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AVIACIÓN **C**IVIL

Report A-015/2017

Accident involving a Bell 206B3 helicopter, registration D-HHMP, operated by Rotorsun, in Pego (Alicante) on 5 August 2017

GOBIERNO DE ESPAÑA

MINISTERIO DE TRANSPORTES, MOVILIDAD Y AGENDA URBANA

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Foreword

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 degrees, minutes and seconds
ACO	Coordination and observation aircraft
ACT	Relevant activities
AESA	National Aviation Safety Agency
AG	Agricultural
AOC	Air Operator Certificate
ASC	Aircraft of similar characteristics
ATO	Aviation Training Organization
CAMO	Continuing Airworthiness Management Organization
SOC	Special operator certificate
CPLH	Commercial pilot license helicopter
DGAC	Civil Aviation General Directorate
DGPS	Differential global positioning system
GIS	Geographic information system
IGE	In Ground Effect
kg	Kilograms
LBA	National civil aviation authority of Germany
FF	Firefighting
MAGRAMA	Spain’s Ministry of Agriculture, Food and the Environment
OM	Operating manual
OGE	Outside Ground Effect
PIC	Pilot in command
RTS	Rotorsun
SOP	Standard operating procedure
SP	Special performance
SPO	Specialized operations
STC	Supplemental type certificate
USG	US gallons

Synopsis

Owner:	Agrarflug Helilift GmbH & Co Kommanditgesellschaft - Germany
Operator:	Rotorsun – Spain
Date and time of accident:	Saturday, 5 August 2017 at 09:40[1]
Site of accident:	Pego (Alicante)
Persons on board:	1 pilot, uninjured
Type of flight:	Aerial work – Commercial – Agricultural
Phase of flight:	Takeoff

Date of approval: 27th March 2019

Summary of event

The helicopter had taken off from a temporary landing site in the vicinity of Pego in order to apply phytosanitary products by spraying chemicals on the surface of a crop field using auxiliary fumigation equipment installed on the aircraft.

After flying for about 1:30 hours, and during the sixth takeoff of the day, after landing to refill the chemicals, during the initial takeoff phase and before reaching an effective translational lift speed, the aircraft lost height, with the right part of the spray boom impacting the crop field. This caused the subsequent dynamic rollover and impact with the ground.

The aircraft sustained significant damage to its landing gear, booms, spray equipment and main rotor. The pilot, who exited the aircraft under his own power, was not injured.

The investigation has determined that the accident was most likely caused by the execution of a takeoff maneuver without maintaining suitable external visual references. The following factors contributed to the accident:

[1] All times in this report are local unless specified otherwise.

- Applying less power than necessary to avoid losing altitude before reaching the effective translational lift speed during takeoff.
- Maintaining a curved, instead of straight, flight path over the terrain during takeoff.
- The improper implementation of the reduced flight periods specified in the operator's *Operations Manual* for pilots with little experience in aerial spraying operations.

1. FACTUAL INFORMATION

1.1. History of the flight

The aircraft had taken off from the heliport in Sueca, Valencia, toward the rice paddies of Pego, in the province of Alicante. A ground support team had also traveled there to refuel and load chemicals in the area. The members of the support team prepared a landing and refueling site for taking on fuel, water and fumigation chemicals that was adjacent to the fields to be sprayed. The area to be sprayed did not have any power lines or geographic features that could hamper the spraying operations. It was a very flat parcel of land at sea level with a crop height of around 1.20 m.

1.2. Injuries to persons

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

1.3. Damage to aircraft

As a result of the accident, the helicopter sustained significant damage to its spray booms, landing gear, main rotor, tail cone and engine compartment, as well as to other components.

1.4. Other damage

Not applicable.

1.5. Personnel information

Pilot in command of the aircraft

Age:	26
Nationality:	Spanish
Medical certificate:	Class 1; valid until 20/08/18
Commercial pilot license (Helicopter) (CPL (H)):	Issued by AESA, initial issue date 12 April 2012
BELL206/SP rating:	Valid until 30 April 2018
Proficiency check:	Qualified Rotorsun 27 April 2017

Total flight hours:	1365:35
Total hours on the type:	908:10
Hours in the last 30 days:	71:45
Hours on the type in the last 30 days:	71:45

Pilot's Schedule in July and August

The pilot was scheduled to work 21 days in July on four activities: fire observation and coordination, firefighting, company training and cleaning of power line insulators.

