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Report A-012/2020

Accident involving a Piper PA-60-602P aircraft, registration EC-HRJ, on final approach to Pamplona Airport (Navarra) on 20 February 2020

GOBIERNO DE ESPAÑA

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Advertencia

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission (CIAIAC) regarding the circumstances of the accident object of the investigation, and its probable causes and 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 (UE) nº 996/2010, of the European Parliament and the Council, of 20 October 2010; Article 15 of Law 21/2003 on Air Safety and articles 1., 4. and 21.2 of Regulation 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future civil aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent from their reoccurrence. The investigation is not pointed to establish blame or liability whatsoever, and it's not prejudging the possible decision taken by the judicial authorities. Therefore, and according to above norms and regulations, the investigation was carried out using procedures not necessarily subject to the guarantees and rights usually used for the evidences in a judicial process.

Consequently, any use of this report for purposes other than that of preventing future accidents may lead to erroneous conclusions or interpretations.

This report was originally issued in Spanish. This English translation is provided for information purposes only.

Contents

Abbreviations

° ' "	Sexagesimal degree(s), minute(s) and second(s)
ºC	Degree(s) Celsius
ACFT	Aircraft
AD	Aerodrome
AEMET	Spain's Meteorological Agency
AESA	Spain's Aviation Safety Agency
AGL	Above ground level
CPL(A)	Commercial aircraft pilot license
CR(A)	Aircraft class rating
CTR	Control zone
EASA	European Aviation Safety Agency
FAA	United States Federal Aviation Administration
FAR	Federal aviation regulations
FL	Flight level
ft	Feet
ft/min	Feet(s)/minute
h	Hours
hPa	Hectopascal
inHg	Inches of mercury
IR(A)	Instrument rating
KCAS	Knots-calibrated airspeed
KIAS	Knots-indicated airspeed
km	Kilometres
kt	Knot(s)
LELL	ICAO code for Sabadell Airport
LEPP	ICAO code for Pamplona Airport
m	Metres
MEP	Multi-piston engine aircraft rating
METAR	Aviation routine weather report (in aeronautical meteorological code)
N	North
NM	Nautical mile(s)
OACI	International Civil Aviation Organisation
QNH	Altimeter subscale adjustment to obtain elevation while on land (precision adjustment to indicate elevation above mean sea level)
RPM	Revolutions per minute
S/N	Serial number
SEI	Fire extinguishing service
SEP	Single-piston engine aircraft rating
TAF	Terminal aerodrome forecast
TBO	Time between overhauls
TSN	Time since new
TSO	Time since overhauls

TWR	Aerodrome control tower or aerodrome control
UTC	Universal time coordinated
Vmca	Minimum control speed airborne
VFR	Visual flight rules
W	West

Synopsis

Owner:	Private
Operator:	Private
Aircraft:	Piper PA-60-602P, registration EC-HRJ
Date and time of accident:	20 February 2020, 18:19 h[1]
Site of accident:	On final approach to Pamplona Airport (Navarra)
Persons on board:	One, deceased
Type of flight:	General Aviation – Private
Phase of flight:	Final approach
Type of operation:	VFR
Date of approval:	24th February 2021

Summary of accident

On Thursday, 20 February 2020, the Piper PA-60-602P aircraft, with registration EC-HRJ, took off from Sabadell Airport (LELL) bound for Pamplona Airport (LEPP).

At 17:51:43 h, when the aircraft was in the vicinity of the SURCO waypoint, a sudden change in course from 300º to 317º was observed on the aircraft's radar trace. Moments later, at 17:53:12 h, the pilot of the aircraft contacted the Madrid air control units to report problems with one of his engines, adding verbatim: *I'm not sure if I've lost the turbo*. In a subsequent communication with the same air traffic controller, at 17:57:22 h, the pilot stated*: I've lost an engine*.

At 17:57:58 h, the pilot contacted the controller of the Pamplona control tower. The controller asked him if he required any assistance, and the pilot replied that he did not.

At 18:16:15 h, the pilot told the control tower controller that he was on right base for the head of runway 33. The controller cleared him to land and asked him to notify him when he was on final.

At 18:19:40 h, the control tower controller alerted the airport Fire Extinguishing Service (SEI) when he saw the aircraft crash and a column of smoke coming from the wreckage area. The aircraft had impacted the ground during the final approach manoeuvre. As it fell, it hit and severed a power line.

[1] All times used in this report are local time. The UTC is one hour less.

The pilot, who was the sole occupant of the aircraft, was killed during the accident.

The impact and subsequent fire completely destroyed the aircraft.

The investigation concluded the probable cause of the accident was that the aircraft lost control on final approach to runway 33 as a result of flying with asymmetrical power.

1. FACTUAL INFORMATION

1.1. History of the flight

The Piper PA-60-602P aircraft, with registration EC-HRJ, was maintained by maintenance organisation ES.145.227 at Sabadell Airport (LELL). According to the maintenance records of this organisation, the last maintenance tasks performed on the aircraft's engines were:

- Between 17 June and 13 July 2019, the right engine's left turbo was removed and replaced by an overhauled one due to a power failure in that engine.

- A few days later, between 3 August and 5 August 2019, the flexible pipes in the right engine were changed, and the propellers were inspected.

Subsequently, the pilot (and owner of the aircraft) went for an extended period without using the aircraft. Specifically, from 24 October 2019 to 27 January 2020, the aircraft was parked at Pamplona Airport (LEPP) for 95 days. After which, the pilot resumed his usual activity (he usually flew once a week from Pamplona Airport to Sabadell Airport for business reasons) and made the following flights:

- On 27 January 2020, the pilot flew from Pamplona to Sabadell. He returned on 30 January.

- On 3 February 2020, the pilot flew from Pamplona to Sabadell. He returned on 6 February. Before returning, he made a local flight from Sabadell Airport.

- On 11 February 2020, the pilot flew from Pamplona to Sabadell. He returned on 13 February.

- On 18 February 2020, the pilot flew from Pamplona to Sabadell. It was during his return, on 20 February, when the accident occurred.

During the aircraft's last two stays in Sabadell, several maintenance tasks were carried out after the pilot informed his maintenance organisation that he had experienced a power outage during the flight. Specifically:

- On 13 February 2020, the automatic turbocharger system controllers for both engines were adjusted and

- On 20 February 2020, the wastegates of the automatic turbocharger systems in both engines were lubricated.

After the latter, the aircraft took off from Sabadell Airport bound for Pamplona.

At 17:51:43 h, when the aircraft was in the vicinity of the SURCO waypoint, a sudden change in course from 300º to 317º was observed on the aircraft's radar trace. Ground speed began to decrease rapidly and the aircraft also began to lose altitude.

Moments later, at 17:53:12 h, the pilot of the aircraft contacted the Madrid air control units to report problems with one of his engines, adding verbatim: *I'm not sure if I've lost the turbo.* He requested a descent to flight level FL110 to pass the RONKO waypoint. The controller asked him if he had visual contact with the terrain, and, as the pilot's reply was affirmative, he authorised him to descend at his discretion. In a subsequent communication with the same air traffic controller, at 17:57:22 h, the pilot stated: *I've lost an engine.*

At 17:57:58 h, the pilot contacted the Pamplona control tower controller to explain that he was 44 NM from the airport, had lost an engine, and intended to descend slowly, maintaining visual contact with the ground until he reached the airport. The control tower controller informed him of the runway in use and the weather conditions at the airport and asked him to confirm whether the approach would be visual, entering directly through La Higa at right base of runway 33. The pilot's response was affirmative. The controller asked him if he required any assistance, and the pilot replied that he did not and added: *I've lost an engine and I'm not sure what's happened.*

After studying the aircraft's radar trace, it was concluded that the pilot continued the flight with a constant heading and a ground speed ranging between 140 and 120 knots. The aircraft continued descending, initially at approximately 500 feet/minute and subsequently at around 600 feet/minute.

