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AVIACIÓN **C**IVIL

Report
IN-040/2019

Incident involving a Sikorsky S-76 C+ aircraft, registration EC-JES, over the Vigo estuary (Pontevedra) on 26 July 2019

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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 (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.

Contents

Abbreviations

00°	Geometrical degrees/magnetic heading
00°C	Degrees Celsius
%	Per cent
ACC	Area Control Centre
AEMET	Spain's State Meteorological Agency
AESA	Spain's National Aviation Safety Agency
AHRS	Attitude and Heading Reference System
ALT	Altitude
ALT ALERT	Altitude Alert
ALT PRE	Altitude Preselect
AP	Autopilot
APP	Approach
ATPL H	Air Transport Pilot Licence – Helicopter
ATT	Attitude
CIAIAC	Civil Aviation Accident and Incident Investigation Commission
CFIT	Controlled Flight Into Terrain. Controlled Fight Into Terrain
OC	Operational Circular
SOE	Special Operator Certificate
COP	Co-pilot
CPL	Coupled
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DAFCS	Digital Automatic Flight Control System
DECEL	Deceleration
DH	Decision Height
ECU	Engine Control Unit
EFIS	Electronic Flight Instruments System
FD	Flight Director
FDR	Flight Data Recorder
FMS	Flight Management System
ft	Feet
ft/min	Feet per minute
FAA	Federal Aviation Authority
FFAA	Armed Forces
FLIR	Forward-looking Infrared
FTR	Force Trim
GPS	Global Positioning System
GS	Ground Speed
h	Hours
HDG	Heading

LT	Local Time
HSI	Horizontal Screen Indicator
IAS	Indicated Air Speed
ILS	Instrument Landing System
OI	Operational Instruction
IR	Instrumental
KIAS	Indicator Air Speed(knots)
kg	Kilogrammes
kt	Knots
km	Kilometres
FF	Fire Fighting
LEVX	Vigo Airport
m	Metres
METAR	Aviation Routine Weather Report
OM	Operating Manuals
MP	Multi-pilot
NAV	Navigation
ON/OFF	ON/OFF
RSC/O	Rescue Operation
PIC	Pilot-in-command
PF	Pilot Flying
PM	Pilot Monitoring
P/N	Part Number
RAD ALT	Radar Altimeter
RAWS	Radio Altitude Warning System
RD	Royal Decree
RESC	Rescuer
SAFO	Safety Alert for Operators
SAR	Search and Rescue
SAS	Stability Augmentation System
SAU (PLC)	*Sociedad Anónima Unipersona*l (Spanish Public Limited Company)
SLC	SAR Line Check
s/n	Serial Number
SOP	Standard Operations Procedures
SP	Single-pilot
SW	South-west
Crew	Crew
TWR	Tower
UTC	Universal Time Coordinated
VEL HLD	Velocity Hold
VFRN	Visual Flight Rules Night
VHF-FM	Very High Frequency- Frequency Modulation
VS	Vertical Speed
W	West

Synopsis

Owner and operator:	Babcock SAU.
Aircraft:	Sikorsky S-76 C+ EC-JES
Date and time of accident:	26-07-2019 23:15 LT[1]
Site of accident:	Vigo estuary (Pontevedra).
Persons on board:	Five
Type of flight:	Air Search and Rescue/night training flight
Phase of flight:	Approach
Flight Rules	VFR
Date of approval:	28 October 2020

Summary of incident

On 26 July 2019 the SIKORSKY S76 C+ helicopter, registration EC-JES, was involved in an incident when the crew inadvertently descended the aircraft to an altitude of 22 ft above sea level during a training exercise over the Vigo estuary.

The helicopter took off from Vigo Airport, with a pilot, co-pilot, rescue swimmer, winch operator and instructor on board. In addition to being a training exercise, the winch operator was to undergo a SAR verification during the flight. This would involve a simulated rescue in the vicinity of a cliff. As the helicopter was descending to an altitude of 500 ft and positioning itself to begin the training exercise, the crew realised the aircraft was continuing to descend rapidly, and they were only 50 ft above sea level. They were forced to execute a sudden manoeuvre to put the helicopter into an ascent regime and reverse the descent.

The occupants were unharmed, and the aircraft did not sustain any damage.

The investigation has concluded the incident was caused by a failure to adhere to the proper procedures.

In light of our findings, a recommendation has been issued to the operator, Babcock. The recommendation proposes improvements to the operator's training on procedural adherence, response to warnings and alarms and, particularly, CFIT prevention during initial and recurrent crew training exercises.

[1] Unless specified otherwise, all times in this report are local. On the day of the incident, local time was UTC+2 hours.

1. FACTUAL INFORMATION

1.1. History of the flight

On 25 July 2019, the Sikorsky S-76-C+ aircraft, registration EC-JES, set out to carry out a night training exercise over the Vigo estuary, in the vicinity of Cape Home. The winch operator was to undergo a SAR line check during the flight.

After take-off, fog formation decreased visibility, and the flight was called off due to the adverse meteorological conditions. It was rescheduled for the following day - 26 July.

The training exercise involved the simulation of a night-time cliff rescue whereby the helicopter is positioned near a cliff and a training dummy is thrown into the water to simulate a victim. Next, the winch operator lowers the rescue swimmer who recovers the dummy and secures it. The dummy and rescue swimmer are winched back to the helicopter by the winch operator, who operates the helicopter remotely.

On 26 July, the service crew reported for duty at 20:00 UTC. They held a briefing to review the day's meteorological conditions, expected manoeuvres and emergencies involved in the operation. Specifically, they reviewed the manoeuvres required to carry out the night-time cliff exercise, including the transferral of the controls from the pilot to the winch operator.

The aircraft took off at 21:10 UTC from runway 01 at Vigo airport then turned left towards the estuary.

Before reaching point W, the commander and co-pilot changed roles so that the co-pilot, who had been the PIC for take-off, became the PM, and the commander, who had previously been acting as PM, took over as PF.

According to his testimony, when taking the controls, the PIC, who at that time acted like PF, engaged the IAS, NAV (navigation towards the mouth of the estuary) and ALT (over 1900 ft) modes.

The crew had uploaded a sequence of navigation points to the FMS. This would guide them along the estuary to the area where they would begin the training exercise by descending from the 1900 ft cruising altitude to the starting point for the SAR approach, 500 ft above the water.

On passing point W, Vigo's tower transferred them to the Santiago Approach Control Service.

While these events were taking place, the PM was communicating with the Vigo Maritime Rescue tower on the maritime VHF-FM band. When the PM ended his communications with Maritime Rescue, the PIC asked him to contact the Santiago Approach Control Service.

