DATA SUMMARY

LOCATION

Date and time	**23 February 2008 at approximately 21:10**[1]
Site	**Playa de San Jorge (Ferrol - A Coruña)**

AIRCRAFT

Registration	**EC-FVO**
Type and model	**SIKORSKY S-61N**
Operator	**INAER HELICÓPTEROS OFF-SHORE**

Engines	N.º 1	N.º 2
Type and model	**General Electric CT58-140-2L**	**General Electric CT58-140-2**
Serial Number	**295-261C**	**295-051C**

CREW

	Pilot in command	Copilot
Age	**54 years old**	**39 years old**
Licence	**CPL(H)**	**ATPL(H)**
Total flight hours	**6,260 h**	**3,930 h**
Flight hours on the type	**1,722 h**	**125 h**

INJURIES	Fatal	Serious	Minor/None
Crew			**6**
Passengers			
Third persons			

DAMAGE

Aircraft	**None**
Third parties	**None**

FLIGHT DATA

Operation	**Aerial Work – Commercial – Search and rescue**
Phase of flight	**Maneuvering – Hovering out of ground effect – Rescue with external hoist**

REPORT

Date of approval	**19th September 2012**

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

1. FACTUAL INFORMATION

1.1. History of the flight

On 23 February 2008, a SIKORSKY S-61N helicopter, registration EC-FVO, based at the A Coruña Airport as the "Helimer Galicia", was dispatched at 20:14 to take part in the search for a body that had been sighted floating in the vicinity of the south part of the Playa de San Jorge (San Jorge Beach, Ferrol, A Coruña).

The helicopter took off at 20:20 and reached the area 20 minutes later to join the search and rescue efforts. Barely five minutes after its arrival its crew was informed that a crewmember from a Civil Guard patrol boat had fallen into the water.

At around 21:00, the crew of the helicopter spotted said crewmember some 150 m away from the beach and made preparations to rescue him. The atmospheric conditions were suitable for the operation and the sea seemed calm, though there was a strong swell.

A rescue swimmer lowered on the helicopter's external hoist managed to reach the crewmember that had fallen from the patrol boat. He secured him to the cable and gave the signal to be raised. During this maneuver, with the cable tense and both men still in the water, they were struck by a wave that broke the hoist cable, leaving them both in the water. It was approximately 21:20.

The crewmember that had fallen from the patrol boat disappeared. The rescue swimmer was spotted from the helicopter and guided toward the shore, from where he was raised using an internal hoist onboard. The helicopter continued to take part in search and rescue activities and returned to the A Coruña Airport at 22:55.

Search efforts continued all night and the body of the crewmember who had fallen from the patrol boat was found the next day, 24 February 2008, at 10:15.

Over the course of the same search operation, another crewmember from the same patrol boat and two from another vessel also fell into the water and swam ashore.

1.2. Personnel information

The helicopter crew consisted of two pilots, two rescue swimmers and two hoist operators. Although the minimum crew required for rescue operations with an external hoist consists of only one hoist operator, a second operator was onboard doing training.

The pilot in command of the helicopter had a JAR-FCL commercial pilot license –CPL(H)– issued in Spain on 15/03/1988 and valid until 22/07/2010. He had SIKORSKY 61 and instrument –IR(H)– ratings valid until 21/07/2008 and a class 1 medical certificate valid until 23/06/2008.

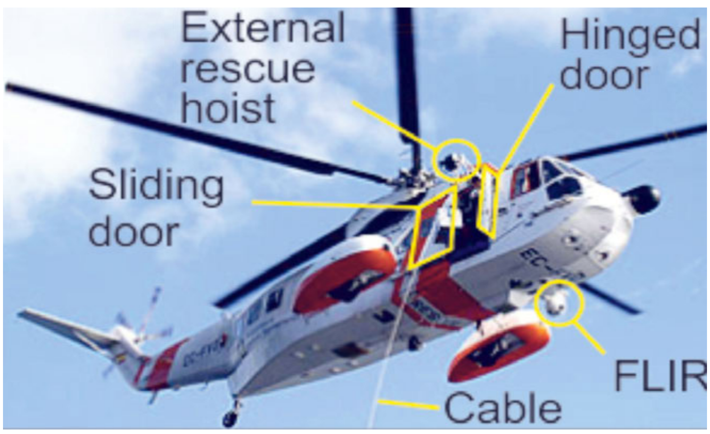
The helicopter copilot had a JAR-FCL helicopter airline transport pilot license –ATPL(H)– issued in Portugal on 07/02/2008 and valid until 07/02/2013. He had SIKORSKY 61 and instrument –IR(H)– ratings valid until 03/03/2008, Aerospatiale SA365/365N and multiengine –ME(H)– ratings valid until 31/01/2009, a Robinson 22 rating valid until 24/05/2008 and a flight instructor rating –FI(H)– valid until 24/05/2009. He also had a valid class 1 medical certificate valid until 01/09/2008.

The rest of the crew satisfied the requirements specified in the operator's Operations Manual to engage in rescue operations with an external hoist. The hoist operator under instruction was training as per the requirements of the corresponding training program.

