DATA SUMMARY

LOCATION

Date and time	**Tuesday, 24 February 2009; 18:40 local time[1]**
Site	**Descending 55 NM south of the Santander Airport**

AIRCRAFT

Registration	**EC-IKZ**
Type and model	**BOMBARDIER CL-600 2B19 (CRJ-200ER)**
Operator	**Air Nostrum**

Engines

Type and model	**GENERAL ELECTRIC CF-34-3B1**
Serial Number	**2**

CREW

	Pilot in command	First officer
Age	**48 years old**	**30 years old**
Licence	**ATPL**	**ATPL**
Total flight hours	**9,328 h**	**4,084 h**
Flight hours on the type	**5,052 h**	**2,824 h**

INJURIES

	Fatal	Serious	Minor/None
Crew			**4**
Passengers			**44**
Third persons			

DAMAGE

Aircraft	**None**
Third parties	**N/A**

FLIGHT DATA

Operation	**Commercial Air Transport – Scheduled – Domestic – Passenger**
Phase of flight	**Normal descent**

REPORT

Date of approval	**3rd May 2012**

[1] All times in this report are local. To obtain UTC, subtract one hour from local time.

1. FACTUAL INFORMATION

1.1. History of the flight

The crew had started its activity that day in Valencia. It was scheduled to make four flights: Valencia-Madrid, Madrid-Santander, Santander-Madrid and Madrid-Nantes.

The aircraft took off from Madrid at 18:13:27 en route to Santander. The captain was the pilot flying (PF). Twenty-six minutes into this second flight of the day, at 18:39:37, with the aircraft at FL 200 and flying at 268 kt, both of the aircraft's engines shutdown at the same time. The flight data recorder (FDR) logged a fuel flow reading of 0 kg/h to both engines.

The air-driven generator (ADG) deployed automatically to supply electrical power to the aircraft. The crew proceeded to restart the engines selecting continuous ignition. The engines started and after about one minute, at 18:40:44, the fuel flow readings returned to the values present before the engines stopped.

During the restart process, an airline flight crew member who was flying as a passenger entered the cockpit.

At 18:41:11, the crew declared emergency at the suggestion of the third crewmember who had gone to the cockpit, and reported having had a double engine failure, that they were in the process of restarting and requesting landing priority.

ATC acknowledged their request and gave them landing priority. During the communications prior to the landing, ATC inquired about the number of people who were onboard the aircraft.

Figure 1. Aircraft after landing with the ADG deployed

The rest of the flight and landing proceeded normally and without any damage or injury to the aircraft or to any of the passengers onboard. The aircraft taxied to a parking zone and the passengers deplaned normally.

The flight took place in VMC with no significant meteorological phenomena.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total on aircraft	Third persons
Fatal				
Serious				
Minor				N/A
None	4	44	48	N/A
TOTAL	**4**	**44**	**48**	

1.3. Personnel information

1.3.1. *Captain (CM-1), seated in the LH seat*

The 48-year old captain was the pilot flying (PF). He had a JAR-FCL airline transport pilot license and the CL-600 and instrument flight ratings. All were valid and in force at the time of the incident. He had a total experience of 9,328 flight hours, of which 5,052 had been on the aircraft type involved in the incident.

He had been a captain in the DHC 8-315 fleet from January 2002 until November 2004, and had been a captain in the CL-600-2B19 fleet since November 2004. Before that, from November 1999 until January 2002, he had flown as a first officer in the CL-600-2B19 fleet.

He started his duty period on the day of the incident at 13:05 after a five-day rest period.

His normal residence was in Malaga though he was based out of Valencia.

In July 2008 he had taken an airplane systems course as part of the periodic training program, which he passed with a grade of 92.5%. His last proficiency check had been on 8 September 2008, and received a mark of satisfactory.

1.3.2. *First officer (CM-2), seated in the RH seat*

The 34-year old first officer had a JAR-FCL airline transport pilot license and CL-600 and instrument flight ratings, both valid and in force at the time of the incident. He had a total experience of 4,084 flight hours, of which 2,824 had been on the aircraft type involved in the incident.

He had been a CL-600-2B19 first officer since September 2005.

He started his duty period on the day of the incident at 13:05 after a five-day rest period.

In May 2008 he had taken an airplane systems course as part of the periodic training program, which he passed with a grade of 100%. His last proficiency check had been on 2 December 2008, and received a mark of satisfactory.

1.4. Aircraft information

1.4.1. *General*

The BOMBARDIER CANADAIR CL-600-2B19 CRJ 200 is a twin-engine jet airplane with a capacity for 50 passengers and is designed for use in commuter and short-range flights. Its maximum takeoff weight is 23,133 kg.

It is powered by two GENERAL ELECTRIC CF-34-3B1, dual rotor, high-bypass ratio turbofan engines.

The incident aircraft, S/N 7732, had been manufactured in 2002. On the date of the incident it had all of the permits, certificates and insurance required to engage in operations involving the public transportation of passengers.

1.4.2. *Condition of the aircraft and maintenance*

The aircraft had a total of 16,903.72 flight hours (TSN) and 14,264 cycles (CSN).

The left engine, serial number (MSN) 873615, had 16,903 flight hours (TSN) and 14,264 cycles (CSN) and was new when it was installed on the aircraft in December 2002.

The right engine, serial number (MSN) 872428, had 23,781 flight hours (TSN) and 19,712 cycles (CSN). The engine had been overhauled in September 2008 and then installed on the aircraft on 18 September 2008. The number of flight hours since the overhaul (TSO) was 959 and the number of flight cycles (CSO) was 914.

The throttle control gearbox for the number 1 engine, part number (P/N) 2100140-010 and serial number (S/N) 324, had 13,668 flight hours (TSN) and 11,784 cycles (CSN). As for the throttle control gearbox for the number 2 engine, part number (P/N) 2100140-010 and serial number (S/N) 448, it had 12,905 flight hours (TSN) and 11,261 cycles (CSN).

No recent maintenance activities involving thrust lever inspection on rigging checks had been carried out.

There were also no reports of any power levers splits.

1.4.3. *Engine thrust control system*

The engine thrust control system is used to operate the engine. It consists of two thrust levers, two thrust reverser levers, a friction knob and stops to control the engines in the forward and reverse ranges.

The thrust levers control the application of power in the forward thrust range, and the lever settings of SHUTOFF, IDLE and MAX POWER. There are two latches (shown in red) behind each thrust levers. These latches are used to release the mechanical stops that guard against inadvertent movement of the thrust levers to SHUT OFF.

