

CIAIAC

COMISIÓN DE
INVESTIGACIÓN
DE **A**CCIDENTES
E **I**NCIDENTES DE
AVIACIÓN **C**IVIL

Report A-037/2011

Accident involving
two Bell 212 aircraft,
registration EC-GIC and
CC-CIS, operated by INAER,
at Bienservida (Albacete),
on 30 September 2001



GOBIERNO
DE ESPAÑA

MINISTERIO
DE FOMENTO

Final report

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SUBSECRETARÍA

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DE ACCIDENTES E INCIDENTES
DE AVIACIÓN CIVIL

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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) n° 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.

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Abbreviations

00°	Geographical degrees
00 °C	Degrees centigrade
ACO	Aircraft Coordinator
AESA	Spanish Aviation Safety Agency
COP	Provincial operations centre
COR	Regional operations centre
CPL (H)	Commercial Pilot License (Helicopter)
CVR	Cockpit Voice Recorder
DGAC	Directorate General for Civil Aviation
GPS	Global Positioning System
h	Hour(s)
hPa	Hectopascal(s)
IR (H)	Instrument flight Rating (Helicopter)
kg	Kilogram(s)
km	Kilometer(s)
kt	Knot(s)
m	Meter(s)
MHz	Megahertz
MTOW	Maximum Take-Off Weight
NE	Northeast
NW	Northwest
PAIF	Position of Analysis of Forest Firefighting
S/N	Serial Number
SE	Southeast
SEIF	Operational Service for Forest Firefighting
SESCAM	Castilla La Mancha Health Service
SHp	"Shaft Horse power" Horsepower of output at the turbine shaft
SMEIF	System of Emergency Management of Forest Fires
SW	Southwest
TSN	Time Since New
UTC	Universal Time Coordinated

Synopsis

Owner and operator:	INAER Helicópteros S.A.U
Aircrafts:	Bell 212, registration EC-GIC and CC-CIS
Date and time of accident:	30 September 2011; 13:33 local time
Site of accident:	Bienservida (Albacete)
Persons on board and injuries:	2, 1 fatal and 1 seriously injured
Type of flight:	Commercial Aviation, aerial work, fire fighting
Date of approval:	26 June 2013

Summary of the accident

At 12:45 h¹, Friday 30 September 2011, a fire was declared north of Bienservida (Albacete); very close to this location. A few minutes later, the first ground-based firefighting teams arrived at the fire site. Three helicopters joined the extinguishing operation afterwards. These helicopters were EC-GXA (identified as H01), EC-GIC (identified as H02) and CC-CIS (identified as H13).

There was a single pilot for each one of the 3 helicopters as flight crew.

The area selected to load the bambi bucket of each helicopter with water was a pool located 2 km NE² of Bienservida, known as Balsa de Gómez.

At 13:33 h the H02 and the H13 met overhead the pool colliding in flight and falling down both helicopters into the pool. The pilot of the H02 managed to get out of the cabin by his own means and survived the collision, while the pilot of the H13 perished in the accident.

It was the fourth load of water in the pool for the H02 and the third for the H13, while the H01 had made its sixth load at 13:32 h and it was arriving at the fire site to drop the water at the moment of the accident.

The aerial resources aircraft coordinator arrived at the fire site at 13:57 h, this is, 24 minutes after the accident occurred.

¹ All time references of this report are local time. UTC is calculated subtracting two hours from the local time.

² Northeast.

1. FACTUAL INFORMATION

1.1. History of the flight

Fire, Aerial resources activation and their arrival to the fire site

At 12:45, Friday 30 September 2011 a fire was declared north of Bienservida (Albacete); very close to this location. A few minutes later, the first ground-based firefighting teams arrived at the fire site. At 12:54 h, the COP³ scrambled 2 Bell 212 helicopters of the BIFOR A⁴ of Molinicos base to assist in the actual fire fighting efforts. Molinicos base is located approximately 33 km to the east of Bienservida, within the province of Albacete.

Likewise, at 12:57 h, the COP mobilized the Bell 212 helicopter of the BIFOR B⁵ of Liétor base to help in the fire fighting operation. Liétor base is located approximately 58 km to the east of Bienservida, within the province of Albacete.

At 13:04 h, the two helicopters took off from Molinicos base towards the fire site. The helicopters were the EC-GXA (identified as H01) and the EC-GIC (identified as H02). The H01 carried one forest technician and 6 specialists and the H02 carried one supervisor and 6 specialists.

At 13:06 h, the helicopter from Liétor base took off towards the fire site. This helicopter was the CC-CIS (identified as H13) and it carried one forest technician and 6 specialists.

There was a single pilot for each one of the 3 helicopters as flight crew.

At the same time, at 13:06 h, the ACO⁶-1 was assigned to coordinate the operation of the three aerial resources from the air. The ACO-1 was based in Quinto de Don Pedro (Toledo) at approximately 140 km NW⁷ of Bienservida.

At 13:12 h the H01 and H02 arrived at Bienservida. The fire brigades disembarked at 13:14 h and 13:19 h respectively at locations close to the fire site.

³ Provincial Operations Centre: Basic Unit of the Operating Service for the Prevention and Extinction of forest fires of the Plan INFOCAM (Emergency plan for forest fires of Castilla La Mancha). Centre where provincial prevention and forest fire fighting is planned and coordinated, where provincial fire fighting means are managed.

⁴ Heliborne forest brigade of reinforcement: personnel specially trained physically and technically to carry out extinction works, specialized in the reinforcement of large fires. Its implication is deferred and its mobilization is COP's duty.

⁵ Heliborne forest brigade: personnel specially trained physically and technically for extinction works. Its implication is immediate within a radius of 50 km, outside that range its mobilization is COP's duty.

⁶ Surveillance and coordination aircraft. Must be mobilized by the COR (Regional Operations Centre), centre where regional prevention and forest fire fighting is planned and coordinated, where supra-provincial fire fighting means are managed, as well as the monitoring and general assessment of the Operating Service for the Prevention and Extinction of forest fire of the Plan INFOCAM. It is mobilized when there are 3 or more aerial means at a fire.

⁷ Northwest.

At 13:22 h the H13 arrived at Bienservida and, at that same time, the aircraft coordinator (ACO-1) took off from the Quinto de Don Pedro base.

At 13:26 h the H13 carried out the disembarking of its fire brigade at a location close to the fire site.

Load and drop of water at the fire site

The area selected to load the bambi bucket of each helicopter with water was a pool located 2 Km NE of Bienservida, known as Balsa de Gómez.

The H01 was the first one to load water at 13:17 h.

The H02, once its brigade had disembarked, proceeded to perform its first water loading at 13:23 h. Similarly, the H13 proceeded to carry out its first water loading at 13:28 h, when the H01 and the H02 were already engaged in the fire fighting efforts.

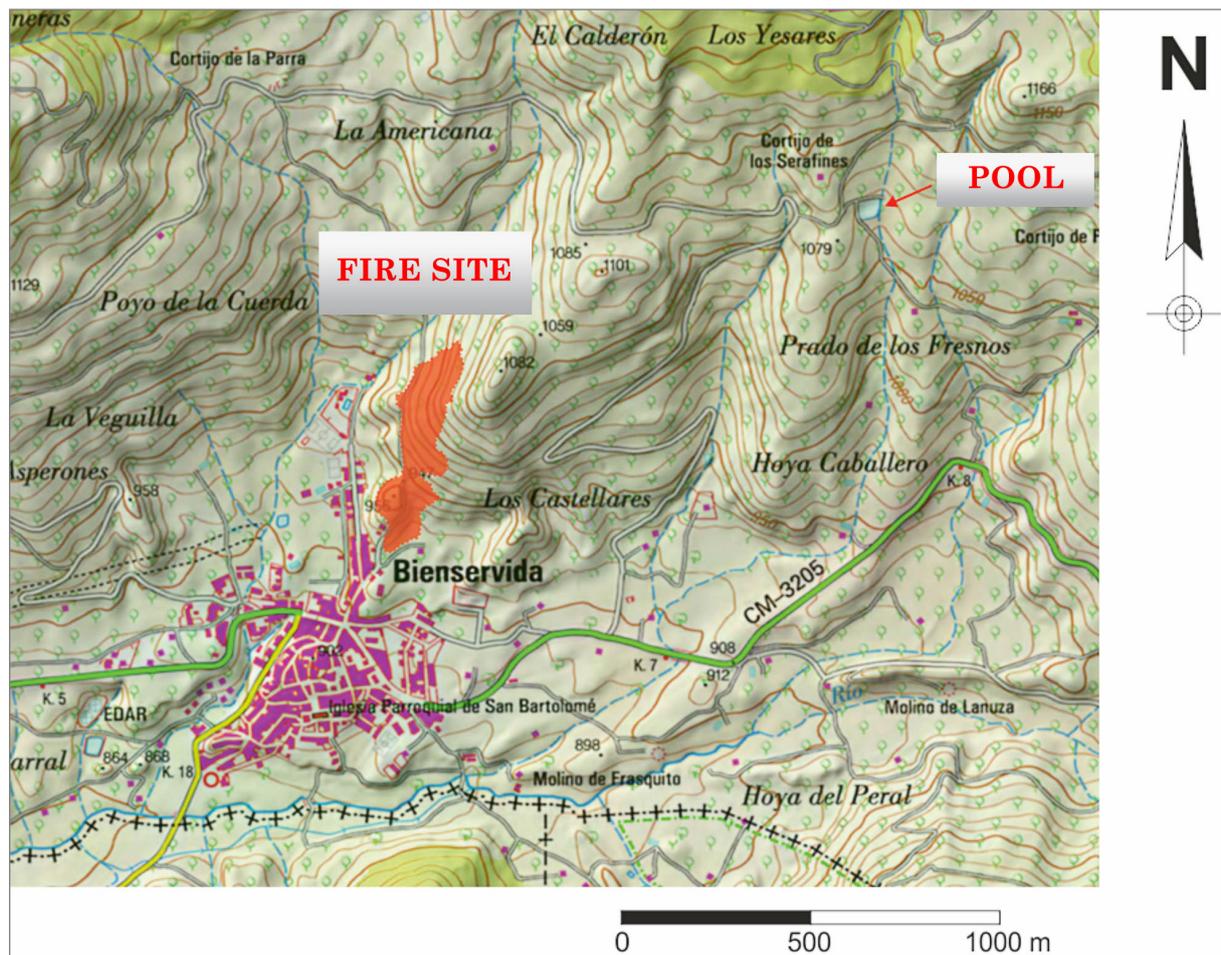


Figure 1. General view of the area

Collision on the pool

At 13:33 h the H02 and the H13 met overhead the pool colliding in flight and falling down both helicopters into the pool. The pilot of the H02 managed to exit the cabin by his own means and survived the crash, while the pilot of the H13 perished in the accident.

It was the fourth load of water in the pool for the H02 and the third for the H13, while the H01 had made its sixth loading at 13:32 h and it was arriving at the fire site to drop the water at the moment of the accident.

The aerial resources aircraft coordinator arrived at the fire site at 13:57 h, this is, 24 minutes after the accident occurred.