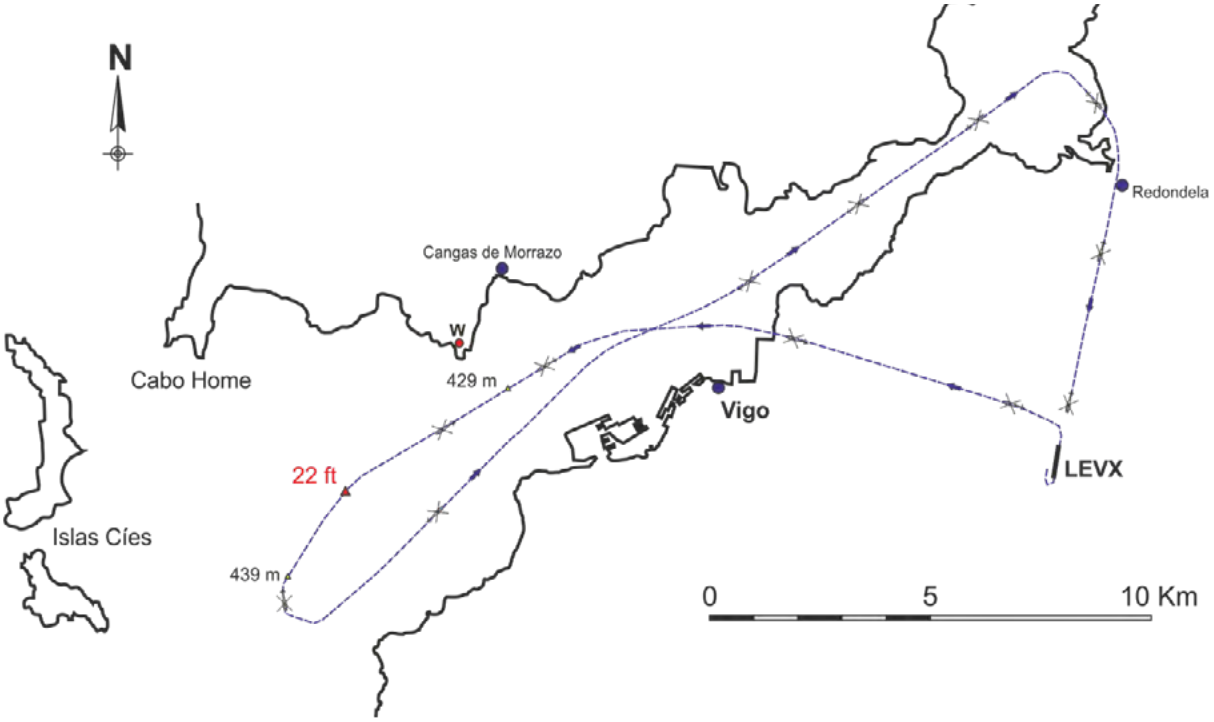


Fig. 1. - Aircraft flight path

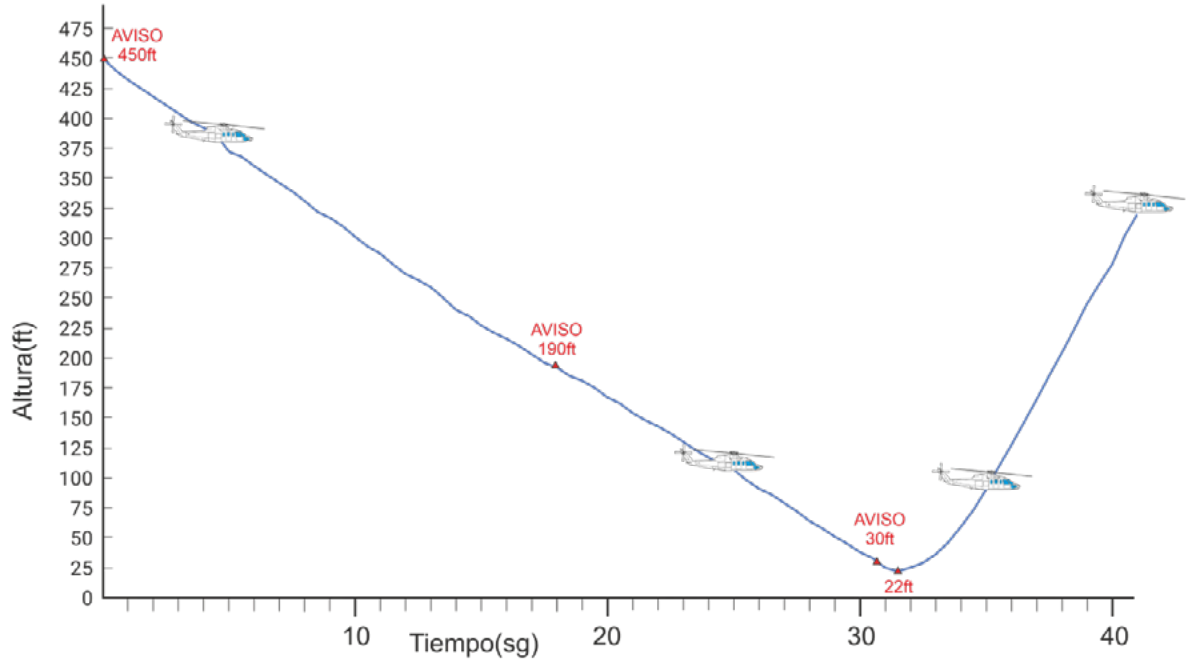


Fig. 2. - Profile of the flight path around the time of minimum altitude above the water

While these communications were taking place, and according to the crew's statements only, the PIC selected AL-300 to 500 ft so that the aircraft would maintain the desired altitude once it had reached it. At the same time, he set 80 kt of IAS.

Realising that the helicopter was still too high as it approached the position specified for the night-time cliff exercise, the PIC manoeuvred the aircraft to keep heading over the estuary, passing the Cíes Islands to the right and creating more time to descend.

During the descent, at 1300 ft of altitude, the winch operator saw a sailing boat in the estuary entrance channel with the FLIR[2].

At that time, the rescue swimmer, sitting in the left rear seat, requested confirmation that they were descending. The pilots confirmed they were descending to 500 ft.

Immediately afterwards, the winch operator, sitting in the right rear seat, saw the sailing boat he had previously located with the FLIR through the window of the left passenger door. He noted that the helicopter was slightly above the boat's mainsail mast-head light. According to his testimony, he then turned his head to take note of references through his window (rear right-hand side) and in the darkness of the night saw what looked like the surface of the sea. He turned again to look for the sailing boat on the left side of the co-pilot, located it through the left rear window and realised that the helicopter was now just below the previously mentioned mast-head light.

In that instant, the various members of the rescue crew began to call out, shouting that they were going down, at which point the co-pilot exclaimed "50 ft" and put the aircraft into a steep climb by pulling the collective pitch control lever upwards.

The PIC felt the "sudden pull" on the collective pitch control lever and pulled it up as well, noting that the N1 was on red. They climbed to a safe altitude and, once straight and levelled, he asked the co-pilot to relinquish the controls, and they returned to the base.

[2] FLIR: Forward-looking Infrared

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Other
Fatal				
Serious				
Minor				N/A
None	5		5	N/A
Total	5		5	

1.3. Damage to the aircraft

The aircraft did not sustain any damage as a result of the incident.

1.4. Other damage

No other damage sustained.

1.5. Personnel information

Information about the pilot:

The 54-year-old Spanish pilot joined the company on 1 March 2008, having previously been a member of the armed forces. He had an air transport pilot licence for helicopters ATPL(H) issued by Spain's National Aviation Safety Agency (AESA) on 11 November 2015, with valid type ratings for the following models of helicopter:

Model	Valid until
S-76/IR/MP	31.10.2019

He had a certificate of linguistic competence in Spanish and English issued by AESA and valid until 31 January 2025.

He also had a Class 1 medical certificate valid until 04 January 2020.

His flight experience was 5170:13 h, of which 1583:25 h were in the incident aircraft type (1,190:55 as PIC), and 3074:40 in Maritime SAR operations, of which 773:58 were night-time hours.

Over the previous 365 days, he had flown a total of 125:30 h, 100:05 of which were as PIC.

In the last 30 days, he had flown 5:55 h as PIC, 1:40 h of which were during the week leading up to the incident.

Information about the co-pilot:

The 50-year-old Spanish co-pilot joined the company on 06 March 2016, having previously been a member of the armed forces. He had an air transport pilot licence for helicopters ATPL(H) issued by Spain's National Aviation Safety Agency (AESA) on 11 March 2019, with valid type ratings for the following models of helicopter:

Model	**Valid until**
S-76/IR/MP	28.02.2020
Bell 212/412/IR/SP	31.07.2020

He had a certificate of linguistic competence in Spanish and English issued by AESA and valid until 31 March 2025.

He also had a Class 1 medical certificate valid until 01 July 2020.

His flight experience was 4806:42 h, of which 76:10 h were in the incident aircraft type, 465:30 h as a flight instructor and 766:40 night-time hours.

Over the previous 365 days, he had flown a total of 127:35 h. 80:05 h were as PIC of a B212 and 46:45 h as co-pilot in the type of aircraft involved in the incident.

In the last 30 days, he had flown 11:25 h as co-pilot, 09:20 h of which were during the week leading up to the incident.

He had spent most of his career as a naval pilot, and he combined the SAR operation with his rotations at fire fighting bases flying the Bell 412.

Information about the instructor:

He joined Babcock in December 1998 and became a SAR instructor for RSC/O in January 2008. He had served as a rescue swimmer, winch operator, and an instructor for rescue swimmers and winch operators. He had a total of 1774:05 flight hours, of which 994:20 h had been at night.

Information about the rescue swimmer:

He joined Babcock on 01/10/2001, working as a winch operator and rescue swimmer. He had a total of 1385:35 flight hours, of which 681:20 had been at night.

Information about the winch operator:

He joined Babcock on 01/04/2005, working as a winch operator and rescue swimmer. He had a total of 1590:50 flight hours, of which 764:05 h had been at night.

According to the information and documentation provided by the company, all crew members met the activity and rest requirements detailed in Annexe I of the OC 16B.

1.6. Aircraft information

1.6.1 General

The Sikorsky S-76C+ helicopter has a maximum take-off weight of 5307 kg. It is equipped with two Turbomeca ARRIEL 2S1 engines.

The incident aircraft is serial number 760576, manufactured in 2004, registration EC-JES.

It had an Airworthiness Certificate issued on 29 August 2005 by Spain's Civil Aviation General Directorate and an airworthiness review certificate issued by the Continuing Airworthiness Management Organisation, Babcock Mission Critical Services España, S.A.U., reference ES.MG.H01, valid until 16 August 2019.

The aircraft had a valid insurance policy effective until 31 October 2019.

At the time of the incident, it had accumulated 4779:20 h of flying time.

A thorough and detailed inspection of the aircraft was carried out on the 10 July 2019 when it underwent the 25 h + 50 h + 100 h + 300 h + 500 h + 900 h + 1500 h zone 2 + 12 month + 24 month reviews. At that time it had 4762.50 flight hours. In addition, the 30 h + 300 h inspections were performed on its engines with s/n 20029 and 20722TE.

According to the cargo manifest and aircraft performance data, its centre of gravity and performances were within operational limits.

1.6.2 Automatic Flight Control System

The aircraft has a Honeywell SPZ-7600 Digital Automatic Flight Control System (DAFCS).

The system is coupled to the three axes (pitch, roll and yaw, as well as the collective), and performs the functions of autopilot and flight director. It also incorporates additional functions that reduce the pilot's workload: automatic trim, heading hold, coordinated turns and automatic levelling.

The system consists of two FZ-706 flight control computers, one PC-700 autopilot controller, two MS-700 flight director mode selectors, two P&G air data computers, and one AL-300 control panel.

