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AVIACIÓN **C**IVIL

Report A-008/2011

Accident involving a Bell 407 helicopter, registration EC-KTA, on 19 March 2011, in the municipality of Villastar (Teruel, Spain)

GOBIERNO DE ESPAÑA

MINISTERIO DE FOMENTO

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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°	Degree(s)
00 °C	Degree centigrade(s)
00”	Inch(es)
AD	Airworthiness Directive
ASB	Alert Service Bulletin
CARB	Corrective Action Review Board
CASA	Civil Aviation Safety Alert
CIAIAC	Comisión de Investigación de Accidentes e Incidentes de Aviación Civil
cm	Centimeter(s)
CPL(H)	Commercial Pilot License (Helicopter)
DAH	Design Approval Holders
EASA	European Aviation Safety Agency
ECU	Engine Control Unit
ELT	Emergency Locator Transmitter
FAA	Federal Aviation Administration
FADEC	Full Authority Digital Engine Control
ft	Foot
g	Acceleration due to gravity (9,81 m/s2)
GPS	Global Positioning System
h	Hour(s)
HYD SYS	Hydraulic System
KIAS	Indicated air speed in knots
kt	Knot(s)
lb	Pound(s)
L/H	Left Hand
LTP	Laboratoty Test Procedure
m	Meter(s)
mb	Milibar(s)
min	Minute(s)
mm	Milimeter(s)
P/N	Part Number
PPL(H)	Private Pilot License (Helicopter)
psi	Pound(s) per square inch
QNH	Altimeter subscale setting to obtain elevation when on the ground
R/H	Right Hand
s	Second(s)
SB	Service Bulletin
SL	Service Letters
S/N	Serial Number
TC	Transport Canada
UTC	Universal Time Coordinated

Synopsis

Owner and operator:	INAER
Aircraft:	Bell 407, S/N 53831
Date and time of accident:	19 March 2011; at 12:37 UTC[1]
Site of accident:	Municipality of Villastar (Teruel, Spain)
Persons onboard:	7; 6 killed, 1 seriously injured
Type of flight:	Aerial work – Commercial – Firefighting
Date of approval:	27 March 2014

Summary of accident

On 19 March 2011, the Bell 407 helicopter took off from its base in Alcorisa (Teruel) at 12:09 and proceeded to the burned area on Los Olmos Mountain, near the locality of Alcorisa. The purpose of the flight was to pick up a firefighting brigade and transport it to a fire that had broken out between the towns of Villel and Cascante. While en route to the fire, the crew reported its location once past the town of Cedrillas at around 12:30. The helicopter crashed into the ground a few minutes later in a large clearing without any obstacles.

Of the aircraft's seven occupants, six died and one was seriously injured.

[1] All times in this report are in UTC. To obtain local time, add one hour to UTC.

1. FACTUAL INFORMATION

1.1. History of the flight

On Saturday, 19 March 2011, at 11:30, a fire was reported between the towns of Villel and Cascante in the province of Teruel. The first units mobilized by the Provincial Operations Center in Teruel, a division of the Government of Aragon's Council of Agriculture, Livestock and the Environment, requested back-ups due to the advancing state of the fire. It was then decided to mobilize the heliborne forest firefighting brigade

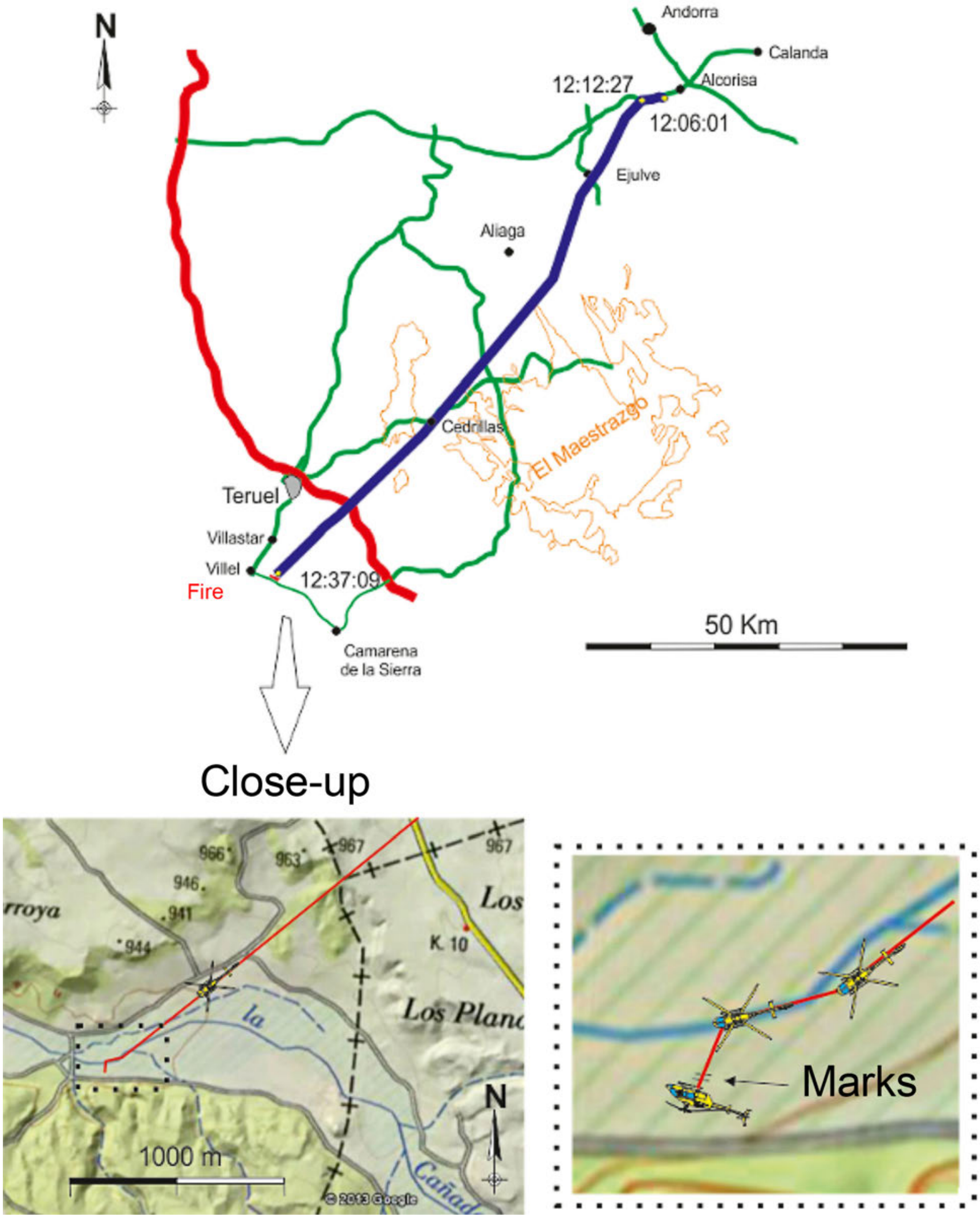


Figure 1. Flight path of the aircraft and close-up of final segment

from Alcorisa (Teruel), which was doing maintenance work in a burned area on nearby Los Olmos Mountain. To transport the brigade, a Bell 407 helicopter, registration EC-KTA and operated by INAER, took off from its base in Alcorisa at 12:09:34, on what was its first flight of the day. After picking up the members of the fire frigade at 12:12, the crew reported they were en route toward the fire.

At around 12:30, as per the Provincial Fire Coordinator, the brigade reported its location once past the town of Cedrillas and informed that it had the fire in sight.

Minutes later, the Provincial Operations Center asked the firefighting teams on the ground if the heliborne unit was onsite. In light of the negative response, the aircraft's position was verified using the fleet tracking system installed in the Operations Centers, which showed that the last known location had not changed since 12:36.

Several attempts were then made to contact the brigade using both cell phones and the radio. When no reply was received, a helicopter based in Teruel for the 112 emergency service was requested at 13:00 to inspect the site of the last known coordinates.

At 13:24, the accident was confirmed by 112 emergency services.

Of the seven people onboard –the pilot, the five firefighters and a forest ranger–, six perished in the accident. One firefighter survived but was serioiusly injured. The aircraft was destroyed.

1.2. Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	1	5	
Serious		1	
Minor			Not applicable
None			Not applicable
TOTAL	1	6	

1.3. Damage to aircraft

The aircraft was destroyed by the impact.

1.4. Other damage

There was no additional damage.

1.5. Personnel information

The pilot in command, seated in the R/H seat, a 38-year old Spanish national, had valid and in force commercial pilot (CPL(H)) and private pilot (PPL(H)) licenses, along with the following ratings:

- He had a valid and in force class 1 medical certificate as well Spanish proficiency (6) and English proficiency (4) certificates.

Based on the information provided by the company, his experience as a firefighting pilot was verified to have begun in 2008. He had a total of 1,664 h and 33 min of flight experience, of which 393 h and 33 min had been on the type. In the last year he had flown 132 h, 43 min; 25 h and 48 min in the last 90 days and 17 h and 48 min in the last 30 days. The accident flight was the first flight of the day.

1.6. Aircraft information

The aircraft, a Bell 407 model, registration EC-KTA and serial number 53831, was manufactured in 2008. It was equipped with a Rolls Royce 250 C47B engine, S/N CAE 848099, and it had a skid landing gear (see figure 2).

In the cabin the seats were arranged such that the two front seats were for the pilot (R/H) and another occupant, with five additional seats in the rear, two immediately behind the two front seats and facing aft, with the last three facing in the direction of motion (see figure 3).

Figure 2. Accident helicopter

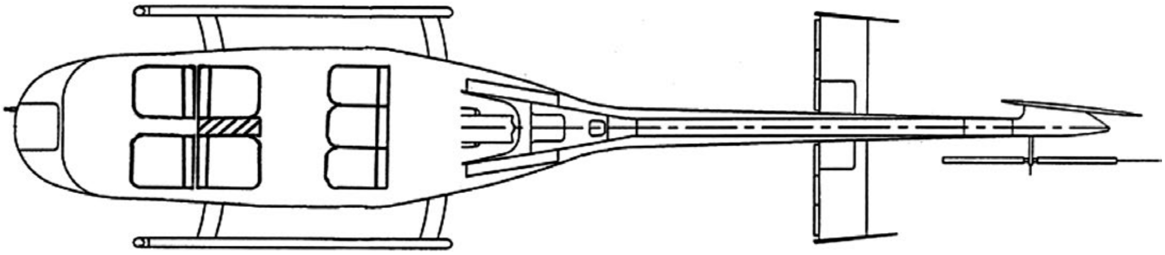


Figure 3. Cabin configuration

The aircraft's flight controls were operated hydraulically, requiring less force to move them, thus making it more comfortable and efficient to control the aircraft.

1.6.1. *Aircraft maintenance information*

The aircraft's administrative documentation was in order. Its Spanish registration certificate was valid and had been issued on 23 September 2008. The airworthiness certificate had been issued on 27 June 2008 and renewed on 27 June 2010. It was valid until 26 June 2011.

The aircraft also had an aircraft station license that was valid until 26 June 2011.

The last entries in both the Aircraft and Engine Logbooks had been made on 13 March, with 363 h 50 min on the aircraft.

As for the maintenance condition of the aircraft, the detailed inspections in the Maintenance Program were confirmed to have been performed. There were no deferred maintenance items or any malfunctions pending resolution.

Inspection	Hours	Date
B 300 h/12 m, E annual	105:45	29-05-2009
B 300 h/12 m, E annual, C Standard 1200 h/24 m, F biannual	280:20	05-05-2010

As regards the hydraulic system, an inspection was carried out to verify the servos on 6 September 2009, pursuant to Service Bulletin ASB 407-07-90, published by Bell Helicopter on 3 November 2009. This inspection revealed the need to replace the L/H servo, S/N HR2590 before 600 flight hours or 6 months. The part was replaced on 5 May 2010.

Up to that moment, aircraft and engine were in compliance with both FAA and EASA Airworthiness Directives, as well as with the manufacturers' Service Bulletins.

The aircraft's Continuing Airworthiness, thus, had been properly maintained until the date of the servo replacement.

1.6.2. *Description and operation of control surfaces*

The Bell 407 helicopter has four servos and their associated mechanisms and linkages to the controls and control surfaces. The support of three of the four servos are located in the top front part of the cockpit. They are identical and have the following functions:

- A servo near the main rotor shaft to control the collective pitch. Actuated using the collective control. Modifies the pitch of all the main rotor blades.
- Two cyclic pitch servos located on either side of the collective actuator, the left having primary control over lateral motion and the right over longitudinal motion. Actuated using the cyclic control lever. Their combined movements determine the plane of rotation of the main rotor.

The fourth servo is at the rear of the tail boom and is actuated using the pedals in the pilot's position. Their purpose is to adjust the pitch of the tail rotor blades so as to control the aircraft's yaw. This servo is different from the rest, since the piston's actuation area is smaller, and thus so is the amount of force it is capable of supplying.