In August he was scheduled to work 20 days on three activities: aerial spraying (fumigation), cleaning of electrical insulators, and fire observation and coordination.

The accident occurred in the first week of work in August, during which he was scheduled to work three consecutive days on aerial spraying activities.

On the day before the accident, the pilot had flown 5 hours in 2 hours periods with 40 minutes breaks between flight periods. His total duty time that day, as determined by his presence at the spraying site, was 7:40 hours.

1.6. Aircraft information

The Bell 206B helicopter is a single-engine turbine helicopter with two-bladed main and tail rotors. The minimum crew is one pilot. This serial number places it among those marketed as the 206B and Jetranger III.

Serial number	3823
Year of manufacture	1984
Maximum authorized takeoff mass	1461 kg
Hours at the time of the accident	6058
Engine manufacturer	Rolls-Royce Corporation (Allison)
Engine model	ALLISON 250-C20-J250-C20-J
Engine serial number	S/N3823
Engine power	313 kW
Owner	Agrarflug Helilift – Germany
Operator	Rotorsun - Spain
CAMO	Rotorsun, since 22 May 2017, with AESA approval number ES.MG.101.

Certificate of Airworthiness

Issued by	LBA - National civil aviation authority of Germany.
Issue date	1 April 1996
Validity	Indefinite when accompanied by the Airworthiness Review Certificate

Airworthiness Review Certificate

Issued by	Agrarflug Helilift GmbH & Co Kommanditgesellschaft, with LBA approval no. DE.MG.385
Issue date	17 January 2015
Extended on	19 January 2017
Expiration date	2 February 2018

Registration certificate

Issued by	LBA - National civil aviation authority of Germany.
Issue date	13 September 2006

Load and balance

The helicopter was within the mass range allowed by the aircraft manual, about 1309 kilograms at the time of the accident, and within the center of gravity limits, both at the start of the flight and at the time of the accident.

1.6.1. Aircraft performance

The altitude density was approximately 1000 feet, which allowed the aircraft to hover in-ground effect in the area of operation with a takeoff weight of 1447 kilograms at an approximate altitude of 100 feet. The helicopter could hover in-ground effect by applying around 90-95% of engine torque, within the 5 minutes maximum takeoff power limit, set at 100% engine torque.

1.7. Meteorological information

Based on the information provided by Spain's National Weather Agency (AEMET), the weather data recorded at the station located in Pego on the day of the accident between 09:00 and 10:00 local time were as follows:

- Wind: increasing from 2 to 5 kph, veering from Southwest to Northeast.
- Temperature: increasing from 27 to 30º C.
- Humidity: falling from 75 to 70%.

Satellite images showed barely any cloud cover.

1.8. Aids to navigation

Not applicable. The flight was conducted under visual flight rules.

1.9. Communications

Not applicable.

1.10. Aerodrome information

Not applicable.

1.11. Flight recorders

The aircraft did not have flight recorders, as they were not required for aircraft of its type.

As part of the fumigation equipment (see 1.18.1), the helicopter had a differential global positioning system (DGPS) installed, the data files from which were downloaded for analysis.

Figures 1 and 2 show, respectively, the flight path taken on the flight prior to the accident, and the final takeoffs recorded on the DGPS, including the one immediately prior to the accident.

