

Technical report A-055/2019

Accident happened on 3 November 2019 to the BOEING B787-8 aircraft, registration N796AV, between VAKIN and DIRMU waypoints of the UN725 airway (Barcelona FIR/UIR)

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Notice

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission regarding the circumstances of the accident object of the investigation, its probable causes and its consequences.

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with Articles 5.5 of Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010; Article 15 of Law 21/2003 on Air Safety; and Articles 1, 4 and 21.2 of RD 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent their recurrence. The investigation is not intended to attribute any blame or liability, nor to prejudge any decisions that may be taken by the judicial authorities. Therefore, and according to the laws detailed above, the investigation was carried out using procedures not necessarily subject to the guarantees and rights by which evidence should be governed in a judicial process.

Consequently, the use of this report for any purpose other than the prevention of future accidents may lead to erroneous conclusions or interpretations.

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ABBREVIATIONS

° ' "	Degree(s), minute(s) and second(s)
°C	Degree(s) Celsius
%	A certain percentage
AEMET	Spanish Meteorology Agency
AFDS	Autopilot & Flight Director System
AIP	Aeronautical information publication
ATC	Air traffic control
ATPL	Airline Transport Pilot License
CAS	Calibrated airspeed
CPL	Commercial Pilot License
CTR	Control zone
CSN	Cycles since new
CVR	Cockpit voice recorder
E	East
FA	Flight attendant
FAA	Federal Aviation Administration
FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Training Manual
FDR	Flight data recorder
FIR/UIR	Flight information region/Upper flight information region
FL	Flight level
FMC	Flight management computer
Ft/min	Feet per minute
ft	Feet
g	Normal acceleration
h	Hour(s)
IAS	Indicated air speed
ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
ILS	Instrument landing system
km	Kilometre(s)
kt	Knot(s)
lb	Pound(s)
LEBL	Barcelona airport ICAO code
LNAV	Lateral navigation
m	Metre(s)
MCP	Mode control panel
N1	Low pressure compressor speed (two-stage compressor); fan speed (three-stage compressor)

NE	Northeast
NM	Nautic mile(s)
Nº	Number
PA	Public address system
PF	Pilot flying
PM	Pilot monitoring
QAR	Quick access recorder
SAT	Static Air Temperature
SKBO	Bogotá airport ICAO code
SW	Southwest
TSN	Time since new
UTC	Coordinated universal time
VMC	Visual meteorological conditions
VMO	maximum permissible operating speed
VMO/MMO	maximum permissible operating speed/Maximum Mach operating speed
VNAV PTH	Vertical navigation path mode
VNAV SPD	Vertical navigation speed mode

Synopsis

Operator:	Avianca
Aircraft:	BOEING B787-8, registration N796AV
Date and time of incident:	Sunday, 03 November 2019: 10:50 h ¹
Site of incident:	Airway UN725, Barcelona FIR/UIR
Persons on board:	10 crew and 251 passengers, 1 crew member and 1 passenger seriously injured
Type of flight:	Commercial air transport - Scheduled - International - With passengers
Phase of flight:	On route - Normal descent
Flight rules:	IFR
Date of approval:	30 June 2021

Summary of incident:

On 03 November 2019, the Boeing B787-8 aircraft, registration N796AV, was flying with callsign AVA018 between the airports of Bogotá (SKBO) and Barcelona/Josep Tarradellas-EI Prat (LEBL).

During the descent to Barcelona Airport through FL260, the aircraft's speed increased to a value approaching the maximum permissible operating speed (VMO) while the commander, who was the pilot at the controls (PF), was making a passenger announcement. To reduce the speed, the commander extended the speed brakes, disengaged the autopilot and pulled the control column to rear the aircraft, registering, at that moment, a maximum vertical acceleration of +2.14 g.

The commander's actions on the control column caused the aircraft's vertical acceleration to change from a maximum of +2.14 g to a minimum of +0.69 g, causing serious injuries to a passenger and a member of the cabin crew.

The aircraft continued its flight without further incident and landed at Barcelona Airport.

The injured occupants were transferred to a hospital.

The investigation has concluded the probable cause of the accident was the set of actions taken by the pilot at the controls (PF) to prevent the aircraft from exceeding the maximum

¹All times in this report are expressed in UTC. Local time at the departure airport (Bogotá) can be calculated by subtracting 5 hours from UTC. Local time at the destination airport (Barcelona) can be calculated by adding 1 hour to UTC.

permissible operating speed (VMO), which resulted in the abrupt change in vertical acceleration that seriously injured a passenger and a member of the cabin crew.

The pilot at the controls' (PF) decision to make a passenger announcement without delegating his functions to the pilot monitoring (PM) and a lack of monitoring from the latter are considered to have been contributing factors.

The report contains a safety recommendation addressed to the operator, AVIANCA.

1. FACTUAL INFORMATION

1.1. History of the flight

On 03 November 2019 at 01:44:12 h, the Boeing B787-8 aircraft, registration N796AV, took off from Bogotá Airport (SKBO) bound for Barcelona/Josep Tarradellas-EI Prat Airport (LEBL) with 261 people on board (3 pilots, 7 cabin crew and 251 passengers).

It was flying under the callsign AVA018.

After 8 and a half hours of flight, the aircraft began to fly over the Iberian Peninsula.

The flight deck was occupied by the commander who was the pilot flying (PF), the co-pilot who was the pilot monitoring (PM) and the relief pilot who was in the observer's seat.

The aircraft was flying at flight level FL410 in the Madrid FIR/UIR, following the UN725 airway. The autopilot and autothrottle were engaged.

ATC instructed the aircraft to descend to FL300, indicating that they should be established at that level five miles before the VAKIN waypoint, which is the waypoint that separates the Madrid and Barcelona FIR/UIRs.

The flight crew complied with the instruction and were transferred to ATC in Barcelona.

Holding FL300, the flight crew requested further descent, and after being cleared by ATC, the PF began the descent to FL200.