1.3. Aircraft information

The SIKORSKY S-61N helicopter model, certified in the US by the FAA in 1962, is a civilian version of the SH-3 "Sea King" ASW (anti-submarine warfare) military helicopter developed by Sikorsky in the late 1950s.

It is an amphibious helicopter with a watertight hull and sponsons to provide stability in the water such that it can land on and take off from water. The main landing gear is retractable and its legs are housed in the sponsons. It is designed to transport personnel (up to 30 passengers) and cargo, the latter of which can be transported inside or externally hanging from a sling. Also, as in the case at hand, it can be outfitted with a hoist to raise people or cargo onboard while the helicopter is in the air. There is a cargo door on the right side that closes by means of a sliding hatch and a hinged door that opens forward, in the direction of motion. These features make the S-61N a widely used helicopter for transporting people and cargo between land and oil rigs at sea, for various types of aerial work and for search and rescue operations.



Photograph 1

It is outfitted with two General Electric CT58-140-2 engines, each capable of delivering a maximum continuous power of 1,267 CV (1,250 HP) and a maximum takeoff power of 1,420 CV (1,400 HP) to the shaft.

It has a conventional rotor configuration with a main and a tail rotor, both with five blades. They are driven by the engines through a transmission gear and are controlled by the helicopter's flight control systems.

1.3.1. *Airframe*

Manufacturer:	Sikorsky Aircraft Corporation
Model:	S-61N
Production number:	61756
Year of manufacture:	1975
Registration:	EC-FVO
Operator:	INAER HELICÓPTEROS OFF-SHORE

1.3.2. *Airworthiness certificate*

Number:	3,665
Type:	Normal
Category:	Large Rotorcraft
MTOW:	9,298.8 kg
Issue date:	20/02/2006
Renewal date:	02/02/2007
Expiration date:	01/03/2008

1.3.3. *Maintenance records*

At the time of the incident the helicopter had 27,565:40 total flight hours and 36,375 total cycles.

The table below lists the inspections specified in the maintenance program, their corresponding intervals and their completion status on the helicopter:

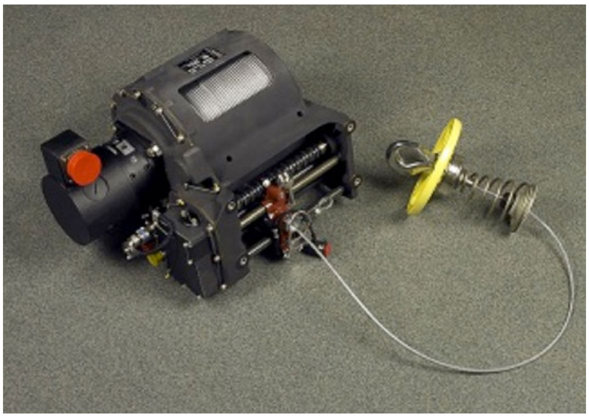
Inspection	Interval	Scheduled	
		Last	Next
1A (Areas 1, 2, 3, 4, 5)	40 (+5) hours[2]	27,555:00	27,595:00 (+5)
	30 days	12/02/2008	17/03/2008
2B (Area 1)	240 (+5) hours	27,422:20 10/08/2007	27,662:20 (+5)
2B (Area 3)		27,422:20 10/08/2007	27,662:20 (+5)
2B (Area 4)		27,422:20 10/08/2007	27,662:20 (+5)
2B (Area 5)		27,422:20 10/08/2007	27,662:20 (+5)
3B (Area 1)	720 (+5) hours	27,185:35 17/01/2007	27,905:35 (+5)
3B (Area 3)		27,185:35 17/01/2007	27,905:35 (+5)
C	2.400 (+40) hours	26,508:15	29,908:15 (+40)
	3.5 years	21/01/2008	21/07/2011
D	14,400 (+40) hours	24,307:50	38,707:50
	15 (+1) years	03/04/1997	03/04/2012

1.3.4. *Engines*

Manufacturer:	General Electric Company	
Position:	N.º 1	N.º 2
Model:	CT58-140-2L	CT58-140-2
Production number:	295-261C	295-051C
Installation date:	14/10/2003	08/05/2007
Total flight hours:	22,686:08 h	27,221:17 h
Last overhaul:	19,317:04 h	21,088:59 h
Remaining hours:	4,630:56 h	1,868:02 h

[2] The number in parentheses corresponds to the tolerance allowed by the Approved Maintenance Program for this aircraft.

1.3.5. *Rescue hoist*



Photograph 2

The helicopter was equipped with an electric rescue hoist manufactured by Goodrich Actuation Systems (formerly Lucas Air Equipment) and designed for operation onboard helicopters. It was certified to raise or lower people or cargo weighing up to 267 kg (600 lb) with the helicopter in a hover and at a maximum operating angle not to exceed 20° from the vertical.

The system consisted of a variable-speed electric hoist, an electronic control box and an actuator. The hoist, installed on the outside of the helicopter above the cargo door, allows up to 90 m of cable to be reeled out or in at a speed of between 0 and 0.75 meters/second.