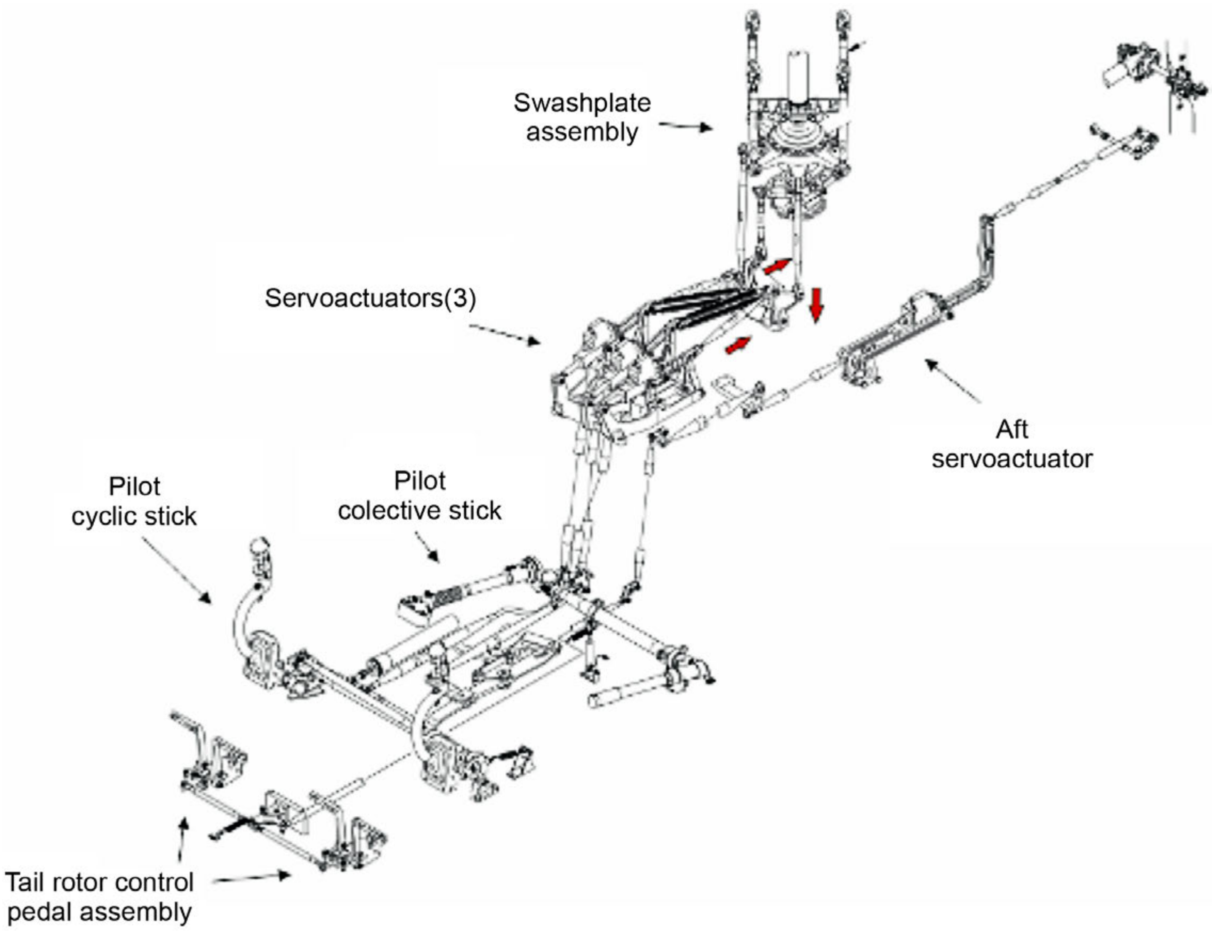


Figure 4. Control surface diagram

Considering more in-depth the workings of the servo-pivot hinges that command the movements of the cyclic and collective to the swash plate, when the pilot moves the collective control lever, in addition to moving the central servo, which conveys the force to the mast and changes the pitch of the blades, the two other servos must also respond to some extent so as not to alter the lateral or longitudinal attitude of the main rotor blades as a whole. A solely lateral input by the pilot to the cyclic does not mean that only the left servo will move, just as a solely longitudinal input to the cyclic does not imply that only the right servo will move; rather, the orientation that conforms the plane of the main rotor is determined by the combined motions of the two servos commanded by the cyclic control.

If one servo seizes, that is, if it keeps the piston from moving, the remaining components in the affected servo-pivot assembly will be unable to move.

1.6.3. *Description and operation of the hydraulic system in the Bell 407*

The hydraulic system on the aircraft has pressurized and return headers that include the following components: hydraulic fluid tank, pump, filters, solenoid valve and relief valve, manifold, pressurized and return hoses and servos.

The tank supplies hydraulic fluid through the pump, where it is pressurized to 1,000 ± 25 psi. By the corresponding coupling, the fluid then passes through a filter that traps those particles that, due to their size, could be dangerous to the operation of the system. The fluid then goes through the relief valve, which opens at pressures in excess of 1,225 ± 150 psi, dumping the fluid back to the supply tank through the return header hoses after passing through another filter so as to prevent potential damage to both the solenoid valve and to the servos. If the pressure is good, the hydraulic fluid passes through the solenoid valve, which opens (or closes), allowing (or not) the hydraulic fluid to go to the servos.

The HYD SYS switch for the helicopter's hydraulic system, located in the cockpit, is usually in the ON position, even in the event of a total electrical failure. The HYD SYS switch controls the solenoid valve such that when it is not energized, either because the switch is in ON or due to an electrical fault, the hydraulic fluid is allowed to flow through to the four servos. In contrast, when the HYD SYS switch is in OFF, the valve prevents the flow of fluid to the servos.

Before reaching the servos, the hydraulic fluid flows through the hydraulic distribution system, which regulates the flow of the fluid, either in the direction of the pump toward the servos in the pressure header, or from the servos back to the tank through the return header.

The support of three of the helicopter's four servos, and their associated mechanisms, are located on the top forward part of the fuselage. The fourth servo is in the tail boom.

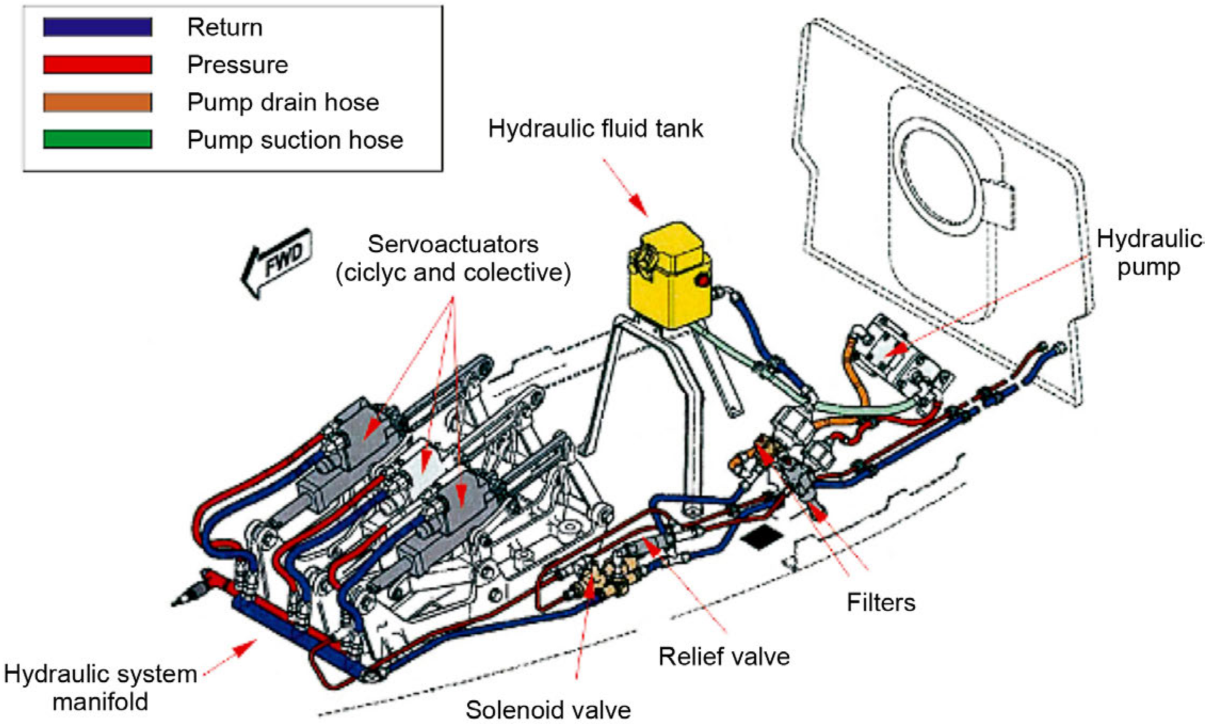


Figure 5. Hydraulic system

1.6.3.1. Description and operation of the servos

A servo has a cylinder with a piston inside it that relies on hydraulic fluid pressure to create the force necessary to move a system on the aircraft or a control surface.

The pressurized hydraulic fluid and the servos move the connections that control the direction and attitude of the flight. The force the pilot exerts on the collective pitch and cyclic pitch control levers, or on the directional control pedals, only actuates the associated solenoid valve. This force is much lower than would be required to act directly on the controls.

Each servo is controlled and protected by several devices or valves that respond depending on different conditions. Of note are the hydraulic solenoid valve, the bypass solenoid valve and the relief valves, which are actuated based on pressure differential or on thermal conditions.

The hydraulic solenoid valve comprises the main control mechanism since it conveys the orders received from control system actuated by the pilot to the servo. The piston must move at the speed required by the pilot when acting on the controls. To do this, the solenoid valve has a spindle that moves inside the servo and sets the travel limit of the inputs the pilot can provide to the flight controls.

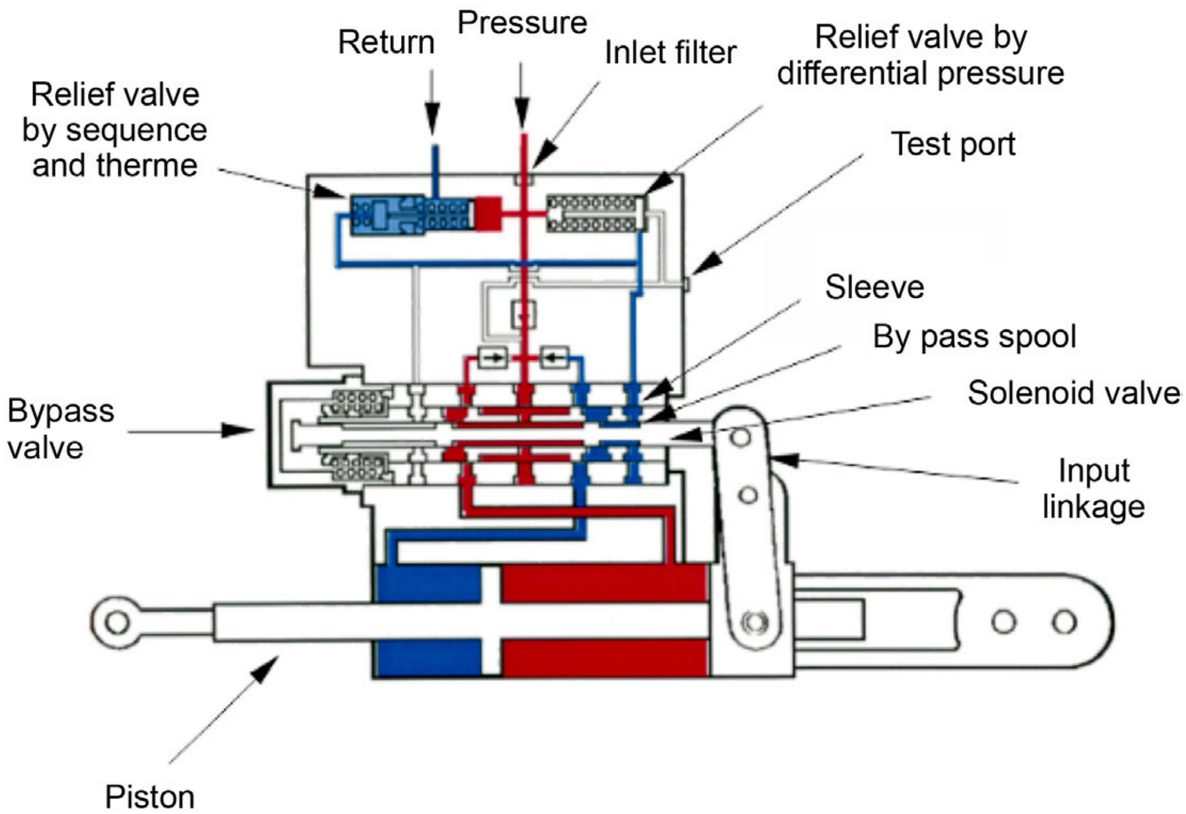


Figure 6. Diagram of the servo

The solenoid valve has a closed three-way core that comprises the bypass valve. Depending on the inlet pressure applied, the valve will enter into operation or not, allowing, or not, the hydraulic fluid to flow to the ports on the servo.

There is also a relief valve that relies on differential pressure to protect the servo and the valve from the forces transmitted from the control surfaces.

1.7. Meteorological information

According to data provided by the National Weather Agency and considering the overall weather map, satellite images, the low-level significant weather chart for 12:00 UTC, the forecast for Teruel and data from automated stations, the most likely conditions for the Teruel area at the time of the accident were as follows:

- Weak northerly winds (average speed up to 10 kt) gusting to 15 kt.
- Good surface visibility.
- Clear or mostly clear skies.
- Surface temperature of about 15 °C.
- Relative humidity: 30 to 40%.

- No significant weather phenomena or storm activity.
- No adverse phenomena warnings.

1.8. Communications

The firefighters on the helicopter were in contact with the Teruel Provincial Operations Center, and reported seeing the smoke from the fire and approaching the area. There were no subsequent communications from the helicopter.

1.9. Flight recorders

There were no flight recorders onboard nor were they required for this aircraft type.

The aircraft was equipped with a Bendix/King KLN-89B GPS navigation unit and a AVL-280 GPS-based positioning unit. Also found in the wreckage were two other portable GPS units, a Garmin GPS Map 96C and a GPS 12XL.

Of all these, information could only be extracted from the AVL280 GPS unit, which supplied position, altitude, speed and heading information, and from the portable Garmin GPS Map 96C, which provided position and altitude data. The remaining units did not have any information, since one was off and the other did not allow for the recording of data.

The flight paths obtained from the data on both recorders, though they did not match exactly, were very similar (see figure 7).

Based on the data taken from the AVL280 unit, by 12:28:48 the helicopter was past the town of Cedrillas and was some 19 nautical miles away from its destination.

The helicopter's average altitude remained slightly above 1,500 m until 12:30:46, at which time the pilot started a descent at an approximate rate of 550 ft/min for about two minutes. The descent rate then dropped to about 190 ft/min for approximately two and a half minutes. On the last segment, lasting about a minute and a half, the altitude was initially constant, followed by a constant descent more pronounced than in the previous segment.

As for the speed data provided by the same unit, these indicate that the helicopter maintained an average cruise speed of nearly 140 kt until 12:31:48, when the speed started to drop gradually to values between 100 and 110 kt, which it maintained until 12:36:27.