At 18:15:33 h, the control tower controller informed the pilot that the wind speed was increasing, particularly at the head of runway 15. At that moment, the wind direction at the head of runway 33 was 300º, and wind speed was 5 knots, while at the head of runway 15, the wind direction was 330º, and its speed was 10 knots. The pilot decided to land via the head of runway 33 and added: *I don't anticipate any problems to enter.* He also indicated that he was on right base for the head of runway 33. At that point, it was 18:16:15 h. The controller cleared him to land via the head of runway 33, informed him that the wind direction was 310º and its speed was 6 knots and asked the pilot to notify him when he was on final.

At 18:19:40 h, the control tower controller alerted the airport Fire Extinguishing Service (SEI) when he saw the aircraft crash and a column of smoke coming from the wreckage area. The aircraft had impacted the ground during the final approach manoeuvre. As it fell, it hit and severed a power line.

The pilot, who was the sole occupant of the aircraft, was killed during the accident.

The impact and subsequent fire completely destroyed the aircraft.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Other
Fatal	1		1	
Serious				
Minor				
None				
TOTAL	1		1	

1.3. Damage to the aircraft

The impact and subsequent fire completely destroyed the aircraft.

1.4. Other damage

First, the aircraft hit and severed a power line. It then split part of a fence on a private property and damaged the surface of a cement road with its propeller. Finally, it ended up colliding with a stationary vehicle that was engulfed by the aircraft fire.

1.5. Personnel information

1.5.1. Information on the pilot

The 64-year-old Spanish pilot had a commercial pilot license for aircraft, CPL(A), issued on 17 February 2003, with the following ratings: IR(A), CR(A) MEP (ground) y CR(A) SEP (ground), valid until 28 February 2021.

He had a Class 1 medical certificate issued by AESA valid until 11 June 2020.

1.5.2. Information about the aircraft's regular maintenance mechanic[2]

The aircraft's regular maintenance mechanic, a 59-year-old Spanish national, had an aircraft maintenance license issued by AESA with, among others, B1.2 and C ratings for group 3 aircraft (the category to which the accident aircraft belongs according to the EASA Part-66) valid until 24 April 2024 with the following limitations: aircraft with a composite material structure and aircraft with a metal tube structure and textile coating (neither of which applied to the aircraft in question).

[2] The maintenance mechanic worked in the maintenance organisation ES.145.227

1.5.3. Information on the maintenance mechanic who adjusted the controllers of the aircraft's turbocharger system a few days before the accident[3]

The maintenance mechanic, a 59-year-old Spanish national, had an aircraft maintenance license issued by AESA with, among others, B1.2 and C ratings for group 3 aircraft (the category to which the accident aircraft belongs according to the EASA Part-66) valid until 24 April 2024 with the following limitations: aircraft with a composite material structure and aircraft with a metal tube structure and textile coating (neither of which applied to the aircraft in question).

1.6. Aircraft information

The Piper PA-60-602P aircraft, with registration EC-HRJ and serial number 62P-0897-8165027 was built in 1981 and registered with the Spanish Aircraft Registry on 21 December 2000 in the name of the current owners. The aircraft was equipped with two Lycoming IO-540-AA1A5 engines. The serial number of the left engine was: L-25641-48A and the serial number of the right engine was: RL-24790-48A.

It had an airworthiness certificate issued by AESA and an airworthiness review certificate that was due to expire on 23 August 2020. The airworthiness review had been carried out by continuing airworthiness management organisation ES.MG.131.

The aircraft had a Bendix King KC-290 autopilot.

illustration 1: photograph of the aircraft taken in 2012 in Sabadell

[3] This maintenance mechanic worked in another maintenance organisation

1.6.1. Last flights performed by the aircraft

According to the aircraft's logbook, on 24 October 2019, the aircraft made its last flight of 2019. In 2020 the flights recorded were as follows:

Date	Departure airport	Departure time	Arrival airport	Flight time (h:min)
27/01/2020	LEPP	14:30 h	LELL	1
30/01/2020	LELL	14:10 h	LEPP	1
03/02/2020	LEPP	15:00 h	LELL	1
06/02/2020	LELL	11:45 h	LELL	01:20
06/02/2020	LELL	14:30 h	LEPP	1

After 6 February, there were no flights recorded in the aircraft's logbook. According to this information, the accumulated flight hours up until that point were 3049:22 h. However, during the investigation, we consulted with the airport managers at Pamplona and Sabadell to obtain information about the pilot's last flights from their airports. They were as follows:

Date	Departure airport	Departure time	Arrival airport	Flight time (h:min)
11/02/2020	LEPP	08:20	LELL	1
13/02/2020	LELL	14:30	LEPP	1
18/02/2020	LEPP	15:20	LELL	1
20/02/2020	LELL	16:05	LEPP	-

According to the flight plan, the local flight from Sabadell airport on 6 February was a multi-engine/IR verification flight.

1.6.2. Fuel supply to the aircraft

The attached table details the fuel supplied to the aircraft at Pamplona Airport and Sabadell Airport from 1 January 2020:

Facility	Start Date	End Date	Destination Airport	Quantity	Quantity 15º
PAMPLONA	18/01/2020 12:32	18/01/2020 12:52	PAMPLONA	454	457
PAMPLONA	03/02/2020 13:52	03/02/2020 13:53	SABADELL	364	366
SABADELL	06/02/2020 09:42	06/02/2020 09:50	SABADELL	110	110
PAMPLONA	10/02/2020 17:08	10/02/2020 17:16	SABADELL	286	288
PAMPLONA	18/02/2020 10:18	18/02/2020 10:35	SABADELL	352	354

1.6.3. Recent maintenance work

The aircraft was maintained by maintenance organisation ES.145.227 at Sabadell Airport. According to the maintenance records of this organisation, the last maintenance tasks performed on the aircraft's engines consisted of:

- Between 20 May and 12 June 2019, the 100-hour and annual inspection of the aircraft, engines and propellers were carried out. In addition, the following tasks, among others, were performed on the engines:

    - Paesa oil analysis, borescope examination, and compression measurement for extending the left engine use.
    - The air induction filters of both engines were checked and cleaned.
    - Propeller inspection.
    - The engine oil was also refilled.

The cylinder compression results were as follows:

    - For the left engine: 80/80, 80/76, 80/78, 80/76, 80/72 and 80/70.
    - For the right engine: 80/80, 80/70, 80/80, 80/76, 80/70 and 80/70.

At that time, the aircraft had 3023 h, and the engines had a TSN (TSO) of 1372 h for the left and 307 hours for the right.

- Subsequently, after the pilot reported an in-flight right-engine power failure, the left part of the automatic turbocharger system was disassembled and replaced with an overhauled one. The maintenance work order was opened on 17 June and closed on 13 July 2019. The aircraft had accumulated 3026 hours, and the engines had a TSN of 1375 for the left and 310 for the right. The maintenance mechanic indicated that an internal seal was broken and the left turbo was leaking oil.

- A few days later, between 3 August and 5 August 2019, the right engine's flexible pipes were changed, and the propellers were inspected.

- On 29 January and 6 February 2020, the mechanics carried out other maintenance tasks not related to the engines.

- On 13 February 2020, the controller of the automatic turbocharger system for both engines was adjusted according to the *Maintenance Manual* (reference 761-732) with satisfactory results. This maintenance task was not performed by the regular maintenance organisation.

- The last maintenance task carried out before the accident consisted of lubricating the wastegates of the automatic turbocharger system in both engines.

Furthermore, the left engine had been overhauled twice[4], once on 24 September 1999 and again on 21 September 2011. On 20 June 2019, an extent of the left engine use was requested, and the use was increased for one year until 20 June 2020. The right engine had been overhauled on 13 June 2012, and the next one was scheduled for 10 June 2024.

1.6.4. Description of the IO 540AA1A5 engine turbocharger system

The engines of the PA-60-602P aircraft were equipped with a turbocharger system. The turbocharger is made up of a compressor and a turbine connected by a common shaft. The turbine uses the flow of exhaust gases to drive the compressor. The compressor supplies pressurised air to the engine. The system delivers an intake pressure of 37 inHg up to approximately 20000 feet of altitude (therefore allowing operation at high altitude levels). It also provides bleed air for the cabin pressurisation system. There is one turbocharger on each exhaust manifold.