As the aircraft was still above the vertical descent profile calculated by the FMC, the PF took action to recover it by selecting a faster speed of 340 kt to increase the descent rate.

The autothrottle was in HOLD mode² and the autopilot's pitch mode was VNAV SPD³.

While maintaining his role as pilot-in-command (PF), the commander began to make a passenger announcement through the passenger announcement system (PA).

As a result of the increased speed the aircraft reached descent rates of 5,700 ft/min. The autopilot's pitch mode changed to VNAV PTH⁴.

Meanwhile, the commander continued making the announcement to the passengers through the PA, and the speed continued to accelerate, almost reaching 357 kt.⁵

When the relief pilot gave the "SPEED" callout, the commander (PF) interrupted the passenger announcement, extended the speed brakes, disconnected the autopilot and pulled the control column, which pulled the aircraft's nose up sharply. He then moved the

² In HOLD mode, the autothrottle servos are inhibited, allowing the pilot to move the thrust levers manually. It is the mode that is activated after the IDLE mode, whereby the autothrottle sets thrust at idle.

³ In VNAV SPD mode, the AFDS sets the pitch attitude necessary to maintain a certain speed during descent.

⁴ In VNAV PTH mode, the AFDS sets the pitch attitude necessary to maintain the descent profile calculated by the flight management computer (FMC).

⁵ The maximum permissible operating speed (VMO) of the B787 is 360 kt.

control column in the opposite direction by pushing it, which brought the aircraft's nose down again.

During this manoeuvre, the vertical acceleration ranged between +2.14 g and +0.69 g, causing serious injuries to a passenger and a cabin crew member.

The cabin crew treated the injured with the help of two doctors who happened to be on board and, as one of the cabin crew members was incapacitated, proceeded to redistribute their positions for landing.

The relief pilot informed ground operations that they would require assistance from the medical services on arrival.

The aircraft continued its descent, completing the ILS approach to runway 25R, and landing on it at 11:15:35 h.

After leaving the runway, it taxied to parking position 277 where the medical services were waiting to assist.

The crew did not ask for the recorders to be preserved after the accident.

1.2. Injuries to persons

<i>Injuries</i>	Crew	Passengers	Total in the aircraft	Others
Fatal				
Serious injuries	1	1	2	
Minor injuries				N/A
Unharmed	9	250	259	N/A
TOTAL	10	251	261	

1.3. Damage to the aircraft

The aircraft did not sustain any damage as a result of the events that caused the accident.

1.4. Other damage

No other damage sustained.

1.5. Personnel information

1.5.1. Commander

The 53-year-old commander had an airline transport pilot license (ATPL), issued by the Colombian government's Special Administrative Unit of Civil Aeronautics on 26 November

2008. His license carried the following ratings: F-50/A-318/A-319/A-320/A-321/B-787. His English proficiency level was level 4, valid until 05/06/2022.

His class 1 medical certificate was also valid until 17 March 2020.

According to the information provided, he had a total flight experience of 14,078 h, of which 1,580 h were in the type of aircraft involved in the incident.

1.5.2. Co-pilot

The 28-year-old co-pilot had a commercial pilot license (CPL) issued by the Colombian government's Special Administrative Unit of Civil Aeronautics on 27 June 2012. He had co-pilot ratings for A-318/A-319/A-320/A-321/B-787 relief pilot in cruise B-787. His English proficiency level was level 4, valid until 20/12/2020.

His class 1 medical certificate was also valid until 15 April 2020.

According to the information provided, he had a total flight experience of 3166 h, of which 1864 h were in the type of aircraft involved in the incident.

1.5.3. Relief pilot

The 26-year-old co-pilot had a commercial pilot license (CPL) issued by the Colombian government's Special Administrative Unit of Civil Aeronautics on 20 March 2013. He had co-pilot ratings for A-318/A-319/A-320/A-321/B-787 relief pilot in cruise B-787. His English proficiency level was level 5, valid until 24/10/2021.

His class 1 medical certificate was also valid until 10 January 2020

According to the information provided, he had a total flight experience of 2895 h, of which 485 h were in the type of aircraft involved in the incident.

1.5.4. Cabin crew

There were seven flight attendants on board.

- FA-1. The purser. Sitting in seat 1L. Total flight experience of 17,558 h, of which 1,708 were in the type of aircraft involved in the incident.
- FA-2. Sitting in seat 1R. Total flight experience of 15127 h, of which 2257 were in the type of aircraft involved in the incident.
- FA-3. Sitting in seat 2L. Total flight experience of 8636 h, of which 878 were in the type of aircraft involved in the incident.
- FA-4. Sitting in seat 2R. Total flight experience of 14409 h, of which 2218 were in the type of aircraft involved in the incident.
- FA-5. Sitting in seat 3L. Total flight experience of 5732 h, of which 1166 were in the type of aircraft involved in the incident.
- FA-6. Sitting in seat 4L. Total flight experience of 11455 h, of which 1474 were in the type of aircraft involved in the incident.
- FA-7. Sitting in seat 4R. Total flight experience of 6667 h, of which 551 were in the type of aircraft involved in the incident.

1.6. Aircraft information

1.6.1. General information

The Boeing 787-8 aircraft, serial number 65315, was manufactured in 2018 and registered with the United States Federal Aviation Administration (FAA) on 01 October 2018.

It has two Rolls Royce TRENT engines, model 1000-D2.

	Left engine	Right engine
Engine model	1000-D2	1000-D3
Serial no.	10242	11162
TSN	16,623:17	5282:05
CSN	2651	658

It has an airworthiness certificate issued on 28 September 2018 by the United States Federal Aviation Administration (FAA) and an airworthiness review certificate valid until 1 February 2020.

1.7. Meteorological information

General meteorological conditions

At medium and upper levels, there was a very intense northwesterly flow over the Peninsula with 100 kt streams to the NE and 70 kt elsewhere, at the entrance to the trough associated with storm Amelie, which was moving rapidly towards the east with its axis over the Balearic Islands.