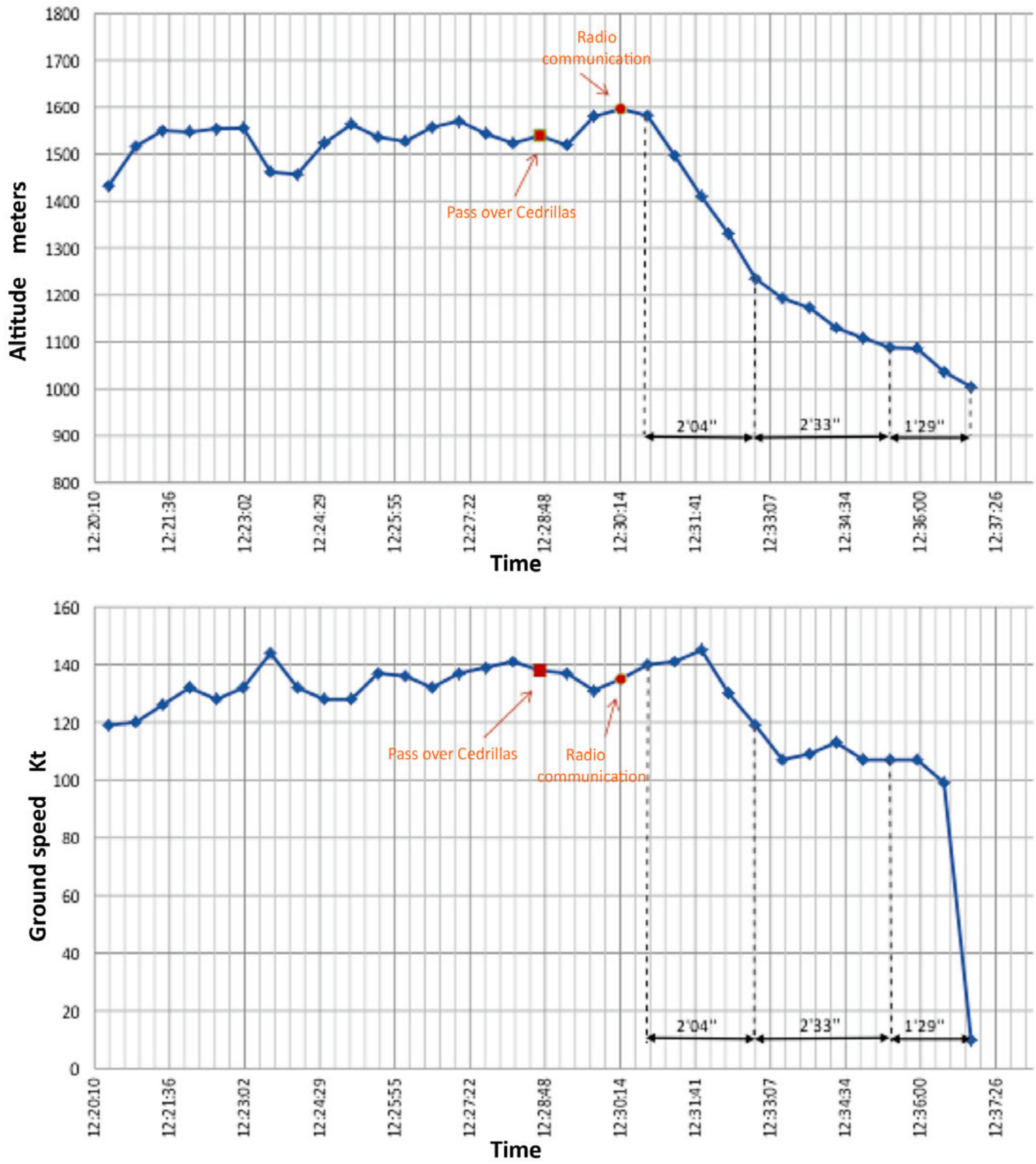


Figure 7. Data from the AVL-280 GPS positioning system

At 12:36:58, the recorded speed was 10 kt. This was the last data point recorded on the Fleet Tracking System.

From then on, the portable Garmin 96C unit provides information for an additional 14 seconds. During the first 8 seconds, the flight path was veering slightly to the right, after which it turned sharply to the left practically 90º.

Investigators were also able to extract information from a memory card found at the accident site and taken from a Panasonic DMC-FX10 camera found among the wreckage.

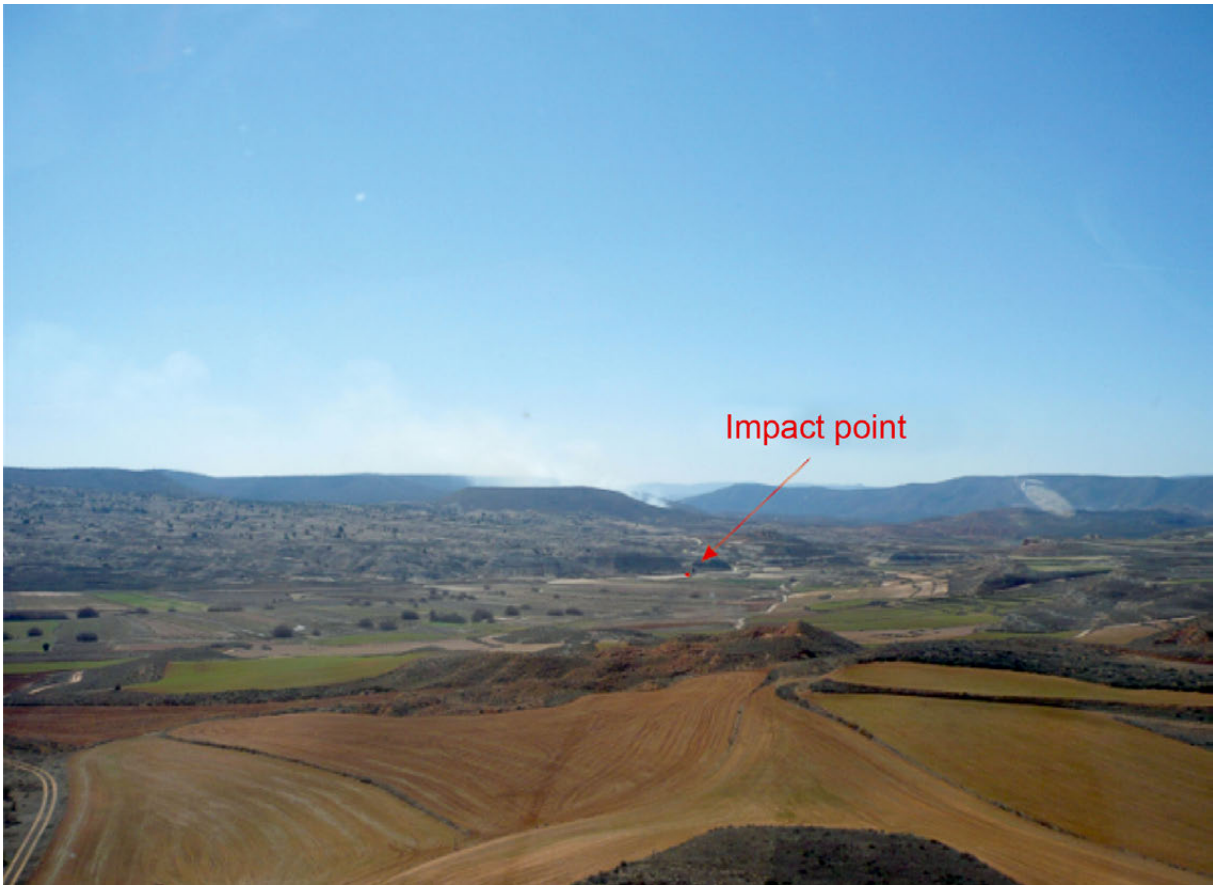


Figure 8. Panoramic view from the cockpit of the flight path and location of the impact point

This card contained six photographs taken looking out the front of the helicopter. They were taken over the course of the final four minutes recorded on the AVL280 positioning system. The photographs show different views of the ground to be flown over en route to the fire, visible as a plume of smoke rising in the background. The photographs reveal how the helicopter's altitude above the ground decreased gradually.

1.10. Wreckage and impact information

The accident took place in the municipality of Villastar (Teruel) on a ploughed, level, dry-farmed field in a valley oriented from east to west. The area was clear, flat and free from obstacles.

The main debris field was very small and the helicopter was found lying on its left side a short distance away from the markings left by the skids on the ground. The nose was on a heading of approximately 290°.

Figure 9. Main wreckage

On the ground just north of the main wreckage there were two parallel marks oriented along the same direction as the fuselage (around 270º). The left mark, as seen in the direction of motion, was about 15 cm deep. The right track was very shallow and a little shorter than the left (see figure 10).

The damage to the aircraft's fuselage was limited to the nose compartment, windows, left side of the fuselage and the landing gear. The underside of the helicopter did not exhibit any significant damage.

The landing gear was only attached to the helicopter by the right rear bolts. The forward cross member on the left side near the skid was broken. Both cross members were bent inward on the left side and outward, and slightly backward, on the right. The left bracket was broken and detached from the landing gear.

There was some minor damage found inside the cabin, though the floor, overhead and sides were not significantly damaged. The floor around the rear left seat had been pushed up.

There was heavy damage to the main rotor head. Two of the four links used to adjust the pitch of the blades were broken.The swashplate scissors were broken at the

Figure 10. Bent landing gear and marks on the ground

attachment point on the plate. Two of the four blades were in one piece, though their surfaces were heavily damaged. The other two were broken and their surfaces were also significantly damaged.

The tail cone was bent at the point where the registration letters were painted and broken just after the horizontal stabilizer. This fracture revealed that the linkages used to change the pitch on the tail rotor blades were slightly bent, though the continuity of the controls was confirmed.

In the engine compartment, the transmission assembly did not exhibit any significant damage. The metallic particle traps were clean, the helicopter's transmission axle was twisted and its length had been cut short by the detachment of the aft coupling. The transmission axle could be rotated to confirm its continuity and the freewheel unit was verified to be working properly.

The aft center and right seats were detached from the floor. The right safety harness attachment on the center seat was broken and the harness detached from said attachment. The anchor point for the center seat was shifted forward and to the left.

The lug on the row of back seats that is screwed to the helicopter frame and used to attach two of the safety harnesses was broken as a result of the accident.

In the cockpit, the windshield was broken. The HYD SYS switch was in the OFF position, and the personnel who had entered the cockpit confirmed that it had not been manipulated after the impact and that the hydraulic system circuit breaker was in the on position.

The instrument panel had moved from its original position, falling back and to the left. The flight instruments were zeroed and the altimeter QNH setting was 1,019 mb. It indicated an altitude of 2,900 ft. The switch for the ELT beacon had been turned off by operator employees to keep it from emitting after the impact.

The top part of the instrument panel, where the warning and caution lights are, was detached from its support, as were several engine instruments.

The collective control was offset from its position. It was loose and only being held by its own cover. The cyclic control was also loose and being held by its cover.

The linkage connecting the pedals to the helicopter controls was twisted and almost broken near the pedals. It broke later when the continuity of the controls was being checked.

The air intake on the left side of the engine was blocked by the dirt it had ingested during the impact.

As for the hydraulic system, the tank was verified to contain hydraulic fluid and the controls were connected. No leaks were found and no significant damage was readily apparent. The piston in the left hydraulic servo (as seen from above) was found in the fully extended position.

1.11. Medical and pathological information

The results of the autopsies carried out on the victims indicate that they all died from multiple traumas suffered during the accident. In the case of the pilot, the results of the toxicological analysis were negative, meaning there is no reason to suspect his abilities were compromised or diminished in any way. All of the helicopter’s occupants had their safety harnesses fastened at the time of the accident.

The injuries described in the associated autopsy reports revealed the presence of mortal injuries to vital organs. These injuries were compatible with a heavy impact and the subsequent trauma as the occupants struck internal surfaces in the aircraft, which was subject to an significant inertial force after the impact with the ground.

According to the studies published in the Pocket Reference to Aircraft Mishap Investigation, The Naval Safety Center, Aeromedical Division, the impact speed, trajectory and resulting injuries indicate that the g forces could have been as high as 50 g on impact.

Although the cabin remained largely intact, there was a correlation between the position in which each of the occupants was seated and the injuries resulting from the various impacts inside the cabin. For example, the occupants seated facing aft had injuries mainly to their right sides, in contrast to the injuries of the remaining occupants, which were mainly to the left sides of their bodies.

1.12. Fire

There was no fire.

1.13. Survival aspects

All seven occupants were restrained with their corresponding three-point harnesses.

Two helicopters and one ambulance from 112 emergency services reported to the scene, along with firefighters and Civil Guard personnel.

Six of the occupants were dead and one was seriously injured. The injured occupant was removed from the cabin by emergency responders. He was given first aid on the scene and then transported to a hospital.

1.14. Tests and research

The aircraft wreckage was taken to a hangar for safeguarding until the necessary inspections could be carried out.

1.14.1. *Investigation of the engine and fuel system*

The analysis of a fuel sample recovered from the aircraft did not reveal any contamination and indicated that the sample of JET A-1 fuel taken complied with all applicable specifications.

The amount of fuel recovered from the helicopter (>300 lbs) also indicates that there was enough fuel to make the flight as initially planned.

An inspection of the fuel system did not reveal any abnormalities prior to the impact. Investigators checked the system's various components –valves, pump, etc.– and determined that they were working properly.

A detailed inspection of the engine was then performed by means of an operational test on a test bench. This test was carried out at the manufacturer's own facilities in the United States under the supervision of CIAIAC personnel. The test revealed a slight drop in the maximum nominal power as well as slightly higher fuel consumption than new production test specifications though both findings were attributable to the amount of dirt ingested by the engine on impact.

This engine is equipped with Full Authority Digital Engine Control (FADEC) system, the central component of which is the Engine Control Unit (ECU). The ECU can monitor and record various engine parameters and, in the event of an abnormality in any of the parameters, it can store the associated parameters both during and in the instants before and after the abnormality so they can be checked later. In the accident at hand, the only abnormality stored by the system was recorded at the moment of impact.

Investigators thus determined that the engine was in proper working order until the moment of impact with the ground.

1.14.2. *Investigation of the hydraulic system. Inspections and tests*

As part of the inspection of the aircraft wreckage, the hydraulic system was subjected to a thorough analysis that revealed the following findings:

There was no apparent wear on the hydraulic pump. Both the pressure and return headers were clean and had no foreign particles. When the pump was energized, it rotated freely and it supplied sufficient hydraulic pressure. While conducting a subsequent operational test, which required connecting the system to a hydraulic test cart, it was noted that the servos did not respond to movements of the cockpit controls. The bent (and in some cases seized) transmission and control tubes were then disconnected to isolate the servos. When hydraulic pressure was directly applied to the servos through the sequencing valve to determine their response, the one on the right, associated with the cyclic control, and the one in the center, associated with the collective control, moved freely throughout their range of motion. The servo on the left, however, as seen from above, associated with the cyclic control, did not move.

In light of these results, a further test was deemed necessary and was conducted at the helicopter manufacturer's facilities in the United States under the supervision of CIAIAC personnel. The most relevant findings of this inspection are detailed below:

Valves and piping assemblies

The system's various control valves and connecting pipes were X-rayed. No type of obstruction or blockage was detected.

Hydraulic system manifold and hoses

Both the manifold and the hoses were X-rayed. No type of obstruction or blockage was found. The manifold was connected to perform the hydraulic test, which revealed that the fluid was flowing normally.