The hoist uses a 94.5 m long galvanized steel cable consisting of 19 cords with 7 wires each and a nominal breaking load of 1,533 kg (3,380 lb). The first 4.5 m of cable on the reel are not usable and must not be unreeled under normal conditions. This section of cable is painted yellow for easy identification.

The table below shows the basic information for the hoist and cable installed on the helicopter at the time of the incident:

Manufacturer:	Goodrich Actuation Systems
Model:	76378-260-D
Serial number:	266
Installation date:	24/01/2008
Last overhaul:	14/09/2007
Total cycles:	2,117[3]
Cycles since last overhaul:	152 (the incident occurred on cycle 153)
Remaining cycles:	848 cycles

[3] In the CMM (Component Maintenance Manual) of the hoist, a cycle is defined as:
- in flight, a lower and raise motion, regardless of the length of cable unreeled or the load used, or
- on the ground, a lower motion equal to or greater than 5 meters plus an equivalent raise, regardless of the load used.

Date cable was installed: 14/09/2007

Cable remaining cycles: 348 cycles

The hoist maintenance program calls for inspections every 6 and 12 months and every 25 and 50 cycles. The time between overhaul is 10 years or 1,000 cycles, whichever comes first.

In this case, the 6-month inspection had been conducted on 30/01/2008 and the last 25+50-cycle inspection had been on 22/02/2008, the day before the incident, with 152 cycles.

The cable mounted on the hoist was from a batch that during the breaking strength test, conducted as part of manufacturing quality control, had broken at a load of 1,890 kg (4,171 lb). As far as the maintenance is concerned, after each mission flown by the helicopter, the cable has to be washed with fresh water and inspected for damage during the cleaning process. In this case, the cable had last been washed and inspected on the day before the incident with 152 cycles. The cable is limited to 500 cycles.

1.4. Medical and pathological information

The autopsy report on the body of the crewmember that fell from the patrol boat lists the cause of death as "mechanical asphyxia from submersion", the mechanism of death being "mechanical asphyxia from submersion with water penetration in the respiratory passages, followed by pulmonary edema resulting in respiratory failure and exitus".

1.5. Tests and research

1.5.1. *Analysis of the recording from the helicopter's FLIR camera*

The helicopter was equipped with an external FLIR (Forward-Looking Infrared) camera, located on the lower left side at the front of the fuselage. This camera can record images in the visual and infrared spectra and is operated by the rescue swimmer who stays onboard the helicopter, operations permitting.

In this case, the entire rescue operation was recorded, yielding 20:41 minutes of footage, the contents of which are described below. The time stamps are referenced from the start of the rescue operation.

Time stamp	Content
START	The rescue swimmer and the victim are in the water. The rescue swimmer is preparing the victim to be lifted to the helicopter. The victim is not wearing his life jacket properly.
01:10	The cable is seen attached to the final hook, which the rescue swimmer is holding.
01:26	The rescue swimmer gives the "up" signal (swings his right arm above his head several times).
01:36	The cable tenses and starts pulling them both up. They exit from view. Everything is dark and only the reflection from the helicopter's strobe light is visible.
01:39	There is a large surge of water and a lighted area appears, probably caused by the flashlight on the rescue swimmer's head or by the search light.
05:26	The camera housing is seen for a few seconds.
06:15	The scene goes dark.
11:00	The camera is properly oriented. The rescue swimmer is alone in the water and seems to be looking around while he is guided toward shore by the helicopter.
13:33	The rescue swimmer is close to shore. There is a strong undertow and he is impacted by several waves.
14:25	He starts walking backwards with his flippers on.
15:10	He removes his flippers and seems to look around.
16:48	He exits the water and runs into another person.
17:22	They separate and only the swimmer is visible.
17:55	The camera focuses out to sea. Everything is dark.
18:13	The camera focuses on the rescue swimmer again, who is now with another person.
18:16	The other person leaves.
18:35	The rescue swimmer signals the helicopter to lower the hoist cable.
18:55	The rescue swimmer takes the guide rope.
18:58	Another person appears.
19:13	The illumination is excessive and only the outlines of the people and the cable are distinguishable.
19:17	Another person appears (three total).
19:20	Another person appears (four total).
19:45	Another person appears (five total). (During this time, it appears that everyone is pulling on the cable).
19:56	The rescue swimmer gives the up signal and he is raised to the helicopter while someone on the ground holds the end of the guide rope.
20:31	The rescue swimmer exits the frame. A person on the ground is still visible.
20:36	The camera focuses on the water. Nothing is visible.
20:41	END OF RECORDING.

1.5.2. *Inspection of the aircraft*

Photograph 3

Photograph 4

The airport was inspected at the A Coruña Airport, where it was based.

The only evidence found of any relevance to the incident was the broken cable on the external hoist installed over the cargo door on the right side of the helicopter, and scratch marks and other imprints on the edges of the hinged door, some of which could have been produced by rubbing with the hoist cable.