There is a takeoff-go around (TOGA) button located on each forward thrust lever.

Mechanical interlocks on the thrust levers prevent reverse thrust from being engaged until the levers are in the IDLE position.

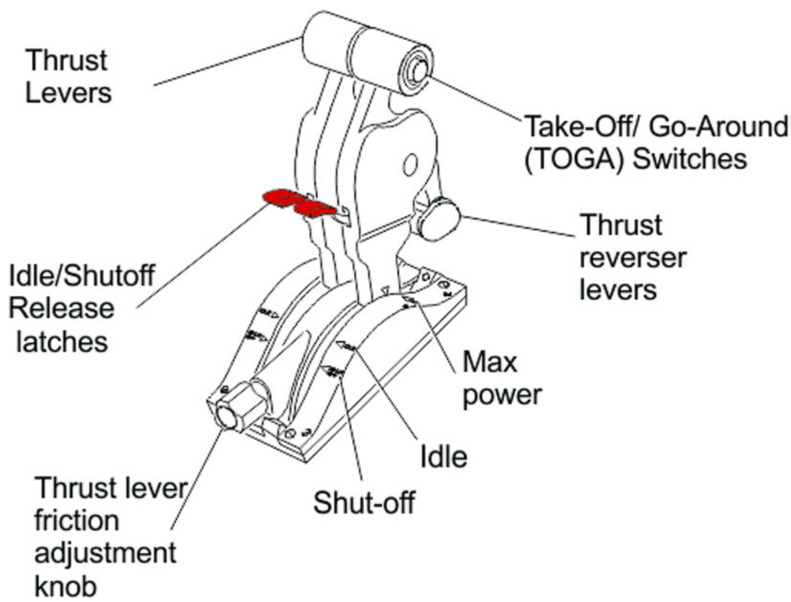


Figure 2. Engine thrust control system

Each thrust lever is connected to its associated fuel control unit by a system of cables. The thrust levers are used to control engine power from idle (IDLE) to takeoff (TO) and reverse.

The system features an electronic fuel control that engages only when the N1 fan speed is above 79%, as is the case during takeoff, climb and cruise. The N1 on the engines when the double engine shutdown took place was 47% on the left engine and 44% on the right.

1.4.4. *Aircraft fuel system*

General

The fuel system consists of three integral tanks within the wing structure, one in the center and one outboard on each wing. The system also has ejection pumps and boost pumps housed in each tank to supply fuel to each engine. At the front of the center tank there are two collector tanks. Fuel from each wing tank supplies the same-side collector tank.

The fuel system also facilitates refueling either under pressure or by gravity. A fuel system computer automatically controls refueling, allows the transfer of fuel between tanks and informs the flight crew of the amount and temperature of the fuel through the engine indicating and crew alerting system (EICAS).

Any problem detected by the fuel computer results in visual and aural messages in the cockpit.

Fuel distribution

The fuel that is supplied to each engine comes from the same-side collector tank housed in the main fuel tank. Two scavenge ejectors pumps located at the lowest part of the wing tanks supply fuel to each collector tank to keep it in a full condition. The collector tanks are designed to keep the engines fuel feed under all normal and transient flight maneuvering.

For engine start, an boost pump inside each collector tank is selected from the fuel control panel. When the output pressure required to supply the engines is reached, the boost pumps turn off automatically. If the engine supply pressure should drop, the boost pumps would energize automatically.

According to the load sheet, the aircraft had 3,000 kg of fuel on takeoff and was expected to consume 900 kg during the flight.

The fuel tanks had a maximum capacity of 6,606 kg.

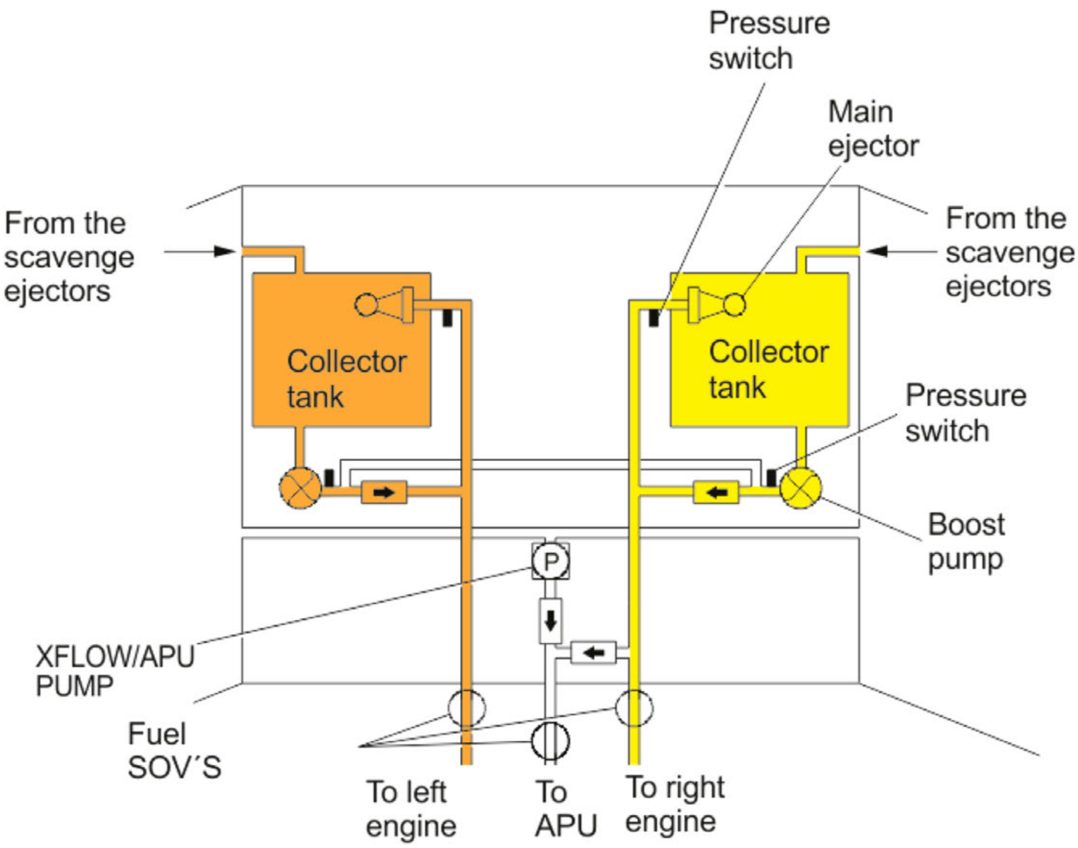


Figure 3. Diagram of fuel distribution system

1.4.5. *Engine lubrication system*

Each engine has an independent lubrication supply system consisting of an oil pump and an oil tank. The pressure pump draws oil from the tank and supplies it to the various engine components for cooling and lubrication. The accessory gearbox is driven by the engine's N2 rotor.