Pump and tank

The pump, tank, filters and associated hoses were also X-rayed. Nothing out of the ordinary was found. The pump was functionally tested and found to be operating correctly.

Hydraulic fluid

An analysis of the sample of hydraulic fluid determined that it was within specifications.

Hydraulic test of the collective and cyclic pitch servos

The three collective and cyclic pitch servos, P/N 206-076-062-107, were also X-rayed. This test did not reveal any type of fractures or internal blockages. Their external appearance did not reveal any significant wear.

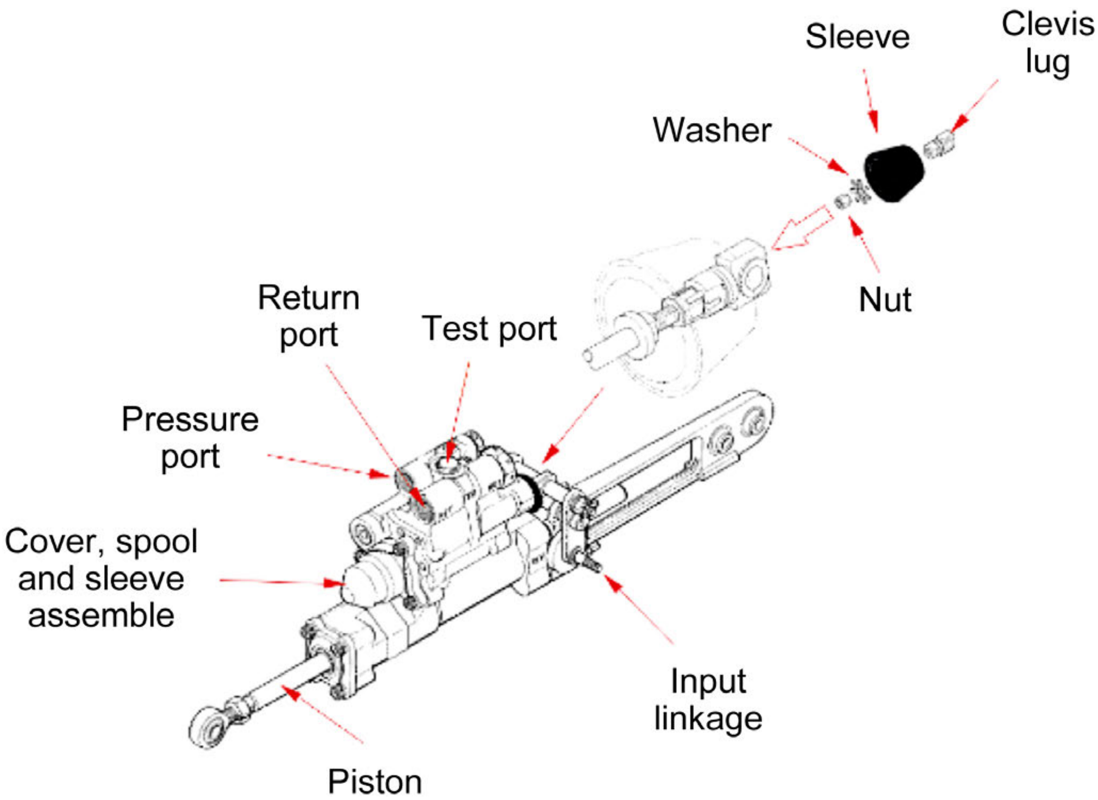


Figure 11. Servo

The protective sheath was removed from the clevis assembly on the various servos in order to check the condition and position of the nuts, lock washers and shafts. The clevis lugs on both the right cyclic servo (S/N HR2588) and the collective servo (S/N HR2539) had four flats. The lock nut had four tabs bent against the corresponding flats on the clevis lug and three tabs bent against the nut. The torque lacquer was in place on the adjustment assembly on both servos, though it was somewhat worn. None of the parts (nut, lock washer of shaft) was loose.

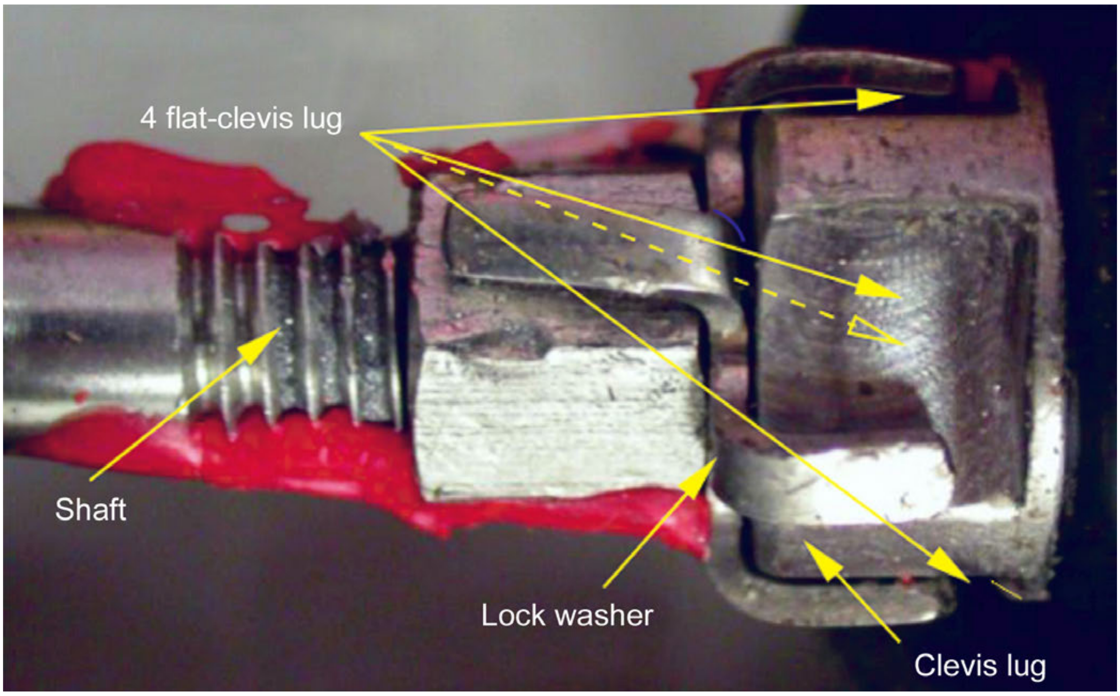


Figure 12. Right cyclic servo HR2588

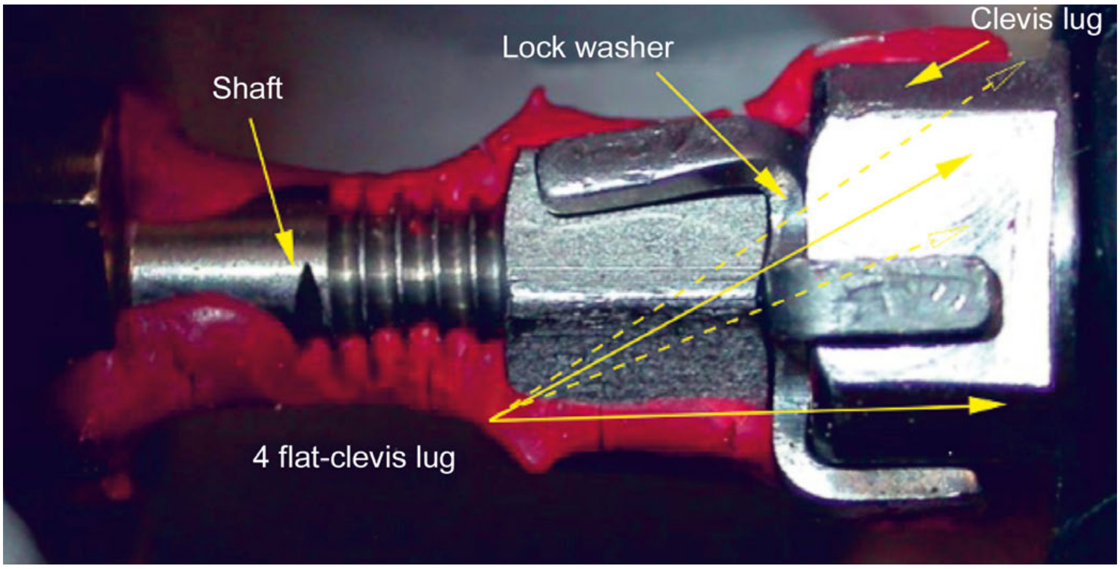


Figure 13. Collective servo HR2539

The clevis lug on the left cyclic servo (S/N HR2036) had two flat surfaces. The lock washer had three tabs bent against the lug and four tabs bent against the nut. The locking tabs on the washer bent against the lug had been bent against a circular part of the lug instead of against the flat surfaces, as evidenced by the angle at which the tabs were bent and the gap present between the tabs and the flat surfaces on the lug. The remains of the torque lacquer were found. The nut and the lock washer were found loose and not in the locking position.

The input lever travel total stroke was also measured on the solenoid valve for all three servos.

The total travel on servo S/N HR2036 was 0.015" (0.38 mm), while on servos S/N HR2588 and HR2539 it was 0.022" (0.56 mm) and 0.021" (0.53 mm), respectively.

All three servos were connected on a test bench so they could be operationally tested. The pistons on the right cyclic servo (S/N HR2588) and the collective servo (S/N HR2539) could be actuated and moved their full length of travel correctly. This was not the case with the piston on the left cyclic servo (S/N HR2036), which was in its extended position and could not be retracted. The input lever total stroke was measured again for the solenoid valve on this servo and found to be 0.011" (0.28 mm), which indicates that the nut and shaft moved while the servo was being connected to the test bench. After being adjusted once more to its initial position of 0.015" (0.38 mm), a second attempt was made to retract the piston, which it did, though very slowly. The extension process occurred at normal speed.

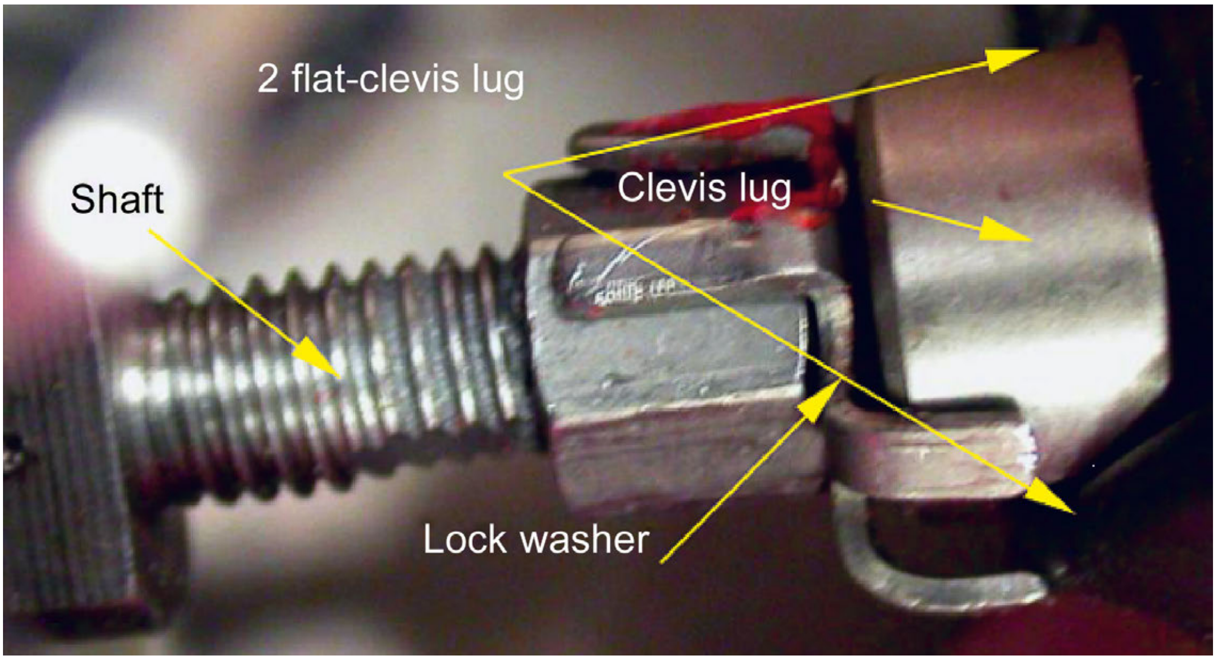


Figure 14. Left cyclic servo HR2036

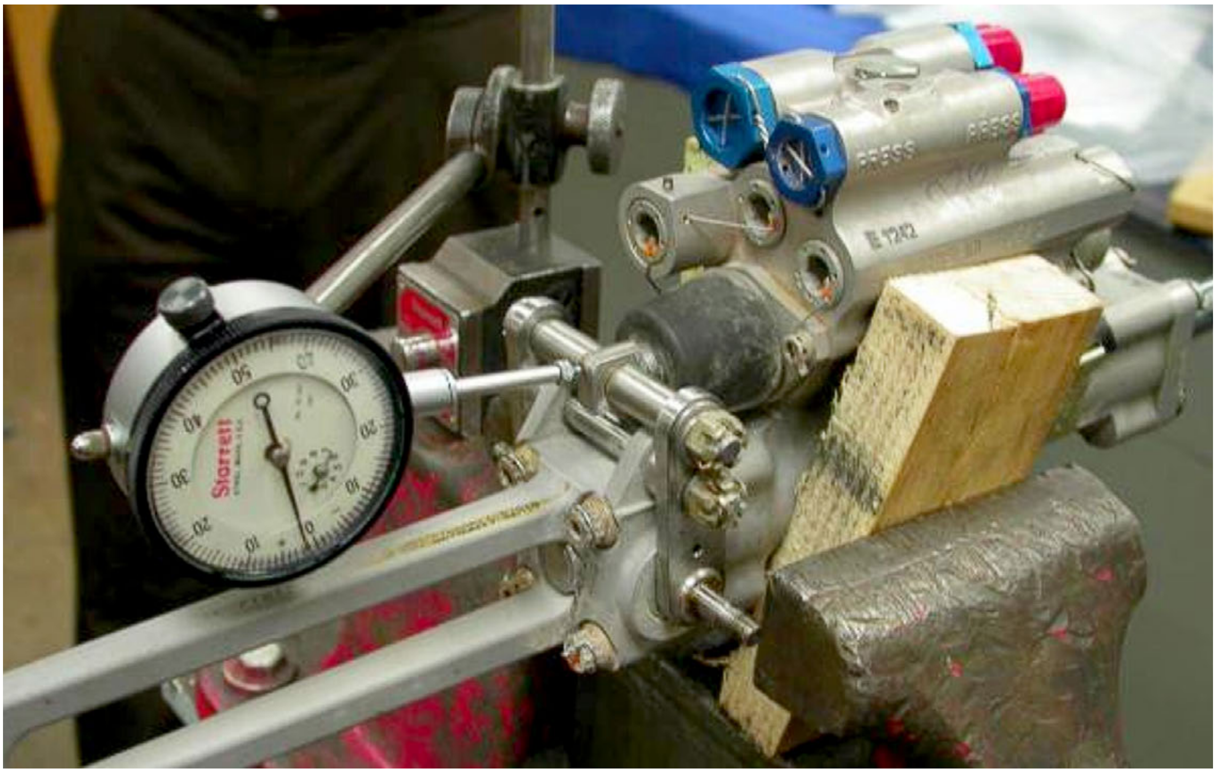


Figure 15. Operational test

The nut and shaft were then adjusted to the position associated with an input lever total stroke of 0.023" (0.58 mm), corresponding to a normal configuration, as found on the two other servos. This time when pressure was applied, the piston extended and retracted at a normal speed, similar to that recorded for the other two servos.