As a result, these components were removed from the helicopter so they could be analyzed at a suitable facility. The two components were initially taken to the facilities of the Esteban Terradas National Institute for Aerospace Technology (INTA), in Torrejón de Ardoz (Madrid).

The initial analysis of the hoist was carried out at the Civil Guard's Helicopter Group facilities, located next to INTA, in Torrejón de Ardoz (Madrid). The second phase, involving an overall inspection of the hoist, was carried out at the facilities of the hoist manufacturer, Goodrich Actuation Systems, in France.

The analyses of the marks found on the hinged cargo door and of the broken hoist cable were conducted at INTA's Materials and Structures Department.

1.5.3. *Analysis of the hoist*

The analysis of the hoist was conducted in two phases:

1st First, the condition of the hoist was checked against the applicable documentation (documentary inspection). The hoist and cable were then inspected visually and the operation of the hoist was checked.

2nd The hoist was subjected to a general inspection.

1.5.3.1. Documentary and visual inspections and functional tests

The initial phase to study the hoist was conducted at the Civil Guard's Helicopter Group facilities, located next to INTA, in Torrejón de Ardoz (Madrid). This Group has hoists of the same type as the one analyzed, P/N 76378-200 instead of -260-D, for use on the BK-117 helicopter. The systems for both models have compatible electronic control boxes and wiring, which is why one of these helicopters was used to run the functional tests.

A specialist from Goodrich, the hoist manufacturer, was involved in this process, along with personnel from INTA, the Civil Guard's Helicopter Group, the operator of the incident helicopter and the CIAIAC.

1.5.3.1.1. *Documentary inspection*

The hoist's documentation was inspected. The manufacturer and operator provided the relevant documentation, which was confirmed to correspond to the correct hoist type. Everything was verified to be in order both with the hoist and the documentation.

1.5.3.1.2. *Visual inspection*

The hoist was inspected visually with the cable fully reeled in. The hoist was verified to be in very good condition, save for a loss of tension in the last few coils of cable and for the presence of marks on the inner surface of the cable entry guide. The components that so required it were verified to be greased and the factory seals were in place.

1.5.3.1.3. *Functional tests*

At the completion of these inspections, functional tests were conducted. This was done by connecting the hoist to the helicopter without physically installing it on the support mounts.

First, the slack cable was manually uncoiled and a piece of cable some 1.25 m long containing the end that broke in the incident was cut off for metallographic analysis. This also allowed the remaining cable end to pass through the cable entry guide on the hoist as in normal operations.

All of the usable cable was then uncoiled electrically up to the unusable part, painted in yellow. Throughout the process, carried out in accordance with the instructions in the corresponding CMM chapter, the hoist performed as expected, uncoiling the cable correctly. The entire length of cable was then extracted and measured, yielding an approximate length of 64.70 m, including the unusable part. Thus, not including the length of cable cut for analysis, the length of cable lost in the incident was estimated at 27.5 m (about 90 ft).

Finally the cable was reinstalled and the hoist adjusted. All of the electromechanical devices involved in automatically stopping the hoist, both when reeling cable in and out, were confirmed to be working correctly. The hoist properly reeled in the cable, also in accordance with the requirements in the relevant chapter in the CMM.

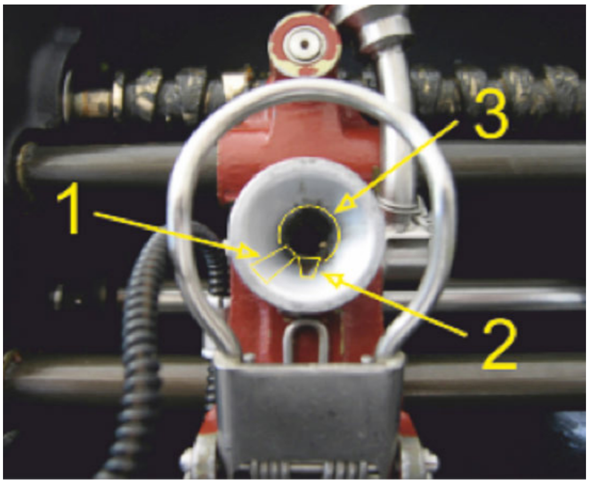
1.5.3.1.4. *Results of this phase*

As a result of the above, it was determined that:

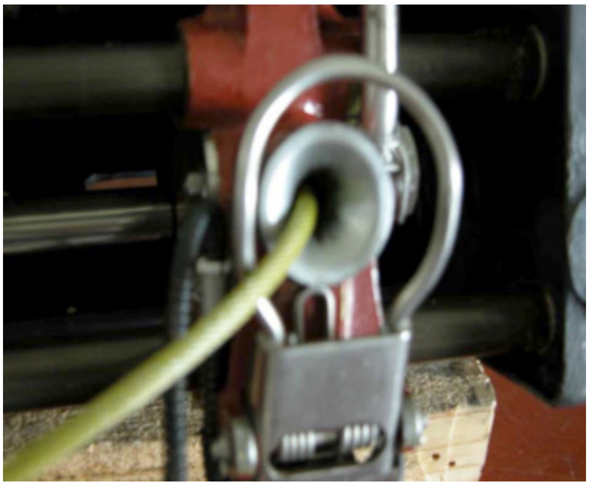
- All of the hoist's documentation was in order.
- The hoist was in good condition and working as specified in the applicable documentation.
- Based on the documentation supplied by the operator, its procedures specify a hover height above water of 70 ft when lifting people with the hoist. Since the approximate length of cable lost in the incident exceeded this length, it is very likely that the cable broke at the cable entry guide to the hoist.
- The marks shown in Photograph no. 6 were found on the surface of the cable entry guide to the hoist. It was determined that:
  - The n.º 1 mark, which was fairly deep, was produced by friction-compression with the cable over tensioned and at an angle in excess of 20º from the vertical.
  - The n.º 2 mark was typical of the friction that results when people are raised into the helicopter.
  - The n.º 3 marks correspond to normal swinging of the cable within the allowed 20º angle.

- Photograph n.º 7 simulates the cable position necessary to produce mark n.º 1, which is considerably in excess of the allowed 20º angle.
- Lacking the results of the metallographic analysis of the cable, it is believed that the cable very likely broke as a consequence of operating the hoist outside its limits of operation.

Photograph 5



Photograph 7



Photograph 7

1.5.3.2. Analysis at the manufacturer's facilities

The second phase in the study of the hoist consisted of a general inspection at the facilities of Goodrich Actuation Systems in France. This inspection consisted of a thorough check of all the components in the mechanical brake and gears, including non-destructive testing.

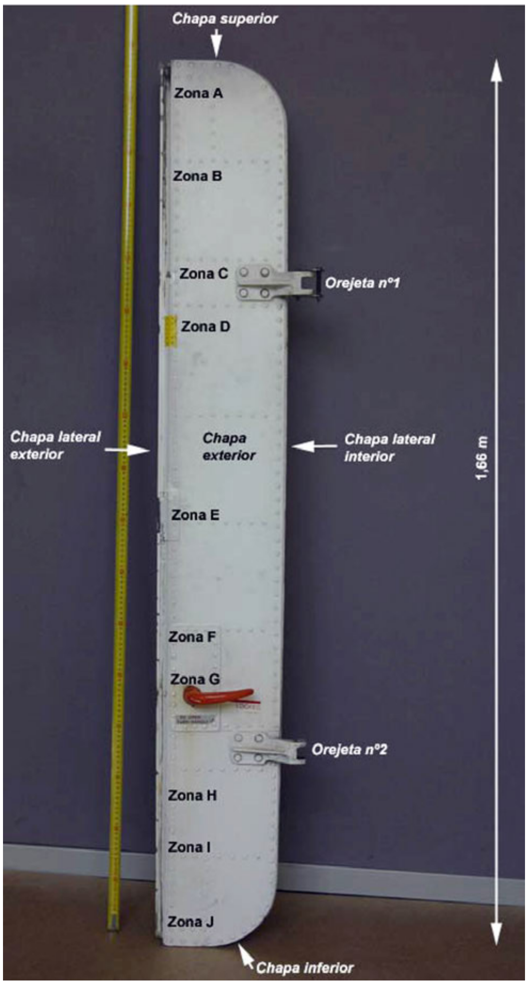
The inspection only revealed minor damage to the components that position the cable entry guide to the hoist and the cable guide, which ensure the hoist winds properly. This damage is believed to have resulted from the over tension and breakage of the cable. The remaining components appeared normal.

From an operational standpoint, the results from this second phase of the analysis of the hoist did not modify the findings of the first phase.

1.5.4. *Analysis of the hinged portion of the cargo door*

The analysis of the hinged portion of the helicopter's cargo door was conducted at INTA's Materials and Structures Department, and consisted of a visual observation of the marks on the door. The paragraphs below present the findings that resulted from these observations.

There is no general deformation of the hinged portion of the helicopter door. In general, most of the damage noted on the structure corresponded to friction marks and imprints on the cylindrical rod located between the outer sheet metal and the outer sheet metal



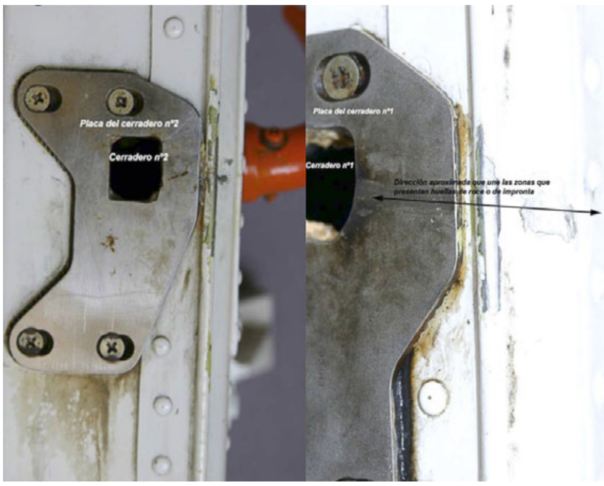
Photograph 8

on the side of the fuselage, and are associated to most of this rod zones, showing chipped white paint. Photograph n.° 8 shows the different sections considered in the analysis of this component.