It includes different pieces of avionics equipment - navigation receivers (short and long-range NAV), gyroscopes/AHRS, radio altimeters and cockpit indicators including electronic flight instrument systems (EFIS).

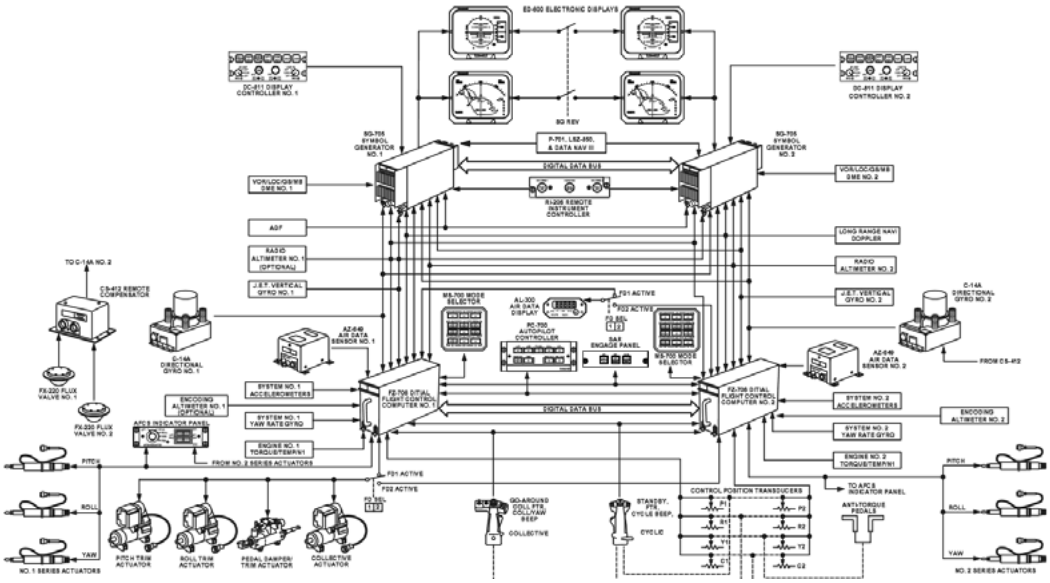


Fig. 3. - Diagram of the DAFCS

FZ-706 Flight Control Computers

The two installed FZ-706 computers provide coupling and redundancy. Standard operation has both systems ON; however, each can be operated independently. System No. 1 is the co-pilot's system, and System No. 2 is the pilot's system. Both computers are identical and interchangeable in installation. When both systems are coupled, the two computers communicate with each other via a serial data bus.

PC-700 Autopilot Control Panel

Located in the aircraft's pedestal, the panel is used to connect the autopilot and manage some flight director functions.

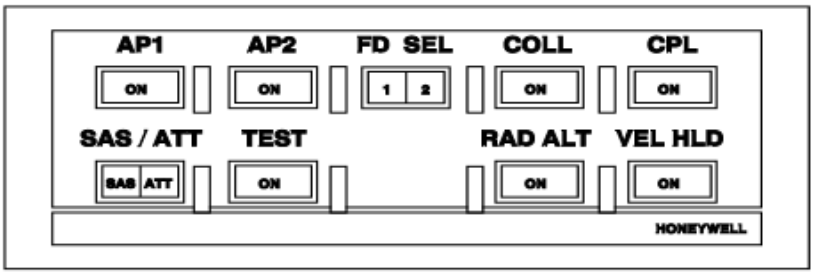


Fig. 4. - PC-700 Autopilot Control

The autopilot has two basic modes of operation: ATT and SAS.

The ATT mode maintains the pitch and roll attitude of the helicopter, consistently returning the aircraft to the attitude set by the pilot after a disturbance. ATT mode is generally used for hands-on flight or coupling to the flight director.

SAS mode is fundamentally a speed damper on the pitch and roll axes. It is used when the pilot wants to fly the aircraft manually during take-off, when landing or when extensive manoeuvring is required. Stability enhancement systems make the aircraft easier to fly by controlling pitch and roll attitude rates during turbulence or in response to pilot action on the cyclic control.

Autopilot faults are displayed on the DAFCS Caution Panel, which is located on the instrument panel.

MS-700 Flight Director Mode Selector

The Flight Director (FD) sends instructions or commands to the system, which can be flown manually by the pilot or coupled to the autopilots.

Flight modes are selected by pressing the appropriate switches for each phase of flight. Each pilot has a selector connected to the respective FZ-706 flight computers. Both selectors can be used simultaneously, but only the FD selected on the pedestal autopilot controller (PC-700 FD SEL ½) will be coupled to the autopilot. Standard flights operate in CPL (Coupled) mode with the autopilots following the FD selected at any given time.

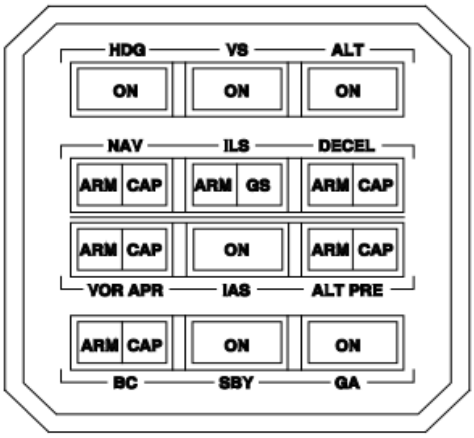


Fig. 5. - Selector modes of the FD, MS-700

AL-300 Altitude Alert Controller

The primary function of the AL-300 is to display the command or reference numbers used with the ALT PRE, IAS, VS, RAD ALT, VEL HLD or altitude alert modes.

When Force Trim is pressed with a mode engaged, the AL-300 will display the current reference value for that mode. When released, the displayed value will become the new reference for that mode.

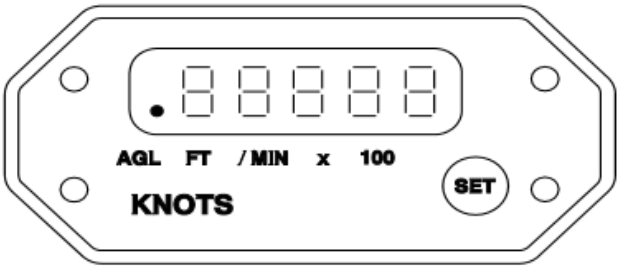


Fig. 6. - AL-300 Flight Data Display

The AL-300 provides a visual and audio alert when the helicopter approaches or deviates from a selected altitude. When the helicopter is within 1000 ft of the selected altitude (whether climbing or descending), a tone sounds for one second and the ALT ALERT light on the instrument panel illuminates. The light stays on until the helicopter is within 250 ft of the selected altitude. If the helicopter subsequently moves more than 250 ft (up or down) from that altitude, the ALT ALERT light comes on again, and the alert tone sounds.

On the cyclical and collective controls, pilots can select different flight parameters, trim the aircraft, use Force trim, disengage the autopilot and enter parameters such as vertical speed. These actions are displayed on the AL-300 screen.

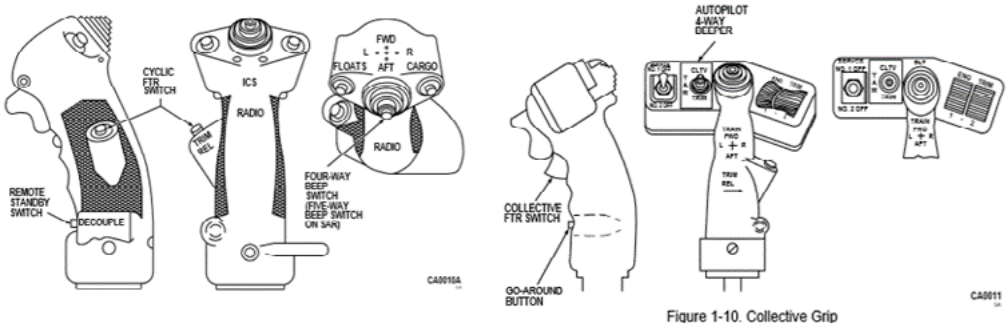


Fig. 7. - Cyclic and Collective S-76

1.7. Meteorological information

According to the information provided by the State Meteorological Agency (AEMET), the meteorological conditions in the area at the time of the incident were light cloud and no convective activity.

The predicted swell was weak - 1 m according to the low-level map, and the sea temperature was 19 °C. According to the maritime forecast for the coastal area of Pontevedra, the waves were 1 to 2 m with light winds (force 2 to 3) and a light swell.