Several adjustments were made to the nut and shaft to obtain different input level stroke lengths for the servo S/N HR2036 in an effort to measure the piston's corresponding extension and retraction speeds:

Input lever travel length	Piston extension time	Piston retraction time
0.022" (0.56 mm)	0.98 s	1.06 s
0.018" (0.46 mm)	1.03 s	2.68 s
0.016" (0.41 mm)	1.08 s	18.80 s

Additionally, the force required increased as the input level travel length was reduced.

The three servos were checked using Bell Helicopter's Laboratory Test Procedure n.º 794. This procedure did not reveal any abnormalities in the operation of the servos. (The nut and the shaft on servo S/N HR2036 were adjusted to the position associated with a total input level travel of 0.022" (0.56 mm), as indicated in LTP n.º 794).

At a later date, servo S/N HR2036 was completely disassembled at the facilities of AEM Ltd. (a center authorized by Woodward HR Textron, which manufactures the servo), in England, using HR Textron CMM 67-31-09, Revision 2, dated 15 March 2006. No new findings were established that could account for a malfunction of the servo.

The left cyclic servo (S/N HR2036) was subject to Service Bulletin 407-05-70 (see 1.18.2 for additional information on servo S/N HR2036), which specified that upon completion of said bulletin, the marking "67-01" was to be etched onto the modification plate. This mark could not be found on the modification plate for this servo.

1.14.3. *Analysis of fracture process for the lug used to attach the safety harnesses*

The process that led to the fracture of the lug that was screwed to the structure and that served to attach two of the safety harnesses from the rear row of seats was studied in detail. This analysis concluded that the fracture occurred as the result of a ductile process caused by heavy tension on the central portion of the lug through the hook in the center hole. This significant overload first led to plastic deformation that bent the central portion. The sections on either side of the hole to which the harness was hooked then fractured under the shear stress of the buckle on the harness.

Figure 16. Location of harness attachment and close-up of fracture

1.15. Organizational and management information

The General Directorate for Forestry Management, an agency of the Department of Agriculture, Livestock and the Environment of the Government of Aragon, entered into a contract with INAER Helicópteros, SAU, to conduct missions that included direct fighting of forest fires, the coordination of air-ground actions, tranporting personnel and materiel to prevent and fight forest fires and any other missions associated with these activities.

On the date of the accident the contract was in an extended status, having been prolonged on 8 April 2010 for a period of two years concluding on 8 April 2012.

1.16. Additional information

1.16.1. *Eyewitness statements*

The survivor, who was seating on the right side of the aircraft facing aft, was available to make a comment. This was the only one of the five occupants seated in the passenger cabin who was in communication with the pilot and the forest ranger seated in the cockpit. His statement revealed the following:

All of the occupants were wearing their safety harnesses, which he himself verified as he was in charge of reporting this to the pilot before taking off.

The flight proceeded normally until they passed the town of Cedrillas, when he heard the forest ranger announce their passage over this spot. There then ensued a brief conversation about refueling, and he heard the pilot say "This is going to be hard! The controls are stiff!" "Relax, it's ok".

He did not recall the helicopter making any strange movements and stated that they seemed to trace out a gradual curve during the descent. He also did not recall feeling a sense of danger before the accident.

He further stated that in January, the same pilot had conducted a drill with the firefighters onboard shortly before landing at low altitude, simulating a failure of the hydraulic system. The drill lasted about 15 seconds.

1.16.2. *Information on the left cyclic servo S/N HR2036*

So as to comply with Service Bulletin ASB 407-09-90, published by Bell Helicopter on 3 November 2009, the L/H servo S/M HR2590, then installed on the accident helicopter, had to be replaced by another servo with the same P/N and S/N HR2036, this one with

12 flight hours. The servo, along with its corresponding Authorized Release Certificate, was sent by the manufacturer Woodward HRT on 28 April 2010, through Bell Helicopter, and installed on the accident aircraft on 5 May 2010 by the operator's (INAER) authorized maintenance personnel.

Previously, on 10 November 2005, Bell Helicopter had issued a Service Bulletin (ASB 407-05-70) that included the requirements of Bulletin no. 41011400-67-01, issued by the manufacturer of the servo, HR Textron, on 9 November 2005. This bulletin, which was not applicable to the serial numbers on the original servos, did affect the servo HR2036 that replaced the original. This SB warned of the possibility that the shaft on the clevis lug could be loose if the tabs on the lock washer were not properly bent against the nut or the clevis lug, and required a mandatory inspection of the system's components: nut, washer and shaft. The completion of this inspection was to be signaled by etching the marking 67-01 on the modification plate, which would indicate compliance with said buletin. This inspection had to be completed before the next ten flight hours after the issuance of the bulletin or before 15 December 2005, whichever came first (see Appendix IV).

The checks made of the servo (S/N HR2036) after the accident revealed an improper adjustment of the lug and laboratory tests confirmed that the adjustment gradually shifted until it impeded the proper operation of the servo.

On 29 June 2011, after the inspection of the hydraulic system performed as part of this investigation, Bell Helicopter issued Service Bulletin n.º 407-11-96 to warn of the fact that some of the servos affected by the previous bulletin, ASB 407-05-70, had not yet been inspected. The operators were thus instructed to verify and ensure that the hydraulic servos subject to the original bulletin had been inspected.

In addition, the civil aviation authority of the State of design of the helicopter, Transport Canada, issued Airworthiness Directive n.º CF-2011-17 on 30 June 2011, which warned that, due to a quality escape in a product sent to Bell Helicopter by a supplier, it was necessary to check the control system in the servos for proper adjustment. The directive went into effect on its application date and had to be applied before the next flight (see Appendix III).

The FAA reiterated these findings by issuing its own Airworthiness Directive AD 2011-15-51 on 8 July 2011, which also required performing an inspection to check the condition of the servos (see Appendix II).

On 22 February 2012, Bell Helicopter informed the owners and operators of its 407 model helicopters of the expansion of the requirements applicable to the 12- and 24-month scheduled maintenance inspection. The 12-month check now requires an inspection of the clevis lug to ensure the integrity of the locking system, and the 24-month check requires measuring the input lever travel total stroke to ensure its proper operation.

1.16.3. *Process for issuing Airworthiness Directives (ADs)*

According to information provided by Transport Canada (TC), an AD is issued when an unsafe condition is detected in an aeronautical product and said condition is likely to result in an undesired event.

To this end, Design Approval Holders (DAH) are required to report to TC any events that take place depending on the likelihood of a repeat occurrence and of the seriousness of its consequences.

Based on this information and once an unsafe condition is identified, the DAH is required to engage in a risk management process that identifies the level of risk and proposes a mitigation plan. This risk management process comprises the basis for the dialogue between TC and the DAH to reach an agreement on how to correct the condition. Once decided upon, the DAH is required to take specific actions, such as a design change, inspection procedures, revisions to manuals or additional compliance instructions, such as Service Bulletins (SB).

Every SB that is the object of an AD must be approved by TC to ensure that the corrective actions specified reduce the risk identified.

In those cases where the adoption of mandatory measures is not warranted, the TC may issue a Civil Aviation Safety Alert (CASA) or an information bulletin, or the DAH may issue a non-mandatory corrective action, such as messages to operators, Service Letters (SL), SBs, etc.

As for the method used by the American Authority, the FAA uses the process established by the Corrective Action Review Board (CARB) to determine whether the need exists to issue an AD or not. It does so by evaluating the risk and the benefit of issuing an AD based on information relevant to the situation, including any SBs that may have been published.

Whenever an unsafe condition is deemed to exist, the department in charge will design, coordinate and publish an Airworthiness Directive.

Manufacturers may use their own criteria to issue SBs. Compliance with SBs is required by operators licensed under FAA Part 135 (commuter and charter) with an approved maintenance program. Operators, however, who are licensed under FAA Part 91 are not required to comply with SBs. In any event, all operators are required to comply with a published AD that makes reference to their aircraft.

On rare occasions the FAA may, if deemed necessary, publish an AD without a SB having been published first.

For products with a USA type certificate, the FAA approves the technical aspects of the manufacturer's service bulletins. If an AD is lkely to follow, then the manufacturer and FAA will work together to incorporate the SB into the AD, which becomes law.

In the case of products for wich the USA is not the state of design, as in the case in question, the FAA relies on the foreign authority to ensure the continued airworthiness of its products and to coordinate as required in terms of the SBs. In this regard, the foreign authority may or may not inform the FAA of the imminent issuance of an SB. Likewise, if the authority is going to engage in any airworthiness actions, these may be reported to the FAA prior to their publication. In any event, the FAA ratifies any airworthiness action that is issued by a foreign authority.

1.16.4. *Emergency operation*

Section 3 of the flight manual, Emergencies/Malfunctions, considers two emergency situations involving the hydraulic system: loss of pressure and abnormal operation of one of the flight control servos. For both cases, the manual lists the indications of the situation and the procedure for dealing with it (see Appendix I).

For both situations there is a set of actions in common to be carried out: reduce speed to between 70 and 100 KIAS, place the hydraulic system switch (HYD SYS) in OFF and make a run-on landing at an effective translational speed of about 15 kt.

Depending on the emergency in question, a distinction is made between landing as soon as practical when faced with a loss of pressure and landing as soon as possible when faced with the abnormal operation of a servo. See Appendix I.

According to information provided by the operator, Bell 407 pilots are trained annually during ground and air competency checks on the normal and abnormal operation of the hydraulic system. A failure of the hydraulic system is also simulated during the operator's competency check.

2. ANALYSIS

2.1. Analysis of the wreckage

The accident took place on a ploughed and level field located on a valley in an east-west orientation. The clearing was wide, flat and free from obstacles. These aspects made the area ideal for making an emergency landing, if not a run-on landing, given the loose and soft composition of the terrain.

Two parallel markings were found on the ground that were facing in a similar direction as the wreckage. The left marking, as seen from the direction of flight, was about 15 cm deep and the right marking, which was a little shorter than the left, barely penetrated into the ground at all.

These markings indicate that the aircraft impacted the ground directly with its landing skids. The difference in depth between the two indicates that the left skid made contact first, absorbing most of the impact force, followed by the right skid, which impacted with less energy.

The landing gear broke at several points as a result of the impact. It was only attached to the fuselage by its right rear anchor point. The two cross members on the left were bent inward while the ones on the right side were bent outward and slightly aft.

The damage exhibited by the cross members was consistent with the markings found and point to the landing gear impacting the ground violently with the helicopter in a left bank angle with respect to its longitudinal axis and with a clear left lateral speed component.

The damage to the main rotor blades was consistent with a sudden stoppage as a result of the blades striking the ground while the main rotor was operating in a normal rotational regime.

No pre-impact anomalies were found. The controls remained connected and operational until the impact. The damage to the tail cone also occurred as a result of the impact and did not contribute to the accident.

There was minor damage inside the cabin, though the floor, roof and lateral panels were not significantly deformed. The only deformed part was where the reat left seat was located, which had been lifted up as a result of the landing gear bars pushing upward through the fuselage, affecting the fuel tank before eventually lifting the seat up.

There was a broken lug that was screwed to the fuselage structure and which was used to hook two of the safety harnesses from the back row of seats. So as to determine what had caused this lug to fracture, it was sent to the Material Testing Laboratory of the Aeronautical Engineering Department at the Universidad Politécnica de Madrid, which found that the piece had been manufactured from stainless steel with good mechanical properties, and that its performance during the overload was adequate. The piece was subjected to a significant plastic deformation, resulting in ductile failure.

In the cockpit, the HYD SYS switch was in the OFF position. This switch was confirmed not to have been operated after the impact, meaning it was disengaged by the pilot. This is in keeping with the performance of an emergency maneuver following a failure of the hydraulic system.

2.2. Medical and pathological analysis

There is an acceptable correlation between the injuries caused, and considered fatal, and the deceleration vectors generated by the force of the impact with the ground, which inside the cabin was transformed into the motion of the occupants in the direction of the inertial forces to which they were subjected.

The position of the only survivor, who was seated in the right side facing aft, could have proven beneficial and given him an extra margin of safety in terms of the flight path taken by the helicopter.

2.3. Analysis of the eyewitness's statement

The information provided by the eyewitness revealed that the occupants were all wearing their safety harnesses and that the flight was proceeding normally to the extent that no one in the cabin felt endangered at any point. Once past the town of Cedrilla, the pilot noted how stiff the controls felt while at the same time conveying a sense of serenity in light of the situation. The eyewitness also stated that once before this same pilot had simulated a failure of the hydraulic system.

2.4. Analysis of the hydraulic system

The inspection of the hydraulic system revealed that there was fluid in the system and that its quality was acceptable. The system's various controls and hoses were also correctly connected. No leaks were found and the system did not have any clearly visible damage.

The inspection of the three servos located in the top front part of the cabin, one used to control the collective pitch and the other two the cyclic pitch, yielded the following findings:

The clevis assembly on both the right cyclic servo (S/N HR2588) and the collective servo (S/N HR2539) was properly adjusted, there being no undesired twisting of any of their component parts: nut, washer and shaft. This was because in both, four of the seven tabs on the lock washer were properly bent against the four flat surfaces on the lug and the other three were bent against the surfaces of the nut. The torque lacquer certifying the torque on the adjustment assembly was also in place in both servos.