The turbocharger is operated via an automatic control system consisting of a controller and an actuator:

- The controller uses a diaphragm to detect the selected pressure at the engine inlet manifold[5] and the compressor discharge pressure. The controller is set with a ratio of these two pressures (between 1 and 6 inHg). The controller's internal diaphragm moves until it finds that ratio while at the same time acting on an oil metering valve which regulates the oil pressure inside the actuator.

As the 602P engines are turbo-normalised, the maximum manifold pressure is 29.92 inHg.

- The actuator is mechanically connected to the wastegates located in each of the exhaust manifolds. The actuator repositions the wastegates according to the oil pressure.

- Depending on the position of the wastegates (more closed or open), greater or lesser quantities of exhaust gases are diverted to the turbochargers causing the turbine to increase or decrease the RPM.

  Wastegates are normally closed, and the controller and actuator modulate their opening after the engine is started. When the engine is started, the controller allows the engine oil pressure to open the wastegates.

[4] The TBO for the engine is 1800 hours or twelve years

[5] The pilot sets the controller by moving the throttle to adjust the desired pressure at the engine inlet manifold

If, due to a possible malfunction of the turbocharger system, the wastegates remain completely closed, the engine has another relief valve that opens or closes to regulate the pressure in the engine. Moreover, the pilot would notice an excessive over-pressurisation of the engine through the intake pressure and could address it by manually adjusting the throttle.

If the wastegates remained fully open due to a possible malfunction of the turbocharger system, the engine would operate in a similar way to an engine without a turbocharger (in normal-aspiration mode) but with a slightly reduced maximum manifold pressure due to the airflow losses.

If the wastegates were to get stuck in a particular position, there would be a loss of flow, but a mode door (located in the air filter box) would open to allow the induction air to bypass the turbos.

1.7. Meteorological information

The aerodrome reports (METAR) at Pamplona Airport were as follows:

METAR LEPP 201630Z VRB02KT CAVOK 15/04 Q1024=[6]
METAR LEPP 201700Z 30004KT CAVOK 15/05 Q1024=[7]
METAR LEPP 201730Z 32009KT CAVOK 13/06 Q1025=[8]

And the forecast for the aerodrome at the time (TAF) was:

TAF LEPP 201400Z 2015/2115 33009KT CAVOK TX16/2015Z TN01/2106Z PROB40 TEMPO 2100/2106 3000 BR BKN012=[9]

The data and remote sensing images confirm that there was little cloud cover in the area of the accident and along the flight route from Sabadell Airport. The wind was light, with an approximately north-westerly direction, below 10 kt, with no gusts. There were no other significant phenomena.

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[6] The METAR for Pamplona on the 20th at 16:30 UTC warned of wind with variable direction and a speed of 2 kt. Visibility greater than 10 km, absence of clouds below the CAVOK reference height and absence of *cumulonimbus* and tower-shaped *cumulus* clouds, no significant weather phenomena. Temperature 15ºC. Dew point 4ºC. QNH 1024 hPa.

[7] The METAR at 17:00 UTC warned of wind from a 300º direction and a speed of 4 kt. Visibility greater than 10 km, absence of clouds below the CAVOK reference height and absence of *cumulonimbus* and tower-shaped *cumulus* clouds, no significant weather phenomena. Temperature 15ºC. Dew point 5ºC. QNH 1024 hPa.

[8] The METAR at 17:30 UTC warned of wind from a 320º direction and a speed of 9 kt. Visibility greater than 10 km, absence of clouds below the CAVOK reference height and absence of *cumulonimbus* and tower-shaped *cumulus* clouds, no significant weather phenomena. Temperature 13ºC. Dew point 6ºC. QNH 1025 hPa.

[9] TAF for Pamplona on the 20th at 14:00 UTC. Forecast valid from the 20th at 15:00 UTC to the 21st at 15:00 UTC. Wind direction 330º with a speed of 9 kt. Visibility greater than 10 km, absence of clouds below the CAVOK reference height and absence of *cumulonimbus* and tower-shaped *cumulus* clouds, no significant weather phenomena. Maximum temperature 16ºC on the 20th at 15:00 UTC. Minimum temperature 1ºC on the 21st at 06:00 UTC. With a high probability that, temporarily, between 00:00 and 06:00 UTC on the 21st, the visibility will be reduced to 3000 m due to mist and abundant cloud cover at 1200 feet.

1.8. Aids to navigation

The most significant moments of the flight are detailed below:

At 17:51:26 h, the aircraft was close to the SURCO waypoint. At that moment, it was flying at an altitude of 16,900 feet with a ground speed of 200 knots.

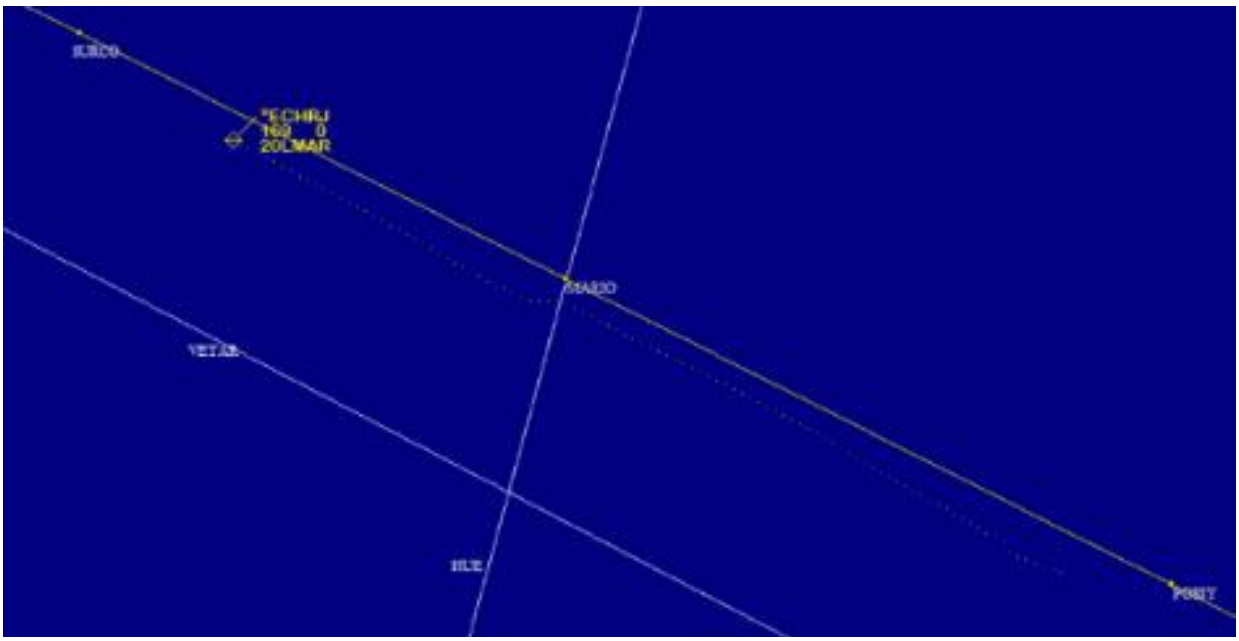


Illustration 2: aircraft position at 17:51 h

Moments later, at 17:51:43 h, the aircraft's heading suddenly changed from 300º to 317º five seconds later, and its ground speed began to decrease rapidly, from 197 knots to190 knots five seconds later. At 17:53:08 h, the aircraft also began to lose altitude.

From 17:55 h, its heading remained constant. Its ground speed oscillated between 140 and 120 knots. The aircraft continued to descend until it reached the vicinity of Pamplona Airport, where its radar trace was lost. On average, the aircraft descended 500 feet/minute, and from 18:11 h, its speed increased to 600 feet/minute. Prior to the increase in descent speed, the aircraft's ground speed had dropped below 117 knots.