If oil pressure drops below 25 psi during flight, an "ENGINE OIL" aural warning is issued in the cockpit. This warning is inhibited while the airplane is on the ground.

1.4.6. *Certification of engine levers*

The Canadian certifying authority, Transport Canada Civil Aviation, issued the type certificate for the CL 600 2B19, with associated data sheet no. A-131, on 31 July 1992.

The type certificate was validated by the EASA and assigned no. IM.A.023, based on the certification issued by the German authority (LBA) on 15 January 1993. The certification standard used was "JAR 25 Large Aeroplanes, Change 13, 05 October 1989".

The certification standards of Canadian and European authorities are equivalent insofar as the engine controls are concerned. Both include the following in paragraph 1143 on "Engine controls":

(a) There must be a separate power or thrust control for each engine.
(b) Power and thrust controls must be arranged to allow—

(1) Separate control of each engine; and
(2) Simultaneous control of all engines.

(c) Each power and thrust control must provide a positive and immediately responsive means of controlling its engine.
(d) For each fluid injection (other than fuel) system and its controls not provided and approved as part of the engine, the applicant must show that the flow of the injection fluid is adequately controlled.
(e) If a power or thrust control incorporates a fuel shutoff feature, the control must have a means to prevent the inadvertent movement of the control into the shutoff position. The means must—

(1) Have a positive lock or stop at the idle position; and
(2) Require a separate and distinct operation to place the control in the shutoff position.

1.5. Meteorological information

According to the Santander Airport METAR, weather conditions at 17:30 UTC were as follows:

- Surface winds: from 90° at 9 kt.
- Visibility: in excess of 10 km.
- Cloud cover and altitude: 5/8 at 2,900 ft.
- Temperature: 9.2 °C.
- Dew point: 3.8 °C.
- QNH: 1,023 hPa.

1.6. Communications

The crew contacted Santander Tower at 18:38:49 to report that they were 16 miles away from EMANU and descending through flight level 200 to flight level 150.

ATC cleared them to perform the MOSCO2G standard arrival (see Figure 4) and to descend to FL 80. The crew replied that it preferred to go directly to the VOR to start the approach (VOR approach), to which ATC indicated that there would be traffic at the VOR in six minutes and asked if they could cross MOSCO "established"[2] on flight level 80. At that time the flight data recorder reading for the engine fuel flows indicated 0 kg/h on both.

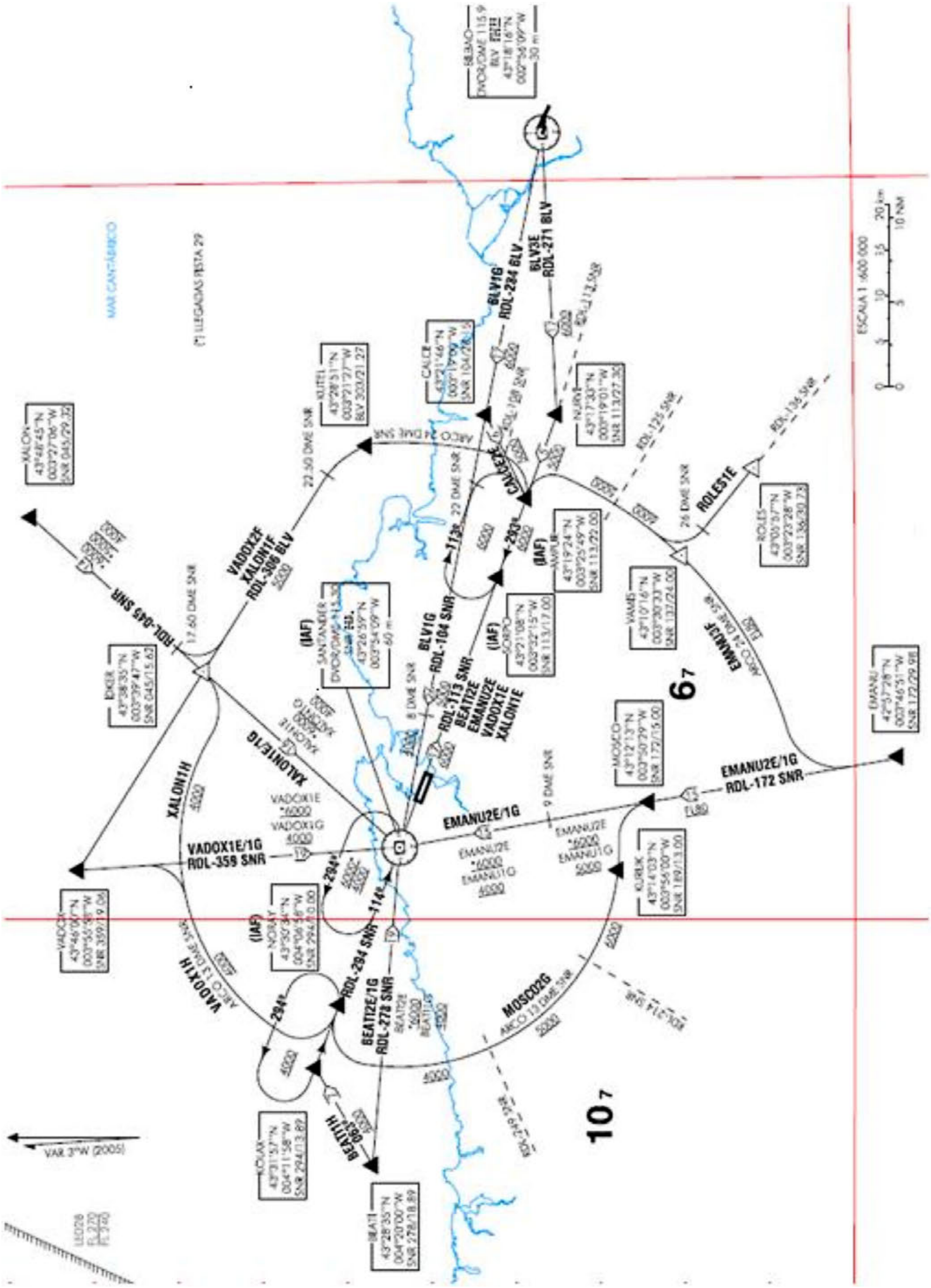


Figure 4. Standard instrument arrival chart for Santander

[2] The expression "established" means that when the aircraft crosses point MOSCO, it must be steady (level horizontal flight) at flight level 80, that is, at 8,000 feet.