On the clevis assembly for the left cyclic servo (S/N HR2036), however, the nut and lock washer were found loose and not in a locking position. Four of the tabs on the lock washer were bent against the nut and the other three were improperly bent against a circular part of the lug instead of being bent against its flat segments, of which there were only two. This was evidenced by the angle at which the tabs were bent and the gap present between the tabs and the flat surfaces on the lug. Only parts of the torque lacquer were found in this assembly.

The tabs on the lock washer improperly bent against the lug and the lack of any markings on the modification plate indicate that the servo had not been inspected as required by Service Bulletin 407-05-70.

When the servo is installed on the helicopter, the range of motion of the flight controls and of the spindle on the solenoid valve must be consistent, at which time this range of motion is locked in place so as to ensure the operability of the servo. Any change in this adjustment, such as the one described earlier, could result in motions of the piston that do not match those commanded by the pilot since the relationship between the neutral mechanical and hydraulic positions has been altered.

The input lever travel total stroke on servos S/N HR2588 and HR2539 was 0.022″ (0.56 mm) and 0.021″ (0.53 mm), respectively. These values were clearly different from that noted for servo S/N HR2036, which was 0.015″ (0.38 mm).

The functional test of the three servos revealed that the piston on the right cyclic servo (S/N HR2588) and on the collective servo (S/N HR2539) could be actuated and that they extended and retracted correctly, while the piston on the left cyclic servo (S/N HR2036), which was extended, could not be retracted.

It was also noted that the washer and the shaft on the solenoid valve on servo S/N HR2036 moved freely while the servo was being prepared to be connected to the test bench when a new measurement was made of the input lever travel total stroke.

The investigation also determined that servo S/N HR2036 was working properly when the nut and shaft were adjusted to a position equivalent to an input lever travel total stroke of 0.022″ (0.56 mm), which is the normal configuration, as evidenced by the two other servos. In this case when the piston was actuated, it extended and retracted at a speed that was similar to those recorded for the two other servos.

Once various adjustments were made to the nut and shaft to set different input lever travel total strokes for servo S/N HR2036, it was discovered that small changes in the input lever strokes resulted in large differences in the piston response times as it retracted and extended. Also, greater force was required as the input lever stroke was reduced.

It may be stated, then, that a servo that is improperly adjusted can translate into stiffer controls for the pilot and a very sluggish response of the controls in one of the two directions that degraded as the misadjustment worsened, possibly reaching a point where the pilot felt no response at all.

2.5. Analysis of the flight path

An analysis of the data provided by the fleet positioning system indicates that by 12:28:48, the helicopter had flown over the gown of Cedrilla, and that it maintained an average altitude slightly in excess of 1,500 m until 12:30:46.

From then on, despite being over ten miles away from its destination, the helicopter started to descend at an average sink rate of 550 ft/min over two minutes. The rate was then reduced to 190 ft/min for an additional two and a half minutes. These rates are consistent with a normal in-flight descent, with the rate decreasing in magnitude as the aircraft approaches the ground.

In the final recorded segment, lasting approximately a minute and a half, the helicopter initially maintained its altitude, followed by a constant descent that was more pronounced than in the previous segment. This rapid final descent was not consistent with the normal progression of the flight, since it should have been more gradual given the aircraft's proximity to the ground. It could have resulted from the pilot's haste to reach the ground in response to the difficulty he was having controlling the aircraft, as well as from the drop in the helicopter's speed, as detailed below.

The eyewitness's statement gives a rough timeline for the pilot's comments regarding the stiff controls once they flew over the gown of Cedrillas, and indicates the pilot's awareness of the problem with the hydraulic system and the need to start an emergency maneuver, as reflected in the flight path data.

The speed information provided by this same equipment indicates that the helicopter had an average cruise speed of almost 140 kt until 12:31:48, after which its speed dropped gradually to between 100 and 110 kt, which it maintained until 12:36:27. This drop in speed to values near 110 kt is consistent with the performance of an emergency maneuver due to a failure of the hydraulic system.

The Garmin 96C portable unit provides an additional 14 seconds of positional and altitude information. The heading remained steady during the first eight seconds, after which the helicopter turned slightly right in response to the changing terrain. The flight path then suddenly deviated perpendicularly to the left for about 70 m.

The information taken from the files recovered from the memory card found among the wreckage indicate that six photographs had been taken from the front of the cockpit over the last four minutes recorded by the AVL280 positioning system.

These photographs showed different panoramic views of the ground over which the helicopter would have had to fly to reach the fire, indicated by a column of smoke in the background. A time lapse sequence of the photographs reveals that the helicopter was gradually losing altitude. The last photograph clearly shows the site where the helicopter eventually impacted the ground and reveals that the helicopter would have had to turn to the right to adapt to the layout of the valley, as reflected by the data from the portable GPS unit.

Over the last segment of about 70 m flown by the helicopter, there was a sudden, practically perpendicular change in direction to the left. This change was not in response to a coordinated course change, but was rather a lateral displacement of the helicopter to the west, as evidenced by the marks on the ground and by the wreckage, and brought about by an unexpected change in the flight conditions.

The emergency maneuver was being carried out in a controlled fashion by flying in a straight path without the need to make significant inputs to the controls.

It was in the final segment, when the pilot needed to make a gradual turn to the right to adapt to the features of the terrain, that he must have actuated the cyclic control, first to the right and then to the left to finish the turn and stabilize the aircraft. Given the proximity of the terrain, the input to the cyclic control could have been accompanied by another to the collective to raise the swashplate in preparation for landing.

These motions of the helicopter's controls would explain the extended position of the left servo on the one hand, and the sudden deterioration in the ability to move said piston on the other.The inputs to the servos and the vibrations of the helicopter could have resulted in the worsening misadjustment of the control of the solenoid valve, which as was noted earlier, can cause significant delays in the servo's response time.

The piston on the right servo was found seized in an extended position, which resulted in the left inclination of the plane of the main rotor and the consequent motion of the helicopter to that side. This would explain the sudden motion experienced by the aircraft in the final segment of its flight path just prior to impact.

During the final six minutes of the flight, therefore, the helicopter seems to have been engaged in an emergency maneuver brought on by the failure of the hydraulic system.

This conclusion is supported by the constant decrease in speed to a range that was consistent with that specified in the Operations Manual for this maneuver.

2.6. Analysis of the publication of Airworthiness Directives

Based on the information provided by the revelant organizations, there are procedures for establishing channels of communication between manufacturers and authorities that ensure the latter are aware of potentially unsafe conditions and make it possible to take corrective actions, including the issuance of Airworthiness Directives.

On 10 November 2005, Bell Helicopter issued Service Bulletin 407-05-70, requiring the inspection and possible adjustment of the clevis assembly on certain servos. Had this bulletin been complied with, the unsafe condition that resulted in this accident would have been avoided. Transport Canada did not issue a related Airworthiness Directive.

After the accident, on 29 June 2011, Bell Helicopter issued a new Service Bulletin, 407-11-96, which reiterated the measures presented in the previous bulletin. On this occasion Transport Canada did issue an Airworthiness Directive.

3. CONCLUSIONS

3.1. Findings

- The helicopter was transporting the members of a firefighting brigade to fight a forest fire.
- The pilot was properly qualified to fly the helicopter and had a valid and in force license, ratings and medical certificate.
- The helicopter had a valid and in force airworthiness certificate and had undergone all of the scheduled maintenance inspections. There were no malfunctions or defects pending resolution.
- The weather conditions were good for the flight.
- The damage to the helicopter and the markings on the ground indicate the impact took place with the helicopter moving quickly to its left.
- The aircraft's occupants were wearing their three-point safety harnesses.
- The left servo was blocked in the extended position.
- The helicopter was making an emergency maneuver due to a failure of the hydraulic system, in keeping with the instructions provided in the Operations Manual.
- The hydraulic system had been disengaged by the pilot in preparation for the emergency maneuver.
- The mechanism for adjusting the left servo was not locked as required by the instructions given in Service Bulletin no. 407-05-70.
- Servo HR2036 had been supplied by the manufacturer, Bell Helicopter, with its associated Authorized Release Certificate, though it was not in compliance with Service Bulletin n.º 407-05-70.
- The issuance of Service Bulletin no. 407-11-96 on 29 June 2011 led to the publication of Airworthiness Directives by both Transport Canada and the Federal Aviation Administration in the USA that required inspections and possible corrective actions be performed on the adjustment system for certain servos. These servos were already covered by Service Bulletin 407-05-70, issued on 10 November 2005 for the same purpose, though on that occasion no Airworthiness Directive had been issued.

3.2. Causes

The accident occurred when the pilot lost control of the aircraft due to the piston in the left hydraulic servo that controls the cyclic pitch being locked in the extended position. This malfunction was caused by the gradual misadjustment of the mechanism that controls the movement of the servo, itself resulting from its components not being properly locked in place due to a failure to comply with Service Bulletin ABS 407-05-70.

4. SAFETY RECOMMENDATIONS

REC 12/14. It is recommended that HR Textron review and enhance its production and control systems so as to ensure the quality of its products.

REC 13/14. It is recommended that Bell Helicopter enhance its Quality System and adapt its control systems so as to ensure the quality of the products provided by its suppliers.

REC 14/14. It is recommended that Transport Canada establish the measures needed to ensure that the procedures used by Bell Helicopter guarantee the total quality control of its products.

REC 15/14. It is recommended that Transport Canada review its evaluation and assessment criteria for determining when to issue Airworthiness Directives.

APPENDICES

APPENDIX I

Flight Manual. BHT-407-FM-1. Section 3.
Emergency maneuvers.
Paragraph 3.6. Hydraulic System

3-5-B. FIXED PITCH FAILURES

This is a situation involving inability to change tail rotor thrust (blade angle) with anti-torque pedals.

- INDICATIONS:

  1. Lack of directional response.
  2. Locked pedals.

NOTE

If pedals cannot be moved with a moderate amount of force, do not attempt to apply a maximum effort, since a more serious malfunction could result. If helicopter is in a trimmed condition when malfunction occurs, TRQ and AIRSPEED should be noted and helicopter flown to a suitable landing area. Certain combinations of TRQ, NR, and AIRSPEED will correct a yaw attitude, and these combinations should be used to land helicopter.

- PROCEDURE:

NOTE

Pull pedal stop emergency release to ensure pedal stop is retracted.

3-5-B-1. HOVERING

Do not close throttle unless a severe right yaw occurs. If pedals lock in any position at a hover, landing from a hover can be accomplished with greater safety under power-controlled flight rather than by closing throttle and entering autorotation.

3-5-B-2. IN-FLIGHT — LEFT PEDAL APPLIED

In a high power condition, helicopter will yaw to left when power is reduced. Power and AIRSPEED should be adjusted to a value where a comfortable yaw angle can be maintained. If AIRSPEED is increased, vertical fin will become more effective and an increased left yaw attitude will develop. To accomplish landing, establish a power-on approach with sufficiently low AIRSPEED (zero if necessary) to attain a rate of descent with a comfortable sideslip angle. (A decrease in NP decreases tail rotor thrust.) As collective is increased just before touchdown, left yaw will be reduced.

3-5-B-3. IN-FLIGHT — RIGHT PEDAL APPLIED

In cruise flight or reduced power situation, helicopter will yaw to right when power is increased. A low power, run-on type landing will be necessary by gradually reducing throttle to maintain heading while adding collective to cushion landing. If right yaw becomes excessive, close throttle completely.

3-6. HYDRAULIC SYSTEM

3-6-A. LOSS OF HYDRAULIC PRESSURE

- INDICATIONS:

  1. HYDRAULIC SYSTEM caution light illuminated.
  2. Grinding or howling noise from pump.
  3. Increase in force required to move flight controls.
  4. Feedback forces may be evident during flight control movement.

- PROCEDURE:

  1. Reduce AIRSPEED to 70 to 100 KIAS.
  2. HYD SYSTEM circuit breaker — Out. If hydraulic power is not restored, push breaker in.
  3. HYD SYS switch — HYD SYS; OFF if hydraulic power is not restored.

4. For extended flight set comfortable AIRSPEED, up to 120 KIAS, to minimize control forces.

5. Land as soon as practical.

6. A run-on landing at effective translational lift speed (approximately 15 knots) is recommended.

3-6-B. FLIGHT CONTROL ACTUATOR MALFUNCTION

An actuator hardover can occur in any flight control axis, but a cyclic cam jam will only occur in the fore and aft axis. An actuator hardover is manifested by uncommanded movements of one or two flight controls. If two controls move, the pilot will find one of these controls will require a higher than normal control force to oppose the movement. This force cannot be "trimmed" to zero without turning the HYD SYS switch OFF. Once the hydraulic boost is OFF, the forces on the affected flight control will be similar to the "normal" hydraulic off forces.

- INDICATIONS:

1. Uncommanded flight control movements.
2. High flight control forces to oppose movement in one axis.
3. Feedback forces only in affected flight control axis.
4. Flight control forces normal in unaffected axis.

- PROCEDURE:

1. Attitude — Maintain.
2. HYD SYS switch — OFF.
3. AIRSPEED — Set to 70 to 100 KIAS.
4. Land as soon as possible using procedure from paragraph 3-6-A.

3-7. ELECTRICAL SYSTEM

3-7-A. GENERATOR FAILURE

- INDICATIONS:

1. GEN FAIL caution light illuminated.
2. AMPS indicates 0.
3. Voltmeter — Approximately 24 volts.

- PROCEDURE:

1. GENERATOR FIELD and GENERATOR RESET circuit breakers — Check in.
2. GEN switch — RESET; then GEN.
3. If power is not restored, place GEN switch to OFF; land as soon as practical.

NOTE

With generator OFF, a fully charged battery will provide approximately 21 minutes of power for basic helicopter and one VHF COMM radio (35 minutes with optional 28 ampere/hour battery).

3-7-B. EXCESSIVE ELECTRICAL LOAD

- INDICATIONS:

1. AMPS indicates excessive load.
2. Smoke or fumes.

- PROCEDURE:

1. GEN switch — OFF.
2. BATT switch — OFF.
3. FUEL BOOST/XFR LEFT circuit breaker switch — LEFT (on).

APPENDIX II
Airworthiness Directive CF-2011-17 of 30 June 2011 issued by Transport Canada

Transport Canada / Transports Canada

TP 7245E

No.	1/2
CF-2011-17	
Issue Date: 30 June 2011	

AIRWORTHINESS DIRECTIVE

URGENT URGENT URGENT URGENT URGENT URGENT URGENT URGENT URGENT

TRANSPORT CANADA EMERGENCY AIRWORTHINESS DIRECTIVE
PLEASE FORWARD IMMEDIATELY TO THE PERSON RESPONSIBLE FOR THE OPERATION AND MAINTENANCE OF YOUR AIRCRAFT

Number: CF- 2011-17

Subject: Incorrect Assembly of Hydraulic Servo Actuators

Effective: 30 June 2011

Applicability: **Bell Helicopter Textron Canada (BHTC) helicopters:**
Model 407, serial numbers 53000 through 53900, 53911 through 53999 and 54000 through 54070
Model 427, serial numbers 56001 through 56077, 58001 and 58002

Compliance: **As indicated below.**

Background: Transport Canada was advised that a quality escape by a supplier has occurred and a number of Bell Helicopter hydraulic servo actuators may have a loose nut, shaft, and clevis assembly. The loose connection is due to improper lock washer installation. This discrepancy is not traceable or identifiable except by inspection. A disconnect of the affected components may lead to loss of control of the helicopter.