Annexe I includes an illustration of the aircraft's altitude, descent speed, ground speed and heading.

1.9. Communications

At 17:53:12 h (or 16:53:12 UTC), the pilot of the aircraft contacted the Madrid air control units to tell them he had problems with one of his engines, adding: *I'm not sure if I've lost the turbo*. He asked to descend to flight level FL110 to pass the RONKO waypoint. The controller asked him if he had visual contact with the terrain, and, as the pilot's reply was affirmative, he authorised him to descend at his discretion.

At 17:57:22 h (or 16:57:22 UTC), the controller contacted the pilot and asked if he needed help and if he wanted to declare an emergency. The pilot's response was negative, and he added: *I've lost an engine*. Given that he was 48 NM from Pamplona Airport and had visual contact with the ground, he did not envisage any problems. The controller asked him if he wanted to contact the controller of the control tower in Pamplona, and the pilot answered affirmatively.

At 17:57:58 h (or 16:57:58 UTC), the pilot contacted the controller of the Pamplona control tower and told him that he was 44 NM[10] from the airport, that he had lost an engine and that he was going to descend slowly in visual contact with the ground until reaching the airport. The control tower controller informed him of the runway in use and the weather conditions at the airport and asked him to confirm whether the approach would be visual, entering directly through La Higa at right base of runway 33. The pilot's response was affirmative. The controller asked him if he required any assistance, and the pilot replied that he did not and added: *I've lost an engine, and I'm not sure what's happened*.

Another pilot, who happened to be the instructor of the pilot of the accident aircraft, was on the same frequency and overheard the conversation with the control tower controller. Through the control frequency, the other pilot recommended the runway 15 instead of runway 33 because it would be easier to move a plane with ground manoeuvrability issues, due to only having one working engine, to the hangar from there. However, at 18:15:33 h (or 17:15:33 UTC), the control tower controller informed the pilot that the wind speed was increasing, particularly at the head of runway 15. At that moment, the wind direction at the head of runway 33 was 300º, and wind speed was 5 knots, while at the head of runway 15, the wind direction was 330º, and its speed was 10 knots. The pilot decided to land via the head of runway 33 and added: *I don't anticipate any problems to enter.* He also indicated that he was on right base for the head of runway 33. At this instant, it was 18:16:15 h (17:16:15 UTC). The controller cleared him to land via the head of runway 33, informed him that the wind direction was 310º and its speed was 6 knots and asked the pilot to notify him when he was on final.

At 18:19:40 h (17:19:40 UTC), the control tower controller alerted the airport Fire Extinguishing Service (SEI) when he saw the aircraft crash and a column of smoke coming from the wreckage area.

1.10. Aerodrome information

The aircraft was heading to Pamplona Airport (Navarra), with ICAO code LEPP. The airport is located 6 km south of the city of Pamplona. It has an elevation of 459 metres and an asphalt runway with a 15/33 orientation. At the time of the accident, the aircraft was approaching the head of runway 33 to land.

[10] The fact that the pilot had indicated, 36 seconds before, that he was at 48 NM is inconsistent because it implies a speed above the never exceed speed.

1.11. Flight recorders

The accident aircraft did not have any flight recorders because they are not a requirement for that type of aircraft. However, the last moments of the aircraft's flight were captured by security cameras installed in a group of warehouses near the accident site. From the images, it is concluded that the aircraft rolled to the right before hitting the ground.

1.12. Aircraft wreckage and impact information

When the accident occurred, the aircraft was in the final leg of the aerodrome traffic circuit for landing on runway 33 at Pamplona Airport, just a few metres from the runway.

The image on the right shows the location of the accident and the runway at Pamplona Airport.

As it fell, the aircraft hit and severed a power line. The wreckage inspection revealed that it probably hit the power line with its tail cone because marks compatible with the cable impact were found on the vertical stabiliser.

Afterwards, the aircraft split part of a house fence. Again, the wreckage inspection revealed that it probably hit the fence with its left wingtip, which was found on the ground near the fence. At the same time, the left propeller left marks on the cement road, and the right propeller left tracks on the soft ground.

The aircraft ended up hitting a car parked near the house, which it must have moved with its horizontal stabiliser. The tail was oriented towards the extension of the runway centreline. The rest of the aircraft was found bent about 90° to the right, with the right wing effectively on top of the horizontal stabiliser. Part of the electrical cable was also found under the aircraft's tail cone.

Most of the wreckage was completely destroyed by the impact and subsequent fire. The front landing gear was observed partially extended. The landing gear doors were open and displayed abrasion marks. The main landing gear wheels were retracted and under the fuselage. The photograph shows the aircraft wreckage at the accident site.

Illustration 3: damage to the accident aircraft

Only a few pieces of wreckage were not burned; they were found scattered around the site as follows:

- Firstly, small pieces of material from the aircraft were found, denoted as 1 and 2 in the photograph.
- Subsequently, the tail cone's rear vertical stabiliser was observed on the right (denoted as 4 in the photograph) and, to the left, the left wingtip was found (denoted as 3 in the photograph).

Illustration 4 on the left, the left wingtip (number 3), and on the right, part of the tail cone, number 4

Further on, there were marks made by the left propeller on the cement road and by the right propeller on the softer ground. The elevator was found to the right (denoted as 6 in the photograph). And lastly, the main remains of the aircraft.

Illustration 5: close-up of the propeller marks and, to the right, the right elevator (number 6)

The right engine's propeller blades struck soft ground and were not feathered. The extensive rearward deformation of the left engine's propeller blades suggests it was providing power at the time of the accident.

Illustration 6: Photographs of the right engine (left) and left engine (right) propeller blades

When the police investigators recovered the body, the pilot was found with his left leg extended and pressing on the left pedal and his right leg set back.

1.13. Medical and pathological information

There is no evidence of any physiological factors or disabilities that may have affected the pilot's actions.

1.14. Fire

A fire broke out after the aircraft hit the ground, affecting a vehicle parked close to the accident site. The fire was extinguished by the Pamplona Airport fire brigade.

1.15. Survival aspects

Considering the nature of the accident and the degree of destruction caused to the aircraft, the pilot's chances of survival were practically nil.

1.16. Tests and research

1.16.1. Statement from the aircraft's maintenance mechanic

The aircraft maintenance mechanic indicated that he had been the aircraft's regular mechanic since the owner acquired it around twenty years ago.

On the day of the accident, the mechanic carried out minor repairs that consisted of greasing the automatic turbocharger system's wastegates on both engines. The wastegates have to be periodically greased to prevent them from seizing up and causing a power loss when the engine is running on the turbocharger system. The mechanic explained that, in any case, if the wastegates were to seize, the engine would revert to the "normally aspirated" mode, providing less power.

A week before the accident, the pilot complained that neither of the engines was providing full power when cruising. Another mechanic friend of his[11], as he was not available, carried out some on-ground engine tests. No anomalies were found, and the engines provided full power on the ground. In other words, the lack of power occurred in-flight while at altitude but not on the ground. This second mechanic adjusted the automatic turbocharger system controller of both engines.

1.16.2. Statement from the pilot who witnessed the accident and who was also the instructor of the pilot killed in the accident

The pilot was in-flight and witnessed the accident from his aircraft. The pilot had been the instructor of the pilot of the accident aircraft.

He indicated that the pilot of the accident aircraft reported that he was flying with only one engine. He did not declare an emergency to the control tower controller at Pamplona Airport, although he did indicate that he would possibly need help to exit the runway. His main concern was not to block the runway for too long. His voice remained calm at all times.

He advised the pilot of the accident aircraft to land via the head of 15 as this would allow him to clear the runway more quickly. However, the wind changed, with tailwinds of more than 10 knots, and the pilot of the accident aircraft decided to land on runway 33.

He saw the aircraft roll sharply to the right at an angle of 90º, but he could not see what had destabilised it.