1.2. Injuries to persons

The H02 pilot suffered burns in hands, face, forehead, scalp, nape and shoulders due to a fire that broke out in his helicopter and which self-extinguished when the helicopter fell into the water.

The pilot of the H13 perished after the collision due to multiple traumatism (severe hit in the left lateral-front area of the skull) and asphyxia caused by drowning and submersion.

1.3. Damage to aircraft

Both aircraft resulted seriously damaged after the accident.

1.4. Other damage

The pool, as a consequence of the fall of the aircraft into it (and their fragments projected with speed due to the collision), suffered various damages in the waterproof fabric that covers its structure and in its perimeter fence.

In addition, the water of the pool resulted polluted by the fluids poured by both aircraft.

1.5. Personnel information

Pilot of the aircraft EC-GIC (H02)

Age:	52 years old
Nationality:	Spanish

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Commercial Pilot License (Helicopter) (CPL (H)):	Valid until 30/04/2013
Medical certificate renewed on 28/07/2011:	Valid until 02/09/2012
Valid ratings:	
• Bell 212/412:	Valid until 31/03/2012
• Instrument Flight Helicopter (IR (H)):	Valid until 31/03/2012
• Agricultural:	Valid until 30/04/2013
Most recent flight hours:	
• Last 24 h:	None
• Last 7 days:	1:05 h (all on Bell 212)
• Last month:	8:20 h (all on Bell 212)
• Last 3 months:	22:05 h (all on Bell 212)
Flight hours:	
• Total:	4,429 h
• On the Bell 212/412:	914 h
Last proficiency check:	05/07/2011
Fire fighting campaigns flown in Spain:	13

Pilot of the aircraft CC-CIS (H13)

Age:	58 years old
Nationality:	Chilean
Commercial Pilot License (Helicopter) (CPL (H)):	Issued by the DGAC ⁸ of Chile valid until 30/11/2011 ⁹
Certificate of psycho-physical competence:	Renewed on 18/05/2011, valid until 30/11/2011 issued by the Centro de Medicina Aeroespacial de la Fuerza Aérea de Chile (Centre of Aerospace Medicine of the Chilean Air Force)
Language proficiency certificate in Spanish:	Issued by the Chilean DGAC

⁸ Directorate General for Civil Aviation.

⁹ In general, the validity of the license will coincide with the validity of the medical certificate, in accordance with the Civil Aviation Personnel Licensing Regulation of Chile.

Valid ratings (issued by the DGAC of Chile):

- Bell 212/412: Valid until 30/11/2011
- Forest fire fighting: Valid until 30/11/2011

Recent flight hours:

- Last 24 h: None
- Last 7 days: 1:00 h (all on Bell 212)
- Last month: 3:26 h (all on Bell 212)
- Last 3 months: 27:01 h (all on Bell 212)

Flight hours:

- Total: 10,723 h
- On the Bell 212/412: 3,728 h

Last agricultural (only fires) proficiency check in Spain: 22/06/2011

Last license for agricultural (only fires) activities in Spain issued by AESA¹⁰: 12/07/2011, 1 year validity

Fire fighting campaigns flown in Spain: More than 8

Ground personnel, duties and enrolment

a) Forest technician of the H01

- On the ground, he coordinated the heliborne fire fighting brigades of the H01 (6 specialists and him) and of the H02 (1 supervisor and 6 specialists). He coordinated with the pilots of the H01 and H02 the areas to drop the water.
- He works for the company Geacam¹¹.

b) Forest technician of the H13

- On the ground, he coordinated the heliborne fire fighting brigade of the H13 (6 specialists and him). He coordinated with the pilot of the H13 the areas to drop the water.
- He works for the company Geacam.

c) Environmental agent 1

- He was also Area Manager, so he was the person of highest rank to coordinate the extinction of the fire and who should assume the management of the Fire

¹⁰ Spanish Aviation Safety Agency.

¹¹ The public company "Gestión ambiental de Castilla-La Mancha, S. A." was created by Law 1/2006, 23 March (BOE N. 150 of Saturday 24 June 2006) as a mean to serve the environmental policy and the rural development of the Junta de Comunidades de Castilla-La Mancha (Community Board of Castilla-La Mancha).

fighting¹² operation. However he assigned the leadership to another environmental agent present in the fire site.

- The reason for the assignment was that, from the top of the hill (where he was) and with his radio, he could not communicate well. On the other hand, he had never coordinated aerial resources before and he had not been trained on this matter.
- He is a civil servant of the Junta de Comunidades de Castilla-La Mancha (Community Board of Castilla-La Mancha).

d) *Environmental agent 2*

- He took over the management of the fire fighting. He was placed on the lower area of the hill and had a more powerful radio.
- He is a civil servant of the Junta de Comunidades de Castilla-La Mancha (Community Board of Castilla-La Mancha).

e) *Forest guard*

- The surveillance site was located 3,275 m from the pool, in direct line of sight, without obstacles. The guard house was located SE¹³ of the pool, at an altitude of 1,450 m, in an area known as "Cerro Pelao".
- He was not active in the fire fighting operation, but he was a witness of the collision between the two aircraft.
- He works for the company Geacam.

1.6. Aircraft information

Description of the Bell 212

The Bell 212 is a two-blade main rotor helicopter that turns counter-clockwise, top view. The diameter of this main rotor is 14.63 m. The dimensions and main features of the Bell 212 are shown in figure 2.

Landing gear

The landing gear of the Bell 212 consists of two tubular skids joined together by two crossbars (one front and one rear) in an inverted U-shape. The crossbars are joined through the belly of the helicopter in its central part.

¹² The Incident Commander assumes the coordination of the ground means for the fire fighting and of the aerial means in the absence of the aircraft coordinator.

¹³ Southeast.

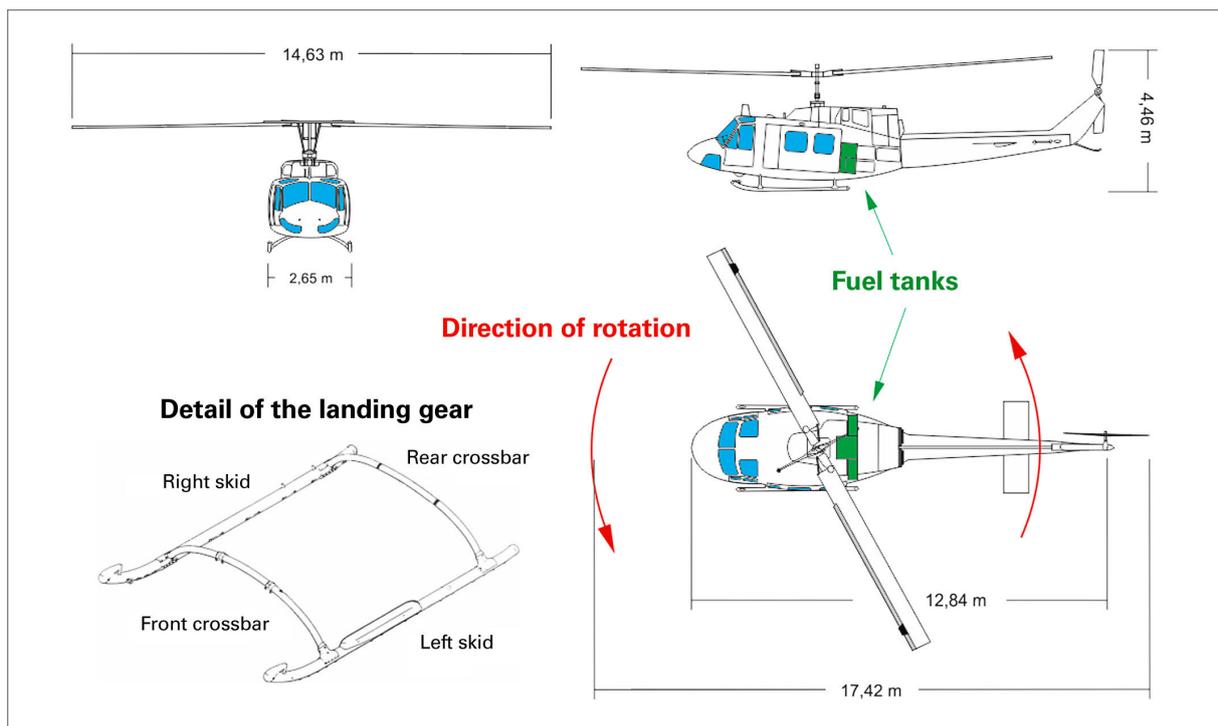


Figure 2. Bell 212

1.6.1. Aircraft EC-GIC (H02)

Airframe of the aircraft EC-GIC (H02)

Manufacturer:	Bell
Model:	212
Number of manufacture:	30775
Registration:	EC-GIC
Year of manufacture:	1976
MTOW ¹⁴ :	5,085 kg
Owner:	Helicópteros del Sureste, S.A.
Operator:	INAER Helicópteros, S.A.U.

Airworthiness certificate of the aircraft EC-GIC (H02)

Number:	3953
Date of issuance:	18/09/2006 ¹⁵

¹⁴ Maximum Take-Off Weight.

¹⁵ Issued by the Spanish Directorate General for Civil Aviation.

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Date of review: 03/06/2011¹⁶

Date of expiration: 02/06/2012

Maintenance records of the aircraft EC-GIC (H02)

<i>Last inspection</i>	<u>Date</u>	<u>Hours</u>
25 hours/30 days	25/08/2011	23.923:55
25 hours/30 days	22/09/2011	23.936:15
600 hours/6 months	19/05/2011	23.894:25
600 hours/12 months	22/11/2010	23.816:05

Engine (#1 and #2) of the aircraft EC-GIC (H02)

Manufacturer: Pratt & Whitney

Model: PT6T-3

Serial number: #1: CPPS 61373
#2: CPPS 61635

Power: 1,600 SHp¹⁷ (1,800 SHp in maximum continuous 5 min.)

<i>Last inspection</i>	<u>Date</u>	<u>Hours</u>
25 hours/30 days	25/08/2011	#1: 6.425:10 #2: 9.002:20
25 hours/30 days	22/09/2011	#1: 6.437:30 #2: 9.014:40
100 hours	30/06/2011	#1: 6.409:10 #2: 8.986:20
Aircraft assembly:	Both after overhaul 12/07/2005, with 23,144 h airframe	

Main rotor blades of the aircraft EC-GIC (H02)

Manufacturer: Bell

Model: 212-015-501-115

¹⁶ Reviewed by the Spanish Aviation Safety Agency.

¹⁷ Shaft Hp: Horsepower of output at the turbine shaft.

Serial number:	A-5395	
Assembly:	<u>Blade hours (TSN¹⁸)</u>	<u>Date</u>
	3.321:12	29/05/2010
Serial number:	A-5337	
Assembly:	<u>Blade hours (TSN)</u>	<u>Date</u>
	3.419:24	29/05/2010

Each blade built up 161 h from 29/05/2010 until the accident.

Records of the aircraft EC-GIC (H02)

From the last maintenance inspection performed to the helicopter on 22/09/2011 until the day 30/09/2011 (the accident) the helicopter had only performed one flight on 26/09/2011 of 1 h duration in which there was one start of the engines and 3 landings.