At low levels, there was an Atlantic anticyclone centred west of the Azores and extending to the Canary Islands and a deep depression in the North Atlantic with several centres located over and to the west of the British Isles. The farthest southeast of these was called Amelie and later merged with the rest of the low-pressure system. There were very strong gusts of wind over the Peninsula due to the rapid passage of the cold front associated with Amelie, which, around the time of the accident, was approaching the Balearic Islands with scattered light rainfall in the Sierra de Tramontana and very strong winds in Mallorca and Menorca. At the same time, a warm front began to move into Galicia, producing some light rainfall.

Meteorological conditions in the area of the incident (10:50 UTC)

According to the remote-sensing images, there were few clouds, which is consistent with the presence of strong winds blowing at all levels.

The wind was expected to exceed 80 knots from the northwest at FL180, 90 kt at FL300 and reach 110 knots along the axis of the stream located around FL330. Although there

was no storm activity, it's likely there was moderate to strong turbulence above 6,000 feet, as the relevant weather maps indicated.

Having considered the data, AEMET concluded that the incident area would have been highly susceptible to moderate or strong turbulence.⁶

1.8. Aids to navigation

At the time of the accident, the aircraft was descending to Barcelona Airport between the VAKIN and DIRMU waypoints on the UN725 airway that precede the LOBAR entry point to the airport.

Figure 1 shows an extract from the AIP-Spain chart, in which these points are represented.

1.9. Communications

As part of the investigation, we analysed the audios of the communications between the different air traffic control units and the aircraft. The cockpit voice recorder (CVR) information could not be retrieved.

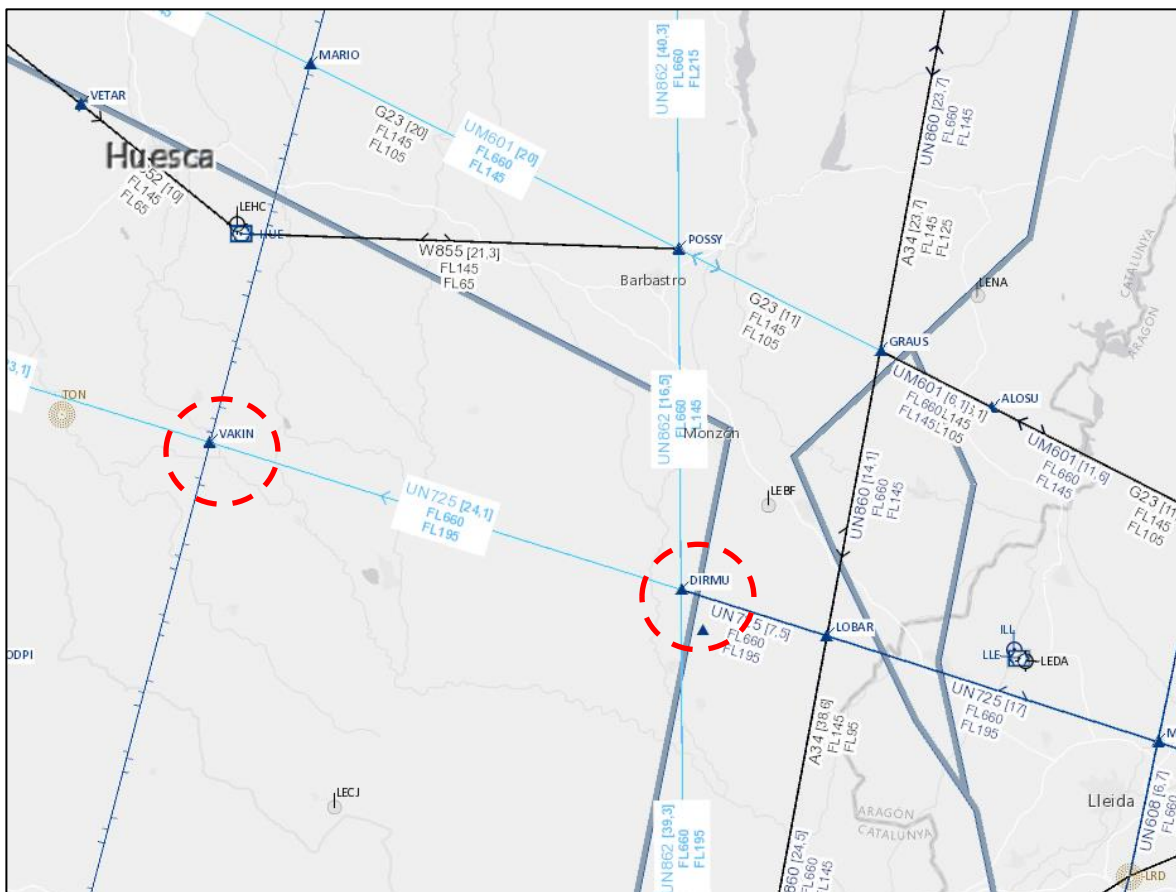


Figure 1: Extract from the AIP-Spain en-route navigation chart, in which the VAKIN and DIRMU points are encircled with a red dotted line

⁶ The wind and vertical acceleration values recorded by the QAR prior to the moment the highest speed was reached did not indicate the presence of moderate or strong turbulence. See section 1.11.

The communications were routine. The following is a summary of the communications during the period in which the accident occurred.

- At 10:49:47 h, AVA018 requests a descent to a lower level.
- At 10:49:50 h, Barcelona ATC clears AVA018 to descend to flight level 200.
- At 10:49:56 h, AVA018 acknowledges the clearance.
- At 10:52:54 h, Barcelona ATC transfers AVA018 to frequency 135.280, and AVA 018 acknowledges the frequency change.