1.16.3. Statement from the control tower controller at Pamplona Airport

The first communication with the aircraft was at 17:56 h when it was located 44 NM from Pamplona Airport. The pilot reported that one of his engines had stopped. The controller asked him if he needed any assistance, and the pilot replied that he did not because he could approach and land normally with one engine. The pilot requested permission to descend slowly in visual contact with the terrain and proceed towards the right base of runway 33.

[11] In paragraph 1.5.3 it is provided information regarding this maintenance mechanic

However, as the pilot indicated he might have problems exiting the runway after landing (as he would have to carry out a 180º manoeuvre and backtrack), the control tower controller alerted the airport fire brigade.

The pilot was considering landing via the head of runway 15 instead of runway 33, which would not require him to backtrack to leave the runway. However, due to the increased wind speed, the pilot decided to land via the head of runway 33.

The last communication with the aircraft was at 18:17 h. The pilot notified runway 33 right base, and the controller cleared him to land.

The controller observed, through binoculars, that the plane made a final long approach to land on runway 33; the aircraft was aligned with the runway centreline and was flying with its wings level and no appreciable roll angle. He was surprised the aircraft was flying so low. However, he assumed the pilot, who had extensive experience approaching the airport, knew that he was coming in low. Given that he was flying with an inoperative engine, the controller concluded that the pilot was unable to increase his flight height to correct the low approach. In short final, the aircraft suddenly rolled to the right and fell. A few seconds later, he noticed a plume of smoke and alerted the fire brigade.

1.17. Organisational and management information

N/A.

1.18. Additional information

1.18.1. Map of final visual approach to Pamplona Airport

Map of the final visual approach to Pamplona Airport extracted from the AIP is shown. The aircraft's position at 18:15:57 h is indicated on the map. At that time:

- its altitude was 1188 m (or 3900 feet) and, given that the elevation of Pamplona Airport is 459 metres (or 1506 feet), the aircraft was 729 metres (or 2394 feet) above it
- its heading was 300º, and
- the geographical coordinates for its position were 42º 42' 56" N and 1º 32' 9" W.

The location of the accident, which occurred at 18:19 h, after the aircraft had travelled a further 5 NM (approximately), is also shown. At that point, the aircraft's position was 0.4 NM from Pamplona Airport.

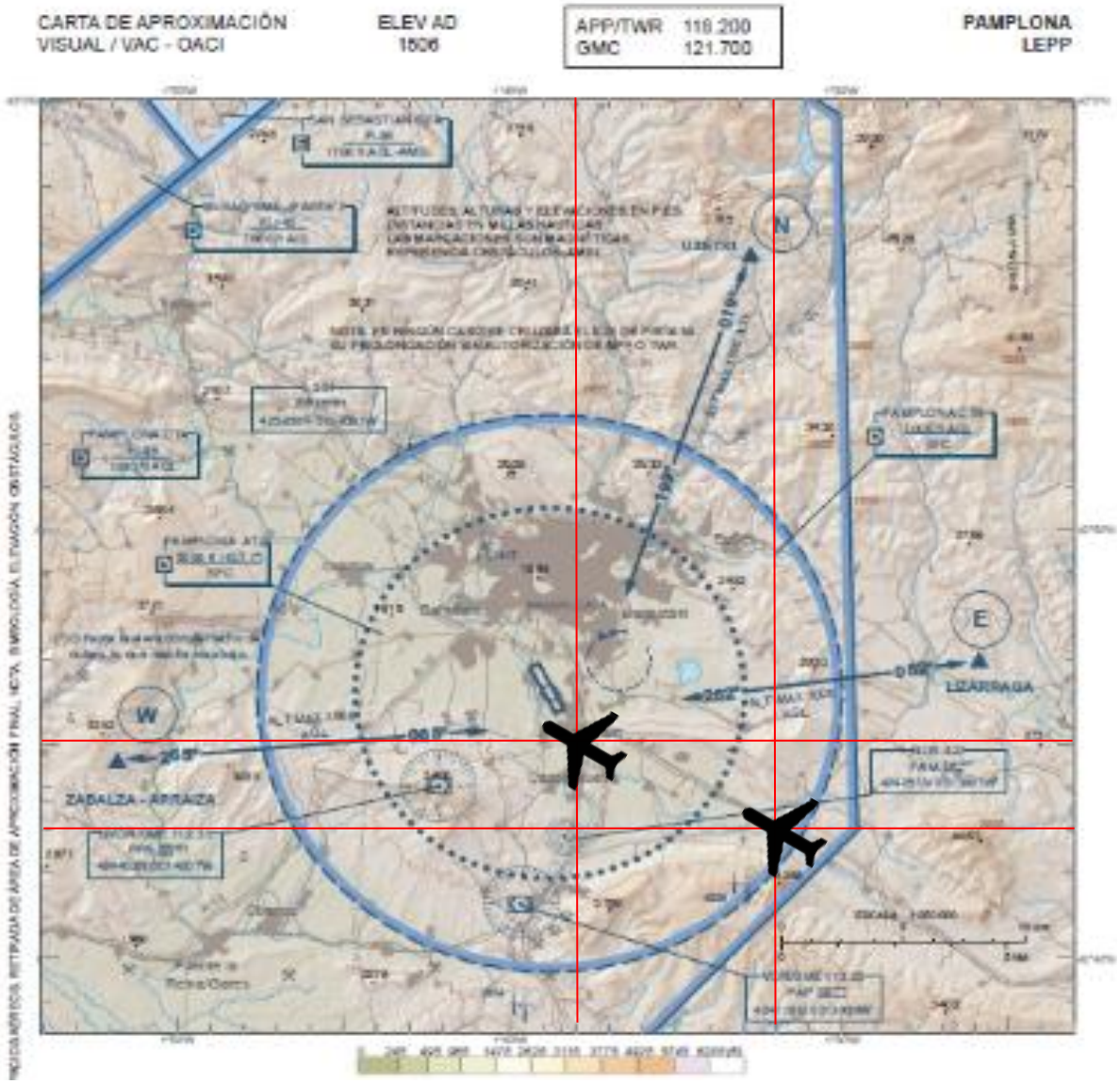


illustration 7: map of final visual approach to pamplona airport

According to the map, aircraft bound for Pamplona Airport flying VFR must establish radio contact with TWR at points N (Usetxi), E (Lizárraga) or W (Zabalza - Arraiza) and request permission to enter the CTR, giving their position and altitude and maintaining a maximum 1000 ft AGL. When requested by TWR, aircraft must wait at the points indicated above before obtaining the final authorisation to enter the CTR.

The following Google Earth image shows the course the aircraft was following moments before losing the radar trace and the location of the wreckage of the crashed aircraft (in yellow). The runway at Pamplona Airport can be seen.

1.18.2. Single-engine landing procedure

The *Pilot's Operating Handbook* and the *Flight Manual* for the PA-60-602 P Aircraft approved by the FAA specifies:

1.- Minimum Control Speed in the Air (VMCA) of 80 KCAS or 84 KIAS.

2.- The in-flight engine failure procedure (when speed is greater than 84 KIAS) establishes, among other actions, that lateral and directional control is maintained by applying the aileron and rudder in the opposite direction to the roll and yaw produced by the inoperative engine. Speed should be kept above 117 KIAS (optimum rate of climb with one inoperative engine).

3.- The procedure for landing with an inoperative engine establishes, among other actions, that speed must be maintained at 117 KIAS until the landing is assured. When the landing is assured, the landing gear should be extended. Just before landing, the approach speed must be:

1. With flaps UP - 111 KIAS
2. With flaps 20º DOWN - 104 KIAS.

The procedure recommends that directional control be maintained as power is reduced because the aircraft will roll toward the operating engine.

1.18.3. Study of the status of the engines' automatic turbocharger system

Given that the pilot reported possible problems with the automatic turbocharger system to the air traffic controller and that the aircraft maintenance mechanic had carried out maintenance to improve the performance of these systems on the day of the accident, the study concentrated on this particular technical aspect.