Weight and Balance information of the aircraft EC-GIC (H02)

The last calculation of the empty weight and balance of the aircraft was certified on 31 March 2009. With these data, both for the case of forward and aft critical load configuration, the centre of gravity of the aircraft was located within the normal operating range.

1.6.2. Aircraft CC-CIS (H13)

Airframe of the aircraft CC-CIS (H13)

Manufacturer:	Bell
Model:	212
Number of manufacture:	30932
Registration:	CC-CIS
Year of manufacture:	1979
MTOW:	5,085 kg

¹⁸ Time Since New: total hours since the commissioning.

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Owner: EAGLE COPTERS LTD (Canada)

Operator: INAER Helicópteros, S.A.U.¹⁹

Airworthiness certificate of the aircraft CC-CIS (H13)

Number: 4813/2010

Date of issuance: 01/10/2010²⁰

Date of expiration: 18/03/2012

Maintenance records of the aircraft CC-CIS (H13)

<i>Last inspection</i>	<u>Date</u>	<u>Hours</u>
25 hours/30 days	02/08/2011	23.770:54
25 hours/30 days	15/09/2011	23.786:40
600 hours/12 months	11/04/2011	23.736:24

Engines (#1 and #2) of the aircraft CC-CIS (H13)

Manufacturer: Pratt & Whitney

Model: PT6T-3

Serial number: #1: CPPS 61535

#2: CPPS 60527

Power: 1,600 SHp (1,800 SHp in maximum continuous 5 min.)

<i>Last inspection</i>	<u>Date</u>	<u>Hours</u>
25 hours/30 days	02/08/2011	#1: 8.024:12 #2: 11.498:42
25 hours/30 days	15/09/2011	#1: 8.040:42 #2: 11.515:12
100 hours ²¹	11/04/2011	#1: 7.989:24 #2: 11.463:54

¹⁹ By Wet lease to the lessor company INAER Helicópteros Chile, S.A. authorized by AESA on 30/05/2011 for the forest fire fighting campaign of 2011.

²⁰ Issued by the Chilean Directorate General for Civil Aviation.

²¹ Coincided with the 600 h or annual.

Aircraft assembly: #1: 25/02/2010 after overhaul
 #2: 24/02/2010 after 1,144:42 h from overhaul
 with 23.355:42 h airframe

Blades of the main rotor of the aircraft CC-CIS (H13)

Manufacturer:	Bell	
Model:	212-015-501-115	
Serial number:	A-2849	
Assembly:	<u>Blade hours (TSN)</u>	<u>Date</u>
	3.636:12	15/01/2011
Model:	212-015-501-5	
Serial number:	A-1529	
Assembly:	<u>Blade hours (TSN)</u>	<u>Date</u>
	2.990:24	8/02/2011

Each blade accumulated 188:06 h and 143:54 h from their respective assemblies until the date of the accident

Records of the aircraft CC-CIS (H13)

The helicopter had completed two flights, on the 20th and the 27/09/2011, since the last inspection performed to the helicopter on 15/09/2011 until 30/09/2011(day of the accident).

The flight on the 20th was 0:40 h of duration, and included only one start of the engines and 3 landings.

The flight on the 27th was 0:55 h of duration, and included only one start of the engines and 1 landing.

Weight and Balance information of the aircraft CC-CIS (H13)

The last empty weight and balance calculation of the aircraft was certified on 12 March 2010. With these data, for both forward and aft critical load configuration, the centre of gravity of the aircraft was located within the normal operating range.

1.7. Meteorological information

The following data have been obtained from Villarodrigo meteorological station (at approximately 6 km SW²² of Bienservida):

Hour	Wind		Temperature	Humidity	Pressure (HPa ²⁴)
	Speed (kt ²³)	Direction			
13:20	7	113°	23 °C	40%	924
13:30	6	121°	23 °C	40%	924
13:40	7	102°	23 °C	40%	924

The testimony provided by the fire fighting ground brigade shows that there was a SE prevailing wind component of 5 to 10 kt intensity with some stronger gusts. In fact, the fire was spreading in a parallel manner along the west slope of the hill towards the north, but not upslope. This information was confirmed by the pilots of the H01 and H02, for whom the direction of the smoke was a clear evidence of the direction and strength of the wind in the fire site.

According to the testimony provided by the pilots of the H01 and H02, in the pool, 2 km NE of Bienservida, the wind component was SE, 5 to 10 kt intensity, with some stronger gusts.

Visibility conditions were excellent for the visual flight, and there were very few clouds.

1.8. Communications

The aerial resources were communicating on the Albacete province air band frequency 130.125 Mhz.

For the communications there were a channel 1 or simplex from the ground radio assigned to the province of Albacete and a channel 6 of the ground radios. The heliborne fire fighting brigade technicians had ground radios (FM) and air band (AM).

Ground-ground communications among environmental agents and/or forest technicians and/or the supervisor were carried out on channel 1.

²² Southwest.

²³ Knots (1 kt = 1,852 km/h).

²⁴ Hectopascals.

Communications quality

According to the people who took part in the extinction of the fire on the ground, the communications on the radio were hampered due to technical problems which were not the first time that they occurred, and which they had already complained about. The environmental agent 2, as Incident Commander, in view of the problems with the radio, used a mobile phone to communicate with the forest technicians and his head office.

On the other hand, since the pool was located leeward of the hillside where the fire was, most of the conversations on the air band could not be heard from the ground (windward side of the hill, where the fire was)

From the cockpit voice recorder of one of the three helicopters involved in the fire fighting it has been possible to prove that air-to-air communications did not experience major difficulties and that the pilots could communicate with each other without significant problems.

Investigation about the reported communication failures

In the course of the accident investigation this Commission was interested in the circumstances in which these communication failures occurred. To this regard, it must be noted that the Consejería de Agricultura de la Dirección General de Montes y Espacios Naturales de la Junta de Comunidades de Castilla-La Mancha (Department of Agriculture of the Directorate General of Forestry and Natural Areas of the Community Board of Castilla-La Mancha) conducted a radio-communication system analysis to solve the existing problems in each one of the provincial networks and establish the potential improvements.

This analysis resulted in a report titled "Informe sobre el desarrollo del expediente de optimización y mantenimiento de la red de comunicaciones del SEIF²⁵" (Development of the optimization and maintenance record of the SEIF communication network report) issued by the Servicio Forestal de la Consejería de Agricultura (Forest Service of the Department of Agriculture) 25 January 2012.

The report assumes that during the performances of the SEIF resources in several fires various problems related to the radio network were encountered. These problems included lack of coverage, interferences with other relay stations and areas of common influence of several relays.

Regarding **aerial radio-communications** it concludes that it is not planned to modify the equipment nor the communication procedures among the air means and among these

²⁵ Operating Forest Fire Fighting Service.

means and their bases. The only problem encountered is the use of these frequency bands for ground communications. This issue was solved by the approval of a communication protocol and the training and briefing of the personnel involved in the forest fire fighting.

Regarding **ground radio-communications** it concludes that in order to improve the radio-communication network existing in 2008, which was basically inherited from ICONA, a tender was conducted through the public company Geacam. The order for processing the service was awarded on 03/07/2009 with an execution period of 3 years.

1.9. Water loading area information

The water loadings were being performed (by the 3 helicopters involved in the fire fighting) at a pool known as Balsa de Gómez.

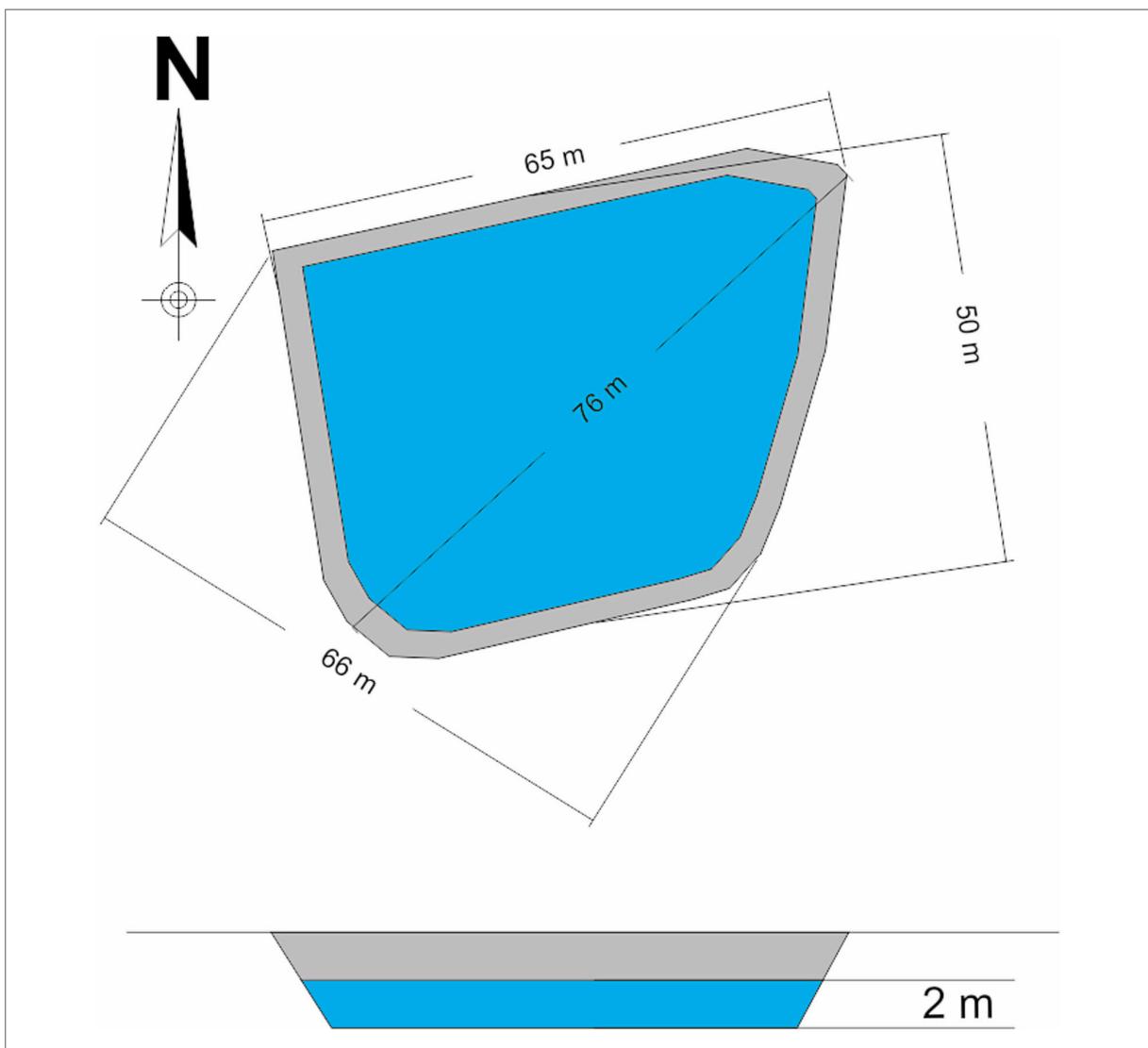


Figure 3. Balsa de Gómez

The Balsa de Gómez is located about 2 km NE of Bienservida. It has an approximate surface of 2,600 m² and the day of the accident it contained around 5,000 m³ of water.