1.10. Aerodrome information

Barcelona/Josep Tarradellas-El Prat Airport, with ICAO code LEBL, is located 10 km SW of the city of Barcelona. Its elevation is 4 metres. The airport has 3 paved runways designated as 25L/07R, 25R/07L and 02/20.

The first two are 2,660 and 3,352 m long, respectively, and 60 m wide.

Runway 02/20 is 2,528 m long by 45 m wide.

1.11. Flight recorders.

The following data was recorded by the flight recorder during the accident, between 10:49:55 h and 10:51:13 h.

At 10:49:55 h, while the aircraft was holding FL300, FL200 was selected on the MCP's altitude selector⁷.

At 10:49:57 h, the aircraft began its descent in modes⁸ IDLE/LNAV⁹/VNAV SPD. The speed (target CAS) was 318 kt.

At 10:50:05 h, passing through 29,900 ft, the autothrottle mode changed from IDLE to HOLD. The calibrated speed was 317 kt, and the pitch angle was +0.24°. The vertical speed was close to - 400 ft/min. The aircraft continued its descent in the HOLD/LNAV/VNAV SPD modes.

At 10:50:09 h, the IAS/MACH display, which indicates the speed selected on the MCP, stopped being blank and registered a progressive increase to 340 kt.

At 10:50:11 h, the engines' N1 increased to 39%.

At 10:50:23 h, the seatbelt sign went from AUTO to ON while descending through 29,000 feet.

At 10:50:25 h, while descending through 28,879 feet, the aircraft reached its maximum pitch angle value of - 5.38°.

⁷ The pilot uses the MCP or mode control panel to programme the autopilot to perform selected actions.

⁸ The AFDS flight mode indications are expressed as follows: AUTOTHROTTLE MODE / LATERAL MODE / VERTICAL MODE.

⁹ In LNAV mode, the AFDS ensures the lateral navigation corresponds to the route programmed in the FMC.

At 10:50:26 h, the autothrottle mode changed from HOLD mode to SPD,¹⁰ and a second later, the aircraft's pitch mode changed from VNAV SPD to VNAV PTH, reaching its maximum vertical speed of -5700 ft/min. The CAS was 327 kt. The aircraft continued its descent in SPD/LNAV/VNAV PTH modes.

The aircraft continued to accelerate, and by 10:50:39 h, the CAS was 340 kt and the engines' N1 was at 40%.¹¹

At 10:50:52 h, the pitch angle was -3.79°, the vertical speed was -4,300 ft/min, and the CAS was 354 kt.

At 10:50:53 h, the extension of the speed brakes was recorded.

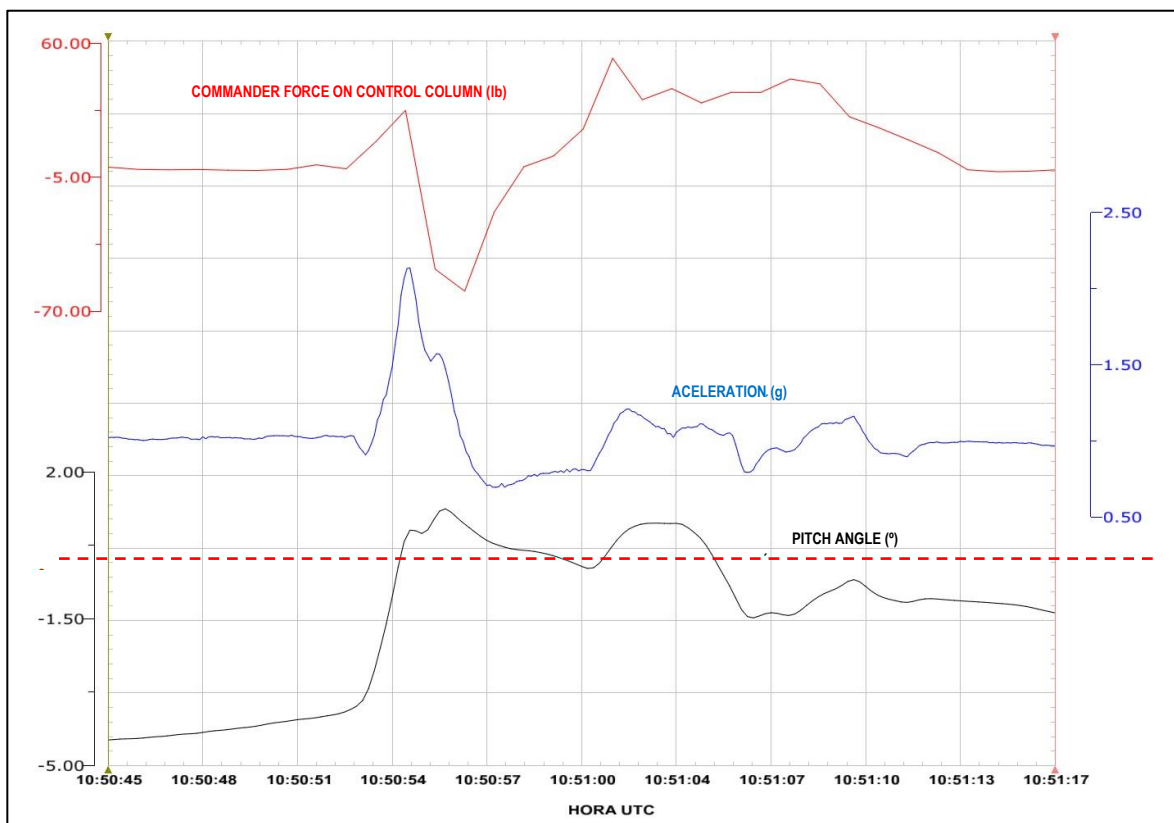


Figure 2: Parameters recorded in the flight data recorder

Between 10:50:54 h and 10:51:13 h:

- The aircraft reached its maximum speed of 356.87 kt CAS (10:50:54 h). The GPS coordinates for the point where the maximum speed was reached are 41° 47' 23.9" N and 000° 07' 48" E, close to the DIRMU waypoint.
- An increase in control column force was recorded, varying between +52.78 lb and -60.26 lb.

