned

FLIGHT DATA

Operation	Commercial air transport – Scheduled – Domestic passenger
Phase of flight	Takeoff - Initial climb

PRELIMINARY REPORT

Date of approval	8 October 2008
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¹ All times in this report are local. To obtain UTC, subtract two hours from local time.

² As of 31 July 2008

0. General

This report includes the most relevant factual information as determined by the initial stages of the investigation, and constitutes the preliminary report described in Annex 13 of the Convention on International Civil Aviation. The information provided is subject to change as the investigation progresses.

On 20 August 2008 at 14:24 local time, a McDonnell Douglas DC-9-82 (MD-82) aircraft, registration EC-HFP, operated by Spanair, suffered an accident immediately after takeoff from Madrid-Barajas Airport, Madrid (Spain). The aircraft was destroyed as a result of impact with the ground and the subsequent fire. Of the aircraft's occupants, 154 were killed, including all six crew members, and 18 were seriously injured.

The Commission (CIAIAC) was notified of the accident at 14:43 by way of a telephone call placed from the Barajas Airport Operations Center (CGA in Spanish). A team of six investigators and the President of the Commission arrived in Barajas in the afternoon of the day of the accident. In keeping with international agreements, the NTSB³ of the United States of America was notified as the representative of the State of design and manufacture of the aircraft. Also informed were national civil aviation authorities and the European Aviation Safety Agency (EASA). The NTSB has appointed an accredited representative to participate in the investigation, assisted by experts from the NTSB, the FAA⁴, Boeing, as successor of the rights and obligations of the original aircraft manufacturer, and from Pratt & Whitney, the engine manufacturer. Spanair, the operator of the aircraft, is participating in and cooperating with the investigation, providing experts on operations, airworthiness and maintenance. The DGAC⁵ of Spain and the EASA are also being informed of the more salient aspects of the investigation.

1. History of the flight

The aircraft and crew had flown in the early morning of 20 August from Barcelona to Madrid in what was the first segment scheduled for that day. They departed Barcelona at 08:55 and arrived in Madrid at 10:13. The flight proceeded normally and no incidents were recorded. Their next segment was to have been from Madrid to Las Palmas. It was a regularly scheduled passenger transport flight, JKK5022, from Madrid-Barajas Airport to the airport of Gran Canaria, located on the island of the same name. The estimated departure time was 13:00.

During the stopover in Barajas, the aircraft was prepared for the flight, refueled with 10130 liters of JET A-1 fuel, and the passengers and load taken on. As stated on the load sheet, the maximum takeoff weight (MTOW) was 147000

³ The National Transportation Safety Board is the official agency for the investigation of transportation accidents in the United States of America.

⁴ The FAA, Federal Aviation Administration, is the civil aviation authority of the United States of America.

⁵ The DGAC, Dirección General de Aviación Civil, is the civil aviation authority of Spain.

pounds. The total weight of the load was 5190 pounds and of the passengers 27655 pounds. Last minute changes (LMC) were annotated on the load sheet which increased the weight by 555 pounds. The total number of passengers noted on the load sheet was 163. This number was corrected to 166 once the last minute changes were made. The crew consisted of 2 pilots and 4 cabin crew. On the whole, the actual takeoff weight (ATOW) reflected on the sheet was 141863 pounds.

The aircraft was authorized by control for engine start-up at 13:06:15⁶. It then taxied to runway 36L from parking stand T21, which it occupied on the apron of terminal T2 at Barajas. According to the information recorded on the digital flight data recorder (DFDR), the aircraft had the flaps⁷ extended 11°. Once at the runway threshold, the aircraft was cleared for takeoff at 13:24:57. The crew informed the control tower at 13:26:27 that they had a problem and that they had to exit the runway. At 13:33:12, they communicated that they were returning to the stand.

The crew had detected an overheating Ram Air Temperature (RAT) probe, and noted this in the Aircraft Technical Log Book (ATLB⁸). The maximum temperature logged on the DFDR⁹ for the probe was 104° C.

The aircraft returned to the apron, parking on remote stand R11 of the terminal T2 parking area. The crew stopped the engines and requested assistance from maintenance technicians to solve the problem. The mechanic confirmed the malfunction described in the ATLB, checked the RAT probe heating section of the Minimum Equipment List (MEL)¹⁰ and opened the electrical circuit breaker that connected the heating element. Once complete, it was proposed and accepted that the aircraft be dispatched. The information recorded on the DFDR during the taxi and subsequent takeoff run prior to the accident noted a maximum RAT probe temperature of 30° C.