At 18:41:11 the crew declared an emergency and reported a double engine failure. They requested to be number one and reported being in the process of restarting the engines. At that time the fuel flow to both engines had been reestablished.

ATC gave them priority and, at 18:42:45, cleared them for the VOR approach to runway 11.

At 18:44:39 ATC asked about the number of people onboard the aircraft, information that the crew provided.

1.7. Aerodrome information

The Santander Airport has a 3,100-m long, 45-m wide concrete runway, 11/29. The aerodrome elevation is 3.25 ft.

1.8. Flight recorders

The aircraft had a cockpit voice recorder and a flight data recorder. Both were recovered in good condition.

1.8.1. *Flight data recorder*

The flight data recorder was a Fairchild F1000 solid state recorder (SSFDR), P/N S800-2000-00, S/N 02602. It recorded 64 words per second and held a total of 100 h of data.

The information was downloaded correctly, though no information was recorded on the SSFDR between the time the engines shut down and were restarted. This is because the SSFDR is powered by the no. 1 DC bus, which is supplied by the engine-driven generators.

Appendix 1 shows the graphs for the most important engine parameters.

1.8.2. *Cockpit voice recorders*

The cockpit voice recorder was a FA2100 solid state model, P/N 2100-1020-00 and S/N 000190600, with a recording capacity of 2 hours and 4 minutes.

The CVR recorded to its six tracks, four of them in high quality and lasting 30 minutes, and two others in standard quality and lasting two hours. The CVR recording was not interrupted at any time since it is powered by the essential DC bus.

1.8.3. *Information involving the incident*

At 18:38:49, while the aircraft was at an altitude of 21,100 ft, a speed of 284 kt and fuel flow in both engines of 154 kg/h, the crew contacted the Santander Control Tower.

At the time the high-pressure compressor rpm's (N2) were 74% on engine 1 and 71% on engine 2.

At 18:39:23 the crew requested to go directly to the VOR to make a VOR approach instead of the MOSCO2G approach suggested by ATC. Their speed was 272 kt and their altitude 20,083 ft.

At 18:39:31 ATC informed them that traffic was expected to arrive at the VOR in six minutes. The speed was 270 kt and the altitude 19,833 ft.

At 18:39:37 ATC asked if the aircraft could cross MOSCO established on flight level 80. The speed was 268 kt, the altitude 19,615 ft and the fuel flow to both engines was 0 kg/h. Ten seconds later the first of four "ENGINE OIL" warnings was heard in the cockpit. At that time the high-pressure compressor rpm's were at 42% in both engines.

The flight data recorder showed simultaneous low oil pressure warnings in both engines at 18:39:43.

The last valid data were recorded on the FDR at 18:39:48.

The second "ENGINE OIL" warning was received at 18:39:50.

The ambient noise level in the cockpit increased at 18:39:51.

At 18:40:14 the first officer said "you stopped both engines, man". At no time were the pilots heard identifying the emergency or indicating that they were executing the procedure for a double engine failure in-flight.

At 18:40:44 the FDR resumed operation. The fuel flow readings were 109 kg/h in the left engine and 103 kg/h in the right.

At 18:40:52 a third person was heard in the cockpit. At 18:41:05 this third person asked if they had declared emergency. At 18:41:11 the crew declared emergency, reporting that they had experienced a double engine failure. They requested to be number one and reported being in the process of restarting the engines and proceeding to the VOR.

1.9. Tests and research

1.9.1. *Tests conducted on the aircraft following the incident*

Fuel

After the incident, fuel samples were taken from both the aircraft and from the fuel tank where the aircraft last refueled in Valencia. The analysis of the tanker fuel did not indicate any contamination.

The analysis of the onboard fuel tanks showed moderate microbiological contamination in the sample taken from the right tank.

There was no water contamination in any of the samples analyzed.

Aircraft

On 5 March 2009, the investigation team, along with the operator and the aircraft manufacturer, conducted the following checks of the aircraft:

The chip detectors in both engines were inspected. Nothing out of the ordinary was found.

Both engines were started and checked for proper operation. No warnings or alarms were received to indicate improper operation.

The ADG, which was deployed, was stowed and verified to deploy automatically when both engine-driven generators were disengaged. The fuel pumps were also verified to be working in accordance with specifications.

In addition, the thrust levers were verified to be working properly and in keeping with the specifications in the operations manual. Investigators confirmed that both engines could be stopped using just one hand. Lastly, it was shown that moving the release latches required placing the hand in a different position from that used during normal operations.

Figure 5. Positioning the lever from IDLE to SHUT OFF

Additional tests performed on the aircraft before returning it to service

Before returning the aircraft to service, the operator:

1. Checked for the presence of contamination in fuel system components.
2. Visual inspection of the fuel pumps.
3. Visual inspection of the fuel system filters and of their bypass mechanisms.
4. Replaced the fuel system filters.
5. Rigging of the fuel control units as well as the engine thrust control system.
6. Functional test of the engine thrust control system.
7. Functional test of the engine thrust control system levers.
8. Measured the tolerances of the engine thrust control system.
9. Inspected the chip detectors on the engines.
10. Checked the engine oil system.
11. Inspected the air intake duct and exhaust gas area on the engines.
12. Operational tests of the fuel pumps and the fuel shutoff valves.
13. Operational test of the reverse thrust system.
14. Measured the thrust power of both engines.
15. Tested the fan on both engines for vibrations.

All of the tests and checks were satisfactory and yielded no discrepancies.

Checks of engine thrust control system

Tests were also carried out on an aircraft of the same type and model as the incident aircraft in an effort to check the exact point between SHUT OFF and IDLE at which the engines stopped.

Pilots from the operator's CRJ-200 fleet took part in the test.