The most significant imprint mark is on the cylindrical rod in zone D of Photograph no. 8, where the deformed surface, a close-up of which is shown in photograph n.° 9, exhibits a very bright texture without practically any directional markings. The nature of this mark seems to indicate that it was produced under local loading that was practically perpendicular to the outer sheet metal on the side of the fuselage.

Also of note are the two areas adjacent to the two locks on this part of the door, located on its side (zones C and G in photograph n.° 8), and which show friction marks on both the outer metal and on the cylindrical rod. These marks line up with certain friction marks found on the strike plates on the locks (see photograph n.° 10), which seems to indicate that these marks could be due to relative motion between these areas and a single element located on the other component of the helicopter door.

Photograph 9



Photograph 10

1.5.5. *Analysis of the break of the hoist cable*

The analysis of the break of the hoist cable was conducted at INTA's Materials and Structures Department and consisted of a visual observation of the cable, the characterization of its material, including its chemical composition, a microstructural analysis of the wires that comprise it, a stress test of the cable and a fractographic study of the each of the wires. The key findings from this study are detailed in the two sections that follow.

1.5.5.1. Report

The findings from the observations and analyses conducted are presented below.

The hoist has a non-rotating cable with three layers of wire cords. There is a cord in the center of the cable, called the core, an inner layer consisting of six cords, and an outer layer with twelve cords. Each cord has seven wires, one in the center and six around the outside. The average diameter of the cable is around 4.7 mm.

Both the macrofractographic and microfractographic studies indicate that the breaks were of a ductile nature and resulted from a static overload. There were no progressive fracture mechanisms involved.

A high percentage of bevel fractures (56%) was found, in excess of the percentage of cup and cone fractures (44%). This indicates that in addition to the axial load effect, there was an effect from a compression load perpendicular to the length of the cable in the area of the break.

Some of the wires on four consecutive cords on the outer layer of cords were bent, indicative of the probable existence at some point of contact between the cable and another component that resulted in the wires in these cords being bent.

No evidence or signs were found that the cable had been previously weakened by fatigue, general or local corrosion in the area of the break.

The results of the quantitative chemical analysis conducted on the cable wires indicated that these wires were made of AISI 1069 carbon steel. All of the wires had a Zn coating. The chemical composition of the cable wires is consistent with that stipulated in the manufacturer's specifications.

The maximum load obtained on the tensile test (1,796 kg) conducted on a sample taken from an area of the cable close to the break exceeded the minimum fracture load (1,533 kg) stipulated by the manufacturer for this type of cable.

The characterization tests of the cable material did not reveal the presence of any factor that justified a strength for the material below the expected strength for the type of material and heat treatment utilized. No intrinsic defects were found in the cable's material or in the cable itself. There is no indication, therefore, that the cable's strength was below that expected for the fracture mechanism that was present.

From the foregoing it may be concluded that the break experienced by the cable resulted when a load level was placed on the cable at a certain point that translated into a tensile stress with a strong compressive effect perpendicular to the length of the cable that was in excess of the design strength of the cable.

The effect of the compression perpendicular to the length of the cable reduces the breaking load of the cable under tension in comparison to the breaking load when the cable is only under tension.

1.5.5.2. Conclusions

This section presents the findings from the analysis of the break in the hoist cable.

The fracture mechanism at work in the initiation, development and completion of all the breaks in the wires was of a ductile nature, and the load level that resulted in the breaks was a static overload under a primarily tensile load with the addition of a considerable compression effect perpendicular to the length of the cable. There were no progressive fracture mechanisms involved.

The compression perpendicular to the length of the cable had the effect of lowering the fracture load of the cable under tension versus a situation in which the cable is subjected solely to loads under tension.

No evidence or signs were found that the cable had been previously weakened by fatigue, general or local corrosion in the area of the break. The break occurred at a given moment as the result of a single process induced by a static overload. No intrinsic factors were found in the broken wires that could have resulted in the strength of said wires being below their expected static load; in other words, the overload was applied here to the load level that acted on the cable.

The above paragraph allows us to state that the break in the cable was produced as a result of a load level being reached at a given moment that was in excess of the cable's strength for the fracture mechanism present.

The base material of the cable wires analyzed was consistent with the type of material specified in the manufacturer's information.

1.6. Additional information

1.6.1. *Statement from the Pilot in Command of the helicopter*

The statements made by the helicopter's crewmembers to the judiciary police were available to investigators. Since all the five crewmembers who were onboard at the time of incident gave similar accounts, only the key points in the statement made by the Pilot in Command are given below.

On 23 February 2008 he was on duty on the noon to midnight shift. At about 20:11 they received a notification from the CZCS (Regional Rescue Coordination Center - Finisterre) to search for a body in San Jorge beach off Prioriño Cape. They took off at 20:20 and returned at 22:55.