The pool is located 1,070 m above sea level, while the location of Bienservida is at 900 m. The fire site was located at a hillside at an altitude between 940 and 1,050 m.

Westbound of the pool the terrain is elevated around 10 m above it; north of the pool the terrain is uphill; south of the pool the terrain is downhill; and east of the pool the terrain has a smooth uphill slope elevation. Figure 4 shows two cross sections of the field that contains the pool:

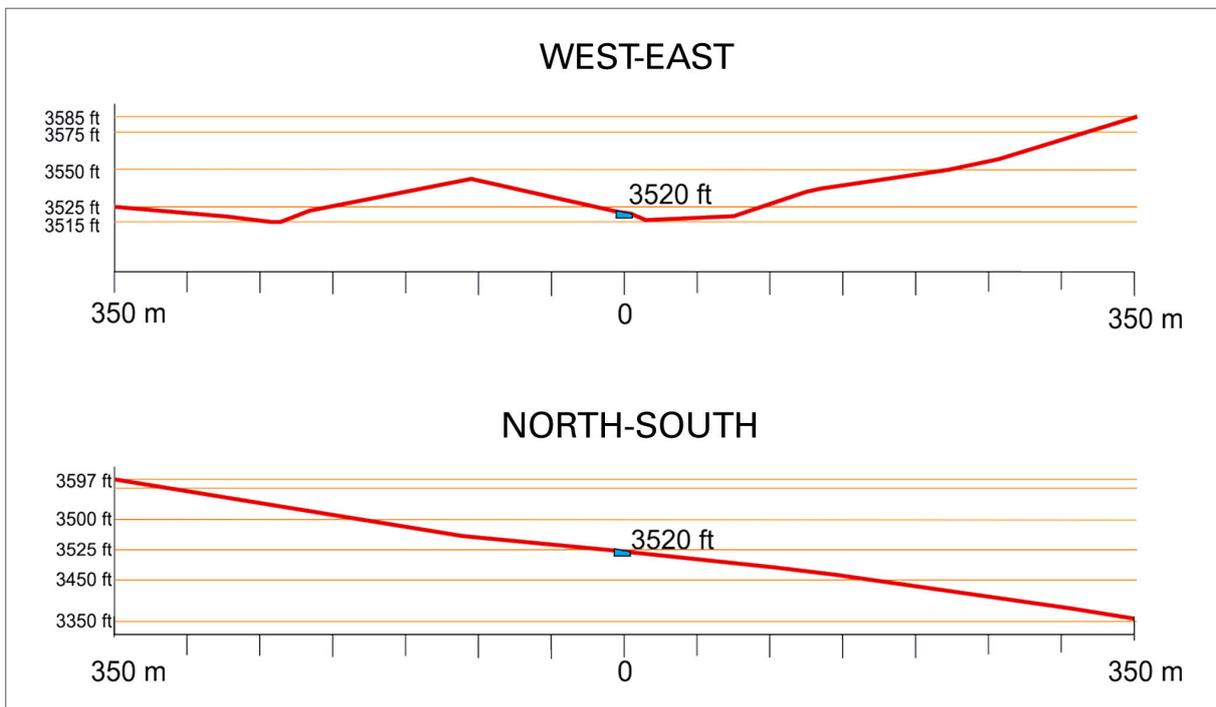


Figure 4. Sections of the field that contains the pool

1.10. Flight recorders

The installation of flight recorders in this type of aircraft for this kind of operation is not mandatory. However, the H02 had a CVR²⁶ installed and activated which content could be downloaded despite having spent more than 24 hours submerged in the pool and which has allowed to know the communications among the aircraft and among the aircraft and the ground.

The recorder is a FAIRCHILD A100 model, S/N 52839, of magnetic tape able to save the last 30 minutes of conversation.

²⁶ Cockpit Voice Recorder.

Likewise, the three helicopters involved in the fire fighting operation had a “Fleet tracking system” installed and activated consisting of their respective GPS beacons that emit at constant intervals (around 15-20 seconds) via telephone the following data: UTC²⁷ (hours, minutes, and seconds), position geographic coordinates, altitude, course and speed.

1.11. Wreckage and impact information

Location of the aircraft prior to the impact

The collision between the two aircraft occurred overhead the pool, when none of them was in translational²⁸ flight and they were a few meters above the pool at a level position, both roll and longitudinal wise. Figure 5 shows the position of both aircraft just before the initial impact:

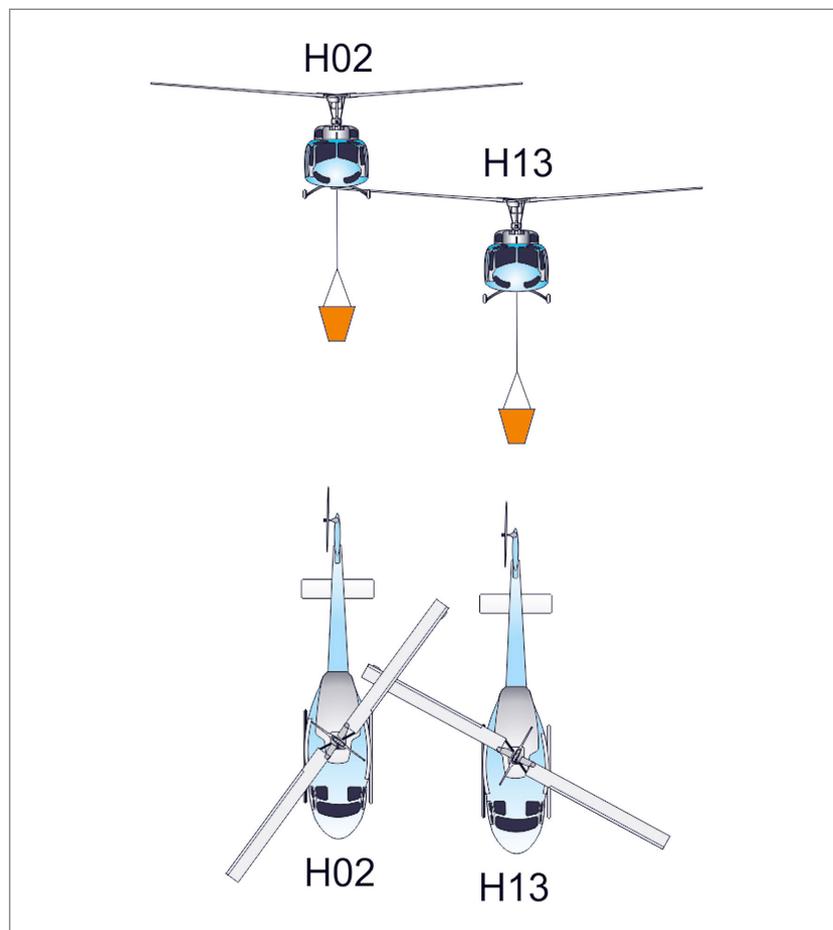


Figure 5. Position of both aircraft just before the impact of the first blade

²⁷ Universal Time Coordinated.

²⁸ As they were overhead the pool, practically in its centre, they were in descent attitude to load the bucket (or climb attitude if the water had already been loaded), hence if any speed was occurring, it was essentially of vertical component.

Just before the impact, the positions of the aircraft were as follows:

- Orientation: both helicopters were facing south, which is the usual operation in which the water loads were being performed in the pool.
- Vertically: the H13 was about to make contact with the bambi bucket into the water (approximately 6.5 m from water surface to the belly of the helicopter). The H02 was higher than the H13.
- Horizontally (regarding the pool): the H13 was in the centre of the pool, while the H02 was to the right²⁹ of the H13, approximately in the same longitudinal position regarding the north and south edges of the pool.

In summary, the position instants before the impact was that, for the H13 pilot, the H02 was to his right (and higher), and, for the H02 pilot, the H13 was to his left (and lower), without almost any translational speed of any of the two aircraft.

Impact and damage

The first contact among the helicopters occurred between one of the two blades of the main rotor of the H13 and the aft side of the left skid of the H02. This first contact broke the rear crossbar where it joins the left skid and placed the blade moving forward horizontally between the left skid and the belly of the H02 helicopter. In that same movement a second contact occurred, this time against the anchor cables of the bambi bucket, cutting them. The bambi bucket of the H02 did not suffer any damage and fell into the pool.

The same blade, following its movement above the left skid made a third contact breaking the front crossbar where it joins the left skid, leaving the left skid free and throwing it towards the south, stopping against the fence on the pool (metal fence). This blade did not impact the right skid of the H02 and did not detach from the H13, but it broke into various fragments that did become detached.

After the abovementioned impact the H02 descended so the other blade of the H13 impacted the H02 on a higher area as follows: the tip of the blade hit the tail cone of the H02, cut it horizontally, and entered in the H02 cabin. The blade, while moving forward through the interior of the tail cone to the front side of the H02, cut with its

²⁹ Since they were parallel and equally oriented, the right and left indications are consistent for both aircraft.

most external side the fuel tank of the H02 (placed in the right-hand side of the H02, behind the last seat row) causing a big flame towards the front that reached the pilot of the H02.

This blade did not detach from the H13 either, but it did break into various fragments that became detached. The tip of the blade (a fragment of about 60 cm long), where its counterweight is, became detached stopping at the passenger cabin of the H02 just behind the pilot seat. The right skid of the H02 was not hit by any blade of the H13. After the abovementioned collision of the two blades of the H13 main rotor into the