First, the distance between the IDLE and SHUT OFF marks was determined to be 0.97 cm, although the levers could move a little further, i.e. beyond the SHUT OFF mark.

The engines were then started and the amount of thrust lever travel between the IDLE mark and the point at which fuel flow read 0 was checked.

1. Left engine-left thrust lever. From IDLE until zero fuel flow was indicated, the thrust lever moved 0.55 cm.
2. Right engine-right thrust lever. From IDLE until zero fuel flow was indicated, the thrust lever moved 0.98 cm.

The pilots taking part in the test noted that the engines never shut off at the SHUT OFF position, but somewhere between IDLE and SHUT OFF.

It was also noted that operating the release latches that allow the lever to go from IDLE to SHUT OFF is not easy using the same hand position that is normally kept on the thrust levers while in flight.

1.9.2. *Report provided by the engine manufacturer*

Based on the information contained in the FDR, the engine manufacturer, General Electric, reported that the engines had stopped simultaneously in a manner consistent with a normal engine shutdown[3], given the existing flight conditions.

1.10. Organizational and management information

1.10.1. *Procedure for an in-flight double engine failure*

An analysis of the operator's emergency checklists for this aircraft, as contained in its Operations Manual, revealed that there was no defined task sharing, as was the case for the normal checklists.

Whenever both engines fail, the ADG automatically deploys to supply electricity to essential systems. In this condition, some systems are not powered, such as the PFD 2 (Primary Flight Display), the MFD 2 (Multifunction Display) and the FD 2 (Flight Director), among others. In general, the systems on the first officer's side are not energized.

Based on information in the operator's Operations Manual, should both engines fail in flight, the memory items require setting ignition to continuous and maintaining a minimum airspeed of 240 KIAS (see Appendix 2).

Step 3 requires checking the values of N1, N2 and ITT. If engine power continues to decrease, then step 4 states to place the thrust levers in SHUT OFF. Step 5 is to manually deploy the ADG. A series of tasks then follows that includes starting the APU (Auxiliary Power Unit) and, in item 13, restarting the engines using impact air to spin the engine. After this point the crew is referred to a flow chart to make the decisions involving other procedures to be carried out, such as "Windmill Relight Procedure", "APU Bleed Air Relight Procedure" and "All Engine Out Procedure".

The procedure does not describe the task sharing between the pilot flying (PF) and the pilot not flying (PNF or PM), or between CM-1 and CM-2, since the RH systems are not energized.

[3] A normal engine shutdown is understood to mean the procedure used when the aircraft is parked at the end of a flight.

1.10.2. *Engine shutdown procedure for the BOMBARDIER CL-600 2B19 (CRJ-200ER) aircraft*

For this aircraft, in keeping with the company's procedures, the left engine is shut down after exiting the runway by moving the thrust lever to the SHUT OFF position. This action is carried out by the CM-2. The aircraft thus taxies to parking on a single engine unless icing conditions exist. In order to position the levers in SHUT OFF, the latches on the levers must be released before the levers can be moved from the IDLE to the SHUT OFF position.

Once the aircraft is parked, the CM-1 shuts down the right engine by moving the thrust lever to the SHUT OFF position.

1.10.3. *Company policy on allowing people into the cockpit and sterile cockpit*

According to the airline's operations manual, there are several drawbacks to allowing access into the cockpit, including the possibility of distracting the flight crew during the performance of their tasks.

An interview conducted with the airline's operations personnel revealed that the operations manual does not envisage having a flight crew report to the cockpit during an emergency, unless the captain so requests it. This practice is also not encouraged or recommended.

1.10.4. *Information in the Operations Manual involving control of the engines*

Part B of the company's Operations Manual includes a description of the thrust control system.

Included in this description is information on the safety latches that prevent the inadvertent movement of the thrust levers into the SHUT OFF position. There is a description of the various positions of the thrust lever and, specifically, as regards the SHUT OFF position, it states that this position cuts off fuel to the engine's fuel control unit (FCU), adding that this position is at the rear mechanical stops of the thrust lever.

1.10.5. *Information in the aircraft Flight Manual on idle rate*

According to the aircraft Flight Manual, the high-pressure compressor rpm's (N2) are limited to between 56.5% and 68% when the engine is at idle.

1.11. Additional information

1.11.1. *Engine shutdown procedure in other aircraft types*

MD-80 Series

This aircraft features two levers, one to control the engines in flight and another to control fuel flow (ON/OFF). Shutting down the engines on an MD-80 series aircraft requires reducing engine thrust to IDLE and, once the levers are in this position, moving the fuel levers to the OFF position.

A320

In the case of the A320, shutting down the engines first requires placing the thrust levers in the IDLE position and then turning the ENGINE MASTER switches to the OFF position.

1.11.2. *Interviews of flight crew*

Captain

The captain reported being over point EMANU at a flight level of approximately 200 and an airspeed of 250 kt. He was the pilot flying and the first officer was handling communications. As the pilot was talking the radio, the engines shut down smoothly. In fact, he watched as the fuel flow reading dropped to zero.

Once the engines stopped he moved the thrust levers forward. He also reported moving the friction wheel in order to be able to move the levers more comfortably during the descent.

Another captain who was deadheading with them went inside the cockpit. It was he who told the first officer to declare emergency.

He added that when the engines stopped, the LH OIL PRESS and RH OIL PRESS warnings turned on at the same time. He estimates that they glided for about two minutes.

He explained that to restart, they had to bleed APU air since ram air was not enough.

He also stated that, to the best of his knowledge, the engines turned off before the SHUT OFF position was reached.

Lastly he added that placing the engine control in the off (SHUT OFF) position requires forcefully using both hands.

First Officer

The first officer stated that the captain was controlling the thrust levers during the flight. This aircraft model does not have autothrust, meaning that the thrust levers must be controlled manually during the flight.

The first officer was speaking with ATC Santander, which told them to proceed via "the arc" to make the VOR approach to runway 11. They wanted to go directly to the VOR, and ATC cleared them to MOSCO established on flight level 80.

The first officer thought that the engines had run out of fuel. According to him, it was like a normal shutdown on the parking. He also thought that the engines could be shutdown with just one hand.

He did not recall hearing the ENGINE OIL warning, but he saw both engines shut down simultaneously. He saw how the captain engaged the continuous ignition and notified him that the minimum airspeed was 240 KIAS.

He then started the APU, notified Santander and took out the QRH (Quick Reference Handbook). He remembered that the captain moved the levers several times and that the engines started by themselves, without the need for APU bleed air.