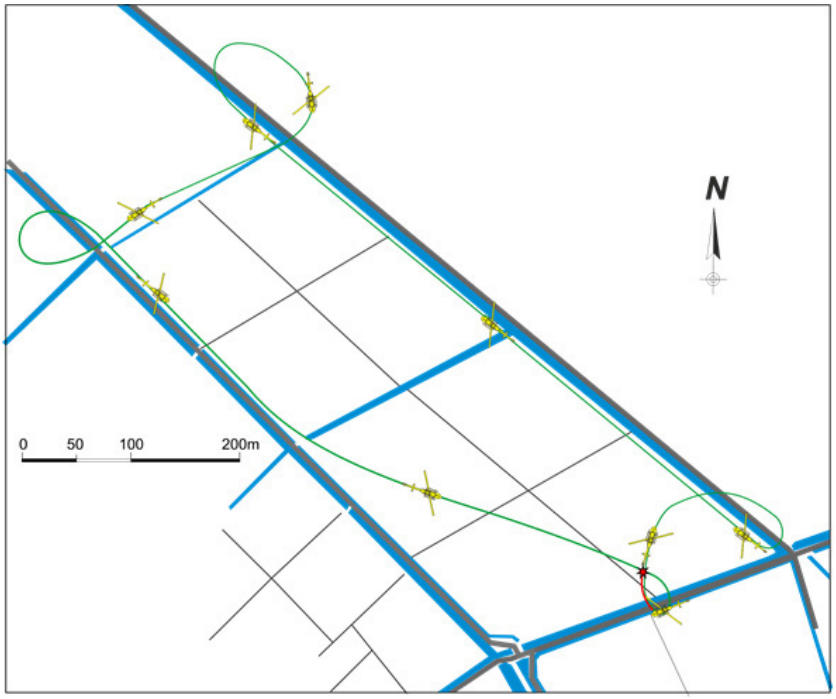


Figure 1. Flight path taken by the helicopter in the flight before the accident flight

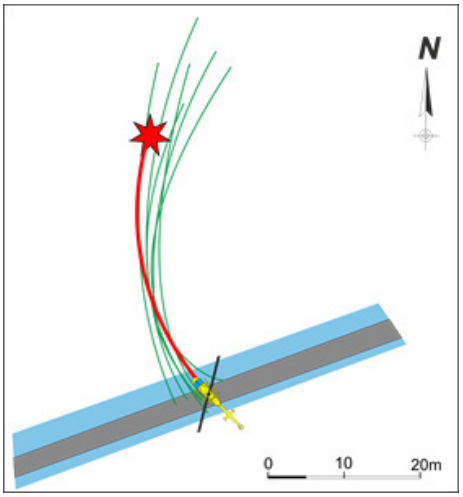


Figure 2. Flight paths taken by the aircraft in the final takeoffs recorded by the DGPS

1.12. Wreckage and impact information

The aircraft impacted at coordinates 38º 51' 43" N, 0º 03' 11" W, at an elevation of 0 m. It came to rest on its right side near an irrigation canal for the rice paddies, some 50 m away from the takeoff point.

After the initial contact between the fumigation boom and the ground, the aircraft's right skid impacted the ground, pivoting in an attitude consistent with dynamic rollover. The aircraft came to rest on its right side after the impact.

Figure 3. Condition of the aircraft after impact

1.13. Medical and pathological information

Not applicable.

1.14. Fire

There was no fire.

1.15. Survival aspects

The low speed and altitude resulted in a low-intensity impact such that the pilot was able to exit the aircraft by opening the door on the copilot's side.

Personnel on the ground called emergency services (112). A few minutes later, law enforcement officers (a local Pego police car and a Civil Guard car) reported to the accident site, along with an ambulance and a unit from the Denia (Alicante) firefighters.

1.16. Tests and research

1.16.1. Pilot's statement

The pilot explained that he had started working at Rotorsun as ground staff/loader[2] in 2011. He was then employed on a seasonal basis by the same company, which he alternated with work at other companies.

In the years he had been flying as a pilot, he had gained experience doing several types of aerial work, such as firefighting, external loads and fumigation.

He said that in the seasons he had worked at Rotorsun, he had always received the necessary training. The month before the accident, an instructor gave him a few hours of refresher training on using the DGPS and how to make passes using it. He stated that the passes were usually made at a height of 3 meters.

He had started spraying in the area Thursday afternoon (two days before the accident). The day before the accident he had flown for five hours. He flew for two hours and rested for 40 minutes.

At the time of the accident, he had been flying between an hour and one and a quarter hour. The pilot said he may not have taken off with the power needed, thinking he may have taken off with 90% engine torque instead of 95%. He had turned right during takeoff to face into the wind, he then made contact first with the right-side boom, though it may have been both because before he knew it, he was in the rice paddy. Prior to that he had taken off six times from that same spot. After impacting the

[2] Ground personnel tasked with refueling and loading the fumigation product.

ground, he closed the fuel valves and turned the master switch off. He exited under his own power through the copilot's door, since his was against the rice paddy.

In the area the wind tends to be swirling at that time, but that morning it was very weak. The temperature was 27 or 28 degrees.

The pilot ruled out any fault with the aircraft, which had no anomalies.

He started flying that day with about 45-50 gallons of fuel. He estimated that the time of the accident, he would have had between 20 and 30 gallons. He had also just taken on 100 liters of product.

The farmer (owner of the plot) alerted emergency services with the coordinator's telephone.