1. Right engine

The lever was in the full-power position:

a. Automatic turbocharger system controller

The right engine's turbocharger system controller is shown in the photo to the right. (The S/N of the controller was: 005298). The controller was severed.

b. Wastegates of the automatic turbocharger system controller

Both the wastegates on the right engine were found fully closed.

2. Left engine. Wastegates of the automatic turbocharger system controller

Both the wastegates on the left engine were found slightly open.

1.18.4. Condition of the aircraft. Search for potential corrosion in the right engine.

The *Aircraft Maintenance Manual* establishes a series of measures to prevent aircraft deterioration during extended periods of inactivity. In particular, when the period of inactivity is 90 days or more, the following measures should be taken to protect:

- The engines, as per the latest version of the Avco Lycoming Service Letter, No L180.
- The engine's fuel system:

- Completely fill the wing and fuselage fuel tanks.
- Check for moisture condensation in fuel sumps every ninety days.

- Batteries:
  - Disconnect and remove them from the aircraft. Charge them fully and store in a safe place.
  - Clean and preserve the battery compartment.
- Tyres:
  - Reposition them every thirty days to prevent "flat spotting".

The latest version of the Avco Lycoming Service Letter No L180 describes the measures to be taken to prevent engine corrosion. It states that to prevent moisture from the air and products of combustion combining to attack cylinder walls and bearing surfaces, vulnerable surfaces should be coated with rust inhibitive compounds.

The cylinders of the right engine of the accident aircraft were disassembled to look for signs of corrosion on their walls as a result of the aircraft's extended period of inactivity before the accident. No corrosion was found on their walls. The attached photograph shows the condition of one of the right engine's cylinders.

Illustration 8: interior of one of the engine cylinders

1.19. Useful or effective investigation techniques

N/A.

2. ANALYSIS

For the analysis of this accident, we deemed it relevant to analyse the maintenance and condition of the engines, the cause of the right-engine power loss, and the pilot's performance after the engine failure.

2.1. Analysis of the maintenance and condition of the engines

According to his logbook, the pilot regularly flew from Pamplona Airport to Sabadell for business reasons. However, from 24 October 2019 to 27 January 2020, the aircraft was parked at Pamplona Airport.

The aircraft's maintenance mechanic did not know if the pilot had taken steps to protect it during this 95-day period without activity. The *Aircraft Maintenance Manua*l establishes, among other measures, that when the period of inactivity is ninety days or more, the engine fuel system must be preserved by completely filling the wing and fuselage fuel tanks. During the investigation, we learned that fuel was supplied to the aircraft on 18 January 2020. Therefore, at least up until that date, the fuel system had not been preserved as specified in the aircraft's Maintenance Manual.

After that period of inactivity, the pilot flew from Pamplona to Sabadell four times: on 27 January, 3 February, 11 February and 18 February 2020. On the last two trips, the pilot experienced an in-flight power loss during the flight, and the maintenance mechanic carried out various maintenance tasks on the components of the automatic turbocharger system to try and resolve the issue:

- On 11 February, the pilot travelled from Pamplona to Sabadell. According to the maintenance mechanic, on arrival in Sabadell, the pilot complained that neither of the engines was supplying full power in cruise. Another mechanic, who was not the aircraft's usual mechanic, adjusted the automatic turbocharger system controller of both engines in accordance with the Maintenance Manual (reference 761-732). He also ground-tested the engines and confirmed that maximum power was being supplied on the ground. No corrosion was detected when carrying out the procedure[12]. The pilot then flew back to Pamplona on 13 February.

[12] The *Aircraft Maintenance Manual* does not provide instructions on how to preserve the automatic turbocharger system. As part of the investigation, we consulted the aircraft manufacturer for information on how the automatic turbocharger system should be preserved. The aircraft manufacturer responded that, obviously, during long-term stationary periods, the aircraft should be protected to prevent the corrosion and deterioration of seals and gaskets. This includes the components of the turbocharger system. He added that some of the procedures outlined in Service Letter No. L180B are applicable to the turbocharger system, such as replacing the oil with a preservative oil mixture and operating the engine to circulate the preservative oil mixture.

- Subsequently, on 18 February, the pilot travelled from Pamplona to Sabadell. Once again, having noticed a lack of engine power, the pilot asked the maintenance mechanic to lubricate the wastegates of the automatic turbocharger systems in both engines[13]. The mechanic carried out the maintenance task on 20 February before the aircraft left for Pamplona. Once again, no corrosion was detected when carrying out the procedure.

Given that during the flight back to Pamplona, the pilot again experienced an in-flight power loss, neither the lubrication of the wastegates nor the controller adjustments solved the problem.

2.2. Analysis of the cause of the right-engine power loss

The aircraft's radar trace shows that at 17:51:43 h, it suddenly changed course from 300º to 317º five seconds later and that its ground speed began to decrease rapidly, from 197 knots to 190 knots five seconds later. At 17:53:08 h, the aircraft also began to lose altitude.

At 17:53:12 h, the pilot contacted the Madrid Control units to tell them he had problems with one of his engines, adding: *I'm not sure if I've lost the turbo.* In the first communication, the pilot attributed the lack of power in the right engine to a malfunction of the automatic turbocharger system. However, in the pilot's subsequent communications with the air traffic control units, the pilot indicated that he had lost an engine. Thus, given that he had experienced in-flight power losses in previous flights and the maintenance mechanics had tried to fix the problem by performing various tasks on the components of turbocharger system, such as adjusting the controllers and lubricating the wastegates, at first, the pilot identified the power loss as being related to that system. However, in subsequent communications, the pilot stated that he had lost an engine. In pilot jargon, the phrase: I've lost an engine is understood as an engine failure (not a turbocharger malfunction).

To determine the cause of the right-engine power loss, during the investigation the engines' turbocharger system and the general condition of the right engine were analysed. Given the degree of destruction of the aircraft caused by the sudden impact and subsequent fire, it was unable to conclude what caused the loss of power to the right engine:

- In terms of the engines' turbocharger system, it was found no anomalies in its components except for the fact that the right engine's turbocharger controller was severed, presumably as a result of the impact with the ground.

[13] The aircraft manufacturer confirmed that lubricating the wastegates with the appropriate lubricant (commonly known as Mouse Milk) could temporarily improve their performance. However, ideally, they should be replaced.

In the right engine, the position of the wastegates and the fact that the throttle was full-forward could indicate that the pilot was trying to get maximum power from this engine.

- In terms of the right engine's general condition, there were suggestions that a lack of preservation or inadequate preservation during the aircraft's period of inactivity could have been a factor in the accident. However, its cylinders were dismantled, and no signs of corrosion were found.

  Moreover, a study of the right engine did not identify any type of mechanical anomaly that could have led to a lack of compression, for example.

Given that the pilot reported a lack of power at high altitudes in the preceding flights, it was also analysed the engine fuel system and its behaviour at altitude. While it may be true that the Bendix RSA 10-ED1 fuel injection system works on the principle of measuring airflow to select the amount of fuel and that its operation is influenced by altitude, it is not possible to determine whether it could have been responsible for the high-altitude power losses reported by the pilot.

2.3. Analysis of the pilot's performance after experiencing the loss of power

As indicated in the previous section, the pilot at first believed the yaw to the right he experienced moments before was due to a loss of power in the right engine caused by a malfunction of the automatic turbocharger system. However, minutes later, he believed the problem was due to an engine malfunction.

A study of the right propeller revealed it had not been feathered. The aircraft does not have an automatic feathering system in case of engine failure.

On another note, the aircraft manufacturer does not identify an engine turbo failure as an emergency situation in the *Flight Manual*. In fact, there is no procedure for the situation because the Aerostar 602P's engines are turbo-normalised; if the turbocharger system fails, the engine continues to provide power like any other engine not fitted with a turbocharger.