A captain who was deadheading on the flight went into the cockpit and stayed there until the end of the flight. He told them that the pressurization was correct and coordinated with the FA's to secure the cabin.

They made a visual approach to runway 11, left the runway and parked at a remote stand.

1.11.3. *Measures adopted by the company following the incident*

After the incident, the company paid special attention during training to make sure crews did not operate any guarded switches or latches without a cross check, requiring additional training if this occurred.

The airline's Flight Safety department sent a memo to all pilots in the fleet telling them to exercise caution when reaching for the flaps lever or the reversers, since this could inadvertently result in operating the latches on the thrust levers.

The incident was included as a case study in one of the CRM courses.

1.11.4. *Previous similar events*

ASRS database

NASA's ASRS database was checked and two cases were identified involving the same aircraft model in which the crew inadvertently moved the thrust lever and shut down the engines. In both cases this occurred during the landing run when the reversers, one of which was inoperative, were actuated.

Emergency landing at False River Air Park, New Roads, Louisiana

In February 1994, a Saab 340 turboprop experienced a double engine shutdown in flight and made a power-off emergency landing at False River Park. The engines shutdown while the aircraft was descending toward its destination. Onboard were 23 passengers, two pilots and one flight attendant, who sustained minor injuries during the evacuation. Everyone else was uninjured. The aircraft suffered significant damage.

The causes of the accident were determined to be the captain's movement of the thrust levers below the flight idle position, the inadequate certification requirements and consequent design of the thrust levers that permitted them to be moved below the flight idle position into the beta[4] range, either intentionally or inadvertently, while in flight, and the inadequate action taken to require a positive means to prevent beta operation on airplanes for which such operation is prohibited.

The investigation resulted in the issuance of a safety recommendation to modify the certification standards to electrically prevent beta mode from being engaged while the aircraft was airborne.

2. ANALYSIS

2.1. Analysis of the flight

The aircraft was descending toward Santander when it contacted ATC. The captain was the pilot flying. ATC cleared them to descend and make the MOSCO 2G approach. The crew did not wish to complete the MOSCO 2G approach, which would have entailed flying an arc to align with the VOR; instead, they requested to proceed directly to the VOR to complete the approach.

ATC informed them that another aircraft was expected at the VOR and asked if they could cross MOSCO "established" at FL 80. Just then, at 18:39:37, the fuel flow in both

[4] Beta mode is an operating mode below normal flight idle that can only be used on the ground. Beta mode allows the crew to engage reverse thrust in order to brake the aircraft. The beta range only refers to turboprop engines.

engines dropped to zero. The aircraft was at 19,615 ft at an airspeed of 268 kt. From that moment on, the high-compressor rpm values fell below the flight idle range until the FDR lost power and stopped recording information, since it was not supplied by the essential DC bus.

The low oil pressure warnings for both engines, indicating that the pressure had dropped below 25 psi, were heard on the CVR, followed immediately by an increase in ambient noise in the cockpit, probably due to the ADG extending as both engines stopped supplying electricity.

The crew was not heard on the CVR identifying the malfunction or expressing surprise. According to the crew's statements, the captain immediately engaged continuous ignition, which is one of the memory items in the in-flight double engine failure procedure, meaning he must have been aware of what had happened despite remaining silent throughout and not verbally identifying the malfunction or coordinating any actions with the first officer.

The minimum speed indication required to restart the engines, the other memory item in the procedure, was not heard on the CVR.

This fact is surprising since having both engines stop in flight is unexpected and is something that must be identified with sufficient authority so as to ensure proper coordination between the flight crew.

What is more, at 18:40:14 the first officer is heard on the CVR saying, "You stopped both engines, man", which shows his realization at that time of what had happened and holding the captain responsible for stopping the engines.

Shortly afterwards, at 18:40:44, the fuel flow to the engines had been reestablished, along with the electricity supplied by the engines. In other words, the engines had been restarted in 37 seconds. The amount of time spent identifying and correcting the situation was very brief.

The captain's actions were immediate, which indicates that he was aware of the dual engine stoppage from the beginning. The crew did not consider whether the engines were damaged or not, and proceeded to restart them immediately.

According to error management studies[5], the key issues for handling an unexpected situation are properly identifying said situation and knowing the proper solution to apply.

The flight data recorder does not record data on the position of the thrust levers. The tests conducted on both engines, however, along with their simultaneous shutdown, the fuel analyses and the behavior of both engines upon stopping and then restarting

[5] Flight Operation Briefing Notes. Human Performance. Error Management. AIRBUS.

indicate that the engines were stopped normally by placing the thrust levers in the SHUT OFF position.

This information indicates that the engines were shutdown by placing the thrust levers below the IDLE position, an action that does not appear to have been unnoticed. It is also likely that shutting down both engines was involuntary, meaning that the captain did not intend to shut down the engines through his actions. As already noted in point 1, moving the levers below IDLE requires releasing safety latches to override the mechanical stops. To release these latches, the hand must be placed in a position that is not normally used in flight (see Figure 5).

The captain expressed his surprise at the fact that the engines shut down before the SHUT OFF mark was reached, which indicates that he did not know for certain that the engines could stop anywhere in the range from IDLE to SHUT OFF once the mechanical stops were overridden.

As explained in the factual information section, the operations manual does not explicitly state that the engines can stop anywhere below the IDLE position. It would be prudent to state this clearly so as to eliminate any vague or erroneous notions that flight crews might have.

The reason why the captain may have positioned the thrust levers below the IDLE position could not be ascertained. At the time the engines shutdown, the crew was talking to ATC, which had cleared them to go directly to MOSCO and to establish flight level 80. This clearance meant having to descend around 13,000 ft in 30 NM, which required a descent rate of approximately 2,000 ft/min, which was the same rate they had maintained until that moment. Perhaps the captain's intention was to reduce thrust to lower the aircraft's speed, which was around 273 kt, with the maximum limit for their present altitude being 335 kt.

Once both engines were restarted, the flight crew member who was in the passenger cabin went into the cockpit. It was he who had the crew declare an emergency, which they did. Although both engines were running, the crew reported that they were in the process of restarting them and requested landing priority.

ATC cleared them for the approach and assigned them priority. The only information ATC requested was the number of passengers onboard the aircraft. On other occasions, as in this one, when emergency is declared, the flight crew does not report the number of persons onboard, something that is essential if emergency services are to be effective in performing their duties should their involvement be necessary.