¹⁰ In SPD mode, the autothrottle system controls thrust to maintain the selected speed.

¹¹ Boeing explained that these values were consistent with thrust at idle.

- The vertical acceleration ranged between +2.14 g and +0.69 g. The highest vertical acceleration value of +2.14 g was recorded at 10:50:55 h, dropping to +0.69 g 3 seconds later.

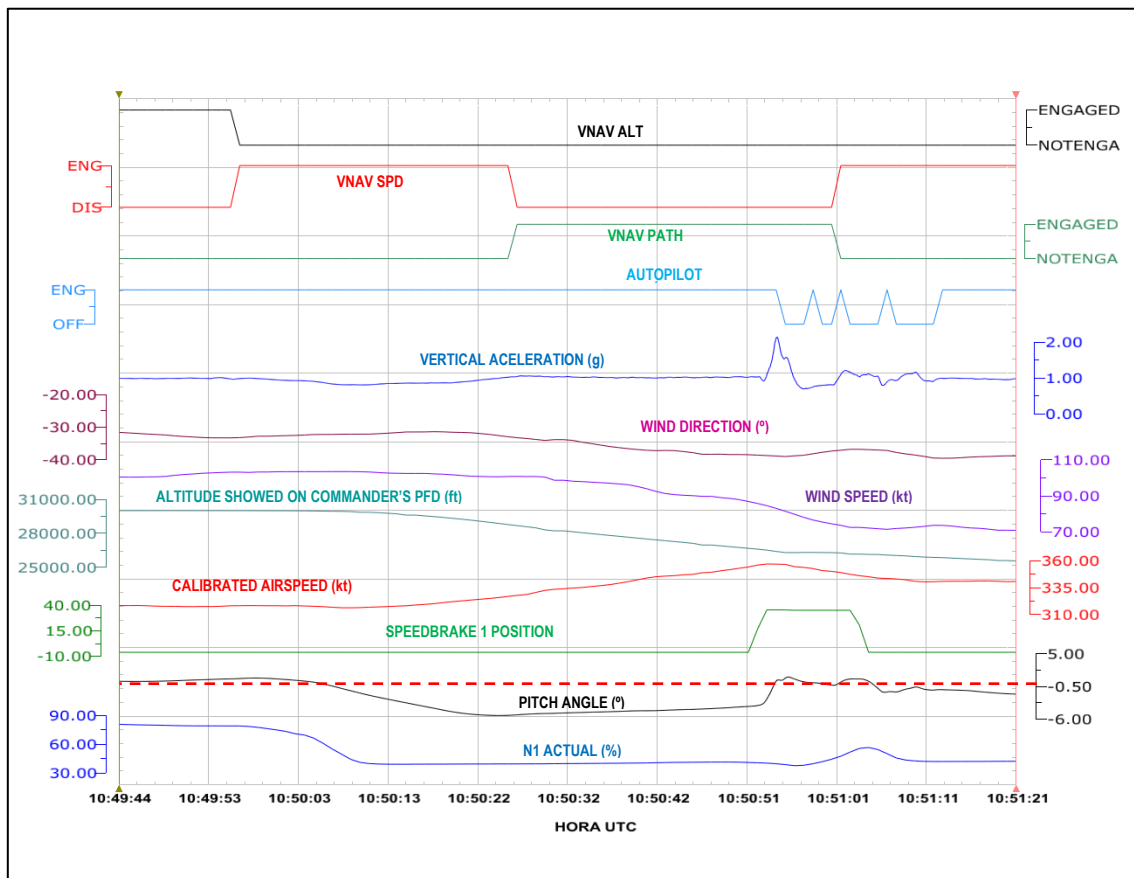


Figura 3. Parameters recorded in the flight data recorder

- During the same period, at 10:50:55 h:
 - the pitch angle reduced to +0.6 °, having changed from -3.7 ° to +0.6 ° in the space of 2 seconds.
 - the activation of the master warning and disconnection of the autopilot was recorded¹². The autopilot remained disconnected until 10:51:13 h.
- At 10:51:02 h, the autothrottle mode changed to IDLE and then HOLD. The pitch mode changed to VNAV PTH. The aircraft continued its descent in the HOLD/LNAV/VNAV SPD modes.
- After that point, the speed began to reduce, reaching 340 kt CAS at 10:51:10 h with a vertical speed of 2,077 ft/min at 25,959 ft of altitude.

¹² The autopilot disconnection is accompanied by audible and visual warnings, including the activation of the master warning light.

- Three 1-second autopilot connections and subsequent disconnections were detected at 10:50:59 h, 10:51:02 h, and 10:51:07 h.
- At 10:51:13 h, the autopilot was permanently reconnected.
- The altitude varied between 26,527 ft and 25,866 ft.

With regard to the wind and temperature parameters, at 10:50:09 h, when the aircraft descended through 29,900 ft, the wind was recorded as coming from 328° at a speed of 103 kt. The SAT was -38°C. At 10:50:54 h, when the aircraft descended through 26,500 ft, the wind was recorded as coming from 322° at a speed of 84 kt. The SAT was -34°C. These parameters are illustrated in the following diagram and in annexes 1 and 2.

1.12. Aircraft wreckage and impact information

Not applicable.

1.13. Medical and pathological information

Not applicable.

1.14. Fire

There was no fire.

1.15. Survival aspects

Not applicable.

1.16. Tests and research

1.16.1. Crew statements

Commander

The captain stated that they were descending under normal conditions with no time restrictions.

As soon as they started the descent, he gave the “crew initiating descent” callout. Furthermore, he said that as they were crossing flight level 290, he asked the co-pilot to switch on the “seat belt” sign.

He added that, during the briefing, he had informed the cabin that there was turbulence forecast on arrival in Barcelona.