3. CONCLUSIONS

3.1. Findings

- The pilot had a valid license and medical certificate.
- The aircraft's documentation was in order.
- The meteorological conditions were suitable for the type of flight.
- From 24 October 2019 to 27 January 2020, the aircraft was parked at Pamplona Airport. In other words, it was inactive for 95 days.
- On 11 February 2020, the pilot flew from Pamplona to Sabadell. As the pilot noticed that neither engine was providing full power in cruise, the automatic turbocharger system controller of both engines was adjusted. After which, the pilot flew back to Pamplona on 13 February.
- On 18 February 2020, the pilot again flew from Pamplona to Sabadell. Once again, due to a lack of power from the engines, the pilot asked the maintenance mechanic to lubricate the automatic turbocharger system's wastegates in both engines.
- It was during his return to Pamplona on 20 February that the accident occurred.
- At 17:51:43 h, when the aircraft was in the vicinity of the SURCO waypoint, it yawed to the right. Its heading changed from 300° to 317°.
- At 17:53:12 h, the pilot of the aircraft contacted the Madrid air control units saying, *I'm not sure if I've lost the turbo*.
- In the pilot's subsequent communications with the air traffic control units, the pilot indicated he had lost an engine.
- The pilot did not feather the right propeller.
- When the aircraft was on its final approach to Pamplona Airport, cameras near the airport recorded it falling and rolling to the right.
- The landing gear of the aircraft had not been extended.
- The flaps were extended to 20°.
- The wastegates for the automatic turbocharger system on the right engine were fully closed, and the ones on the left engine were slightly open.

3.2. Causes/contributing factors

The investigation concluded the probable cause of the accident was that the aircraft lost control on the final approach to runway 33 as a result of flying with asymmetrical power.

4. SAFETY RECOMMENDATIONS

No safety recommendations are proposed.

ANNEXE I: DETAILED ANALYSIS OF THE TRAJECTORY OF THE AIRCRAFT

The radar data is plotted on the chart below: altitude (in metres)[14], descent speed (in ft/min), ground speed (in knots) and heading (in degrees) according to the time (in UTC) from 16:40:08 UTC (or 17:40:08 h) to 17:16:22 UTC (or 18:16:22 h), the moment which almost coincides exactly with the last communication between the pilot and controller of the Pamplona control tower.

Within this period of time, three significant moments have been illustrated with three vertical lines.

- At 16:51:43 UTC, the aircraft suddenly changed its heading from 300º to 317º five seconds later, and its ground speed began to decrease rapidly, from 197 knots to 190 knots five seconds later.
- At 16:53:08 UTC, the aircraft also began to lose altitude.
- From 16:55 UTC, its heading remained constant.

After which:

- The aircraft's ground speed remained between 140 and 120 knots.
- It continued to descend until it reached the vicinity of Pamplona Airport, where its radar trace was lost. On average, the aircraft descended 500 feet/minute, and from 17:11 UTC, its speed increased to 600 feet/minute. Prior to the increase in descent speed, the aircraft's speed had dropped below 117 knots.
- The heading remained constant, except for the yaw (to the right), which must have been unintentional because it was rectified moments later. (An orange circle on the graph illustrates the yaw). It did not affect the aircraft's altitude.

[14] The aircraft's altitude has been calculated using radar mode C (which provides it in hundreds of feet). Therefore, the calculated value is not as accurate as it would be like due to the sensor's resolution.
Moreover, based on CIAIAC's experience, the data from the last moments of a flight is often unreliable as far as altitude is concerned.

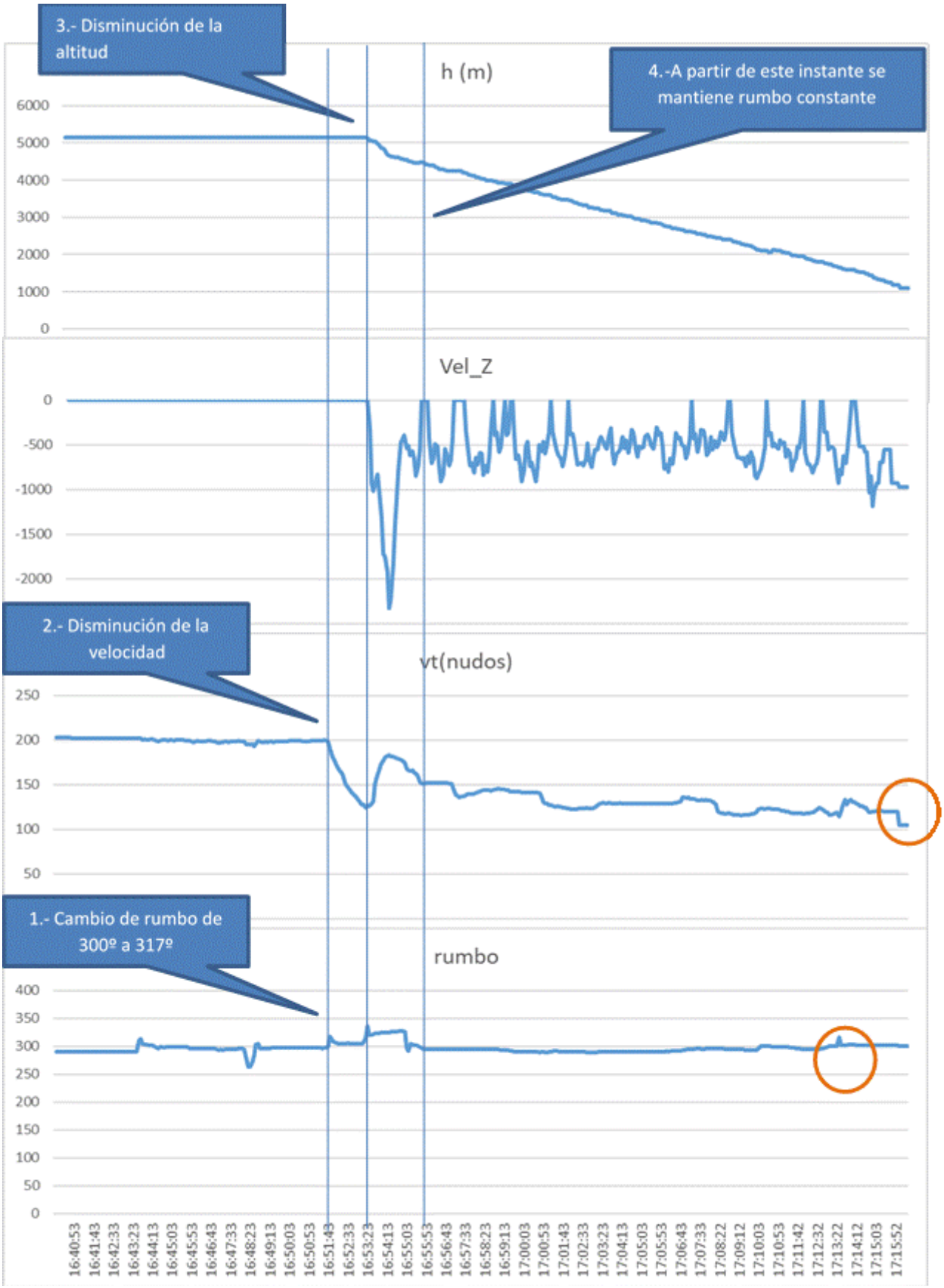


Illustration 9: altitude (in meters), descent speed (in ft/min), ground speed (in knots) and heading (in degrees) as a function of time

The following image shows the aircraft's trajectory over the terrain from 16:40:08 UTC to 17:16:22 UTC. It shows the aircraft's change of heading.