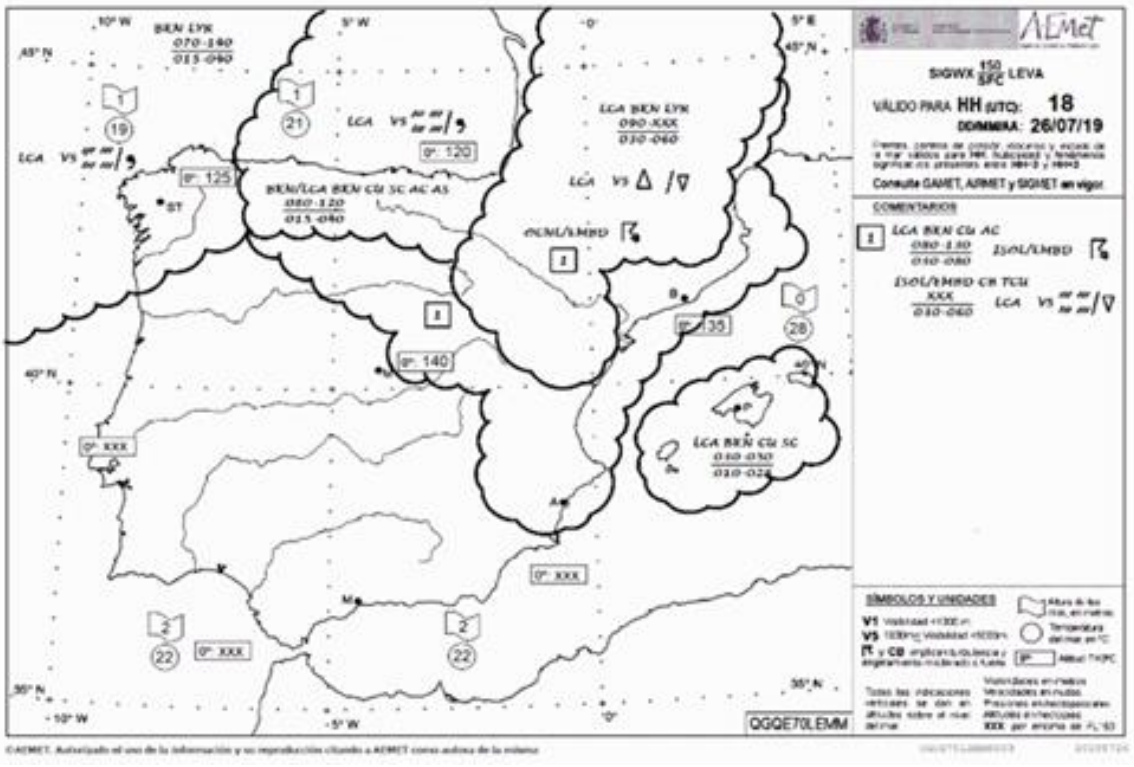


Fig. 8. - Relevant low-level map

The meteorological stations closest to the scene of the incident are in Vigo (13 km to the east) and at Vigo airport (20 km east-south-east).

The records of these stations show the following data at the time of the incident:

Temperature 17 °C - 18 °C, relative humidity 83% and wind 3 - 4 kt from the south-west.

The METAR reports for Vigo Airport between 21 h UTC and 22 h UTC were as follows:

METAR LEVX 262100Z 22003KT 160V250 9999 FEW018 17/14 Q1016 NOSIG=
METAR LEVX 262130Z 24004KT 9999 FEW016 17/14 Q1016 NOSIG=
METAR LEVX 262200Z 22003KT 190V260 CAVOK 17/14 Q1016 NOSIG=

The moon was in the last quarter phase, four nights away from the new moon phase.

1.8. Aids to navigation

N/A.

1.9. Communications

The helicopter maintained a radio link with Vigo Airport and Santiago ACC. It was also communicating with the Vigo Rescue Coordination Centre for technical issues relating to the maritime rescue operation.

On other occasions, they had transmitted information relating to maritime rescues to the Finisterre coordination centre.

As the manoeuvre to be performed began with a descent to 500 feet above the water, they communicated with the airport and coordination centres before losing the radio link.

1.10. Aerodrome information

N/A.

1.11. Flight recorders

1.11.1 Flight Data Recorder (FDR)

The helicopter was equipped with a PA3701K combination recorder with serial number s/n F10475, and part number P/N 612-1-49731, manufactured by MEGGIT AVIONICS for BAE SYSTEMS. It recorded both the flight data and the voices in the cabin.

It was downloaded by the operator Babcock, who sent the files obtained to the CIAIAC for processing.

According to the FDR data, take-off took place at 21:08:36 h UTC, with heading 012º and immediately afterwards they turned left on a 288º course towards the Vigo estuary. On reaching the estuary, they set a 267º heading, stabilised altitude at 1400 ft with 125 kt of IAS and coupled the commander's Flight Director with ALT, IAS and NAV modes.

After 50 seconds (21:13:15 UTC) the commander's VS MODE was activated (disengaging the ALT MODE), and the aircraft began a continual descent of 800 ft/min. The ALT-PRE MODE was not connected at any time. One minute and 20 seconds later, they drop below 500 ft MSL and continue at the same descent rate.

During this time, the FDR recorded numerous communications. The change of navigation mode in the FD, from NAV MODE to HDG MODE, was also recorded.

At 21:15:08 UTC a strong upward movement on the collective decouples the Flight Director. A second later the radio altimeter indicates 22 ft above the water. The revolutions of the main rotor and the power turbines of the two engines drop to 97%, setting off the MASTER WARNING. The engine torques rise from 27% to 110%, and the gas turbines from 84% to 102%. The main rotor revolutions recover within 2 seconds, and the helicopter climbs to 1,800 ft. Subsequently, the heading is changed to 48º, and the commander's FLIGHT DIRECTOR is re-engaged in ALT, HDG and IAS modes. This heading is maintained, with 108 kt and 1670 ft as the aircraft follows the Vigo estuary. It then sets a 200º heading to land at Vigo Airport on runway 20.

The FDR study charts are included in Appendix I.

1.11.2 Cockpit Voice Recorder (CVR)

Four tracks were recorded by the voice recorder, corresponding to the pilot station, the co-pilot station, the rear stations and a fourth for ambient noises.

The recordings reveal the conversations in the cabin, complementing and clarifying the data recorded by the FDR. The recordings confirm that:

As the crew entered data into the FMS (Flight Management System), the commander explained the process to the co-pilot.

The commander can be heard telling the co-pilot that he is activating ALT PRE and VS to descend to 500 ft. The information is copied by the co-pilot. The commander also indicates that he is reducing speed to 80 kt.

The pilot is heard talking with the TWR at Vigo, which transfers him to Santiago Approach, and the co-pilot can be heard talking to Vigo Maritime Rescue. Then, at the commander's request, the co-pilot tries to contact Santiago Approach, while the commander tells him to set a heading to turn left - at that time, the first two low dual warning sounds are heard. A high-pitched warning follows them - and he says *I'll follow a two, two, zero, heading to break away from the Cíes... while we do everything*.

One of the rescue crew asks if they are going down, and the co-pilot answers *affirmative, to 500 ft*. He is then immediately heard again, saying *we're at 50 ft.* At this point, shouting, yelling and alarms can be heard in the cabin.

Subsequently, their conversations express shock and uncertainty about the incident, until normality is once again established and they decide to return to base.

1.11.3 Global Position System (GPS)

The aircraft was also fitted with a fleet tracking system that recorded a trajectory in line with the data obtained from the FDR. It shows the course followed by the aircraft, from take-off to the location of the incident, and its subsequent return to base.

Given that the incident occurred while the aircraft was descending to the starting altitude of the SAR approach (500 ft), neither the SAR approach nor the cliff approach were executed.

1.12. Aircraft wreckage and impact information

N/A.

1.13. Medical and pathological information

N/A.

1.14. Fire

N/A.

1.15. Survival aspects

N/A.

1.16. Tests and research

1.16.1 Interviews with the crew

1.16.1.1 Interview with the pilot

The most relevant aspects of the commander's testimony are detailed below:

- They were scheduled to carry out a training exercise that included an SLC-SAR LINE CHECK to examine the winch operator; they typically do two to three training exercises a week.
- Although the commander normally flies the aircraft during take-off, on this occasion, the co-pilot took off, with a SW wind and a weather forecast predicting possible fog.
- They had programmed a route towards the estuary in the FMS and would later head north to a cliff near Cape Home; a location they often use for this type of exercise.
- They informed Vigo rescue of their planned operation.

- They started the post-take-off checklist before reaching the communications antenna they use as a reference, and finished it shortly before reaching point W.
- When the checklist was completed, the commander took the controls, specifying that he selected the HDG-ALT-IAS-NAV modes, in that order.
- As they passed point W, they contacted the Vigo tower, which transferred them to Santiago Approach.
- At approximately 1900 ft, they selected a 500 ft SAR traffic height to carry out the manoeuvre, a 500 ft/min vertical speed and reduced speed to 80 kt, using the ALT PRE + VS + IAS modes (he confirms that the operation is performed at 500 ft and 80 kt, and that at 500 ft above the water the helicopter should have stopped its descent).
- At 1800 ft he observed that they were too high and had not yet completed the SEA APPROACH. He decided to select HDG+NAV and set a course at 240º, intending to lengthen the route to allow more time for the SEA APPROACH and, therefore, reach the exercise location at the correct altitude.
- The pilot and co-pilot were looking at the weather radar when the rescue swimmer said: *Are we going down?* Alerted by the rescue swimmer, both pilots looked at the altitude and he felt the co-pilot pull the collective (the co-pilot had seen 50 ft on the altimeter). He then immediately pulled it as well, noting that the N1 was already red. He tried to maintain power, control the speed and attitude, climb to a safe height and, when straight and level, asked the co-pilot for the controls since at that point they were both using them. Subsequently, someone said *we touched the water*, and, in light of this possibility, he decided to return to the base.
- The co-pilot's abrupt upward pull on the collective produced a loud clicking sound, which initially led them to think that the helicopter's belly had touched the water. Once back in straight and level flight, and after calming down, they verified that the cabin was dry and used the FLIR camera to check there was no damage and the antennas were all still in place.
- In looking for an explanation for what happened, he raised the following questions and considerations:

- He questioned whether he selected 500 or 800 ft in the VS.