This information, thus, should be included if possible when reporting an emergency so as to reduce the amount of communications and avoid interruptions at a time when the flight crew is handling an emergency in the cockpit.

The rest of the flight proceeded normally and the required checklists were performed.

2.2. Design of engine thrust control

The aircraft's engine thrust control system allows the crew not only to control the engines' output during flight, but also to shut them down. This design features mechanical stops to prevent inadvertent movements of the levers that, as explained previously, requires placing the hand in a position that is not normally used in flight. In summary, the design complies with certification requirements.

Despite this, both engines were shut down in flight. It may have been inadvertent and the captain may have operated the levers automatically without realizing what he was doing, or perhaps he was trying to reduce engine thrust below flight idle, thinking that the engines would continue running until the lever reached the SHUT OFF mark.

What does not seem likely is that the captain intended to shut down the engines in flight, though that is in fact what happened. This event highlights how an engine thrust control system whose implementation includes the possibility of shutting down the engines by mistake due to a lack of knowledge about the system is more vulnerable to an incorrect input than other thrust control system implementations in which the thrust and the fuel cutoff are independent, as in the MD and A320 designs.

It is not the first time that, despite the existence of mechanical stops, have prevented moving the thrust levers below said stops, as evidenced by the accident mentioned earlier in which the engines were placed in the beta range, or by the cases listed in NASA ASRS database in which the flight crew inadvertently shut down an engine when one of the reversers was inoperative instead of actuating the working reverser during the landing run.

As a result, design solutions could be be bring up in which engine thrust control and fuel cutoff are independent.

On the other hand, during the investigation a lack of airmanship and knowledge about aircraft systems has been identified. Then, although and independent engine thrust control and fuel cutoff is considered more robust, in this event a safety recommendation to modify the certification regulation isn't justified.

2.3. In-flight double engine failure procedure

Fortunately the engines were restarted quickly, in 37 seconds, and it was not necessary to complete the in-flight double engine failure procedure. Although the first officer reported in his statement that he turned on the APU, it was not necessary to use it to restart the engines.

In this case the pilot flying was the captain, meaning that a change in flight roles was not necessary since, although the in-flight double engine failure procedure makes no mention of this, the essential bus only supplies the left side of the cockpit. As a result, it was advantageous that the pilot flying was the captain.

The procedure also does not define the task sharing between the captain and first officer, or between the pilot flying and pilot not flying, that is required to complete the steps needed to restart the engines.

The procedure itself also refers to another set of procedures should an engine restart be feasible. This makes it difficult to complete the procedure in the high stress and high workload situation that might result from a dual engine shutdown in flight.

The in-flight double engine failure procedure should be studied in order to improve its efficiency and define the task sharing between the cockpit crew in a way that allows for the rapid completion of the tasks required to restart the engines in flight.

3. CONCLUSION

3.1. Findings

- The aircraft had the necessary certificates and licenses, all of which were valid and in force.
- Both crewmembers had the necessary licenses and certificates, all of which were valid and in force.
- It was the second flight made by the crew that day.
- As the aircraft started its descent, and after contacting air traffic control in Santander, both engines shut down simultaneously in flight.
- The ADG deployed automatically.
- The crew immediately restarted the engines.
- The engines were shut down for 37 seconds.
- Once the engines were restarted, another pilot who was flying as a passenger entered the cockpit.
- At the suggestion of this pilot, the crew declared emergency.
- ATC gave them priority and inquired about the number of persons onboard the aircraft.
- The aircraft landed normally at Santander Airport.
- Tests conducted on the engines did not indicate any malfunctions.
- Analyses of fuel samples taken from the aircraft and from the tanker used during the last refueling did not account for the stoppage of the engines.
- An analysis of the data recorded on the FDR revealed that the shutdown of the engines was normal, like when the engines are shut down at the completion of a flight.
- The operations manual does not explicitly state that the engine may stop when the thrust levers are placed anywhere between IDLE and SHUT OFF.

- The in-flight double engine failure procedure does not include task sharing between the flight crew.
- The design of the thrust control levers complies will all applicable certification requirements.

3.2. Causes

The probable cause of the shutdown of the engines in flight was placing the engine thrust levers below flight idle in an attempt to reduce engine thrust below flight idle.

4. SAFETY RECOMMENDATIONS

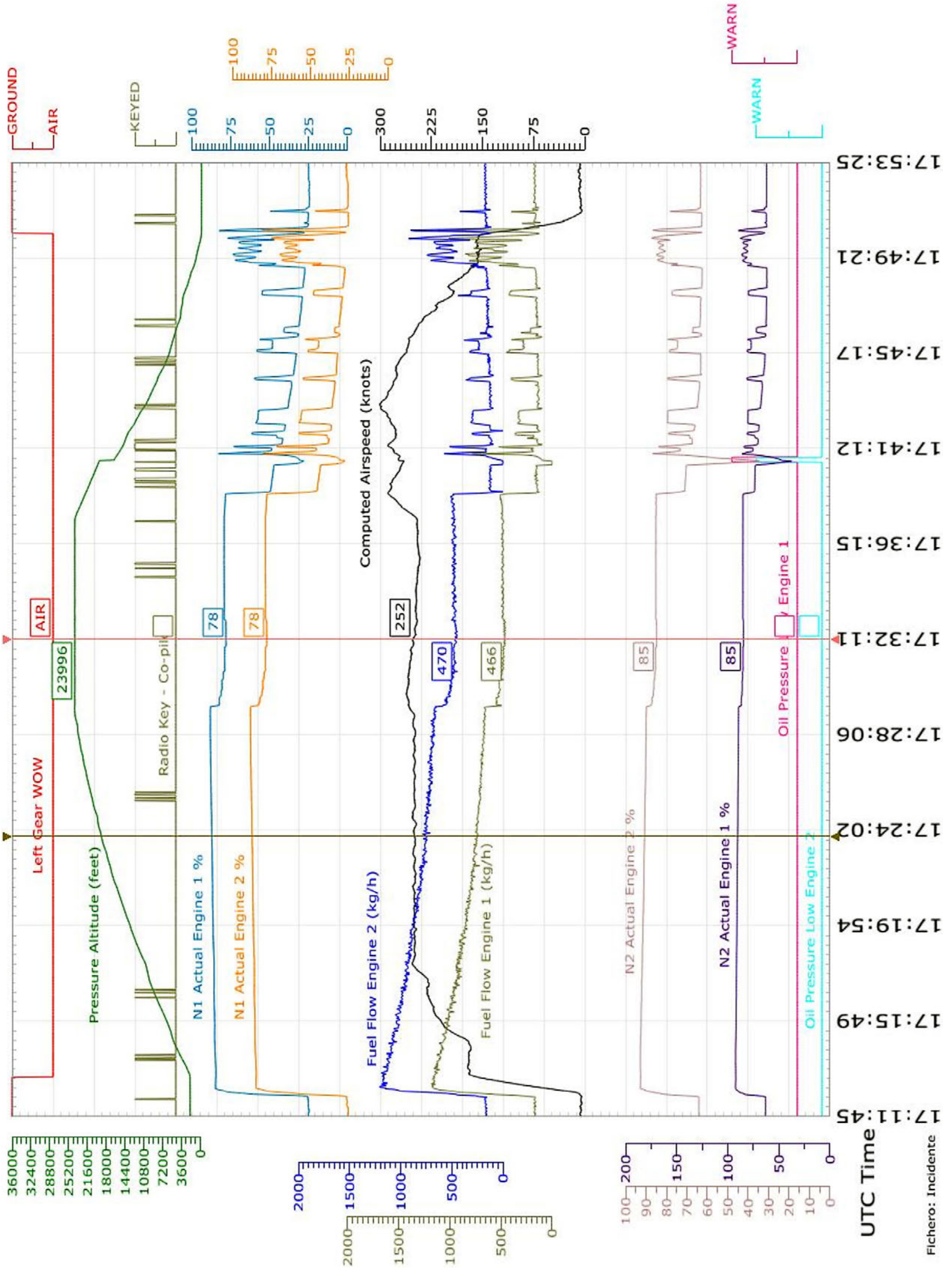
REC 01/12. It is recommended that AIR NOSTRUM modify the company operations manual to explicitly state that placing the thrust levers in any position below IDLE mark, between IDLE and SHUT OFF, could shut down the engines even before the SHUT OFF mark is reached.