He provided the meteorological information that was available at that time, which was: LEBL 10: 30Z 260/17 MAX32 MNM14KTS VIS 10KMS OR MORE CLD FEW 3000FT T18 DP 10 QNH 995, turbulence had also been reported from the ground up to 12,000 ft.

The descent was stable. He heard the SPEED callout from the first officer. The aircraft had accelerated rapidly in an unusual way, coming very close to the VMO/MMO. He reacted by

using the speed brakes, disengaging the autopilot to take control of the aircraft and avoid an OVERSPEED. He indicated that the autopilot disengaged abruptly, and then the brief but unnerving incident occurred. Later, when the aircraft stabilised, he re-engaged the autopilot and they continued their descent.

They received a call from the cabin crew stating that two people had sustained foot injuries. He coordinated with the first officers to arrange medical assistance and ambulances upon arrival at EL PRAT.

Once on the ground, he coordinated with the Avianca manager to arrange for the cabin crew who had bumped into each other to be taken for medical evaluation.

They informed him that two people had suffered foot injuries. A passenger and a cabin crew member. Some of the other members of the cabin crew told him the flight attendant sustained the injury when she fell on top of the passenger.

Co-pilot

As they approached Barcelona his rest period came to an end. He entered the flight deck to resume his position and perform the tasks of "Pilot Monitoring". He began to review all the information loaded for the descent phase, approach and aircraft performance. In his opinion, everything was in order.

The captain proceeded to carry out the approach briefing, handing control of the aircraft over to him. They began the descent to FL300. ATC asked them to cruise for 5NM at FL300 before the VAKIN waypoint. They complied with the instruction. They were then cleared for the standard arrival: LOBAR 1W (chart 10-2T5) TRANSITION SLL1W (chart 11-0D) for runway 25R.

When the briefing was finished, he handed control of the aircraft back to the captain. They removed the sunshades that partially covered the aircraft's windows, observing that there were no clouds near or in the aircraft's path.

They were in VMC and hadn't experienced any type of turbulence since he had returned from his break.

ATC instructed them to continue the descent. He switched on the seatbelt sign as per company policy.

They were above the profile. The captain decided to increase the aircraft's speed so that it would descend more quickly without the need for speed brakes, leaving a margin of between 10 and 15 knots for the VMO/MMO. The aircraft continued to accelerate on its own, without going into overspeed, and somewhere between approximately FL250 and FL240, the relief pilot gave a "Speed" callout. The captain reacted quickly, disengaging the autopilot and making the necessary adjustments to raise the aircraft's nose and slow it down. The movement, in his opinion, was sudden, and in addition to being accompanied by an upward pitch, he perceived a downward movement due to the different g-forces he felt while seated.

He switched off the autopilot disconnect alarm. The autopilot re-engaged and they continued the descent. A few minutes later, a flight attendant contacted them. The relief

pilot spoke with her and took charge of coordinating the necessary medical services on arrival as the flight attendant had indicated that the passenger's "bone was protruding".

He added that the relief pilot later told him the commander had used the speed brakes to their full capacity during the incident that occurred while descending, but he didn't notice him use them at any time.

Relief pilot

He began by stating that when they passed 29,000 feet the seatbelt sign was switched on.

As they descended through approximately 25,000 feet, he noticed the speed increase and approach the upper limit, so he called out "Speed".

The commander proceeded to correct the aircraft's trajectory using the speed brakes. The autopilot disengaged, and they felt intense g-force on the flight deck. They then received a call from the purser, which he answered. The purser notified him of the situation in the back of the plane. He then informed operations in Barcelona to coordinate the medical services while the Commander and Co-pilot prepared and continued the descent and landing.

While he was coordinating the ground medical services, the injured passenger received first aid from the cabin crew and some passengers who had offered their help as doctors.

He stressed that the atmosphere was somewhat unstable during the descent and approach to Barcelona. There had been reports of turbulence down to FL120.

FA-1 (Purser)

The flight had been uneventful. She heard the "initiating descent"¹³ command, and the seatbelt sign immediately came on. She was sitting in jump seat 1LA. The commander began to make an announcement on the PA, which he interrupted when the aircraft changed pitch sharply. She was putting on her harness at the time and, on feeling the movement, hastened to make sure it was fastened.

The movement lasted for a very short time, no more than 30 seconds.

Subsequently, she received a call from the back of the plane. She answered, and a colleague informed her that there were 2 fractures in the back galley and that she was going there to assist with first aid.

Although they were in descent, she called the flight deck to report the situation. The commander asked her to give him the details of the people involved when she had them.

She went to the back of the plane to see what happened. The passenger was on the floor on the 4L side complaining of pain and receiving assistance from 2 flight attendants. In the

¹³ The Avianca Operating Manual explains in Chapter 5 - General Operating Procedures / Normal Operation, the commands or routine calls made by the flight crew to the cabin crew depending on the flight phase. Once the descent has been started, the PIC (or the Co-pilot under instruction from the Captain) will issue the "CREW INITIATING DESCENT" command through the PA.

galley, another cabin crew member was on the floor and being assisted by a colleague. They put out a request for a doctor, and two attended.

She and another flight attendant got the rest of the passengers to sit down and inquired about their condition.

She called the flight deck to provide the data of the injured persons. She spoke to the relief pilot, who informed her that they were ready to land and that medical services would be waiting on arrival.

Upon landing, she made an announcement asking the passengers to remain seated to allow the doctors to board the plane. The doctors arrived. They attended to the situation and transferred the traveller and the cabin crew member to the ambulance. Two other flight attendants were sent to the clinic for medical evaluation.

Statements from the other cabin crew members

The statements from the other cabin crew members coincided almost exactly with the statement from the purser, adding that the crew members relocated positions for landing.

1.16.2. Information provided by Boeing

During the investigation, we asked the manufacturer, Boeing, to help us try to reproduce the event and gather information about the VNAV mode. However, with the information available during the investigation, Boeing was unable to reproduce the speed increase prior to the accident.