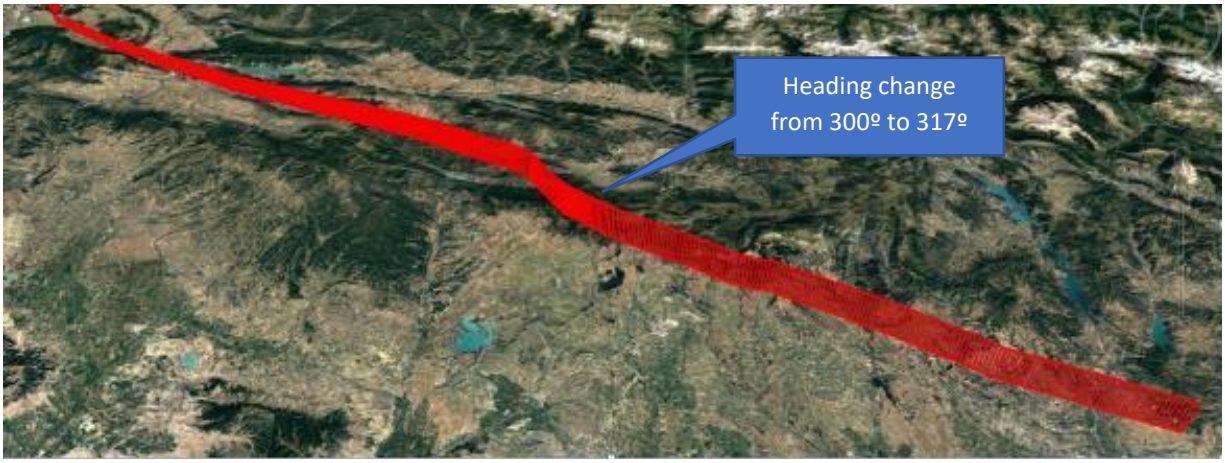
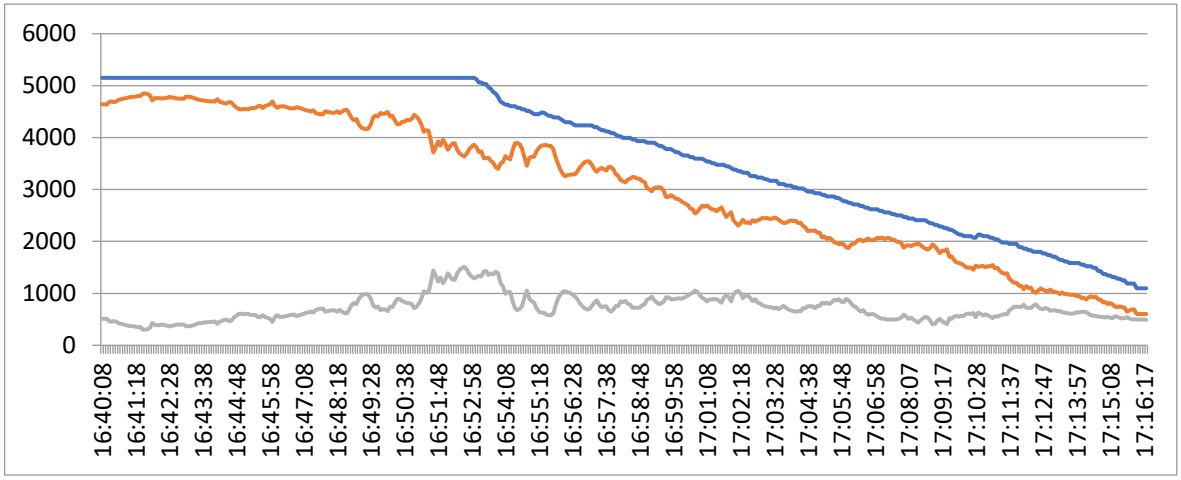


Illustration 10: the aircraft's trajectory from 16:40:08 utc to 17:16:22 utc

The following image shows the aircraft's altitude (in blue colour), height (in orange colour) and the elevation of the terrain (in grey colour), all in metres, from 16:40:08 UTC to 17:16:22 UTC.



After the incident with one of the engines, the aircraft maintained a ground speed of between 140 and 120 knots. In the last minutes of the flight, it neared 117 knots, and in the last recorded moments, it decreased to 105 knots.

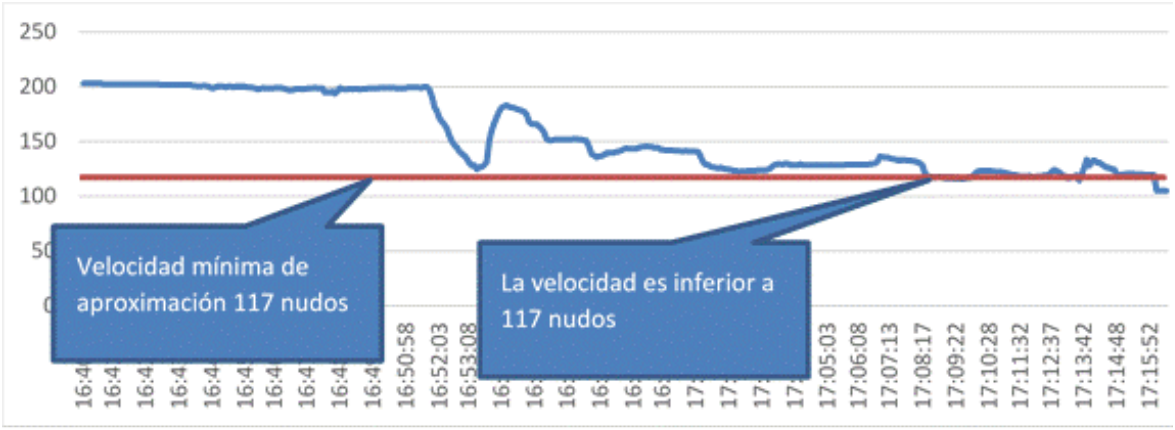


Illustration 11: Ground speed (in knots) as function of time

As of 17:11 UTC, the descent speed increases from 500 ft/min to 600 ft/min.

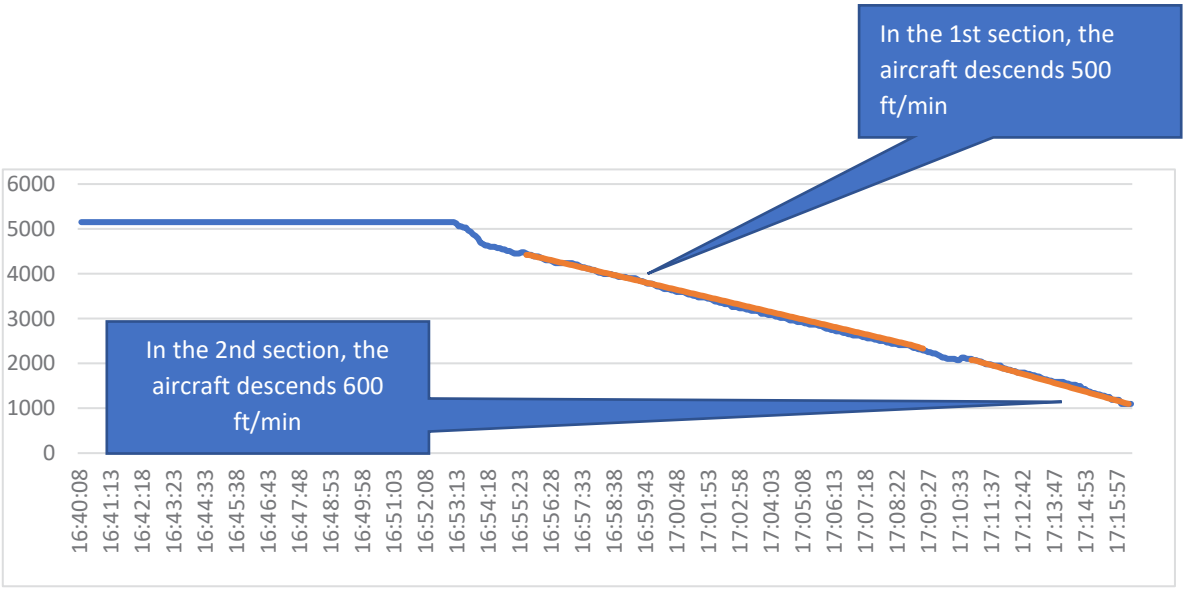


illustration 12: rate of descent as a function of time