1.16.2. Instructor's statement

The instructor stated that he had about 12 years and 5000 flight hours of experience, of which 3000 hours had been on the Bell 206. He had worked cleaning power lines, doing mountain flights and fumigation. He had about 100 hours as an instructor.

He explained that it was normal to start out at the company in firefighting operations, and after 1000 hours to train pilots for fumigation. At Rotorsun, it is the director of Operations who decides what jobs to accept.

The interviewee had trained the pilot, first on the ground for several days and then in flight. The pilot was already familiar with the operation as he had worked previously as a ground assistant at the company. They discussed both on the ground and in the air how to deal with the DGPS, emergencies, cables, obstacles, types of drops, etc. During training he emphasized that the DGPS was support equipment and was not to be operated during flight. It was not his first time using the DGPS.

When asked his opinion about the pilot, the instructor said he was qualified for fumigation activities. He thought he had more than enough experience to do the work he was doing when he had the accident. He had done several fumigation training flights. The pilot knew how to fly, how to do drops and the operation in general. In his opinion, he was a good pilot and the area where he had the accident was easy. He was thoroughly qualified for this type of work.

The instructor thought that the plot where the accident occurred was easy to spray. Pilots who are just starting out with spraying activities are normally assigned easy jobs like this one. He explained that he had personally checked the DGPS data, which show the passes flown by the pilot on the day of the flight, and they had been correct with no sudden turns.

This type of operation is normally started with enough fuel for 2 hours and a load of 100 kg of product. As the fuel is consumed, the amount of product is increased to 140-150 kg. It is the pilot who decides how much product to take on, as well as the starting area.

He had flown that helicopter the day before, applying 90 to 94% of engine torque and the aircraft was fine.

The instructor stated that before translational lift is achieved, the helicopter drops by about one meter.

When asked if he thought the pilot might have been trying to take advantage of the takeoff to make a pass with the product, the instructor replied no because the passes were not in the direction of the takeoff. In his opinion, the pilot was highly skilled. Two days before the accident he had been watching him fly in Pego, which he had done without any problems. As for the accident, the instructor thought it likely that the pilot had not taken off with the thrust required, he looked at the DGPS and lost the horizon. He did not think the pilot could have become spatially disoriented over the field.

1.16.3. Coordinator's statement

The coordinator explained that the pilot, not he, did the pre-flight inspection. This aircraft has no pre-flight inspection for the mechanic to do. The mechanic only checks the levels and provides support to the pilot, with whom he communicates via radio. He stated that the aircraft was fine and had no faults.

The switch for releasing the product is located on the cyclic control. It is tested every day in the morning and afternoon. They had tested it that very morning and it worked correctly.

In his opinion, the pilot had been doing a good job both that morning and on the previous day. At the time of the accident, he had taken off from a clearing that he had used to take off from several times, and he fell shortly after takeoff. He was flying 3-4 meters over the rice field, reaching a height of 5 meters at one point, which, as he stated, was normal. In that area the rice was 1.6 meters tall (taller than normal). He had not touched the rice plants in any of the previous flights.

The aircraft was not at its heaviest when the accident occurred, since it had been flying for a while and had consumed fuel. In the morning, they loaded enough fuel to fly for 2 and a half hours. Just before the accident takeoff, they had loaded 100 liters of water and 1 kg of product, approximately.

When asked if anyone from the company had gone to supervise the work they were doing in Pego or fly with the pilot, he replied no. He thought the pilot had received training days earlier, but it had not been in Pego.

1.16.4. Eyewitness's statement

The owner of the plot was close to the site where the accident occurred, although he did not see the how the helicopter fell, as his view of the area was blocked by some reeds. He did hear the noise that it made. As he stated, by the time he reached the helicopter, the pilot had already exited it.

He explained that the crops were sprayed 2-4 times a year. The fumigation date had been arranged a few days in advance, and it took place as scheduled. His farm was only sprayed on that day, and it required 15-20 flights to spray it completely. He explained that it had been planted with bomba rice, whose plant measures 1-1.2 m in height, a little taller than usual.

He did not notice anything unusual about the pilot.