- *It's not normal not to hold the height entered in the AL-300.*

- *If I say something I press it, maybe the FD decoupled or perhaps I confused the DECEL mode with ALT PRE...*

- *My failure was not monitoring the failure.*

- *In our crew debriefing, we talked about the fact that no alarm had sounded because we register everything that beeps.*

1.16.1.2 Interview with the co-pilot

The co-pilot also provided us with a statement, from which we extracted the following considerations:

- It was a training flight they had been forced to postpone the day before due to bad weather, and it included a line check of the winch operator. The exercise planned for the previous day had included a support boat, but as it was unavailable on the day of the incident, they changed the format to a cliff exercise.
- The flight was to consist of: cliff + dummy recovery inside the estuary.
- It was his second flight with this commander.
- They arrived at the base at 22:00 h to join their shift (they work fifteen days on-fifteen days off).
- There are two rooms at the base: the administration room (normally carried out by the co-pilot), and the briefing room where the entire crew meets.
- All SAR emergencies are always reviewed during the briefing. They decided who would fly the cliff manoeuvre (the commander) and, depending on the wind, which location they would use. They didn't need coordinates because the rest of the crew already knew the location.
- During a day shift, the commander can decide when to make the flight. On a night shift, however, the training exercise is always at the beginning of the shift.
- They carried out the pre-flight checks and began the flight VFRN MULTIPILOT, SAR.

Flight segment with co-pilot as PF:

- The commander asked if he wanted to take-off. He accepted the offer and took-off in a northerly direction. Speeds mentioned: 35 kt, V1: 49 kt, V2: 59 kt. The commander told him if he had visibility to go to his side, to the left.
- The technical crew were advised by the rescue crew to locate an antenna used as a reference point for the estuary's mouth.
- His flew his segment of the flight with the autopilots connected and the Flight Director disengaged.
- His departure was a shortened version of the Vigo north route.
- The commander went through the AFTER TAKE OFF checklist.

Flight segment with the commander as PF:

- The commander asked for the controls just after revising the AFTER TAKE OFF checklist, and once the antenna was located and they were inside the estuary.
- The commander spoke to TWR, signing off.
- The co-pilot spoke with Santiago APP and Vigo Rescue Centre.
- The commander told him they were *going to descend to 500 ft*, to which he replied "okay".
- The commander coupled the FD modes: ALT PRE: to descend to 500 ft, V/S to

descend 500 ft/min, and he checked the selections.

- The commander asked if he had spoken with Santiago APP so he proceeded to call them: he did this twice, but they didn't reply (probably because they were low and didn't have a radio link).
- They had to carry out the Sea Approach manoeuvre. They decided to leave the estuary to the south of the Cíes Islands and extend the approach to give them time to do the lists.
- He looked to the side of the commander who was preoccupied with setting a course between the estuary and the Cíes Islands.
- At that moment, the rescue swimmer asked if they were going down. He saw 50 ft on the RADALT and, realising that it was dark outside, he pulled the collective while pressing the FTR. He grabbed the cyclical without moving it because he considered the attitude suitable for the ascent and could only resolve the situation with power.
- The commander then tried to grab the collective but could not because he had hold of it. He asked the commander if he had control and the commander decided to continue the flight.
- Doubts arose as to whether they had touched the water. The commander reassured them that it would be discussed later, and they returned to the base where they reported the event to the mechanic.

Alarms:

- He heard the ALT300 alarm (2 beeps) which sounds at + -250 ft from the altitude entered in the ALT300. It was not discussed.
- Some commanders make verbal reference to the alarms, but others prefer not to because they can sound simultaneously and in quick succession.
- As they were descending and multiple alarms sound, it is normal to hear them and not mention them in the cabin.
- He does not remember hearing any other alarm; not the landing gear (horn-shaped red light which sounds below 300 ft or 60 kt if the landing gear is up), nor the Decision Height alarm (a gong sound and HSI colour change), or the RAWS (which sounds loudly below 30 ft, although it must be pre-set ON-OFF).

Other considerations:

- He stated that he was not 100% familiar with the incident helicopter; he hadn't quite mastered it.
- He obtained his rating at the beginning of 2019.
- It wasn't his first cliff exercise, nor was it his first flight in the helicopter.
- He combines fire fighting activities flying the Bell 412 as a single pilot, with SAR activities in the multi-pilot Sikorsky S-76.
- He had not been regularly active in the service or the helicopter involved since he received his license.

- He can't remember if there was a full moon. There was patchy cloud.
- The instruments could be seen clearly.
- They cut the departure manoeuvre short intending to go directly to the waypoint.
- The entire crew was extremely experienced.

When asked about the cause of the incident, he says the system failed, that he remembers having seen 500 ft on the ALT300 and the ALT and V/S modes selected on the FD.

1.16.1.3 Interview with the winch operator

The winch operator was interviewed and stated the following:

- They had carried out the corresponding briefing, there were no new developments, all aspects of the operation were clear, there was no pressure of any kind, and visibility was good.
- They were descending from 1300 ft to 500 ft.
- The crew was aware of the descent, as always. His focus was inside the cabin looking at the FLIR in thermal mode, through which he observed a boat in the Vigo estuary entrance channel. He zoomed in on the camera and saw that it was a sailing boat.
- As the crew were discussing their next move, the rescue swimmer, who was sitting in the left rear seat and was less occupied, asked if they were going down. The flight crew confirmed they were descending to 500 ft.
- For his part, on seeing the sailing boat he had seen with the camera to his left, through the co-pilot window, and alerted by the rescue swimmer's question, he looked to his right and saw the water nearby. He then said through his helmet "we're going down", immediately repeating the statement but this time shouting and clearly distressed, "WE'RE GOING DOWN". He tried to open the right rear door but gave up just as he found the lever when he felt the aircraft pull upwards sharply. He believed they had hit the water just as he turned to see the sailing boat on the left and noted that its mainmast was above the rotor.
- When he yelled the second time, the co-pilot yelled "50 ft" and put the helicopter into a sharp ascent by pulling the collective up.

1.17. Organisational and management information

Babcock S.A.U is authorised by AESA to carry out aerial work with helicopters and based at the Mutxamel aerodrome (Alicante), with special Operator Certificate ES.COE 006.

The flight was being carried out within the framework of the operator's contract with the Coastguard Service, which, in turn, is run by the Galician Regional Government's Ministry of the Sea. The ministry deals with matters relating to search and rescue, fisheries surveillance and protecting the marine environment in Galician waters.

1.18. Additional information

1.18.1 Information about the operation

The incident flight was a training flight, during which the winch operator was to be line validated by an examiner.

The training consisted of flying along the Vigo estuary until close to Cape Home, where they would simulate a cliff rescue. To do this, they would descend from their cruising altitude to 500 ft above sea level. Once at that altitude, they would execute a SAR Approach to a safety hover 125 ft above the water. From there, after checking the relevant parameters, they would descend to 50 ft and lower the rescue swimmer with the winch so that he could proceed to recover the dummy victim previously thrown into the water, thus completing the exercise.

The aircraft's seats were in the 2 + 3 SAR configuration, and there were two pilots and three technical crew members on board (an examiner, a winch operator and a rescue swimmer).

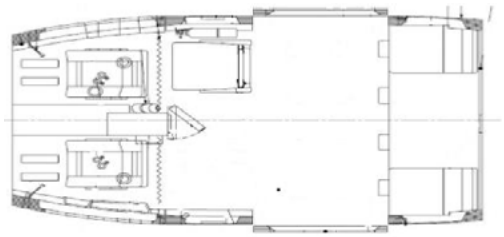


Fig. 9. - S-76C+ SAR cabin seat configuration

The service runs SAR all-weather operations carried out with helicopters capable of automated approach, hover and take-off in any weather condition.

Both pilots will check and confirm the altitude whenever the ALT ALERT light illuminates and the altitude alert tone sounds. If it is a conscious ascent or descent by the crew, the PM confirms by saying "1000 feet for level" or "250 feet for level". These altitudes were not confirmed as the crew did not respond to the alerts.

1.18.2 Control of the helicopter

During all phases of flight, including the ground procedures, all crew members must know which pilot has physical control of the helicopter and is, therefore, the PF.

In situations not covered by the *Operations Manual,* the PIC must determine who the PF is and communicate that information to the crew. Whenever there is a change of role, the pilot relinquishing control of the helicopter must inform the pilot-in-command of any relevant information, such as height, speed, power, navigation status or flight director modes.

Furthermore, the PIC can take control at any moment, and the co-pilot must relinquish control as soon as the PIC informs him of that decision. Notwithstanding the foregoing, the co-pilot may assume control at any moment to protect the safety of the helicopter. It may be necessary for the co-pilot to take control to avoid a collision when there is no time to properly communicate with the PIC or if the PIC is incapacitated.

In standard operations, the PM will be in charge of managing communications. In non-standard operations, when the PM is performing other duties, or when the PIC deems it appropriate, the PF will make the necessary transmissions.