The aircraft was topped off with 1080 liters of kerosene and at 14:08:01 it was cleared for engine start-up and to taxi to runway 36L for takeoff.

The crew continued with the tasks to prepare the airplane for the flight. The conversations on the cockpit voice recorder (CVR) revealed certain expressions corresponding to the before engine start checklists (denominated pre-start and before start checklists in the company's operations manual), the normal start list, the after start checklist and the taxi checklist. During the taxi run, the aircraft was in contact with the south sector ground control first and then with the central sector. On the final taxi segment the crew concluded its checks with the takeoff imminent checklist.

⁶ The time format in hours, minutes, seconds (hh:mm:ss) used in this report follows from the timestamp on the digital flight data recorder (DFDR). The correlation of times between the Control Tower clock and the data recorder was made at the moment the takeoff clearance was given prior to the accident.

⁷ Flaps is the term used for the high-lift surfaces on the trailing edge of the wing.

⁸ Aircraft Technical Log Book

⁹ Digital Flight Data Recorder

¹⁰ The Minimum Equipment List (MEL) is a list prepared by the operator and accepted by the Authority and which permits operation of an aircraft with certain instruments, equipment or functions inoperative at the start of the flight.

At 14:23:14, with the aircraft situated at the head of runway 36L, it was cleared for takeoff. Along with the clearance, the control tower informed the aircraft that the wind was from 210° at 5 knots.

The 14:00 METAR¹¹ for the airport reported good visibility, wind from 350° at 2 knots, a temperature of 28° C and QNH¹² 1019 millibars. The 14:30 METAR showed no change in visibility or temperature conditions, with wind from 180° at 7 knots, varying in direction from 90° to 240° and QNH 1018 millibars.

At 14:23:19, the crew released the brakes for takeoff. Engine power had been increased a few seconds earlier and at 14:23:28 its value was 1.4 EPR¹³. Power continued to increase to a maximum value of 1.95 EPR during the aircraft's ground run. The CVR recording shows the crew calling out "V1"¹⁴ at 14:24:06, at which time the DFDR recorded a value of 147 knots for calibrated airspeed (CAS), and "rotate"¹⁵ at 14:24:08, at a recorded CAS of 154 knots. The DFDR recorded the signal change from ground mode to air mode from the nose gear strut ground sensor. The stall warning stick shaker was activated at 14:24:14 and on three (3) occasions the stall horn and synthetic voice sounded in the cockpit: "[horn] stall, [horn] stall, [horn] stall". Impact with the ground took place at 14:24:23.

During the entire takeoff run until the end of the CVR recording, no noises were recorded involving the takeoff warning system (TOWS) advising of an inadequate takeoff configuration. During the entire period from engine start-up while at parking stand R11 to the end of the DFDR recording, the values for the two flap position sensors situated on the wings were 0°.

The length of the takeoff run was approximately 1950 m. Once airborne, the aircraft rose to an altitude of 40 feet above the ground before it descended and impacted the ground. During its trajectory in the air, the aircraft took on a slight left roll attitude, followed by a fast 20° roll to the right, another slight roll to the left and another abrupt roll to the right of 32°. The maximum pitch angle recorded during this process was 18°.

The aircraft's tailcone was the first part to impact the ground, almost simultaneously with the right wing tip and the right engine cowlings. The marks from these impacts were found on the right side of the runway strip as seen from the direction of the takeoff, at a distance of 60 m, measured perpendicular to the runway centerline, and 3207.5 m away from the threshold, measured in the direction of the runway. The aircraft then traveled across the ground an additional 448 m until it reached the side of the runway strip, tracing out an almost linear path at a 16° angle with the runway. It lost contact with the ground after reaching an embankment/drop-off beyond the strip, with the marks resuming 150 m away, on the airport perimeter road, whose elevation is 5.50 m lower than the runway strip. The aircraft continued moving along this irregular

¹¹ The METAR is the routine weather report for an aerodrome.

¹² QNH is the altimeter setting to obtain elevation while on the ground.

¹³ Engine Pressure Ratio (EPR). Value indicative of the power being supplied by the engines.

¹⁴ *VI* is the maximum speed in the takeoff at which the pilot must take the first action (e.g., apply brakes, reduce thrust, deploy speed brakes) to stop the airplane within the accelerate-stop distance. *VI* is commonly known as the decision take-off speed.

¹⁵ Voice in English that calls out the rotation speed during takeoff.

terrain until it reached the bed of the Vega stream, by which point the main structure was already in an advanced state of disintegration. It is here that it caught on fire. The resulting fire affected an area of some 12 hectares, mainly to the right of the stream, charring the vegetation which consisted of shrubs and trees. The distance from the initial impact site on the ground to the farthest point where the wreckage was found was 1093 m.