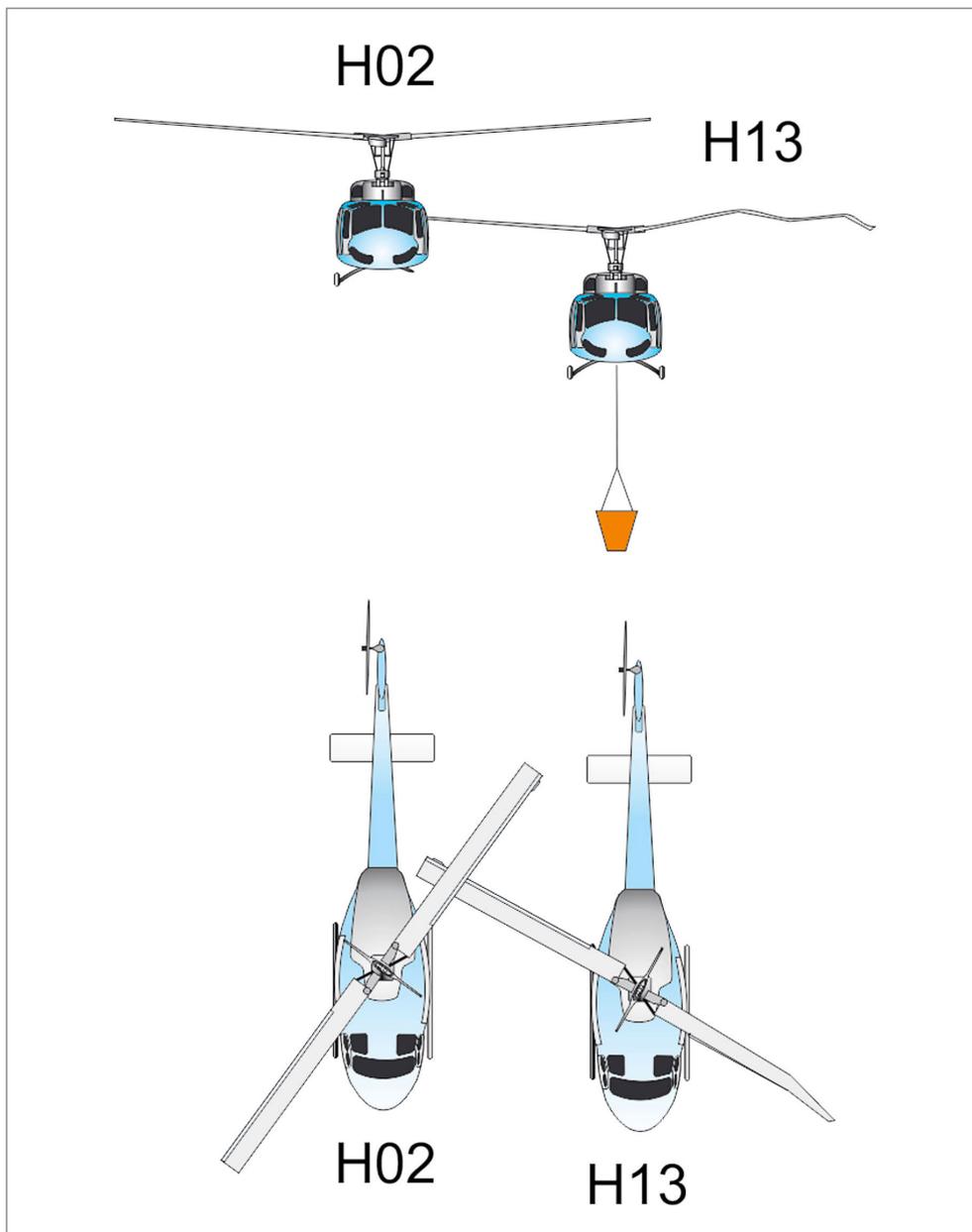


Figure 6. Position of the two aircraft just before the impact of the second blade

H02, both aircraft plunged vertically into the pool, but before reaching the water, another impact occurred between the aircraft as detailed next:

- The H02 turned 180° to the left, heading north and before falling into the water, its right skid crashed into the right lateral side of the H13 cabin at the right-hand front access door to the H13 cabin with the following geometry: the H02 was approximately 45° nose up regarding the H13, with the aft side of the H02 skid impacting on the lower part of the right-hand front access door of the H13 cabin.

In this impact, the rear crossbar where it joins the right skid of the H02 broke by bending stress and the front one ended up tearing itself apart (because the aft side of the right skid of the H02 was hooked to the right lower part of the H13 cabin and the H02 continued moving with regard to the H13).

Afterwards, the right skid of the H02 became detached and fell down into the pool

The blades of the H02 did not become detached and did not show marks on their leading edges that indicated any contact against rigid surfaces other than the pool. Finally, the H02 helicopter lay in the pool on its left side.

- The H13 in its fall did not vary its heading towards the south and fell down on its right-hand side pitching down after suffering the abovementioned impact of the right skid of the H02. The H13 suffered damage by crashing along the area where the right skid of the H02 contacted the cabin, being the damage more intense in the lower part of the right front door, reaching also the floor of the cabin and the attachments of the pilot seat to the floor.

The impact against the water caused damage in the frontal right-hand side and right lateral side of the helicopter. On the other hand, the cyclic control of the pilot was broken at the top since the pilot crashed his forehead into it.

Distribution of the debris of the aircraft

The distribution of the debris of the aircraft shows the following scheme (figure 7).

The main debris of the two helicopters stayed inside the pool, except for the parts that were thrown outside the pool by the impact of the main rotor blades of the H13 against the H02.

The projection of the debris was towards the south.

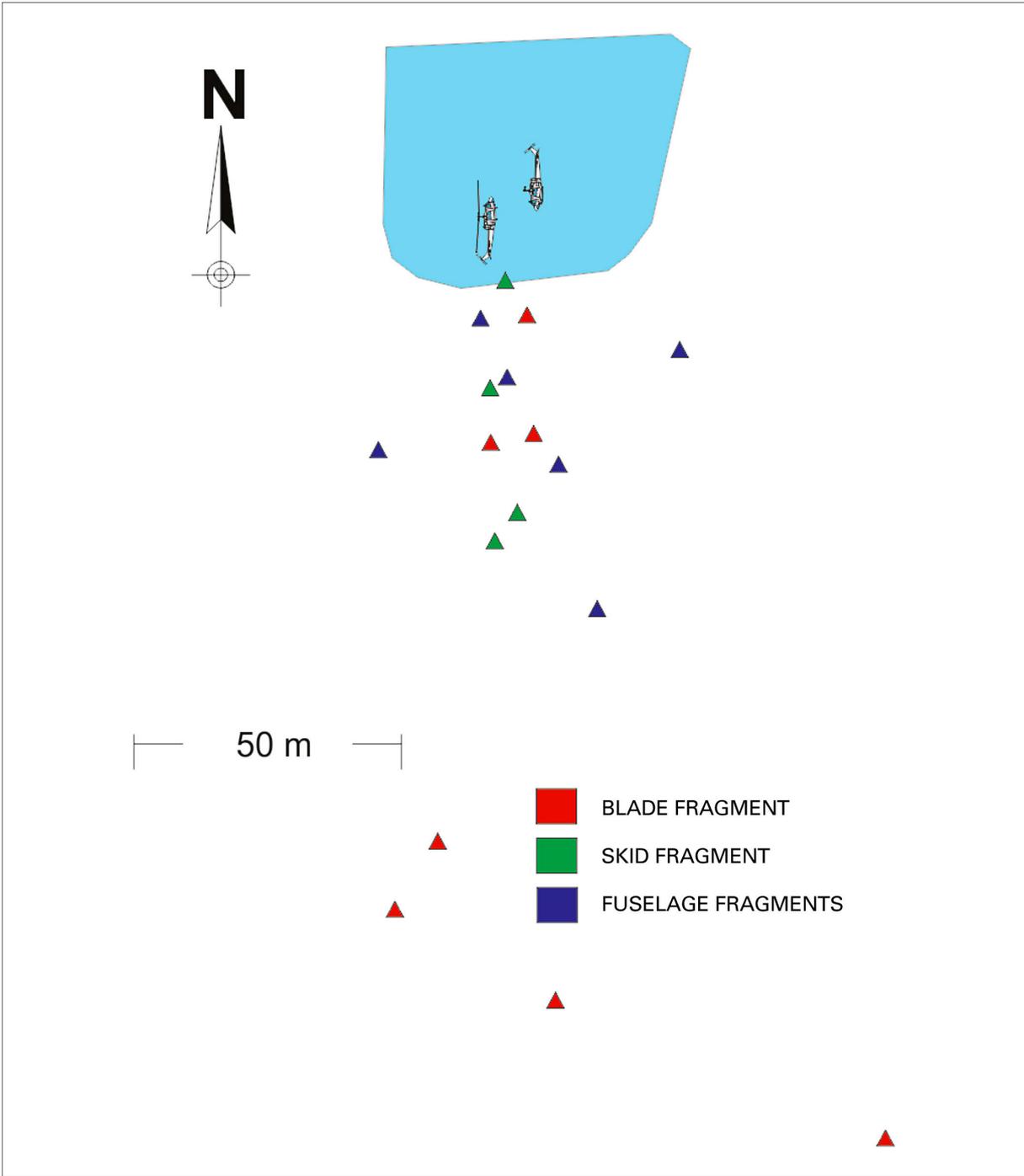


Figure 7. Distribution of debris chart

1.12. Medical and pathological information

The toxicological studies carried out on blood samples and vitreous humor removed during the autopsy to the H13 pilot do not show traces of ethyl alcohol, nor drugs or medicines.

1.13. Fire

The blade of the H13 that cut off the fuel tank of the H02 caused a fire that initially spread in the direction of advance of the blade that is, moving forward on the right-hand side of the helicopter H02.

The fire was contained within the fuel tank area, much of the passenger cabin, and right-hand side of the cockpit (place where the pilot was seated).

However, the fire was self-extinguished a few seconds after the helicopter hit the water and sank.

1.14. Survival aspects

Rescue description

The collision between the helicopters H02 and H13 took place at 13:33:40 h, when the other helicopter involved in the fire fighting operations (H01) was performing a water drop at the fire site. Neither the H01 nor the extinguishing resources on the ground heard at any moment any emergency call from the H02 or H13 on the radio.

When the H01 returned to the pool to perform what was intended to be its seventh water load the pilot saw smoke from the distance at an area that he identified very close to the pool. Upon arriving at the pool (at 13:35 h) he confirmed that the smoke came from it and that there were two helicopters inside in a lateral overturned attitude. He did not observe any people at the site.

At that time the pilot of the H01 reported the accident on the radio and returned to the fire site to bring staff to assist in the rescue of the pilots of the H02 and H13. Meanwhile, the pilot of the H02 exited the aircraft by his own means and climbed up the wreckage of the H02 protruding from the water. Shortly after, a farmer who was next to the pool arrived at the accident site alerted by the noise of the impact and the smoke coming from the pool. The H02 pilot swam to the shore of the pool and the farmer threw a rope to help him getting out of the water.

Back at the pool, the 3 persons on board the H01, in addition to the pilot, confirmed that the pilot of the H02 was already out of the water. The H01 disembarked the three persons near the pool and took on board the injured pilot of the H02 with the intention to carry him to a health centre. However, shortly after take-off, the pilot of the H01 spotted an ambulance on the road, so he proceeded to attract its attention to make it stop. The H01 landed next to the ambulance and the medical services took charge of the injured pilot of the H02, taking him to a health centre to be taken care of. Meanwhile, other people from the vicinity, after knowing the occurrence, were also arriving by ground to the pool.

Several people got into the pool and swam to rescue the pilot of the H13. They arrived at the H13 and when they opened the left door of the helicopter the unconscious body of the pilot emerged to the surface of the water showing a front impact on the head. He was placed on the side of the aircraft and was performed resuscitation. He had swallowed water and still had pulse.

They did not stop the heart massage until the SESCAM³⁰ helicopter arrived. The doctor of the SESCAM asked them to take the body out of the pool to be taken care of. The three persons who were in the H13 carried the pilot of the H13 swimming to the shore of the pool with great difficulty. Once out of the pool the doctor continued with the resuscitation, but shortly after indicated that he had perished.

Safety aspects

The pilot of the H02 could get out of the helicopter by his own means since he did not lose consciousness at any moment and did not suffer any hit in the collision or the fall that prevented him from moving normally.

The pilot of the H02 dressed fireproof overalls and had the safety harness completely fastened (both the waist harness and the shoulder straps). However he did not wear helmet or fireproof gloves.

Despite the cabin was flooded, the pilot of the H02 could get rid of the harnesses and get out of the helicopter

The pilot of the H13 dressed casual clothes and shoes and neither was wearing helmet nor gloves. Also, he had not fastened the shoulder straps.