With regard to the use of the SPZ-7600 system controls, pilots initially select the ATT and FD1/2 modes on the PC-700 (1), then select several FD modes on the MS-700 (2). Before the descent, they select 500 ft of altitude on the AL-300 (3) to descend and maintain that height over the estuary, followed by the ALT PRE Mode on the MS-700 (2) and the desired descent rate of 800 ft followed by V/ S mode on the MS-700 (2). The VS figures and altitude are programmed into the AL-300 from the collective control lever.

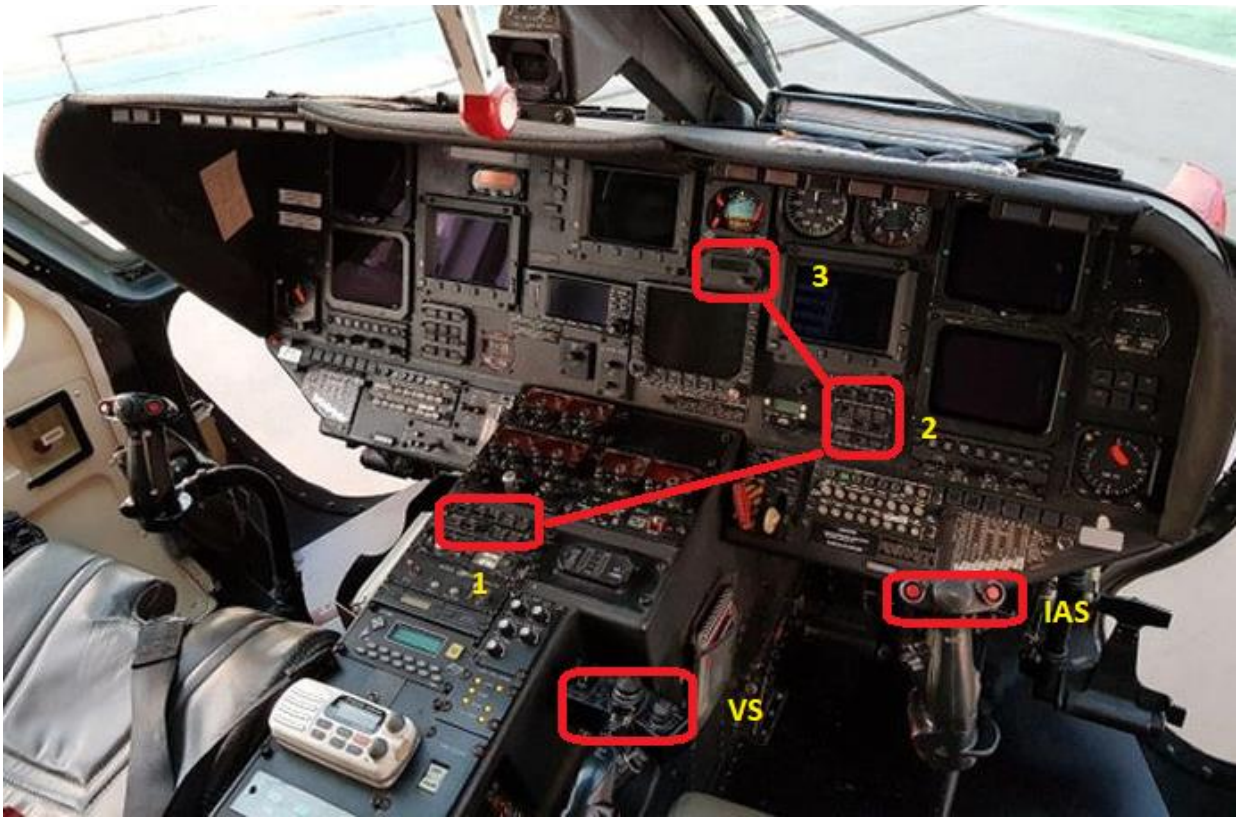


Fig. 10. - Sequence of actions SPZ-7600

1.18.3 Cabin alarms.

The chronological sequence of alarms is as follows:

At 1000 ft above the selected altitude, in this case, 1500 ft, a tone sounds for one second and a red ALT ALERT light illuminates on the instrument panel.

At 250 ft above the altitude selected in the ALT 300, in this case, 750 ft, a beep sounds. At 450 ft on the radio altimeter, the corresponding alarm sounds in the co-pilot's DH. It is a soft sound, only perceptible in the co-pilot's station, and it does not need to be reset.

In this helicopter, at 450 ft on the radio altimeter, the landing gear-up alarm is also activated. It consists of a double deep-toned alert. It only stops when it is reset.

At 250 ft of barometric altitude below the altitude selected in the ALT 300, in this case, 250 ft, two high-pitched beeps sound.

At 190 ft on the radio altimeter, the corresponding alarm sounds in the pilot's DH. It is a soft sound, only perceptible in the pilot's station, and does not need to be reset.

At 30 ft on the radio altimeter, the RAWS alarm sounds until the aircraft reaches 70 ft. This alarm makes a loud and continuous bell sound.

1.18.4 Visual cliff approach. (IO-103.04 SAR survivor rescue).

Safety must be taken into account when making a cliff approach. Thought must be given to escape routes, safety heights, available power, downwind and possible turbulence, and this information must be included in the approach briefing.

If the wind direction means the approach to the cliff/coast must be made with it to the left of the helicopter, the PIC will assess whether the PM should carry out the approach and winch manoeuvre, given that he will have the ground references and any obstacles in sight. An approach to a stationary hover will be made using a standard SAR traffic flight up to the decision point/transition to visual, according to the stipulated minimums. The distance between the decision point or minima, and the cliff, must always be greater than the helicopter's deceleration distance with the FD engaged (according to GS). The segments of standard SAR traffic flights must be adapted to the orography to avoid flying over land without a visual on the obstacles. The winch operator and rescue swimmer will actively participate in the approach, using the FLIR to obtain the distance and azimuth to the target and identify any possible obstacles in the approach path. They will also make visual checks. All available lights on the helicopter must be used.

1.19. Useful or effective investigation techniques

N/A.

2. ANALYSIS

2.1. General aspects

According to the documentation provided, the aircraft's pilots and crew were in possession of the relevant licenses and medical certificates required for the flight. They also had extensive experience in the activity they were carrying out.

The commander had extensive experience of flying the S-76C+ and night operations in the Vigo estuary area.

The co-pilot was an expert in SAR operations and a flight instructor and commander for the company's fire fighting operations in other aircraft models. He had only been stationed at the Vigo base for a short time and had 73:30 hours of flight experience in the type of aircraft involved, for which he had recently obtained the type rating and completed the SAR course.

The aircraft also had the correct documentation for the flight.

The information on the pilots' activity confirmed that their working hours and days met the requirements of OC 16B and Annexe 1.

The take-off weight of the aircraft was within the operational limits specified by the S-76C+ flight manual.

2.2. Of the meteorological conditions

According to the information provided by the State Meteorological Agency (AEMET), the meteorological conditions in the area at the time of the incident were scant clouds, no convective activity, light swell and light winds.

The moon was in an advanced last quarter phase, four nights before the new moon, and the lack of moonlight made it difficult to visualise the surface of the sea and coastline. For their part, the crew reported good visibility.

According to the SOP SAR MAR 006, training can be carried out in any meteorological condition in which the helicopter's operating manuals say it can fly. When training over the sea, day or night, the required ceiling is 500 ft and the required visibility 3 NM. Training exercises involving the recovery of survivors from the sea or a boat must not be carried out when a member of the crew or other individuals may be placed in danger due to any of the following adverse conditions: a lack of sufficient references whilst hovering, rough sea, adverse temperatures or a combination of temperature and wind, heavy showers or thunderstorms.

Therefore, the operation was carried out within the admissible meteorological conditions for this type of activity.

2.3. Of the operation

It was a routine night-time SAR training operation, with no excessive complications, meteorology compatible with night flight and a crew performing its second night SAR operation together. The winch operator's line check was due to take place during the flight, and for this reason, there was also a winch operator and rescue swimmer instructor on board the aircraft.

The crew's previous flight had taken place the day before the incident but was cancelled after take-off due to fog formation over the Vigo estuary.

During night-time SAR operations, visual references, which are generally used to interpret the aircraft's position during the approach, can be lost, forcing pilots to rely on available data from cockpit instrumentation. To facilitate the flight task in poor visual conditions, pilots require easy access to critical flight information. Flying VFRN, the crew used the flight instrument references in conjunction with external visual references.

Although it was, *a priori,* a routine and straightforward flight, the crew wanted to finalise communications with the Vigo tower and maritime Rescue Coordination Centre because once the descent over the estuary has begun, communications can deteriorate when the visual VHF link is lost.

It can be assumed that a saturation of communications and tasks to be carried out in the cabin meant the crew paid less attention to flight monitoring and cross-checking.

With regard to the use of the AP and FD and their different modes, it must be taken into account that whenever an automatically controlled altitude change is made, the VS and ALT-PRE MODES are used simultaneously. This makes it possible to descend or ascend at a constant vertical speed until the predetermined altitude is reached. That altitude will then be maintained until the pilot modifies the conditions. Caution must be taken to ensure that the different aircraft control modes are activated in the selected FD, which must correspond to the pilot at the controls.