This directive mandates inspections and rectification of the nut, shaft and clevis assembly for all affected components.

Corrective Actions:

A. Upon receipt of this directive and prior to next flight, identify the applicable Bell Alert Service Bulletin (ASB) listed below and determine the helicopter hydraulic servo actuator part number and serial number in accordance with the applicable accomplishment instructions in Steps 1 and 2 of the ASB listed below.

Helicopter Model	Alert Service Bulletin	Date
407	407-11-96	29 June 2011
427	427-11-35	29 June 2011

Pursuant to **CAR 202.51** the registered owner of a Canadian aircraft shall, within seven days, notify the Minister in writing of any change of his or her name or address.

To request a change of address, contact the **Civil Aviation Communications Centre (AARC)** at **Place de Ville, Ottawa, Ontario K1A 0N8**, or **1-800-305-2059**, or **www.tc.gc.ca/civilaviation/communications/centre/ address.asp**

24-0022 (01-2005)

Canada

No. Nº	CF-2011-17	2/2

B. If the part number and serial number determined from paragraph A are listed in Table 1 of the above-mentioned ASB, then *prior to next flight*, perform inspections in accordance with the accomplishment instructions in Step 3 of the ASB.

C. If the part number and serial number determined from paragraph A are not listed in paragraph B, but are listed below, then *within 25 hours air time from the effective date of this directive, but no later than 31 July 2011*, inspect in accordance with the accomplishment instructions in Step 3 of the above-mentioned ASB.

Helicopter Model	Part number	Serial number
407	41011300-101 (BHT 206-076-062-105) ✓	Prior to 807
	41011400-101 (BHT 206-076-062-107) ✓	Prior to 2248
427	41011300-101 (BHT 206-076-062-111)	Prior to 807
	41011700-101 (BHT 206-076-062-109)	Prior to 230

D. If the part number and serial number are not listed in paragraphs A or B of this directive, no further action is required.

E. Any spare parts with part numbers and serial numbers as identified in paragraph B or C must have completed inspections in accordance with the accomplishment instructions in Step 3 of the applicable above-mentioned ASB prior to installation on a helicopter.

Authorization: For the Minister of Transport, Infrastructure and Communities

ORIGINAL SIGNED BY

Derek Ferguson
Chief, Continuing Airworthiness

Contact: Ms. Yosha Mendis, Continuing Airworthiness, Ottawa, telephone 613-952-4357, facsimile 613-996-9178 or e-mail CAWWEBFeedback@tc.gc.ca or any Transport Canada Centre.

APPENDIX III

Emergency Airworthiness Directive 2011-15-51 of 8 July 2011 issued by the Federal Aviation Administration (FAA)

FAA
Aviation Safety

EMERGENCY AIRWORTHINESS DIRECTIVE

www.faa.gov/aircraft/safety/alerts/

DATE: July 8, 2011
AD #: 2011-15-51

Send to all U.S. owners and operators of Bell Helicopter Textron Canada (Bell) Model 407 and 427 helicopters.

This Emergency Airworthiness Directive (AD) is prompted by a report that a quality escape by a supplier has occurred and certain hydraulic servo actuators (servo) may have a loose nut, shaft, and clevis assembly due to improper lock-washer installation. An investigation after an accident revealed the clevis nut on the servo was loose. This condition, if not detected, could lead to a malfunction of a servo in the flight control system and subsequent loss of control of the helicopter.

We have reviewed Bell Alert Service Bulletin (ASB) 407-11-96 and 427-11-35, both dated June 29, 2011, which specify the part numbers and serial numbers of the affected servos and refer to ASB 407-05-70, Revision A, dated November 10, 2005; ASB 427-05-12, Revision A, dated November 14, 2005; with HR Textron Service Bulletin (SB) 41011300-67-01, Revision 2, dated November 9, 2005; HR Textron SB 41011400-67-01, Revision 2, dated November 9, 2005; and HR Textron SB 41011700-67-01, Revision 2, dated November 9, 2005, attached. The ASBs also specify reidentifying the servos with a "67-01" on the modification plate indicating the inspection procedures were followed.

Transport Canada, the airworthiness authority for Canada, notified the FAA that an unsafe condition may exist on these helicopter models. Transport Canada advises that a quality escape by a supplier has occurred, and a number of servos may have a loose nut, shaft, and clevis assembly. Transport Canada states in its AD that the loose connection is due to improper lock washer installation, which is not traceable or identifiable except by inspection. The authority also states a disconnect of the affected parts may lead to loss of control of the helicopter. Transport Canada classified the ASBs as mandatory and issued AD No. CF-2011-17, dated June 30, 2011, to ensure the continued airworthiness of these helicopters.

These helicopters have been approved by the aviation authority of Canada and are approved for operation in the United States. Pursuant to our bilateral agreement, Canada has notified us of the unsafe condition described in the AD. We are issuing this AD because we evaluated all information provided by Canada and determined the unsafe condition exists and is likely to exist or develop on other helicopters of these same type designs. Therefore, this AD requires before further flight for certain affected servos and within 25 hours time-in-service for certain other affected servos, identified by a serial number, retracting the boot and inspecting the servo as follows:

- Applying only hand pressure, determining whether the nut, shaft, or clevis assembly turns independently. If the shaft turns independently of the nut or the clevis assembly, before further flight, replacing the servo with an airworthy servo.

1

• If the shaft does not turn independently, inspecting to determine whether at least one tab of a lock washer is bent flush against a flat surface of the nut and at least one tab of the lock washer is bent flush against a flat surface of the clevis assembly.

• If at least one lock washer tab is not aligned and bent flush with a flat surface of the nut and at least one lock washer tab is not aligned and bent flush with a flat surface of the clevis assembly, before further flight, replacing the servo with an airworthy servo.

• If any tab of the lock washer is not bent flush against either a flat surface of the nut or clevis assembly, bending the tab flush against a flat surface.

• Reidentifying the servo by metal-impression stamping or by vibro etching "67.01" onto the modification plate.

• Before installing a servo with a P/N and S/N identified in this AD, not identified by "67-01" on the modification plate, inspecting it by following the requirements of this AD.

The actions must be done by following specified portions of the alert service bulletins described previously.

This AD differs from Transport Canada AD in that we do not require that the servo be returned to the manufacturer. Also, we do not limit the applicability to specific serial-numbered helicopters. We have specified the inspection requirements rather than referring to the applicable service bulletins. The AD requires that the servo be replaced before further flight, and the Transport Canada AD refers to the ASB, which requires that the servo be replaced within 300 hours time-in-service.

This rule is issued under 49 U.S.C. Section 44701 pursuant to the authority delegated to me by the Administrator, and is effective immediately upon receipt of this emergency AD.

2011-15-51 BELL HELICOPTER TEXTRON CANADA: Directorate Identifier 2011-SW-038-AD.

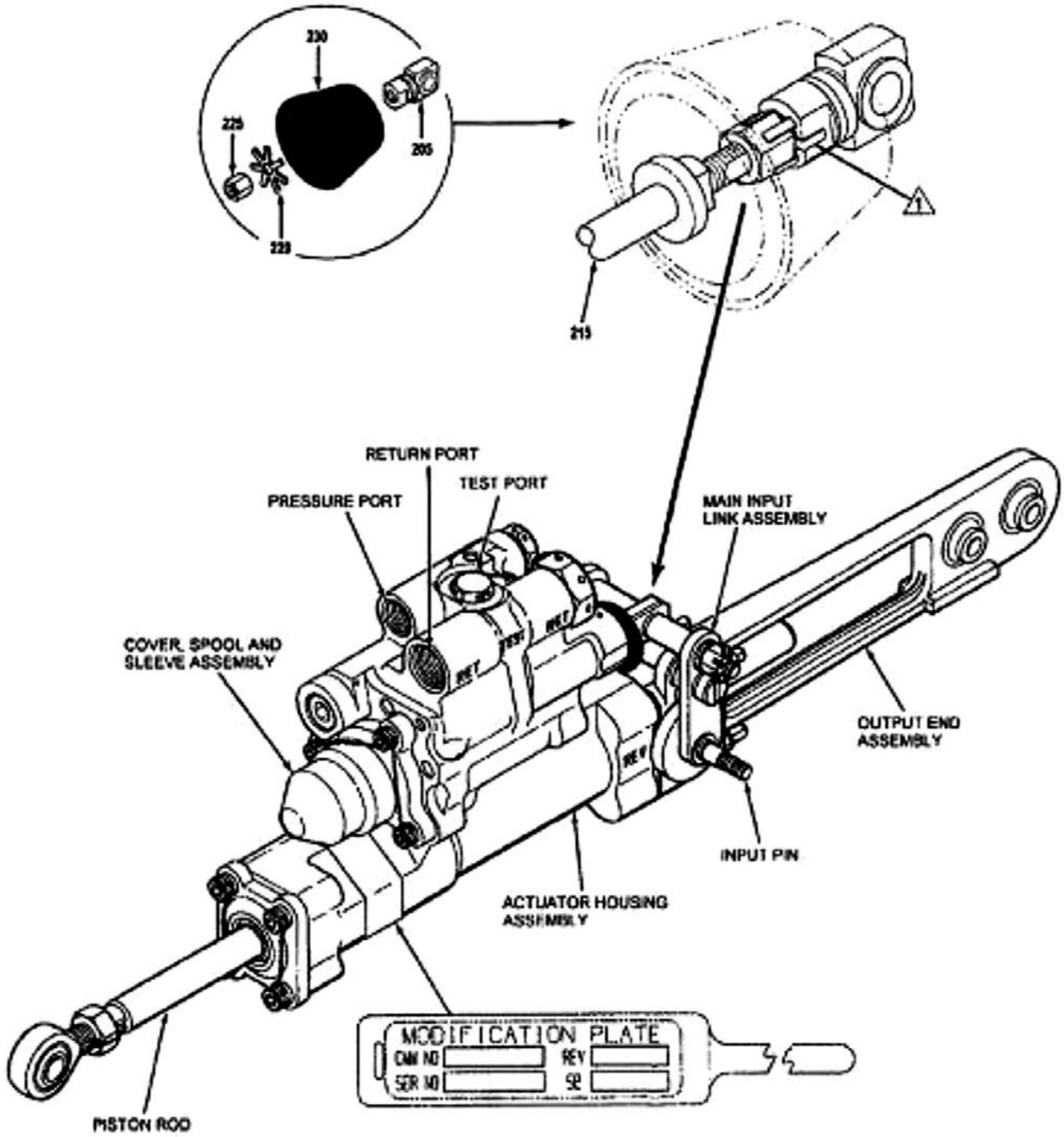
Applicability: Model 407 helicopters with a hydraulic servo actuator assembly (servo), part number (P/N) 206-076-062-105, or -107 and Model 427 helicopters, with servo, P/N 206-076-062-109 or -111, installed, certificated in any category.

Compliance: Required as indicated, unless accomplished previously.

To detect loose or misaligned parts of the servo that could lead to failure of the servo and subsequent loss of control of the helicopter, do the following:

(a) Before further flight, for those helicopters with a servo serial number (S/N) on the modification plate listed in Table 1 of Bell Alert Service Bulletin (ASB) No. 407-11-96, dated June 29, 2011, for the Model 407 helicopters or Table 1 of ASB 427-11-35, dated June 29, 2011, for the Model 427 helicopters, do the following:

(1) Retract the boot depicted as "230" in Figure 1 of this AD:



NOTE:

⚠1 <u>ACCEPTABLE CONDITION</u>
A MINIMUM OF ONE TAB SHALL BE IN LINE AND BENT FLUSH WITH THE NUT FLAT SURFACE AND A MINIMUM OF ONE TAB SHALL BE IN LINE AND BENT FLUSH WITH THE CLEVIS ASSEMBLY FLAT SURFACE

Clevis Assembly
Figure 1

Legend:
205 Clevis Assembly
215 Shaft
225 Nut
220 Lock Washer
230 Boot

3

Note 1. Bell ASB 427-05-12, Revision A, dated November 14, 2005; HR Textron SBs 41011300-67-01, 41011400-67-01, and 41011700-67-01, all Revision 2, all dated November 9, 2005, which are not incorporated by reference, contain information pertaining to the subject of this AD.

(2) Applying only hand pressure, determine whether the nut, shaft, or clevis assembly, depicted as "225," "215," and "205," respectively, in Figure 1 of this AD, turns independently. If the shaft turns independently of the nut or the clevis assembly, before further flight, replace the servo with an airworthy servo.

(3) If the shaft does not turn independently, inspect to determine whether at least one tab of the lock washer is bent flush against a flat surface of the nut and at least one tab of the lock washer is bent flush against a flat surface of the clevis assembly.

(i) If at least one lock washer tab is not aligned and bent flush with a nut flat surface and at least one lock washer tab is not aligned and bent flush with a flat surface of the clevis assembly, before further flight, replace the servo with an airworthy servo.

(ii) If any tab of the lock washer is not bent flush against either a flat surface of the nut or clevis assembly, bend the tab flush against a flat surface.

(4) After accomplishing paragraph (a)(1) through (a)(3) of this AD, reidentify the servo by metal-impression stamping or by vibro etching "67-01" onto the modification plate.

(b) For those servo P/Ns with a S/N less than the S/Ns listed in the following Table A of this AD but NOT specifically included in the list of S/Ns in Table 1 referenced in paragraph (a) of this AD, within 25 hours time-in-service, inspect the nut, shaft, and clevis assembly and accomplish the requirements of paragraphs (a)(1) through (a)(4) of this AD.

Table A

Helicopter Model	Servo P/N	Servo Prefix "HR," S/N
407	41011300-101 (BHT 206-076-062-105)	Less than 807
	41011400-101 (BHT 206-076-062-107)	Less than 2248
427	41011300-101 (BHT 206-076-062-111)	Less than 807
	41011700-101 (BHT 206-076-062-109)	Less than 230

(c) Before installing a servo with a P/N and S/N identified in paragraphs (a) or (b) of this AD, not identified by "67-01" on the modification plate, inspect the servo by following the requirements of this AD.