In all its simulations, the aircraft descended in the VNAV SPD pitch mode and did not revert to the VNAV PTH pitch mode.

According to Boeing, the only way to reproduce the increase to a speed approaching the VMO was by forcing the VNAV PTH pitch mode with a speed close to the VMO and introducing moderate turbulence.

1.17. Organisational and management information

1.17.1. VNAV descent modes

The flight crew used the VNAV mode to descend.

Specifically, in the VNAV PTH mode, the B787 adopts the pitch positions necessary to stay on the descent profile calculated by the flight management computer (FMC). In this case, the FMC prioritises following the descent path over the desired speed for the descent, allowing speed variations in order to keep to the profile. The FCTM reminds pilots that during descent, the VNAV PTH pitch mode may require the use of the speed brakes to maintain the desired speed.

In VNAV SPD mode, the B787 adopts the pitch positions necessary to maintain a certain speed during descent.

According to the operating logic of the VNAV mode, when the aircraft is above the vertical descent profile calculated by the FMC, the aircraft descends in the VNAV SPD mode. When the vertical deviation from the FMC-calculated descent path falls below 150 ft, the pitch mode reverts to VNAV PTH, indicating that the aircraft has captured the FMC descent path.

1.17.2. Flight Crew task distribution

The *Normal procedures, Introduction, Crew duties* section of the FCOM explains that during the different flight phases, the tasks carried out by the flight crew are divided between the pilot at the controls (PF) and the pilot monitoring (PM).

In general, the PF is responsible for:

- Taxiing
- Flight path and speed control
- Configuring the aircraft and
- Navigation

And the PM is responsible for:

- Reading the checklists
- Communications
- Carrying out the tasks entrusted to them by the PF and
- Monitoring the taxi, flight path, speed, configuration and navigation.

The AVIANCA Flight Operating Manual stipulates a similar distribution of tasks and refers to the FCOM, among others, for more information.

Furthermore, in its document “A Practical Guide for Improving Flight Path Monitoring” (2014), the Flight Safety Foundation offers best practices and recommendations to improve flight monitoring by flight crews. One of the best practices featured in the guide stresses that should a non-essential task interfere with the responsibilities of the PF, they may delegate that task to the PM or transfer the controls to the PM in order to carry it out.

1.17.3. Operator's internal investigation

The internal investigation carried out by the operator after the accident revealed that it had no guidelines for the issuing of passenger announcements by flight crews, allowing them to make announcements without delegating functions, even at highly vulnerable moments.

1.17.4. Crew actions in the event of an accident or serious incident

The following is an extract from chapter 10 EMERGENCIES of Avianca's operating manual:

1.10.1 CREW ACTIONS IN THE EVENT OF AN ACCIDENT OR SERIOUS INCIDENT

- *Request the removal of the FDR and CVR in the aircraft maintenance book*

1.18. Additional information

Not applicable.

1.19. Useful or effective investigation techniques

Not applicable.

2. ANALYSIS.

2.1 Analysis of the descent

After reaching and holding FL300, the aircraft remained above the vertical descent profile calculated by the FMC.

Once the descent to FL200 began and intending to recover said profile, the PF selected a speed of 340 kt, which was higher than the one the aircraft was maintaining at that time. The intent was to get the aircraft to pitch downwards to achieve this new speed with the throttle at idle, increasing the rate of descent and consequently reaching the vertical descent profile calculated by the FMC.

While performing this manoeuvre, the commander, who maintained the role of pilot at the controls (PF), issued the alert "initiating descent" and began to make a passenger announcement through the PA. In doing so, he added a non-essential task (the passenger announcement) to those he was already responsible for as PF, which were a priority, such as controlling the aircraft's trajectory and speed.

The logic of the VNAV system changed to VNAV PTH, and the speed continued to increase, approaching the VMO, without the pilot-in-command (PF) making use of the speed brakes to maintain the desired speed value.

Should a non-essential task, such as a passenger announcement, interfere with the responsibilities of the PF, which include controlling the flight path and speed, it is recommended that the PF delegate this new task to the PM or carry it out after the controls have been transferred to the PM.

We consider it probable that the additional task of making the passenger announcement distracted the commander from his priority responsibilities as PF. He, therefore, failed to detect the increase in speed indicated by the change of the AFDS pitch mode to VNAV PTH after capturing the vertical profile and did not use speed brakes to maintain speed at the desired value.

Although the PM's tasks include monitoring the flight path and speed, he also failed to detect the increase in speed.

It wasn't until the relief pilot gave the SPEED callout as the speed approached the VMO that the commander interrupted the passenger announcement, extended the speed brakes, disengaged the autopilot and pulled the control column to reduce speed. These actions resulted in an abrupt change in pitch axis that, together with the subsequent corrections made on the control column, produced the change in acceleration that caused serious injuries to a passenger and a cabin crew member.

Boeing was unable to reproduce the speed increase prior to the accident with the information supplied to them during the investigation. In all its simulations, the aircraft descended in the VNAV SPD pitch mode and did not revert to the VNAV PTH pitch mode.

2.2 Subsequent actions

The commander did not request the preservation of the cockpit voice recorder (CVR) after the flight.

Avianca's Operating Manual establishes that one of the actions to be taken by the crew in the event of an accident or serious incident is to request the removal of FDR and CVR in the aircraft maintenance book.