The FDR data indicates that AP1 and AP2 were selected and that the selected FD corresponded to the commander. The V/S mode was active, among others, but the ALT-PRE was not.

Therefore, we can assume that the aircraft had instructions to descend at 800 ft per minute (which is reflected in the constant slope of the corresponding graph) but that it had no instruction to stop at any specific height: This meant that once it reached the 500 ft entered into the ALT-300, it continued to descend without stopping.

According to the testimony of the PF, he had *selected 500 ft of altitude, a 500 ft/min vertical speed and reduced speed to 80 kt, using the ALT PRE + VS + IAS modes*. He confirmed the operation is performed at 500 ft and 80 kt, and that at 500 ft above the water the helicopter should have stopped its descent. Dialogue corresponding to these settings can be heard on the CVR recording, and the co-pilot copies them.

The information above shows that, although the pilot clearly intended to activate the appropriate modes, the recorded data does not confirm their activation. We checked the data from flights made immediately before and after the incident flight to verify the incident flight data. The results confirmed its reliability.

In his testimony, the commander himself questioned whether he might have pressed DECEL instead of ALT PRE. The DECEL button is located next to ALT PRE, and given that it is only associated with ILS interception, its activation would have been inconsequential. This explanation could be consistent with the events that followed.

The incorrect application or non-application of a particular command should have been confirmed by the crew because a failure to do so, as happened in this case, can lead to an assumption that the aircraft is operating under a specific control or mode when in fact it is not.

If they had cross-checked and used descent call outs, the different aircraft instruments would have alerted the crew to the situation and progression of the vertical navigation during the descent, and they were also able to visualise the surface of the water with thermal cameras and searchlights. Eventually, it was a member of the rescue crew, outside the pilot loop/sequence, who drew attention to the situation by asking the crew if they were going down.

With regard to the alarms in the cabin, according to the CVR records, when the co-pilot was trying to contact Santiago Approach, the co-pilot's DH and the landing-gear up alarms sounded at 450 ft. At 250 ft, the ALT-300 alarm sounded. At 190 ft, the pilot's DH sounded, and between 30 ft and 70 ft, the RAWS alarm can be heard.

In this respect, the pilot stated that "he had reset the 450 ft DH and that he had heard the 190 ft DH". For his part, the co-pilot said *he only heard the 250 ft alarm corresponding to the ALT-300, and that he does not remember hearing any other alarm; not the landing gear alarm (horn-shaped red light which sounds below 300 ft or 60 kt if the landing gear is up), nor the Decision Height alarm (a gong sound and HSI colour change), or the RAWS (which sounds loudly below 30 ft, although it must be pre-set ON-OFF).*

He also indicated that *some commanders make verbal reference to the alarms, but others prefer not to as they sound in quick succession and there are so many of them they become accustomed to hearing them and don't mention them in the cabin*.

From the information above, we can ascertain that there was general confusion in the cockpit with regard to which alarms sounded, which were reset, and even when they should have sounded: the HD 450 ft co-pilot alarm cannot be reset, especially not by the pilot because he cannot hear it. Therefore, this alarm was confused with the landing gear alarm that must be reset and is audible in the cockpit. Furthermore, the co-pilot, who according to his own testimony was not entirely familiar with this helicopter, thought the aforementioned landing gear alarm sounded below 300 ft and not at 450 ft as it does in this specially adapted aircraft.

In any case, mistakenly or not, both crew members heard and noted alarms that warned of positions below the 500 ft altitude supposedly selected in the ALT 300, without either of them realising they were in a compromised situation.

Therefore, we conclude that the crew did not act in accordance with operational procedures because they ignored the cockpit alarms and did not work in a coordinated manner, giving priority to other activities and ultimately failing to monitor the flight, leading to a total loss of situational awareness.

Considering the number and gravity of the discrepancies involved in the incident, the fact that, with greater or lesser severity, these types of situations have already occurred in the past, and especially given the potential seriousness of the outcome, we are issuing a recommendation to the operator, Babcock, advising them to improve training on procedural adherence, response to warnings and alarms and, particularly, CFIT prevention during crew training exercises.

3. CONCLUSION

3.1. Findings

The aircraft pilots held the required licenses, ratings, and relevant medical certificates for the multi-pilot night-time SAR operation.

The co-pilot had little experience in the type of aircraft involved and alternated SAR activity with FF operations, where he had practically double the number of flight hours in a different aircraft.

The aircraft had the corresponding documentation for the flight.

The weight of the aircraft was within the limits of its maximum take-off weight and centre of gravity.

There were no limiting meteorological conditions for the flight.

The flight was performing under visual flight night rules.

The corresponding FD was coupled to the autopilot, the V/S mode was activated in the Automatic Flight Control System, but the ALT PRE was not.

The aircraft was instructed to descend at 800 ft per minute.

The aircraft was not instructed to stop at any specific height.

At all times the crew believed they had activated all the appropriate modes.

No height cross-checking was carried out during the descent and no corresponding call outs were made.

There was a saturation of communications and tasks (distracting elements) to be carried out in the cabin.

No attention was paid to monitoring the flight.

The rescue crew member alerted the flight crew to the dangerous situation.

3.2. Causes/contributing factors

The incident was caused by a loss of situational awareness on behalf of the crew.

This lack of awareness resulted from the crew's assumption that the aircraft was operating under altitude control, when, in fact, it was not because the corresponding system had not been activated. Excess confidence in the automatisms caused the crew to be complacent. They failed to carry out the mandatory monitoring of the descent, which led to a potentially life-threatening situation.

4. OPERATIONAL SAFETY RECOMMENDATIONS

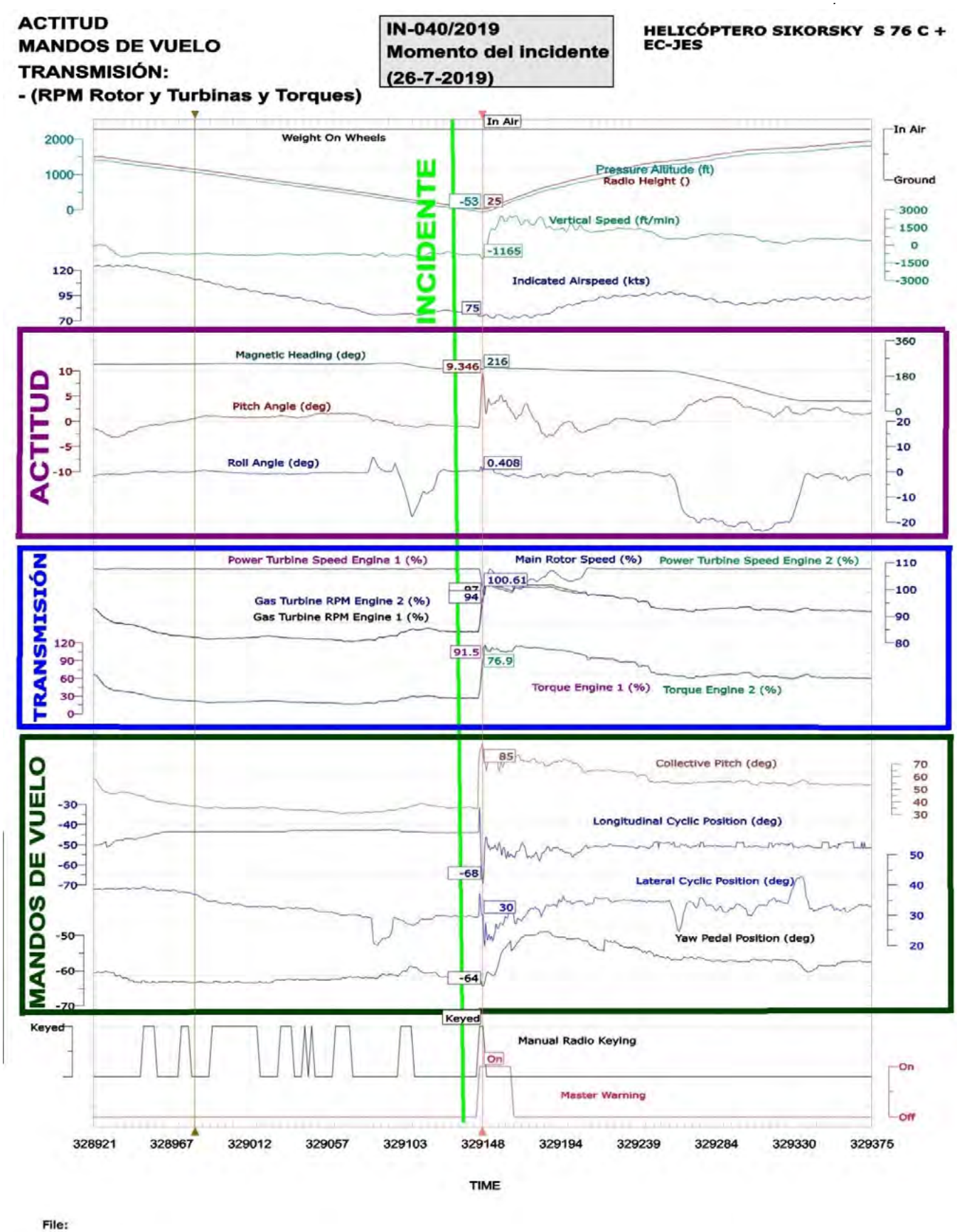
REC 35/20: We recommend that the operator, Babcock, should implement the necessary measures to improve training on procedural adherence, response to warnings and alarms and, particularly, CFIT prevention during initial and recurrent crew training exercises.