1.15. Tests and research

Interview with the pilot of H01

According to his statement, the H01 was the first one to arrive at the fire site (H02 was following him), he was also the first one disembarking its fire fighting brigade and therefore the first one flying outbound to the pool to load water. Hence, he was somehow who showed the way to the others, but he says he did not act as a leader nor was responsible for carrying out any sort of coordination with the other aerial resources. In fact, he says there was not any leader coordinating the flight pattern.

³⁰ Health Service of Castilla-La Mancha.

The flight pattern was not defined with routes, or altitudes, or waypoints. The other two helicopters that entered the flight pattern after the H01 proceeded more or less as the H01 was doing.

The hovering and departure from the pool was performed heading south to take advantage of the headwind.

Regarding final approach visibility to the pool, he stated that such phase of the flight is a "looking outside" manoeuvre, only to the pool, and that in the right turn (in case of performing the approach to the pool not from the north, but from northwest) there is good visibility, without major difficulties, despite sitting on the right-hand seat.

Regarding communications, in his opinion, there was aerial band coverage in the entire flight pattern, and he believes to remember that they were talking to each other reporting arrival and departure to the fire site and to the pool. However, he does not remember hearing any of the two injured pilots reporting entering the pool for loading during the accident. When the accident occurred he did not hear either any emergency from the other pilots on the radio.

There was not any contact among the pilots and the Incident Commander at any moment (at least he did not contact and he did not hear the other two pilots doing it). The Incident Commander never contacted the aerial resources

Both he and the pilot of the H02 saw the pool where they would proceed to load water as they were reaching the fire site. They decided that it was possible for loading water only one at a time, and they did not consider the possibility of loading 2 helicopters simultaneously.

He knew the pilot of the H13 from 1987, and he describes him as a magnificent pilot, unhurried, calm and expert. They had flown together several times, and as far as he recalls, he never wore a helmet nor fastened the shoulder straps

The 3 pilots knew each other personally well and had flown together on more occasions.

Interview with the pilot of H02

He states to have performed the approach to the pool where the accident occurred as the prior times, to have seen the pool free and to have proceeded to the loading without holding. At a relative low altitude above the pool, he felt the collision in flight against something that he did not previously identify. Immediately after he felt a flare of fire that came from behind and then fell into the water.

He unfastened the straps with the cabin already flooded with water and he could not manage to open the right door, so he went out through the window of the same door, which he usually maintains open. Once out of the aircraft, he climbed on top of it, and shortly after a person³¹ appeared on the pool, he spoke bad Spanish (assumed he is foreign). After swimming a few meters to the shore, the person helped him to get out of the pool throwing a rope.

He states that, in the absence of an aircraft coordinator, there is not a coordination procedure among the aerial means other than flying all helicopters on the same frequency, and report the new aerial means, which are incorporating, the way in which the flight pattern is being performed so that they can join it. The first aircraft arriving at the fire site is which establishes the standards and the other aerial means arriving adapt themselves to what they are told it is being done.

He states not having received training on the field of coordinating aerial resources on fires.

Regarding H13 pilot, he states that he knew him before and that he spoke Spanish with foreign accent, but that he was understood and he understood well, without major difficulties.

Interview with the environmental agent 1

According to his statement, that day he was the Fire Chief of the Area 10 (Bienservida belongs to that area) and, since he was the person of highest rank in the fire site, assumed the management of the fire fighting. He climbed up to the top of the hill with a small radio to direct the fire fighting, but he could not carry it out well from there and asked the other environmental agent (environmental agent 2) to assume the Fire Fighting Management from the car (located on the lower part of the mountain) with a more powerful equipment.

He had never coordinated aerial means previously and he states not having received training on that matter.

Interview with the environmental agent 2

According to his statement, he was on ordinary duty at Bienservida, and although in theory the Incident Commander should be the environmental agent 1, the latter delegated in him that management.

³¹ This person is a farmer from Eastern Europe who was working in a plot of land, south of the pool (some 100 ms away). He did not see the impact but heard it, and when he turned back he saw the smoke and went to the pool to help. He was also interviewed but his statement does not add further information to what it is exposed herein.

He found numerous difficulties in the transmission of information with the radio and resorted to use the mobile phone to communicate with the head office and the forest technicians.

In his opinion, the communication failure was not so much due to coverage failure, but due to failure of equipment, of relays, etc. (it was not the first time that had happened and he had already complained) and in addition because they were not sure which channels to use and they were jumping from one to another.

He had worked as environmental agent since 2008 and he stated to have received a basic course in Toledo when he began to work.

Regarding the drop of water of the helicopters, he stated that the last drop carried out by the 2 helicopters that later collided was almost at the same time, so he believes that both flew their way back to the pool simultaneously.

He was one of the 3 persons that jumped into the pool to assist the pilot of the H13 who was still inside the helicopter. He entered the water and swam with a stone in his hand in case he had to break the glass of the door or of the cabin, but the left door of the H13 opened without difficulties. Then, the pilot emerged to the surface.

Interview with the Forest guard

According to his statement, he was carrying out forest monitoring watch at the guard house "El Padrón" at Cerro Pelao. This house is located 3,275 m in straight line from the Balsa de Gómez. The pool is within line of sight, without obstacles, and from top to bottom, for the tower is located at a higher altitude than the pool.

He was observing the water loads from there, and in order to see it better he had moved approximately 20 m off the tower, to an area from which the view of the pool was excellent.

The water loadings were being performed regularly that day, and they were carried out by the 3 helicopters which followed more or less the same procedure, in his opinion. In some occasion, during the fire fighting, a helicopter arrived to load water while another was occupying the pool loading water too. In that circumstance, the second helicopter waited until the one on the pool ended before entering to load.

Asked about the loading when the collision occurred, he states that the sequence of facts was as follows:

- A first helicopter arrived and prepared to load water in the usual way, heading south.

- While this helicopter was with the bambi bucket inside the water (he saw the helicopter hovering over the water and he did not see the bambi bucket, so it should be submerged) a second helicopter arrived to the pool (with the bambi bucket in sight).
- This second helicopter was approaching more and more to the pool, without waiting for the first one (which was already on the pool) to finish and depart. This fact really caught his attention and that is the reason he took the binoculars to watch the scene.
- The second helicopter continued its entrance on the pool (the first one was still hovering on the pool) until both crashed into each other.
- A small fire broke out, but was self-extinguished when the aircraft entered the water. Detached pieces of the helicopters were projected, and a small column of smoke appeared.

He also added that:

- The entrance of the second helicopter to the pool was not especially fast; it was like the others that he had seen.
- The second helicopter arriving to the pool was from his position "further than the first one" (this statement matches with the relative position between the pool, the tower and the 2 helicopters, since he saw firstly the first helicopter that arrived to the pool).
- He assures to have had good visual clearness at all time and better with the binoculars.

1.16. Organizational and management information

1.16.1. *Regarding the Fire fighting Management*

1. "Pliego de Prescripciones Técnicas para el servicio de Medios Aéreos adscritos al Plan INFOCAM durante las anualidades 2010-2011-2012-2013" (technical specifications for the service of Aerial Means under contract to INFOCAM plan during the years 2010-2011-2012-2013)

In Page 9 of the document, regarding the works of the aerial means, it says: "...the drop will be performed at the areas of the fire front indicated by the Incident Commander at that moment".

2. Act (state) 43/2003, 21 November, Forestry.

In Article 46, on organization of the forest fire fighting, it states that the technical incident commander will be a professional that has been given specific accredited training on behaviour of forest fire and adequate techniques for its extinction.

Likewise, article 47 qualifies as authorized officer the manager or technical responsible for the extinction operations

3. Act 3/2008, 12 June, Forestry and Sustainable Forest Management of Castilla-La Mancha.

Articles 60 and 61 show the same concepts (almost literally) than the two already mentioned of articles 46 and 47 of Act 43/2003, of 21 November, on Forestry.

4. Order of 28/05/2010, of the Consejería de Agricultura y Medio Ambiente de Castilla La-Mancha (Department of Agriculture and Environment) that regulates the forest fire prevention and extinction services.

The introduction of the Order announces the need for the approval of a *Technical Directive of organization of the SEIF* (Operational Service for Forest Fire Fighting).

Article 8 establishes that L category (Fire fighting Section Chief) may act as Technical Incident Commander.

Article 21, duties of the Fire Section Chief, establishes that under the Regional Fire Coordinator, and in each one of the sections of the fire regions, there must be a Fire Section Chief who will, among other duties, once arrived at the fire, assume the position of Technical Incident Commander, relieving the agents that had arrived before at the fire site until the arrival of the Regional Fire Coordinator, the Technical assistant of fire fighting or the Fire fighting Technician.

The possibility of handing over the management of the extinction to another person of lower rank level is not expressly indicated.

5. Resolution of 09/05/2011, of the Dirección General de Política Forestal (Directorate General of Forest Policy) Castilla La-Mancha.

It approves *Technical Directive of organization of the SEIF* (Operational Service for Forest Fire Fighting).

6. Technical Directive of organization of the SEIF (Operational Service for Forest Fire Fighting).

It establishes that the Technical Incident Commander shall be executed by personnel of the Administration, with the relevant category according to the Order regulating the forest fire prevention and extinction services. In addition, it establishes that the Technical Incident Commander is the main responsible person of the organization of the Sistema de Manejo de Emergencias de Incendios Forestales-SMEIF (System of Emergency Management of Forest Fires) at the fire site.

It also stipulates that the first Environmental Agent that arrives at the fire constitutes the Puesto de Análisis contra Incendios Forestales-PAIF (Position of Analysis of Forest Fire Fighting) and assumes the Technical Direction of the Extinction until the arrival of a Regional Fire Coordinator

1.16.2. *Regarding the Training of the Environmental Agents*

1. **Order of 28/05/2010, of the Department of Agriculture and Environment (Castilla La-Mancha), regulating the forest fire prevention and extinction services.**

Article 23, Duties of the agent trainee, exposes that it is mandatory for non-experienced Environmental Agents to perform a theoretical-practical selective course of training on the field of forest fires with a duration not lower than 100 learning hours, promoted by the competent Ministry. They will provide service as Agent trainee for at least two months in times of high risk or a minimum of 15 alert shifts. They will always accompany a Fire Section Chief, from whom they depend hierarchically and who acts as advisor. They will collaborate with him in the tasks that he assigns them, being able to be scrambled for training purposes to areas where the fires are.

The introduction of the syllabus of the **Basic Course of forest fires for Environmental Agents** refers to the Order of 28/05/2010 establishing its mandatory teaching to non-experienced Environmental Agents. Among its main features are:

- Duration not less than 100 learning hours.
- Final assessment by questionnaire.
- Theoretical-practical semi-presential course.
- Objective: acquire the essential knowledge for the intervention of the personnel belonging to the Body of Environmental Agents in the forest fire emergencies.
- Consists of 6 modules.
- Module 4 studies the extinction with aerial means.
- Module 5 studies the communications (communication in emergencies, radio-communications and protocols). Mandatory reading of a communication document, instruction manuals of radio sets, and aeronautical alphabet.