1.17. Organizational and management information

1.17.1. Rotorsun

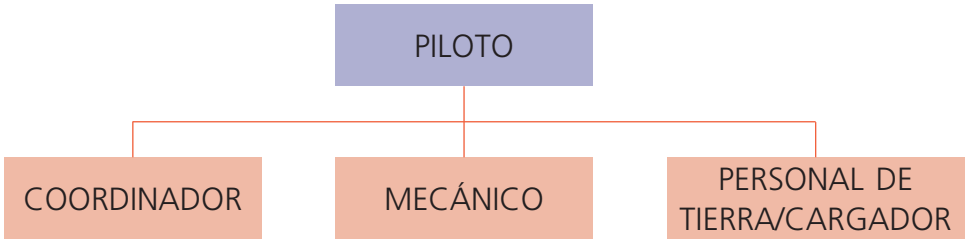
Rotorsun is a helicopter aerial work company headquartered in Águilas, Murcia. It has a permit from the National Aviation Safety Agency (AESA) to engage in work involving oblique photography, observation and patrol, aerial spraying, cleaning of high-voltage insulators, cargo transport, civil protection and water drops from helicopters.

It has special operator's certificate (COE in Spanish) ES.COE.008 for aerial firefighting work and emergencies. It also has an AESA-authorized center for doing Part-145 maintenance on aircraft, no. ES.145.205. As concerns the activity of spraying from a helicopter, Rotorsun is listed as an applicator of phytosanitary products in the registry of the Ministry of Agriculture, Food and the Environment. It also has a Continuing Airworthiness Management Organization (CAMO) certificate, ES.MG.101, issued by AESA.

1.17.2. Standard operating procedure of Rotorsun for aerial spraying

Rotorsun's *Operations Manual* states that the experience level required of pilots is specified by the company in accordance with the applicable law. It also proposes risk mitigation measures for personnel with little experience. The experience or qualification requirements are listed in Part A, Section 5 of its Special Operations Manual.

This manual states that the operation of aerial spraying of agricultural products involves the pilot in command of the helicopter and the ground support personnel:



Section 5.4.1, on risk analysis, considers the risks of using electronic guidance equipment during operations, and reflects on the risks of operations carried out by pilots with little experience with the activity or the helicopter model.

According to section 7.2.3, the flying experience and experience with the activity shall be:

ACTIVIDAD		(PICT)	(ACT)	(ASC)
1	Tratamientos aéreos	500	50	50

In order to be the pilot in command of the various types of operations at Rotorsun, prior experience shall be required in terms of hours as pilot in command (PIC), flight hours in relevant activities (ACT), as well as flight hours in aircraft with similar characteristics (ASC).

In its risk assessment for the activity of aerial spraying with a helicopter, RTS-SOP-FI, pg. 108, in the section on Human Factors and in reference to pilots with little experience in the application of pesticides, Rotorsun states:

> *The hazard identified is the operation by pilots with little experience in the activity or with the helicopter model, with the consequence being excess pilot workload and loss of control of the operation. The barrier proposed in the document is dividing the activity into short periods to avoid fatigue and stress. As a mitigation measure, Rotorsun provides continuing training to pilots with little experience on the activity and the model to be used until they gain sufficient experience.*

As concerns human factors, it considers:

- *Degraded physical conditions (pain, injuries, illness, etc.)*
- *Operation performed by pilots with little experience in the activity and/or with the helicopter model.*

- *Use of electronic systems, such as guidance and/or radio systems, during the operation.*
- *Loss or lack of communication between operator and pilot.*
- *No means of communication to close the flight plan with air traffic services.*

1.18. Additional information

1.18.1. Spray equipment in the helicopter

The fumigation equipment consists of:

- DGPS guidance system
- Auto Call II electronic auto-calibration system
- spray lines with open/close mechanism
- nozzles or Micronair
- ventral tank for the pesticide (Fumigación Symplex)
- an auxiliary external motor to power the pressure pump

Figure 4. Photograph of a similar helicopter with the spray system installed

The DGPS guidance system consists of a DGPS navigation and measurement system made by AG-NAV Inc., in Canada, and specifically the AGNAV-2 and AGNAV GUIA model, which allows spraying an exact area previously entered into the system. This guarantees accurate spraying based on the previously entered GIS information.

It basically consists of a DGPS, an information display and a light bar that shows information using LEDs of various colors to graphically indicate to the pilot the altitude and accuracy of the passes made over the course of the flight. Pilots are urged to operate these electronic devices only before takeoff and not during the flight so as to avoid distractions.

Figure 5. Photographs of the display and light bar. AGNAV2

The light bar on the accident aircraft was located at the top of the glareshield on the instrument panel, as shown in the photograph in Figure 6.