Shortly after arriving on the scene and initiating the search, they were informed that the Civil Guard had lost a man overboard and were requested to join in searching for him immediately, which they did. After a 15-minute search, they found the man in the water some 150 m off the south cliffs of San Jorge beach. They were able to spot him thanks to a small reflective patch. They also noted that he had one arm wrapped around some sort of yellow floating device, which they later deduced, after watching the video footage, must have been a lifejacket.

They hovered some 70 ft above the man and initiated the pick-up procedure as per established protocols. They would lower the rescue swimmer to the water using the sling. The swimmer then, without releasing the sling, would swim to the victim and place the sling around him. After verifying that the sling was properly fastened, the swimmer would give the usual signal to start reeling in the sling. The crew would then engage the corresponding system to have the helicopter automatically approach the point directly over the men (swimmer and victim). Just as the swimmer gave the signal to raise them, a wave dragged both men under the water. Initially both men came back up, but the victim did not respond to the rescue swimmer. Another wave dragged them under a second time, causing the Pilot in Command and the crew to lose both men from sight. A third wave then struck.

As a result of the first wave, the hoist cable, which was attached to the rescue swimmer and the victim, broke. The swimmer's "up" signal was simultaneous with the strong wave. It happens that until that moment, the condition of the sea had seemed calm, so the crew was surprised when the three strong waves lashed the two men below.

When the swimmer came back up, he signaled to the helicopter crew that he was fine, so they used the helicopter's spotlight to signal the way to the beach, which was some 150 m away and which he reached swimming.

Once they verified that the swimmer was unharmed after picking him up from the beach, they continued looking for the missing man, but did not see him for the remainder of their flight.

1.6.2. *Rescue swimmer's report*

On Saturday, 23 February 2008 at 20:40, they were flying over San Jorge beach between Prioriño cape and Prior cape, when they sighted a man in the water. He was alive and was wearing the dark green uniform of the Civil Guard. He was keeping afloat by holding on to an air bladder that went down his right side and which seemed to be slung over the victim's shoulder.

They began the rescue operation and, once he was fully outfitted with the rescue gear and after having been checked by his fellow rescue swimmer to make sure that everything was in perfect condition and in the proper place, he was signaled by the hoist operator to approach the door. In keeping with procedure, the hoist operator blocked the door while he attached the hook on the cable to the quick release on the swimmer's harness. He gave the "ready" signal and stood at the door, ready to begin the descent into the water. He confirmed the "ready" and "down" signal, and was lowered to the water.

He kept the victim in sight during the entire descent and gave the relevant signs to the hoist operators, indicating that everything was fine. The sea was calm and he did not have any problems swimming to the victim. When he got to him, he saw that he was alive and he kept repeating that his partner, who was in the area, was also missing. The swimmer told him not to worry, that they would go looking for him later. He proceeded to attach the victim to the sling, passing it under his right arm, then around his head and finally under his left arm. He fastened the sling under the victim's arms near the armpits and adjusted it around his chest. He passed the safety strap on the sling between his legs and attached it to the corresponding ring. After checking the cable's path in the water and seeing that they were ready to be hoisted, he gave the "up" signal. The hoist operator started to reel in the cable and the swimmer placed his back to the helicopter to protect the victim. He felt the cable go tense and immediately afterwards, felt a strong wave that dragged him and the victim under water, wrapping the cable around them and banging them into each other. He tried to regain the surface grabbing the sling with his right hand. The victim was still attached to it but the cable was completely wrapped around the rescue swimmer's feet and neck. He untangled the cable from around his neck and undid the quick release under the water, managing to reach the surface. The victim also came up but when he grabbed him and asked him how he was, the victim did not respond. Another wave pulled the victim six or seven meters away from him. He tried swimming to him, but a third wave struck, sending him under water again. When he came back up to the surface, there was no sign of the victim. He scanned the area but to no avail. He inflated his life jacket and turned on two strobe lights on his gear.

The water continued to pound him, so he kicked to distance himself from the wave crests. He looked up to see if the hook on the hoist was being lowered so that he could go up again, but they signaled him to swim in a certain direction, which he did, even though he could not see anything. After a few minutes he reached the beach and the hoist operator lowered the hook on the internal hoist with the line guide to evacuate him.

2. ANALYSIS

2.1. Circumstances of the incident

At around 21:00 on 23 February 2008, while taking part in a search operation, the crew of a SIKORSKY S-61N helicopter, registration EC-FVO, based at the A Coruña Airport as the "Helimer Galicia", located the crewmember of a patrol boat who had fallen overboard and was preparing to rescue him. The atmospheric conditions were suitable for the operation and the sea seemed calm, though there was a strong swell.

During the lifting maneuver, with the cable tense and both men still in the water, they were struck by a wave that broke the hoist cable, leaving them both in the water. The crewmember that had fallen from the patrol boat disappeared and the rescue swimmer was spotted from the helicopter and guided toward the shore, from where he was lifted onboard.