1.16.3. *Regarding the scramble of an ACO*

According with the **activation, scramble, and communications protocol of the aerial means in Castilla-La Mancha, INFOCAM 2010**, approved by the Regional Technical Manager of the SEIF dated on 20 May 2010, in its point 7 it is stipulated that:

“when we have three aerial means flying towards a fire site the COR shall mobilize the ACO, being able to be supported by the H-00”.

1.17. Additional information

Regarding flight patterns

The following information has been obtained from the information downloaded from the fleet tracking system of the 3 helicopters involved in the fire fighting:

- The 3 helicopters carried out the water loading in the Balsa de Gómez.
- The H01 and H13 carried out the approaches to the pool from the north, which required proceeding to the pool with a practically south heading during the last seconds. However the H02 performed the approaches to the pool from the west, which required proceeding to the pool with a practically east heading and overtake an altitude of 10 m above the pool to then descend to it with a final turn to the right.
- In the water load prior the impact, the first one loading water was the H02, next the H13 and then the H01. The H02 dropped the water in the northwest side of the fire site (see figure 8) and proceeded with a left turn to the south of the fire towards the pool, while the H13 after emptying its bambi bucket in the southeast side of the fire, proceeded direct to the north of the pool.
- After the last drop of water of the H13 and of the H02, both followed very similar flight patterns (practically parallel) towards the pool, being the H02 more to the south and a little bit behind of the H13.
- The H13 proceeded to the pool from the north, and the H02 proceeded from the northwest, meeting both on the pool where they impacted.
- To summarize, the helicopters H01 and H13 were performing the outbound patterns to the pool more to the north and were proceeding finally with the pool in sight in the direction of advance of the aircraft (to the south). However, the H02 performed the pattern to the pool on a different heading, further south than the others, proceeding finally to the pool with a right turn ending practically on the pool.

Figure 8 shows the last flight pattern described by the H02 and H13 with the times in which the fleet tracking system saved the position information and speed.

Regarding communications among the 3 helicopters

From the information of the CVR that the H02 had installed and activated it has been possible to know that the communications among the 3 helicopters involved in the fire fighting were few in general, and in particular, practically null regarding reporting position of the helicopters to confirm arrivals or departures from the water drop in the fire site or approaching and departing the pool for the water load.

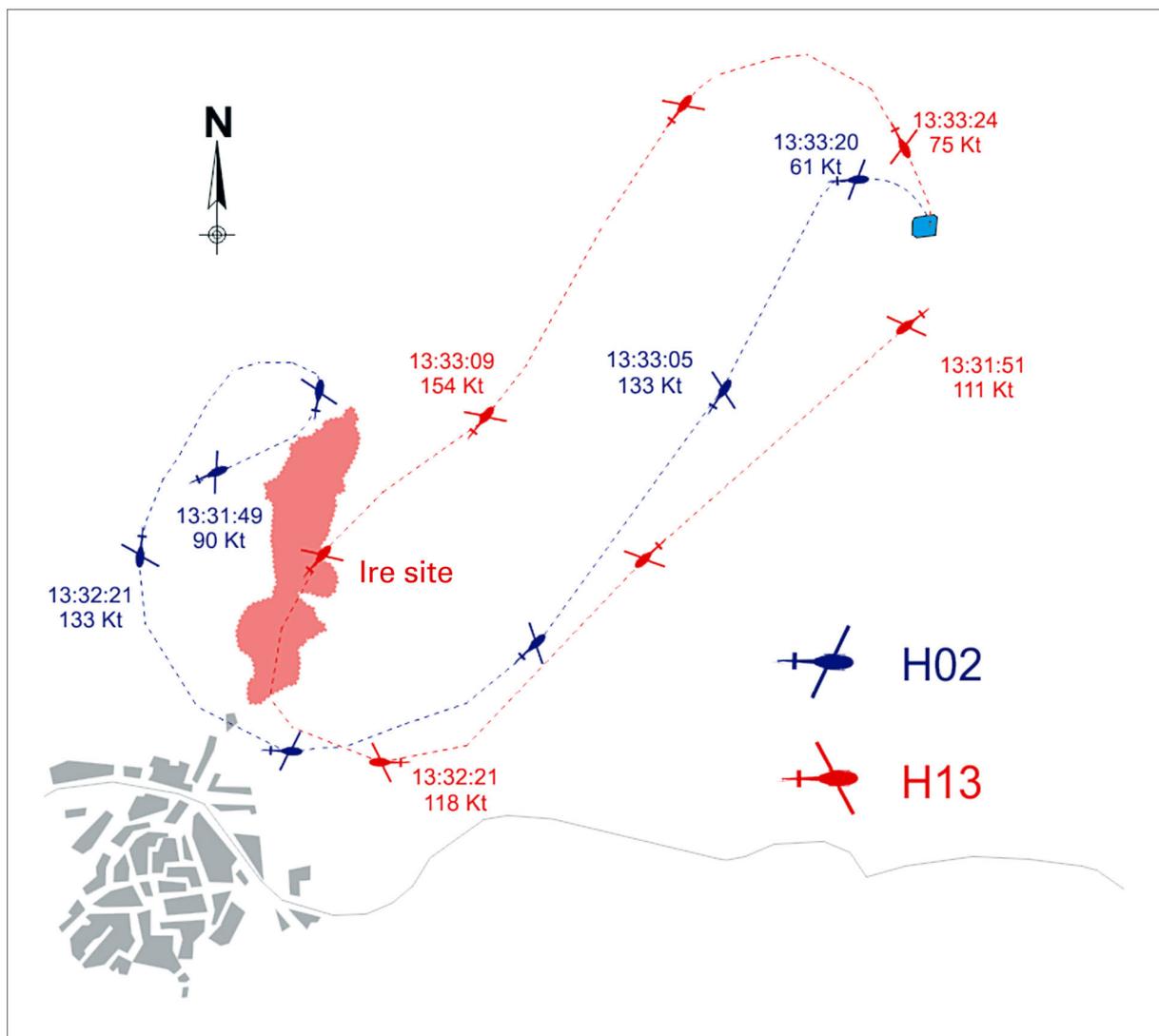


Figure 8. Flight pattern prior to the impact of the H02 and H13

Regarding the flight coordination

From the information of the CVR and the interviews carried out with the pilots of the H01 and H02, it can be confirmed that there was not any prior agreement among the crews on a common entry point to the pool and communication protocol.

In fact, there was the case, once the three helicopters were in the area, that the pilots ignored the position of the other two at a given time. The H01 mistook the H13 by the H02 (in this particular example the communications among the pilots allowed to clarify the situation)

There was not any leader to coordinate the flights neither in the fire site nor in the water loading area.

Regarding the pilot's personal protective equipment

Page 30 of the "Pliego de Prescripciones Técnicas para el servicio de Medios Aéreos adscritos al Plan INFOCAM durante las anualidades 2010-2011-2012-2013" (technical specifications for the service of Aerial Means under contract to INFOCAM plan during the years 2010-2011-2012-2013) document establishes that "...the assigned person will have mandatory safety protective equipment for the flight, consisting of overalls and helmet, being its use mandatory for the crews".

Regarding helicopter's equipment

Page 35 of the "Pliego de Prescripciones Técnicas para el servicio de Medios Aéreos adscritos al Plan INFOCAM durante las anualidades 2010-2011-2012-2013" (technical specifications for the service of Aerial Means under contract to INFOCAM plan during the years 2010-2011-2012-2013) document establishes that "...all helicopters will be required to carry a tracking system that can be migrated to the tracking system that GEACAM has installed..."

1.18. Useful or effective investigation techniques

It happened that both the Fleet Tracking System of the H02 and H13 did not migrate their data to GEACAM, so the only way of being able to obtain their information was reading the content of the memories that were recovered from the helicopters submerged in the pool, after a laborious process of drying.

2. ANALYSIS

2.1. Flight pattern coordination

Both the statements of the H01 and H02 pilots and the recording of the communications among the three aircraft show that there was not efficient or effective coordination among them.

In addition, there is not any protocol by the operator that defines coordination responsibilities among the aerial means in the absence of aircraft coordinator, and in this case the H02 and H13 followed more or less the same actions started by the H01, but without reporting among them entries and/or exits to the fire site or the pool.

The third aerial mean that assisted the fire was the H13 at 12:57 h, which took-off from its base at 13:06 h. It was exactly at 13:06 h when the ACO was assigned. According to the Protocol of activation, mobilization, and communications of the aerial means in Castilla-La Mancha, INFOCAM 2010, when there are three aerial means "flying towards the fire" the COR will mobilize the ACO, so the mobilization was correct in time according to this protocol.

However, since the ACO takes some time from its mobilization until it takes-off (in this case it took-off from Quinto de Don Pedro at 13:22 h, that is, 16 minutes after having been assigned) and it also takes more time in arriving the fire site and start coordinating the aerial means (in this case it was 35 minutes, arriving at the fire site at 13:57 h, that is, 24 minutes after having occurred the accident), too much time was left to three aerial means extinguishing the fire without being provided with coordination from the air.

If the abovementioned Protocol establishes that with three (or more) aerial means at a fire site it is necessary that one aircraft coordinates them from the air, it does not seem reasonable to obviate the time needed by the ACO to position itself in the fire site nor accept that the ACO must be mobilized in the instant that the third aerial mean takes-off to fly to the fire.

If it is also added that none of the three aircraft present at the fire site assumed any type of leadership to coordinate among them in the absence of aircraft coordinator and that the extinction management from the ground did not either coordinate the aerial means, the flight scenario was not the most appropriate to perform a safe fire fighting.

2.2. Flight pattern geometry

As it has been demonstrated by the study conducted on the tracks followed by each aircraft both inbound and outbound the pool and the fire site, the geometry of the

flight pattern was more or less fixed by the relative geometry among the fire, the pool, and the wind direction, but without explicitly specifying waypoints or reporting points.

From a geographical and visibility of the pool point of view:

- Approaches to the pool from the north (with south heading) or the opposite (from the south with north heading) are those which provide better visibility of the ground and the pool.
- Approaches from the west (east heading) require overtaking an altitude to immediately descend over the pool. There is not any visibility of the pool until overtaking, except the approach is performed at a very high altitude above the ground, something impractical because it would require descending on the pool almost vertically.
- Approaches from the east (west heading) provide a good visibility of the pool.

Considering that the prevailing wind in the pool area was of south component, the usual operation is to perform the final approach to the pool from the north heading south taking advantage of the headwind, benefiting the hovering over the pool, and the departure after the loading towards the south heading the aircraft against the wind.

The H01 and H13 aircraft were carrying out the final approach having the pool in front while arriving at it heading south. This operation was possible since the pattern from the fire to the pool was described with northeast heading sufficiently enough northward so, in order to perform the last turn to the right and enter the final approach to the pool, there was a pattern sufficiently long as to keep the pool in sight and to be able to decelerate the helicopter until being located on top of it and carry out the water load.

However, the H02 flew the segment from the fire site to the pool heading northeast also but more to the south than the others, which caused that the last turn to the right to enter final approach to the pool left a pattern considerably shorter than that of the other two aircraft, ending the turn practically on the pool and having a worst visibility of the same.

This route difference makes that the one flown by the H02, from the fire site to the pool, was shorter in distance. Not having set waypoints that fixed the flight pattern, promoted the fact that each pilot flew their flight pattern without a fixed pattern, leading to unequal routes that caused the order established to load the water to break.