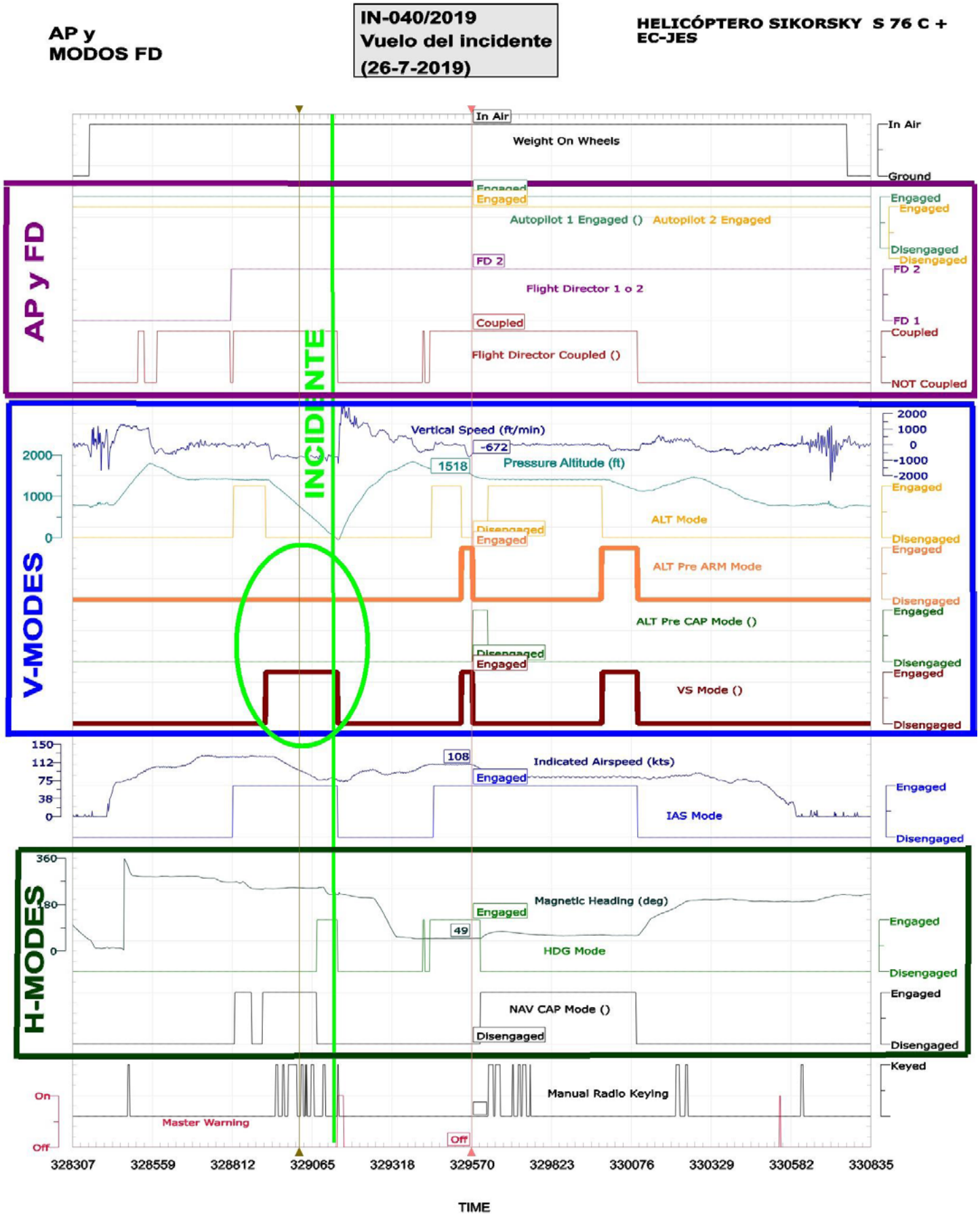
5. APPENDICES

5.1. Appendix 1. Graphics from the FDR study. Values of relevant parameters

APPENDIX 1

GRAPHICS FROM THE FDR STUDY VALUES OF RELEVANT PARAMETERS


ACTITUD
MANDOS DE VUELO
TRANSMISIÓN:
- (RPM Rotor y Turbinas y Torques)
IN-040/2019
Momento del incidente
(26-7-2019)
HELICÓPTERO SIKORSKY S 76 C +
EC-JES
In Air
Weight On Wheels
INCIDENTE
Pressure Altitude (ft)
Radio Height ()
Vertical Speed (ft/min)
Indicated Airspeed (kts)
-53
25
-1165
75
Ground
ACTITUD
Magnetic Heading (deg)
Pitch Angle (deg)
Roll Angle (deg)
9.346
216
0.408
TRANSMISIÓN
Power Turbine Speed Engine 1 (%)
Main Rotor Speed (%)
Power Turbine Speed Engine 2 (%)
Gas Turbine RPM Engine 2 (%)
Gas Turbine RPM Engine 1 (%)
100.61
94
91.5
76.9
Torque Engine 1 (%)
Torque Engine 2 (%)
MANDOS DE VUELO
85
Collective Pitch (deg)
Longitudinal Cyclic Position (deg)
-68
Lateral Cyclic Position (deg)
30
Yaw Pedal Position (deg)
-64
Keyed
Manual Radio Keying
On
Master Warning
Off
328921
328967
329012
329057
329103
329148
329194
329239
329284
329330
329375
TIME
File:


AP y
MODOS FD
IN-040/2019
Vuelo del incidente
(26-7-2019)
HELICÓPTERO SIKORSKY S 76 C +
EC-JES
AP y FD
V-MODES
H-MODES
INCIDENTE
In Air
Weight On Wheels
Ground
Engaged
Autopilot 1 Engaged ()
Autopilot 2 Engaged
Disengaged
FD 2
Flight Director 1 o 2
FD 1
Coupled
Flight Director Coupled ()
NOT Coupled
Vertical Speed (ft/min)
-672
1518
Pressure Altitude (ft)
2000
1000
0
-1000
-2000
ALT Mode
ALT Pre ARM Mode
ALT Pre CAP Mode ()
VS Mode ()
150
112
75
38
108
Indicated Airspeed (kts)
IAS Mode
360
180
49
Magnetic Heading (deg)
HDG Mode
NAV CAP Mode ()
Keyed
Manual Radio Keying
On
Off
Master Warning
328307
328559
328812
329065
329318
329570
329823
330076
330329
330582
330835
TIME

File:

Values of relevant FDR parameters

Parameters corresponding to the AP and FD at the beginning of the incident descent. The ALT-PRE MODE is not selected

UTC	Autopilot 1 Engaged ()	Autopilot 2 Engaged	Flight Director 1 o 2	Flight Director Coupled ()	ALT Mode	ALT Pre ARM Mode	ALT Pre CAP Mode	VS Mode	HDG Mode	NAV CAP Mode	IAS Mode
21:13:13	Engaged	Engaged	FD 2	Coupled	Engaged	Disengaged	Disengaged	Disengaged	Disengaged	Engaged	Engaged
21:13:14	Engaged	Engaged	FD 2	Coupled	Engaged	Disengaged	Disengaged	Disengaged	Disengaged	Engaged	Engaged
21:13:15	Engaged	Engaged	FD 2	Coupled	Disengaged	Disengaged	Disengaged	Engaged	Disengaged	Engaged	Engaged
21:13:16	Engaged	Engaged	FD 2	Coupled	Disengaged	Disengaged	Disengaged	Engaged	Disengaged	Engaged	Engaged

Moment they pull the collective up brusquely. The Flight-Director disengages. Engine reaction. RADIO-HEIGHT minimum 22 ft.

UTC	Pressure Altitude (ft)	Radio Height (ft)	Indicated Airspeed (kts)	Collective Pitch (deg)	Main Rotor Speed (%)	Power Turbine Speed Engine 1 (%)	Power Turbine Speed Engine 2 (%)	Torque Engine 1 (%)	Torque Engine 2 (%)	Flight Director Coupled ()
	-27	38		35	107.7	107	107	26.9	26.2	
21:15:08		33	77	35	107.7	107	107	27.1	26.2	Coupled
	-47	25		70	107.7	107	107	26.9	26.4	
21:15:09		22	74	82	107.7	107	103	42.0	38.5	NOT Coupled
	-53	25		86	104.1	98	98	76.8	66.8	
21:15:10		29	75	72	98.9	97	98	112.8	92.4	NOT Coupled
	-46	36		69	97.8	101	102	116.2	116.6	
21:15:11		46	76	69	102.7	105	106	106.6	111.9	NOT Coupled
	-27	59		72	106.2	107	107	107.4	107.4	
21:15:12		73	74	74	107.6	107	107	105.2	108.8	NOT Coupled
	5	90		75	107.2	106	106	111.8	112.9	
21:15:13		109	72	77	106.6	105	104	110.4	109.2	NOT Coupled
	52	127		76	105.0	103	103	109.4	110.2	