REC 02/12. It is recommended that AIR NOSTRUM include as part of its emergency actions the need to report the number of people onboard the aircraft whenever an emergency is declared. This is so as to avoid additional communications or interruptions during situations that may require a high workload.

AIR NOSTRUM accepted to include as part of the Pilot Reference Manual to report the number of people onboard whenever an emergency is declared and to train this action during simulation sessions.

REC 03/12. It is recommended that AIR NOSTRUM modify its in-flight double engine failure emergency procedure so as to clearly define the task sharing and functions between the flight crew and allow for the efficient completion of the procedure and the restarting of the engines in flight.

APPENDIX 1
Engine data recorded on the DFDR


GROUND
AIR
KEYED
WARN
WARN
Left Gear WOW
Pressure Altitude (feet)
Radio Key - Co-pilo
N1 Actual Engine 1 %
N1 Actual Engine 2 %
Computed Airspeed (knots)
Fuel Flow Engine 2 (kg/h)
Fuel Flow Engine 1 (kg/h)
N2 Actual Engine 2 %
N2 Actual Engine 1 %
Oil Pressure Engine 1
Oil Pressure Low Engine 2
AIR
23996
78
78
252
470
466
85
85
17:11:45
17:15:49
17:19:54
17:24:02
17:28:06
17:32:11
17:36:15
17:41:12
17:45:17
17:49:21
17:53:25
UTC Time
Fichero: Incidente

APPENDIX 2
In-flight double engine failure checklist

CRJ Series Regional Jet	EMER 1-5
	TR RJ/93, Mar 16/07

Double Engine Failure

(1) IGNITION, CONT .... ON
(2) Airspeed .... 240 KIAS MINIMUM

(3) Engine instruments .... VERIFY N_1, N_2, ITT

If engines continue to run-down:

(4) Thrust levers .... SHUT OFF
(5) ADG manual deploy handle .... PULL

When ADG power is established:

(6) STAB TRIM, CH 2 .... SELECT
(7) Oxygen masks (if required) .... DON, SET 100%
(8) Crew communications .... ESTABLISH
(9) PASS SIGNs (both) .... ON
(10) APU (if available, 30,000 feet and below) .... START
(11) APU GEN (if APU available) .... ON

Effectivity:

- *Airplanes 7003 thru 7207* ***not incorporating*** *Canadair Service Bulletin SB 601R–34–094, Installation of a New ADC (-140) and ARP (-104).*

(12) Flight instruments .... CHECK/RESET barometric altimeter setting, altitude preselector, V-speeds and speed bug settings after generator switching.

WARNING

To avoid thermal seizure, increase airspeed as required to maintain at least 4% N_2 indicated. If the N_2 is allowed to drop to 0%, the engine may thermally seize and may not rotate even at higher airspeeds or with starter engagement.

NOTE

1. Between 21,000 feet and 15,000 feet, a minimum of 12% N_2 is necessary for a windmill relight.
2. At 15,000 feet and below, a minimum of 9% N_2 is necessary for a windmill relight.
3. Acceleration to V_{MO} is recommended to attain the necessary N_2 for a windmill relight.
4. The altitude loss when accelerating from 240 KIAS to V_{MO} could be more than 5000 feet.
5. A push-over to as steep as 15 degrees nose down may be required.

QUICK REFERENCE HANDBOOK CSP A-022-023	POWER PLANT EMERGENCIES

Relight of either engine is feasible:

Yes

Windmill relight is feasible:

Yes

(13) Glide airspeed .... ESTABLISH at V_{MO}

CAUTION

The resulting high rate of descent (up to 7800 fpm) will cause a significant reduction of available gliding distance.

(14) Proceed to **"Windmill Relight Procedure"** .... ACCOMPLISH (Refer to EMER 1-9)

- END -

No

(13) Glide airspeed .... MAINTAIN at 240 KIAS MINIMUM

(14) Proceed to **"APU Bleed Air Relight Procedure"** .... ACCOMPLISH (Refer to EMER 1-11)

- END -

No

(13) Target glide airspeed .... ESTABLISH

AIRPLANE WEIGHT	TARGET AIRSPEED
20,000 kg (44,090 lb) or below	190 KIAS
22,000 kg (48,500 lb)	200 KIAS
24,000 kg (52,910 lb)	210 KIAS

(14) Proceed to **"All Engine Out Procedure"** ... ACCOMPLISH (Refer to EMER 1-7)

- END -

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