In particular, the study of the flight pattern prior to the impact shows that:

- The H02 dropped the water in the fire site before the H13, and after that, it flew south (towards Bienservida leaving the fire at its left), passing the H13 that was entering the fire to drop the water.

- The H13, after dropping the water, continued the flight northeast towards the pool, opening towards the north to then fly the final approach segment with south heading.
- The H02 after passing the H13 turned left and headed more directly to the pool, also heading northeast, but more to the south than the route performed by the H13.

2.3. Collision over the pool

According to the impact sequence between the aircraft H02 and H13 described in section 1.11, the H13 was the first arriving at the pool, and was with its bambi bucket inside the water or very close to the water when one of the blades of its main rotor impacted against the H02, which was at a higher altitude and at its right hand having arrived after the H13 to the pool.

The statement of the witness (forest guard) at the guard house “El Padrón” confirms this sequence of arrivals at the pool.

The fact that the H02 did not realize that the H13 was already on the pool could be influenced because the order being followed was that after the loading of the H01, the H02 would enter, and then the H13. In addition, the lack of reporting entries to the pool could make the H02 pilot believe that the pool was free. On top of that, if it is also considered the final turn to the right performed by the H02, that complicates the view of the pool since the pilot is seated on the right seat, the pilot of the H02 probably never saw the H13 in that phase of the final approach to the pool.

On the other hand, the route difference followed in the last flight pattern towards the pool by the H02 and the H13, as well as the difference in cruise speeds, originated that the distances in the time of arrival to the pool were not kept.

Regarding the distance between the two aircraft at the moment of the first impact (see figure 5), since the right skid of the H02 was not hit by the blade of the H13, the horizontal distance between the longitudinal axes of the two helicopters was approximately 7 m.

The analysis of the distribution of the debris shows that the projection was towards the south. This fact is logic and compatible with:

- The relative position of the two helicopters in the impact
- That the H13 hit with the blades of its main rotor the H02, while the H02 never hit the H13 with its blades.
- That the blades of the main rotor of the Bell 212 turn counter-clockwise, top view
- That the blades of the H13 hit the H02 at the moment in which the tip of the blade (of each one the moment of the impact) of the H13 advances towards the south.
- The null translational speed of both helicopters in the impact.

2.4. Survival aspects

The crash into the water of the H02, despite falling from a higher altitude, was not as violent as the H13 as shown by the deformations of both aircraft. This is due to the fact that the H13 lost the lift when its blades were destroyed against the H02, while the blades of the H02 never hit the H13 and its integrity partly contributed to maintain some lift.

On the other hand, the H02 fell and remained on its left side, while the H13 was on its right-hand side. Given that both pilots flew sitting on the right seat, the pilot of the H02 had more time to exit until his cabin flooded, and in addition he was closer to the surface of the water.

In any case, not having lost consciousness after the impact and not having injuries that were reducing his mobility was determinant for the pilot of the H02 to survive. However, the pilot of the H13 did lose consciousness in the impact and had serious traumatism.

The fact that the pilot of the H02 had the safety harnesses completely fastened, both waist and shoulders, is considered a very positive factor for his survival. However, insufficient security protection of the personal equipment made him suffer burns more serious than those that he would have suffered in case of wearing fireproof gloves and regulatory helmet.

Regarding the pilot of the H13, the fact that he had not fastened the shoulders straps caused his body to lean violently forward and receive a strong hit against the cyclic control in the forehead when the helicopter crashed into the water. In addition, he was wearing casual clothes and he was not wearing helmet.

2.5. Communications

A communication or notification protocol among the three aircraft to report their position was not established, or at least to report the arrivals or departures to the fire site or to the pool.

The communications among the three aerial means were very few and they showed that in more than one occasion the pilot talking on the radio transmitting did not know what aircraft had in its sight.

On the other hand, the ground communication equipments did not allow the environmental agent who assumed the management of the extinction communicating properly with the rest of the team involved in the fire fighting due to technical problems which were not the first time that happened and that similar failures had previously been reported.

2.6. Fire fighting Management

In accordance with the Order of 28/05/2010 of the Consejería de Agricultura y Medio Ambiente of Castilla-La Mancha (Department of Agriculture and Environment), that regulates the forest fire prevention and extinction services, the person who had to carry out the brigade management was the environmental agent 1; however he delegated that mission in another environmental Agent (2) present at the fire site.

Both the State Act 43/2003, of 21 of November, of Forestry, and Act 3/2008, of 12 of June, of Forestry and Sustainable Forest Management of Castilla-La Mancha stipulate that the technical incident commander must be a professional who has received specific and accredited training on forest fire behaviour and adequate techniques for its extinction.

On the other hand, there is not any article in the Order of 28/05/2010, of the Consejería de Agricultura y Medio Ambiente of Castilla La Mancha (Department of Agriculture and Environment), that regulates the Forest fire prevention and extinction services that expressly define all and each one of the tasks of the incident commander. This feature is taught in the training courses.

Among the duties listed in the Technical Directive for organization of the SEIF, there is not anything about coordination of aerial means by the Incident Commander on the ground. That matter is taught in the training courses of Environmental Agent, established by the Basic Course of forest fires for Environmental Agents, which introduction refers to the Order of 28/05/2010.

However, the two environmental Agents present in the fire fighting had not received such training, but had received a more basic training years ago which did not teach directives on coordination of aerial means.

3. CONCLUSIONS

3.1. Findings

- Both helicopters had an airworthiness certificate in force and had complied with and passed their respective maintenance programs.
- The weight and balance of both helicopters was within limits.
- Both pilots had flight licence, agro-forestry type rating, and appropriate health certificate, all in force.
- Meteorological conditions and visibility were adequate for the flight.
- The pool where the water loadings were carried out was suitable.
- The pilots never considered the possibility for loading 2 helicopters simultaneously, since the dimensions of the pool were not suitable for that.
- The approach that provided best visibility of the pool was heading south, from the north of the same. On the other hand, since the wind was prevailing south on the pool, this approach was excellent also from a flying point of view.
- The H01 and the H13 performed the final approach to the pool heading south, while the H02 performed the segment to the pool from the fire site more from the south than the other two aircraft. This movement meant to perform a right turn to place itself heading south very close to the pool, having for that matter a worse visibility during the turn, worsen even more by the fact of being sat on the right-hand side seat.
- The communications among the three pilots were very few in general, and in particular there were not any communication reporting arrivals and departures from the pool or the fire site.
- All the flights of the day had occurred without any evidence of technical failure from the take-off until the collision.
- The ACO was scrambled the moment the third aerial mean took-off from its base towards the fire site.
- The ACO arrived at the fire site 35 minutes later than the third aerial mean.
- In the absence of the ACO there was not efficient or effective coordination among the three aerial means.
- In the absence of the ACO there was not coordination of the three aerial means from the management of the extinction on the ground.
- The communications by the aerial band did not present technical problems among the three helicopters.
- Ground-ground communications were hampered due to technical problems.
- The operator of the aircraft did not have a coordination procedure for aerial means in the absence of the ACO.
- None of the three aircraft assumed the coordination task.
- The flight pattern that the aircraft had to perform inbound and outbound the pool and the fire site was not defined by waypoints or reporting points.
- On the ground, the environmental agent 1, who was in addition Fire Section Chief of Bienservida, did not assume his job of Incident Commander and orally asked the environmental agent 2 to perform this task.

- In the absence of the ACO (and of any other people with a higher rank than environmental agent) the environmental agent of higher category or rank should assume the job of Incident Commander, and thus the coordination of the aerial means.
- None of the two environmental Agents had received proper training to coordinate aerial means.
- During the water loading manoeuvre, when the accident happened, the H13 was the first one to arrive at the pool, followed by the H02; however, in the prior loadings, the H02 was the first to arrive before the H13.
- At the moment of the collision the translational speed of both aircraft was practically non-existent, and the H13 was in position to contact the water with its bambi bucket.
- At the moment of the collision the H02 was to the right and higher than the H13, and both helicopters were heading south.
- The blades of the H02 never hit the H13.
- The pilot of the H02 dressed the regulatory uniform, but not the helmet. He was conveniently fastened to the seat by safety harnesses (waist and shoulders).
- The pilot of the H13 dressed casual clothes and was not wearing the helmet. He was not conveniently secured to the seat by the higher safety harnesses (shoulders).

3.2. Causes

As a consequence of the non-existent coordination among the three aerial means involved in the fire fighting operation, that caused that two of the participating aircraft met at the pool to load water, a flight collision occurred.

Factors contributing in the accident:

- Lack of coordination procedure among aerial means in the absence of the ACO.
- Lack of a procedure to define the flight pattern by the aircraft operator.
- Lack of training on aerial mean coordination matters by the ground staff that assumed the Management of the Extinction in the absence of the ACO.
- The ACO procedure assignment makes that the time that it takes to arrive at the fire site after being activated is, in general, longer than the time the third aerial mean takes, so there is an interval of time in which there are three aerial means (or more) present in the extinction without an ACO.

4. SAFETY RECOMMENDATIONS

- REC 31/13.** It is recommended to INAER Helicópteros, S.A.U. as responsible of the operation to establish a communication protocol among aerial means present in the fire fighting operations. This protocol will have to be incorporated in the Operations Manual of the company and in the Training program of the crew.
- REC 32/13.** It is recommended to INAER Helicópteros, S.A.U. as responsible of the operation to establish a procedure to define the flight patterns that the aircraft must comply with during the fire fighting operations so once it is established the aircraft follow it as precise as possible. This procedure will have to be incorporated in the Operations Manual of the company and in the Training program of the crew.
- REC 33/13.** It is recommended to INAER Helicópteros, S.A.U. as responsible of the operation to establish a protocol to coordinate its aerial means in the absence of the ACO. This protocol will have to be incorporated in the Operations Manual of the company and in the Training program of the crew.
- REC 34/13.** It is recommended to INAER Helicópteros, S.A.U. as responsible of the operation to ensure that its crews make the use, mandatory by its Operations Manual, of the safety belts and harnesses
- REC 35/13.** It is recommended to INAER Helicópteros, S.A.U. as accountable of the operation to ensure that its crews make use in flight of the adequate equipment.
- REC 36/13.** It is recommended to the Consejería de Agricultura de Castilla-La Mancha (Department of Agriculture) to ensure that the ground personnel that may assume aerial means coordination duties at a fire is adequately trained for that matter.
- REC 37/13.** It is recommended to the Consejería de Agricultura de Castilla-La Mancha (Department of Agriculture) to review the protocol for activating the ACO to make sure to minimize the time in which three aerial means (or more) can be extinguishing a fire without the ACO assigned.
- REC 38/13.** It is recommended to the Consejería de Agricultura de Castilla-La Mancha (Department of Agriculture) to require to air operators a coordination protocol among aerial means in the absence of the ACO, compatible among different operators, if more than one was taking part in the extinction of the same fire.
- REC 39/13.** It is recommended to the Consejería de Agricultura de Castilla-La Mancha (Department of Agriculture) to ensure full operation of aerial and ground radio-communications in the entire area of operation of the Operational Service for Forest Fire Fighting.