Figure 6. Instrument panel on the Bell 206B and AG-NAV light bar

To apply the phytosanitary product, the helicopter also had installed a SIMPLEX 7800 unit, consisting of a 500-liter tank and its associated pump systems.

These units have been improved by ROTORSUN S.L. based on experience gained in recent years, resulting in considerably better efficiency and endurance. Its technical specifications are as follows:

- supplemental Type Certificate (STC) no. SH 848 NW
- empty weight: 109 kilograms (229 pounds)
- capacity: 530 liters (140 USG)

1.19. Useful or effective investigation techniques

Not used.

2. ANALYSIS

In general, a very low altitude aerial spraying flight entails a very high work load and considerable risk. It is critical to control the altitude over the crop field. This requires maintaining suitable visual references of the operational setting at all times while being constantly mindful of the instruments and the actions required at any given moment.

When the operation is done with helicopters that have a ventral tank and spray booms installed, the takeoff phase is especially critical, particularly the transition from the climb in-ground effect to translational flight, in which the aircraft loses altitude ("it sinks"). In these conditions, the instructor who had provided the refresher training to the pilot on this type of operations estimates this sink distance at one meter.

An analysis of the flight paths obtained from the data recorded by the differential global positioning system (DGPS), shown in Figures 1 and 2, does not reveal any anomalies in the operation performed. It does show, however, that the flight paths taken by the aircraft in the last takeoffs carried out, shown in Figure 2, involved a right turn in every case.

Section 1.16.1 states that the aircraft's operation was within the helicopter's performance limits, with the aircraft being able to hover in-ground effect by applying a torque of 90 to 95%. According to the statement made by the pilot in command of the helicopter, on the accident flight, he took off with an engine torque of 90%.

In these conditions, it is likely that the helicopter descended more than the pilot expected, surprising him and not giving him enough time to react before the boom on the right side made contact with the field he was spraying. This caused the dynamic rollover of the aircraft, which initially pivoted about the spray boom and then about the right skid before the main rotor eventually impacted the ground.

In addition, as indicated in 1.17.2, in its assessment of the risks involved in aerial spraying from a helicopter, the aircraft operator identifies the risk resulting from operations involving pilots with little experience in the activity or with the helicopter model, the potential consequences of which are excess workload for the pilot and loss of control of the operation. As a mitigation measure, the operator provides continuing training to the pilots involved until they become sufficiently proficient. The mitigation barrier specified for pilots with little experience in the activity is reduced flight time periods to avoid fatigue and stress until the pilots gain sufficient experience. In the case at hand, the pilot had sufficient experience as pilot in command on the aircraft type and in relevant activities in general; however, he had little experience in the specific activity of spraying phytosanitary products. This should have been considered, at least initially, when scheduling his activity.

In light of the pilot's schedule during the months of July and August, and the activity he performed, which was generally within the limits specified in the applicable regulation at all times, the mitigation barrier anticipated by the operator in its Operations Manual is deemed to have been improperly applied in this case, which could have contributed to the accident.

3. CONCLUSIONS

3.1. Findings

1. The aircraft pilot was properly qualified, experienced and physically fit, and had a valid license and ratings. He also satisfied the experience requirements specified in the operator's *Operations Manual*.
2. Based on the criteria specified by the operator, the pilot was deemed to have "little experience in the activity or with the helicopter model".
3. The aircraft had been maintained in accordance with the approved *Maintenance Manual* and had a valid airworthiness certificate, airworthiness review certificate and registration certificate.
4. The aircraft was operated within the established limits for center of gravity and performance.
5. The flight was not limited by the weather conditions.
6. The aircraft operator identified the operational risk resulting from operations involving pilots with little experience in the activity or with the helicopter model, the potential consequences of this being excess workload for the pilot and loss of control of the operation.
7. In this case, the mitigation measure specified by the operator in its *Operations Manual* for pilots with little experience in aerial spraying activities was not properly applied.

3.2. Causes/Contributing factors

The investigation has determined that the accident was most likely caused by the execution of a takeoff maneuver without maintaining suitable external visual references. The following factors contributed to the accident:

- Applying less power than necessary to avoid losing altitude before reaching the effective translational lift speed during takeoff.
- Maintaining a curved, instead of straight, flight path over the terrain during takeoff.
- The improper implementation of the reduced flight periods specified in the operator's *Operations Manual* for pilots with little experience in aerial spraying operations.

4. SAFETY RECOMMENDATIONS

No safety recommendations are issued as a result of the investigation into the accident.