3. CONCLUSIONS

3.1. Findings

- There were no limiting meteorological conditions for the flight.
- In descent to FL200, the commander, with the throttles at idle, increased speed to 340 kt, intending to increase the rate of descent and thus capture the descent profile.
- While maintaining his role as pilot-in-command (PF), the commander began to make a passenger announcement without delegating his responsibilities as PF to the pilot monitoring (PM).
- The AFDS pitch mode changed from VNAV SPD to VNAV PTH.
- The aircraft continued to accelerate, approaching the maximum permissible operating speed (VMO) of 360 kt.
- The maximum speed recorded was 356.87 kt and, therefore, did not exceed the maximum permissible operating speed (VMO).
- The relief pilot alerted the other members of the flight crew by giving the SPEED callout.
- The commander and pilot at the controls (PF) interrupted the passenger announcement, extended the speed brakes, disengaged the autopilot and pulled the control column, pulling the aircraft's nose upwards.
- The manoeuvre to avoid exceeding the VMO resulted in +2.14 g of vertical acceleration.
- The commander's actions on the control column produced a change in acceleration, with a maximum of +2.14 g and a minimum of +0.69 g, that caused serious injuries to a passenger and a cabin crew member.
- The captain did not request the preservation of the cockpit voice recorder (CVR) after the flight.

3.2. Causes/contributing factors

The investigation has concluded the probable cause of the accident was the set of actions taken by the pilot at the controls (PF) to prevent the aircraft from exceeding the maximum permissible operating speed (VMO), which resulted an abrupt change in vertical acceleration that seriously injured a passenger and a member of the cabin crew.

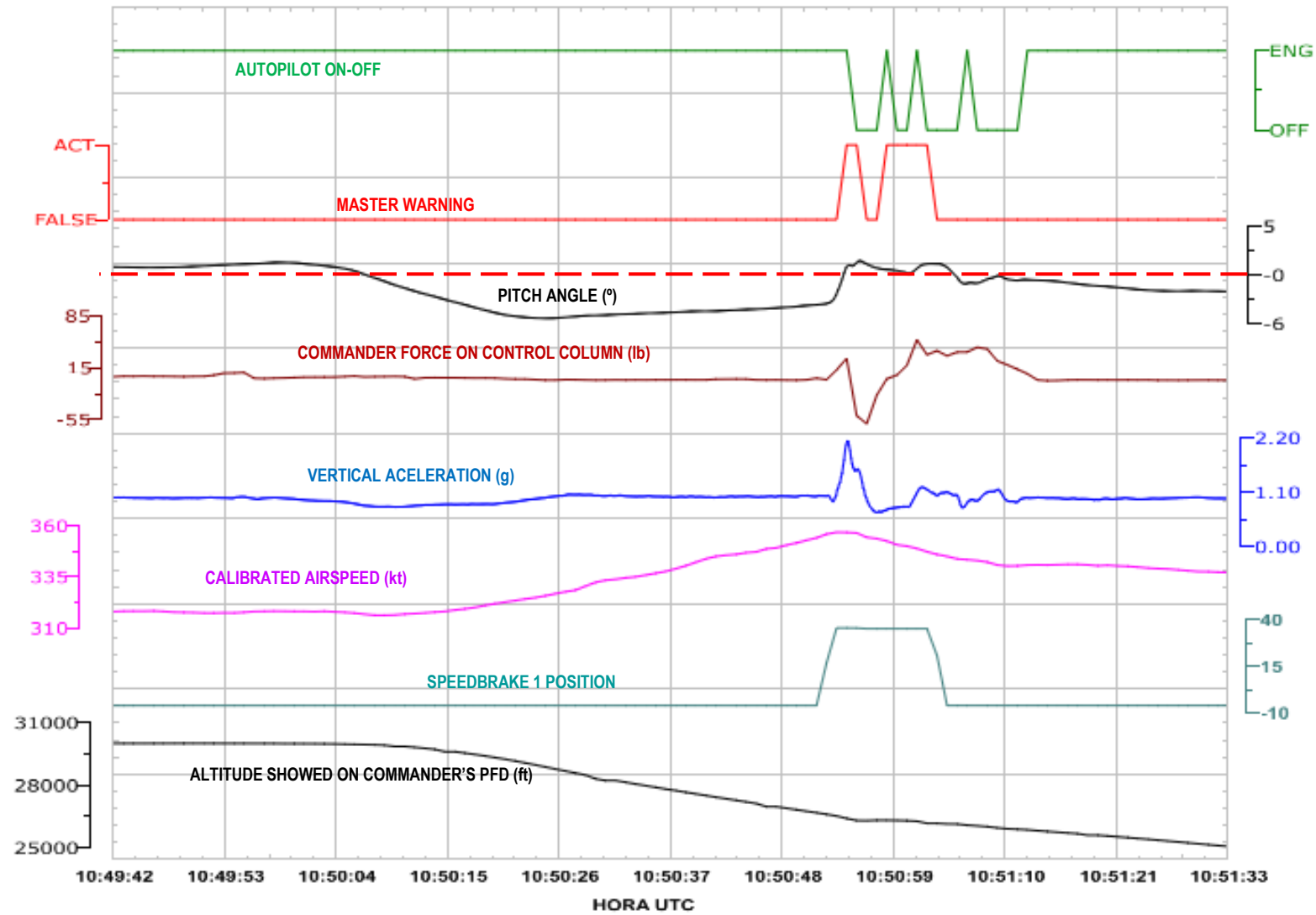
The pilot at the controls' (PF) decision to make a passenger announcement without delegating his functions to the pilot monitoring (PM) and a lack of monitoring from the latter are considered to have been contributing factors.

4. OPERATIONAL SAFETY RECOMMENDATIONS

The AVIANCA Flight Operating Manual covers the distribution of tasks between the members of the flight crew. However, the internal investigation carried out by the operator after the accident revealed that it had no guidelines for the issuing of passenger announcements by flight crews, allowing them to make announcements without delegating functions, even at highly vulnerable moments. Therefore, in line with the Flight Safety Foundation's "A Practical Guide for Improving Flight Path Monitoring" (2014), which offers best practices to improve monitoring by flight crews, the following recommendation is issued:

REC 32/21: It is recommended that AVIANCA establish guidelines for distributing tasks among the members of the flight crew when passenger announcements are being made from the flight deck.

ANNEX 1 – FLIGHT PARAMETERS



ANNEX 2 – AUTOPILOT PARAMETERS