There were 172 people aboard the aircraft, of whom 148 passengers and the 6 crewmembers perished. Eighteen passengers, among them two minors, were seriously injured.

2. Aircraft information

2.1 General information

The McDonnell Douglas DC-9-82 (MD-82) aircraft received FAA type certificate No. A6WE on 29 July 1981. The original certificate holder, McDonnell Douglas, transferred its ownership rights to Boeing on 30 January 1998.

The serial number of the accident aircraft was 53148. Assembly was completed on 1 November 1993, after which it was delivered to Korean Air. In July of 1999 it was sold to its current owner and operator, Spanair, which operated it under Spanish registration EC-HFP.

2.2 High-lift devices

The MD82 is designed with high-lift devices on the trailing edge (flaps) and on the leading edge (slats).

On each wing there are two (2) sections of flaps, inner and outer. Each section is moved via two (2) hydraulic actuators, and all the sections are mechanically linked so as to synchronize all extension and retraction motions.

The slat surfaces are formed by six (6) fins on each wing, which are interlinked and function as one unit. The extension and retraction movements are controlled by hydraulic cylinders on each wing that turn a multiple pulley or drum, which is connected to a system of cables that act directly on the fins.

The flaps and slats are jointly operated in the cockpit via a lever located on the right part of the central control pedestal. The flaps and slats indicators are situated at the lower right of the central instrument panel.

2.3 Takeoff warning system (TOWS)

The MD82 features a Central Aural Warning System (CAWS) which provides various audible warnings to the crew when certain potentially unsafe conditions, inadequate configurations or operational problems with certain systems occur.

The takeoff warning system (TOWS) is part of CAWS. The TOWS activates a horn and a synthetic voice that identify the devices that are improperly configured for takeoff. It is programmed so that as the throttles are advanced on

takeoff, the pilots are alerted if the flaps, slats, trim, parking brake, auto brake or spoilers have been improperly positioned. Should one or more of these components be configured incorrectly, a synthetic voice will automatically announce them after the horn is sounded.

The TOWS is only activated on the ground and is disabled in flight.

3. Flight recorders

The aircraft was equipped with a digital flight data recorder (DFDR), a cockpit voice recorder (CVR) and a quick access recorder (QAR).

The DFDR and CVR were recovered from the aircraft wreckage late in the evening on the day of the accident. They had impact damage and showed signs of having been affected by the fire. The information recorded on them was retrieved at the AAIB¹⁶ laboratory in the United Kingdom.

The solid state DFDR has data logged corresponding to over 100 recording hours.

The airplane was equipped with two (2) digital flight guidance computers (DFGC), such that one is always functional during aircraft operations and the other is kept on standby. The crew selects, at its discretion, the DFGC it wishes to activate. Problems have been detected with the integrity and reliability of the flight parameters transmitted to the DFDR from the No. 2 DFGC. The source of this problem is still under investigation. Among the DFGC parameters recorded is the position of the slats. The DFGC is not involved in the DFDR recording of the flap position and Total Air Temperature parameters. It was noted that during the taxi and takeoff preceding the accident, the DFGC in operation was No. 2.

The CVR has four (4) sound recording channels on which the 32 minutes prior to the accident were recorded.

The QAR was found and recovered from the wreckage on Friday, 22 August, two days after the accident. The outside showed considerable impact and fire damage. Some of the information contained on its magnetic-optical disk has been retrieved with help from the manufacturer and is being analyzed.

4. Inspections and tests performed

The remains of the aircraft were scattered along the path it followed on the ground. The aircraft lost all structural integrity and its main components (fuselage and wings) were either severely fragmented or affected by the fire. The efforts involved in rescuing the victims altered the condition of the wreckage following the accident and introduced considerable additional damage.

Practically the entire aircraft wreckage has been recovered. It is being stored in anticipation of detailed inspections and examinations.

¹⁶ The AAIB (Air Accident Investigation Board) is the official aviation accident investigation agency of the United Kingdom.

Below is a description of the most significant findings revealed so far by the inspections.

4.1. Engines

The aircraft was powered by two (2) Pratt & Whitney engines, model JT8D-219, configured as 217C. The serial numbers for the No.1 (left) and No. 2 (right) engines were P728154 and P725716, respectively. The engines detached from the aircraft as it moved along the ground.

The thrust reverser¹⁷ assembly for the right engine was found some 235 m north of the first marks left by the aircraft on the runway strip, and some 846 m south of the place where the main engine body was found. Its reverse thrust reverser doors were not in the deployed position. Maintenance records showed that reverse thrust had been deactivated, preventing the reverser doors from opening. A seal was placed on the actuating lever in the cockpit to alert the crew.