As regards the wave mentioned in the above paragraph, the Pilot in Command of the helicopter described in his statement how, just as the rescue swimmer gave the "up" signal, a wave struck, dragging the swimmer and the crewmember who had fallen from the patrol boat. Also, the footage from the external FLIR camera mounted on the left side of the helicopter showed how a great swell of water hit them a few seconds after the cable went tense and started pulling them up. From that moment on, the crewmember of the patrol boat was lost from sight. These two aspects confirm the sudden appearance of high intensity waves just as the two men were being lifted to the helicopter and, as a consequence, the possibility that the hoist cable was subjected to a very high tensile force while at an angle from the vertical that was in excess of the hoist's operating limits.

The body of the crewmember from the patrol boat was found the following morning. The autopsy revealed that he had died from drowning.

2.2. Damage to the hinged portion of the cargo door on the helicopter

As noted in 1.5.2, there were marks and imprints on the edges of cargo door located on the right side of the helicopter, some of which had been made when the hoist cable rubbed against the door.

An analysis conducted at INTA of the damage exhibited by this component, the findings from which are shown in 1.5.4, lists three areas, C, D and G in photograph n.° 8, where these marks were significant.

Said analysis concluded that the damage present in areas C and G in photograph n.° 8, next to the strike plates on the hinged part of the door, had characteristics that indicated they had probably been produced by the relative motion between these areas and a single component located on the other component on the helicopter door. This indicates that the damage had, in all likelihood, resulted from friction between the sliding component and the hinged component of the door during normal opening and closing operations of the cargo door.

The most significant mark found was an imprint located on the cylindrical rod in area D of photograph n.° 8. Its nature appears to indicate that it was produced under local loading that was practically perpendicular to the outer sheet metal on the side of the fuselage. As with the marks mentioned in the preceding paragraph, these characteristics are believed to indicate possible interference with the sliding component of the cargo door. In any case, they do not correspond to the marks that would have been made had there been any interference with the hoist cable.

2.3. Break of the hoist cable

The INTA study of the break in the hoist cable, the findings from which are discussed in 1.5.5, revealed that the cable satisfied the hoist manufacturer's specifications, both in terms of the material used to make it and of its strength. It had no apparent defects

As far as the characteristics of the break are concerned, the same study concluded that the break experienced by the cable resulted when a load level was placed on the cable at a certain point that translated into a tensile stress with a strong compressive effect perpendicular to the length of the cable that was in excess of the design strength of the cable. In other words, the cable broke when it was bent against something while under tension. Under these circumstances, the wires that made up the cable were subjected to different tensions, this tensile force being greater in those wires on the outside of the bend. This caused the outer wires to break first, with those toward the inside following suit as the cable's strength was diminished by the decreasing number of wires.

As regards the hoist, the studies described in 1.5.3 determined that it was in good condition and working as expected based on the contents of the applicable documentation. Said studies also determined that the cable very likely broke at the cable entry guide to the hoist, where a fairly deep mark, labeled n.° 1 on photograph n.° 7, was found that had been caused by friction-compression with the cable over tensioned and at an angle in excess of 20° from the vertical. This indicates that the cable entry guide to the hoist was the component that was supporting the hoist cable when it broke.

Finally, as noted in 2.1, there are indications that high intensity waves appeared just as the two men were being raised to the helicopter, and that at that time the hoist cable could have been subjected to very high tensile forces while at an angle from the vertical that was in excess of the hoist's operating limits. This finding is consistent with the fracture characteristics noted on the cable and with the mark on the cable entry guide to the hoist. As a result, it is believed that these circumstances led to the failure of the cable.

3. CONCLUSIONS

3.1. Findings

- The crew of the aircraft was properly qualified and experienced, physically fit and had valid licenses and authorizations.
- The helicopter had been maintained in accordance with the Approved Maintenance Program and had valid airworthiness and registration certificates.
- The hoist had been maintained in accordance with the established Maintenance Program.
- Weather conditions were appropriate for the operation and the sea seemed calm, though there was a strong swell.
- During the lifting maneuver, as they were preparing to rescue a crewmember who had fallen from a patrol boat, with the cable taut and the two men still in the water, a wave struck that broke the hoist cable.
- The analysis of the hoist revealed that it was in good condition and operating in accordance with the applicable documentation.
- These analyses determined that the cable very likely broke at the cable entry guide to the hoist as a result of using the hoist beyond its operating limits.
- The analysis of the break in the hoist cable revealed that the cable satisfied the hoist manufacturer's specifications, both in terms of the material used to make it and of its strength. It had no apparent defects.
- Said analysis determined that the cable broke when, at a given moment, it was placed under tension in conjunction with a strong compressive force perpendicular to the length of the cable.
- The sudden appearance of strong waves just as the two men were being raised out of the water resulted in the hoist being subjected to a very strong tensile force at an angle with the vertical that was in excess of the hoist's operating limits.

3.2. Causes

Over the course of a rescue operation with an external hoist, during the lifting maneuver with the cable tense and both men to be raised still in the water, a strong wave hit the men, causing the hoist cable to break.

The sudden appearance of high intensity waves just as the men were starting to be raised out of the water caused the hoist cable to be outside the hoist's operating limits and the wires that comprise it to be subjected to forces in excess of those specified by the hoist manufacturer.