(d) To request a different method of compliance or a different compliance time for this AD, follow the procedures in 14 CFR 39.19. Contact the Manager, Safety Management Group, FAA, ATTN: Matt Wilbanks, Aviation Safety Engineer, 2601 Meacham Blvd, Fort Worth, Texas 76137, telephone (817) 222-5051, fax (817) 222-5961, for information about previously approved alternative methods of compliance.

(e) The Joint Aircraft System/Component (JASC) Code is: 6730: Rotorcraft Servo System.

4

(f) Copies of the applicable service information may be obtained from Bell Helicopter Textron Canada Limited, 12,800 Rue de l'Avenir, Mirabel, Quebec J7J1R4, telephone (450) 437-2862 or (800) 363-8023, fax (450) 433-0272, or at http://www.bellcustomer.com/files/.

(g) Emergency AD 2011-15-51, issued July 8, 2011, becomes effective upon receipt.

Note 2: The subject of this AD is addressed in Transport Canada AD CF-2011-17, dated June 30, 2011.

FOR FURTHER INFORMATION CONTACT: Matt Wilbanks, Aviation Safety Engineer, 2601 Meacham Blvd, Fort Worth, Texas 76137, telephone (817) 222-5051, fax (817) 222-5961.

Issued in Fort Worth, Texas, on July 8, 2011.

Kim Smith,
Manager, Rotorcraft Directorate,
Aircraft Certification Service.

APPENDIX IV
Alert Service Bulletin 407-05-70 of 10 November 2005 issued by Bell Helicopter TEXTRON

ALERT SERVICE BULLETIN
REVISION NOTICE
Bell Helicopter TEXTRON
A Subsidiary of Textron Inc.

DATE Nov 10, 2005

TO: **All Owners/Operators of Bell 407 Helicopters**

SUBJECT: **REVISION "A" TO ALERT SERVICE BULLETIN 407-05-70: CLEVIS ASSEMBLY – HYDRAULIC SERVO ASSEMBLY, PART NUMBER 41011300 AND 41011400**

Revision "A" to this Alert Service Bulletin introduces the rewritten Hydraulic Research Textron Bulletins. Included in the rewritten bulletins are the following changes:

- The HR Textron Customer Service telephone number phone number, is added in Section 1, Step F.
- The compliance in Section 2, Step A, is changed.
- The inspection criteria are clarified in Section 2.
- HR Textron-Authorized Service Centers telephone and fax number are added in Table 1.
- A better graphic view of the proper installation is shown in Figure 1.

AN APPROPRIATE ENTRY SHOULD BE MADE IN THE AIRCRAFT LOGBOOK UPON ACCOMPLISHMENT
IF OWNERSHIP OF AIRCRAFT HAS CHANGED PLEASE FORWARD TO NEW OWNER

ALERT SERVICE BULLETIN

Bell Helicopter TEXTRON

A Subsidiary of Textron Inc.

DATE	Nov 10, 2005
REV	A

NO.	407-05-70
DATE	Oct 17, 2005
PAGE	1 of 1

MODEL AFFECTED: **407**

SUBJECT: **CLEVIS ASSEMBLY – HYDRAULIC SERVO ASSEMBLIES, PART NUMBER 41011300 and 41011400**

HELICOPTERS AFFECTED: **Bell 407 helicopters serial number 53000 through 53665.** 53831

[Bell 407 helicopters serial number 53666 and subsequent will have the intent of this bulletin accomplished prior to delivery.]

COMPLIANCE: See vendor Bulletins.

DESCRIPTION:

The purpose of this bulletin is to achieve complete distribution of the attached vendor bulletin to the current affected model distribution list on record by Bell Helicopter.

APPROVAL:

See vendor bulletin approval.

AN APPROPRIATE ENTRY SHOULD BE MADE IN THE AIRCRAFT LOGBOOK UPON ACCOMPLISHMENT
IF OWNERSHIP OF AIRCRAFT HAS CHANGED PLEASE FORWARD TO NEW OWNER

HR TEXTRON

Boletín del suministrador

SERVICE BULLETIN

CLEVIS ASSEMBLY – HYDRAULIC SERVOACTUATOR, PART NUMBER 41011400

1. Planning Information

A. Effectivity

This service bulletin applies to the clevis assembly, P/N 41009477-101, used on the hydraulic servo assembly, HR part number 41011400-101 (BHT 206-076-062-107). The intent of this service bulletin has been incorporated into these servo actuators with serial numbers 2248 and subsequent.

B. Reason

HR has discovered the possibility that the shaft (215) (refer to Figure 1) could be loose. The looseness is as a result of lock washer tabs (220), improperly bent over the flat surface of the nut (225) or the flat surface of the clevis assembly (205).

C. Description

This service bulletin defines mandatory inspection of nut, shaft and, clevis assembly for possible looseness as result of improper lock washer installation. This discrepancy is not traceable or identifiable except by inspection. This inspection is applicable to servos identified in paragraph 1.A.of this bulletin.

D. Approval

HR Textron Engineering.

E. Manpower

Approximately 2.0 man-hour, are required to remove and reinstall each hydraulic servo actuator and approximately 0.5 man-hour is sufficient to conduct visual inspection.

F. Material Price and Availability

Prior to returning any servo to service center, contact HR Textron Customer Service and Field Service Manager at: 25200 West Rye Canyon Road, Santa Clarita, CA 91355-1265; 661-702-5509, or 661-702-5358 (tel. numbers) mhowell@hrtextron.Textron.com (email); or 661-702-5970 (fax). Provide HR Textron with the part number, serial number, time since new for new servo and in addition time since overhauled or repaired and the facility if the servo was recently overhauled or repaired. This applies to servos that are found with loose nut, shaft or clevis assembly or improperly installed lock washer only. Warranty claims will be handled on a case-by-case basis.

G. Tooling Price and Availability

New tools are not required.

HR TEXTRON

SERVICE BULLETIN

H. Weight and Balance

Not affected.

I. Electrical Load Data

Not affected.

J. References

67-31-09 Component Maintenance Manual with Illustrated Parts List (for) Hydraulic Servo Actuator Assembly part number 41011400-101 (BHT 206-076-062-107).

K. Other Publications Affected

The intent of this service bulletin will be incorporated into the next revision of 67-31-09.

2. <u>Accomplishment Instructions</u>

A. Within the next 10 flight hours or before December 15, 2005, whichever comes first, accomplish this one-time mandatory inspection.

B. Retract the boot (230) and perform the following inspections:

1. Applying hand pressure only, and check if the nut, the shaft or the clevis assembly is turning independently from one another.

2. If the shaft will turn independently to the nut or the clevis assembly, prior to the next flight, the actuator shall be removed from service and forwarded to HR Textron or one of the HR Textron Service Centers listed in Table 1. Check step 1.F. for condition.

3. If the shaft is not turning independently from the nut or the clevis assembly proceed with step 2.B.4.

4. Check if at least one tab of the lock washer is bent flush against one of the nut flat surface and if at least one tab of the lock washer is bent flush against one of the two flat surfaces of the clevis assembly. Lock washer tab must also be in line with the flat surface of the nut and clevis assembly. If the lock washer tabs are not bent flush against the nut and clevis assembly or are not in line with the flats, proceed with the following steps.

5. If the lock washer tabs are not bent flush against the nut or clevis assembly flat surface, use needle-nosed pliers and make sure the lock washer tab is flush against nut or the flat surface of the clevis assembly.

25200 W. Rye Canyon Road • Santa Clarita, California 91355-1265 • 661/294-6000 • FAX 661/259-9622

HR TEXTRON

SERVICE BULLETIN

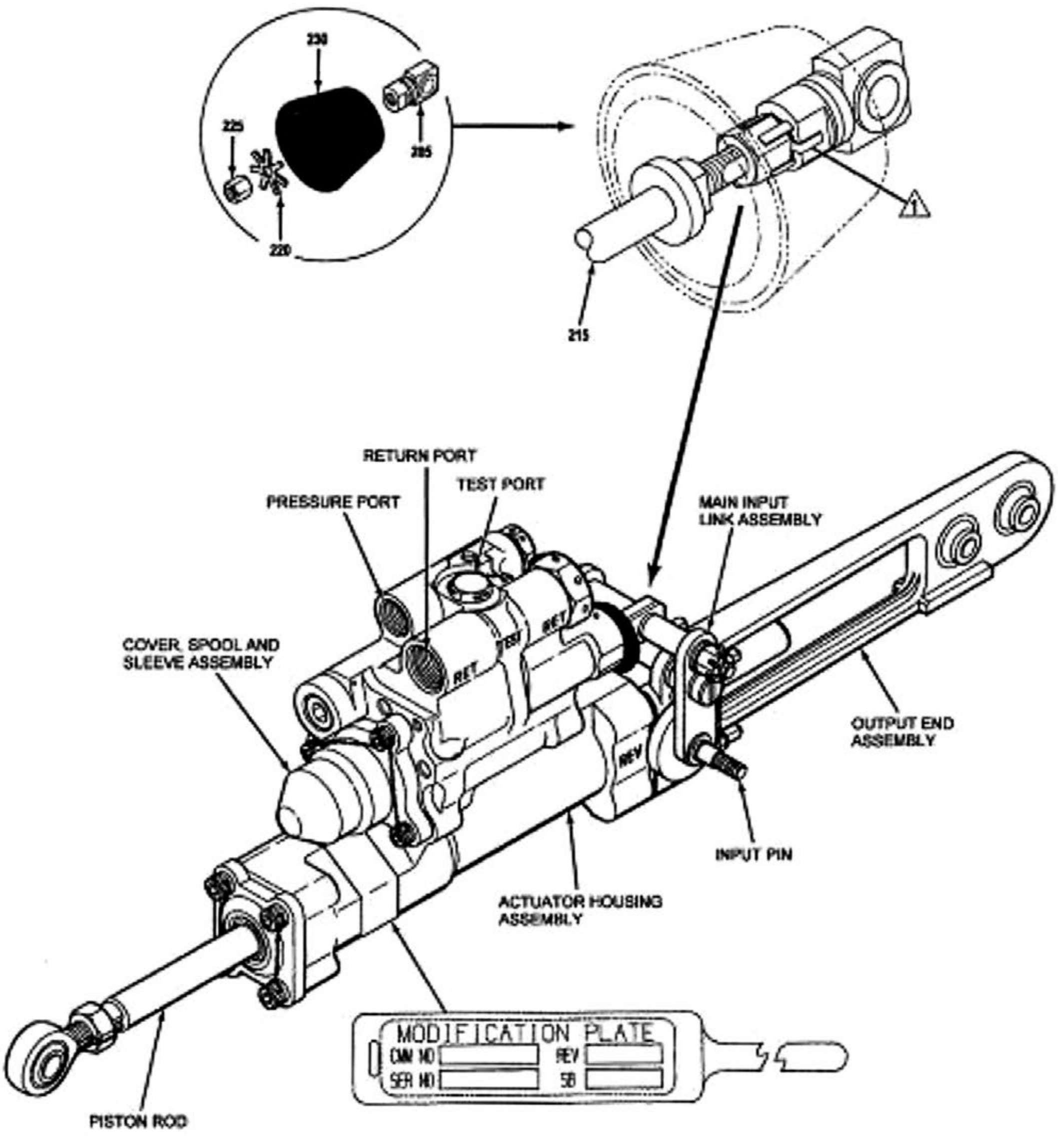
6. If the lock washer tab is on the edge or not aligned with a flat surface (nut or clevis assembly). Within the next 300 hours, but not later than April 30, 2006, the actuator shall be removed from service and forwarded to HR Textron or one of the HR Textron Service Centers listed in Table 1. Check step 1.F. for condition.

C. If the servo meets all the requirements of the inspection or if the operator can accomplish the corrective action, the operator may perform the necessary corrective repairs. Remove modification plate from servo and metal-impression stamp or vibro-etch an abbreviated service bulletin number (67-01) on modification plate to identify compliance with this service bulletin. Modification plates are available; HR Textron will provide replacement modification plates if necessary. Corrective action accomplished by HR Textron or approved repair station will have the same identification added to modification plate.

Table 1. HR Textron-Authorized Service Centers

AEM Ltd 8 Wilton Road Haine Industrial Estate Ramsgate, Kent CT12 5HE (England) Tel; 001-(44)-1-843-591-381 Fax; 011-(44)-1-843-592-641	**Helicopter Support Inc.** 116 Quarry Road Trumbull, CT 06611 (USA) Tel; (203) 416-4300 Fax; (203) 416-4282
Stansted Airport Stansted, Essex CM24 1RB (England) Tel; 011-(44)-1-279-680-030 Fax; 011-(44)-1-279-680-040	**JAMCO Corp** 6-11-25 Osawa Mitaka Tokyo 181 (Japan) Tel; 011-(81) 422-31-6111 Fax; 011 (81) 422-32-6998
HASE Helicopter Accessory Service Inc. East 10102 Aileron Avenue Pensacola, FL 32506 (USA) Tel; (850) 456-8339 Fax; (850) 456-5117	**Motorflug GmbH** Baden-Airpark Gebaude C-312 D-77836 Rheinmunster, Germany Tel; 011 (49) 7229-301-430 Fax; 011 (49) 7229-301-433
HAS West Helicopter Accessory Service Inc. West 10985 Penrose Street Sun Valley, CA 91352 (USA) Tel; (818) 767-2214 Fax; (818) 767-2699	**Ostermans Aero AB** Box 116 SE-190 46 Stockholm-Arlanda Sweden Tel; 011-(46)-8-593-787-00 Fax; 011-(46)-8-593-787-90
HELITRADES 18 Terry Fox Drive Vanleek Hill, Ontario, Canada K0B 1R0 Tel; (613) 678-3027 Fax; (613) 678-2776	**HELITRADES** Site 5, Box 7, RR 2 Airdrie Airport Airdrie, Canada K0B 1R0 Tel; (403) 912-4658 Fax; (403) 948-6475

HR TEXTRON



NOTE:

⚠1 ACCEPTABLE CONDITION
A MINIMUM OF ONE TAB SHALL BE IN LINE AND BENT FLUSH WITH THE NUT FLAT SURFACE AND A MINIMUM OF ONE TAB SHALL BE IN LINE AND BENT FLUSH WITH THE CLEVIS ASSEMBLY FLAT SURFACE

Clevis Assembly
Figure 1

November 9, 2005 | 41011400-67-01
Revision 2 | Page 4 of 4

25200 W. Rye Canyon Road • Santa Clarita, California 91355-1265 • 661/294-6000 • FAX 661/259-9622