The left engine thrust reverser assembly, which had also detached from the engine body, was found 913 meters north of the first marks and 144 meters south of its main engine body. Its reverser doors were found deployed.

Damage to both thrust reverser assemblies and the position of the left engine thrust reverser doors, as described above, were consistent with the damage sustained by the aircraft during its travel over the ground. There was no evidence indicating a malfunction of the thrust reverser system.

The grass covering the terrain under the wreckage was burned, and the destruction evidenced by the trees and shrubs was consistent with that from a ground fire. The No. 1 engine was surrounded by burned grass.

The lower aft part of the pylon for engine No. 1 showed damage produced by an intense fire in an area where several hydraulic lines, which had detached from the pump, were trapped between the pylon and the ground. The right hand side of the pylon came to a resting position facing the ground, while the left hand side was on top. The protective sleeves for several hydraulic lines in this area showed signs of fire damage only on the side that was facing the ground.

The damage noted on the pylon, hydraulic lines and cowlings are consistent with the damage a ground fire would produce, once the engine reached its final resting position.

An onsite visual examination of both engines revealed no evidence of case penetrations by internal engine components, no evidence of in-flight fire, and no evidence of soft body impact on fan blades. The examination revealed hard body impact damage on the leading edges of fan blades in the direction against rotation, which is consistent with impact while the engine was rotating under power.

¹⁷ The thrust reversers on the MD-82 are of the bucket type and have two elements, an upper and a lower door, which move backwards and rotate to capture the air current expelled by the engine nozzle and redirect it forward.

An initial assessment of the engine parameters recorded on the DFDR (lever positions in the cockpit, low- and high-pressure compressor rpm's, N1 and N2, respectively, engine pressure ratios (EPR), exhaust gas temperatures and fuel flow) indicates that both engines functioned properly during the entire accident sequence.

Fuel samples were taken from the tanks used to supply the aircraft during its stopover in Barajas and analyzed in a laboratory. The results show that the fuel was in compliance with specifications.

4.2. Other components, systems and equipment

Aircraft equipment and components have been identified all along the path from the first point at which the aircraft impacted the ground to the place where the main wreckage was located.

The tail assembly was found with the two stabilizers joined to each other. The elevators were attached to the horizontal stabilizer, with the ends of the assembly broken and detached, while the rudder was joined to the vertical stabilizer, this assembly maintaining its structural integrity.

Several of the structure's access panels were removed so as to allow for an inspection of its internal components. The horizontal stabilizer was disassembled to facilitate its transfer and storage. The results of the tests conducted on these components indicate that the actuating systems for the stabilizers and rudder retained their integrity, with no breaks or impact damage. The position of the spindle that acts on the horizontal stabilizer indicated that it was deflected approximately at an 8° pitch-up angle.

Five (5) flap actuators, three (3) from the right wing and two (2) from the left, were identified. Following the loss of hydraulic pressure, four (4) of these actuators were free to extend and retract, while the fifth showed considerable damage from the fire to which it was subjected after detaching from the wing structure and becoming jammed.

The two (2) slat¹⁸ actuating cylinders were found and identified, as well as the components that act directly on three (3) fins. All of these were exposed to the fire and showed signs consistent with a slats retracted configuration.

Many other components and pieces of equipment were found with varying degrees of damage, most notably the autopilot flight guidance control panels, which allowed for the position in which some of their controls were found to be recorded. Also recovered were the left and right air conditioning packs, parts of the cabin pressure control system, VHF radio units, relay panels, some cockpit panels with indicating instruments, including the flaps and slats indicators, the central throttle quadrant, a circuit breaker panel, navigation systems such as digital flight guidance computers, the stall warning computer, the ground proximity warning computer and transponders, the auxiliary power unit, cabin access doors, various remains from the fuselage and wings and parts of the nose and main landing gears.

¹⁸ The *slats* are high-lift devices on the leading edge of the wing.

5. Progress of the investigation

The investigation is continuing and is focusing on obtaining additional evidence that will allow for the configuration of the aircraft at the time of the accident, as well as the operation of its cockpit warning systems, to be determined. To that end it will be necessary to carry out exhaustive checks and inspections of those components recovered from the aircraft which will help to further this goal, as well as to perform a thorough study of the design and change of said systems over time. The performance of the aircraft will also be analyzed so as to verify agreement between its design and observed behavior. The data registered on the flight recorders are still being analyzed and refined. Data recorded in the months leading up to the accident are still being compiled to help in this effort. All operational aspects are also being investigated.