

Report

Accident on **28 October 2010**
off **Adélie Land (Antarctica)**
to the **AS 350 B3 Squirrel**
registered **F-GJFJ**
operated by **SAF HELICOPTERES**

BEA

Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

Ministère de l'Écologie, du Développement durable et de l'Énergie

Safety Investigations

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SPECIAL FOREWORD TO ENGLISH EDITION

This report has been translated and published by the BEA to make its reading easier for English-speaking people. As accurate as the translation may be, the original text in French is the work of reference.

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Glossary

EASA	European Aviation Safety Agency
AGL	Above Ground Level
CTAISB	Canadian Transportation, Accident Investigation and Safety Board
AOC	Aircraft Operator Certificate
DGAC	Direction Générale de l'Aviation Civile (General civil aviation directorate)
DSAC	Direction de la Sécurité de l'Aviation Civile (Civil aviation safety directorate)
DTS	Data Tracking System
FL	Flight Level
ft	Feet
GPS	Global Positioning System
IFR	Instrument Flight Rules
IPEV	Paul Emile Victor French Polar Institute
kt	Knots
NM	Nautical Miles
NTSB	National Transportation Safety Board
PNR	Point of No Return
TAF	Terminal Aerodrome Forecast
SIGWX	SIGNificant Weather chart
VFR	Visual Flight Rules
VHF	Very High Frequency

Synopsis

Date

Thursday 28 October 2010
at around 8 h 15⁽¹⁾

Place

Adélie Land, Antarctica
S 65°58'30.6" E 141°05'34.8"

Type of flight

Public transport of passengers

Aircraft

Eurocopter AS 350 B3 Squirrel
registered F-GJFJ

Owner

OSEO Financement SA

Operator

SAF HELICOPTERES

Persons on board

1 pilot
1 mechanic
2 passengers

⁽¹⁾All times in this report are UTC, except where otherwise specified. Ten hours should be added to obtain the legal time applicable in Adélie Land on the day of the event.

Note: At the time of year when the accident occurred, there is permanent daylight in Adélie Land.

Summary

On 28 October 2010, the pilots of two helicopters operated by SAF HELICOPTERES were flying passengers and equipment from the Astrolabe ship to the Dumont d'Urville base in Adélie Land (Terre Adélie). These flights were undertaken following damage to the ship's propeller, which caused the ship to halt its progress towards Dumont d'Urville. When the decision was made to undertake the flights, the meteorological conditions at the ship and at the base 207 NM away were good. The flying autonomy and performance of the helicopters were compatible with the flights planned.

The pilot of the two helicopters took off about 20 minutes apart. The pilot of the first helicopter encountered poor weather conditions when in cruise, which led him to decide to continue the flight at low altitude, sometimes below 200 ft, to remain under the cloud layer. The pilot of the second helicopter, registered F-GJFJ, initially decided to fly above this cloud layer, but then decided to turn around and also fly below the cloud layer. The pilot made two 360° turns at low speed and at a low height once below the cloud layer.

The helicopter collided with the surface of the pack ice. The last flight path data points recorded indicated a height of about 30 ft.

The investigation showed that the accident was caused by the pilot likely losing all external visual references, following his decision to undertake and continue the flight in unfavourable meteorological conditions, in a hostile environment that offered no or few alternatives to the plan of action. The specific context of the mission, the absence of operational documentation relating to operations in Adélie Land and SAF HELICOPTERES failure to submit part C of its operations manual to the oversight authority were factors contributing to the accident. The pilot having taken medication with sedative effect may have contributed to the accident.

Five safety recommendations have been issued to DGAC and EASA. They relate to:

- ❑ an amendment to the regulations to provide a clearer definition of the concept of an operations base and the procedure for declaring a new base,
- ❑ the description of the areas of operation defined in the operator's AOC and for which the latter has declared an operations base,
- ❑ the obligation to inform the oversight authority of any operations in remote locations,
- ❑ the introduction of a more effective oversight system for operators by the oversight authority,
- ❑ organising an awareness-raising campaign on the risks relating to self-medication for flight crew.

ORGANISATION OF THE INVESTIGATION

The BEA was informed on 28 October 2010 by the CMOVA (an operational monitoring centre that notifies the relevant French authorities of major events) that a helicopter accident had occurred in Adélie Land.

The BEA instituted a safety investigation. Due to the lead times and difficulties in accessing the accident site, the BEA did not visit the site. In addition, the break-up of the pack ice at the accident site did not allow the wreckage to be accessed under sufficiently safe conditions.

Observations from the air performed on 19 November 2010 showed that the wreckage had sunk.

1 – FACTUAL INFORMATION

1.1 History of Flight

The data provided in this section comes from witness accounts and from the data tracking system (DTS) carried on-board the helicopter (see 1.11 Flight Recorders).

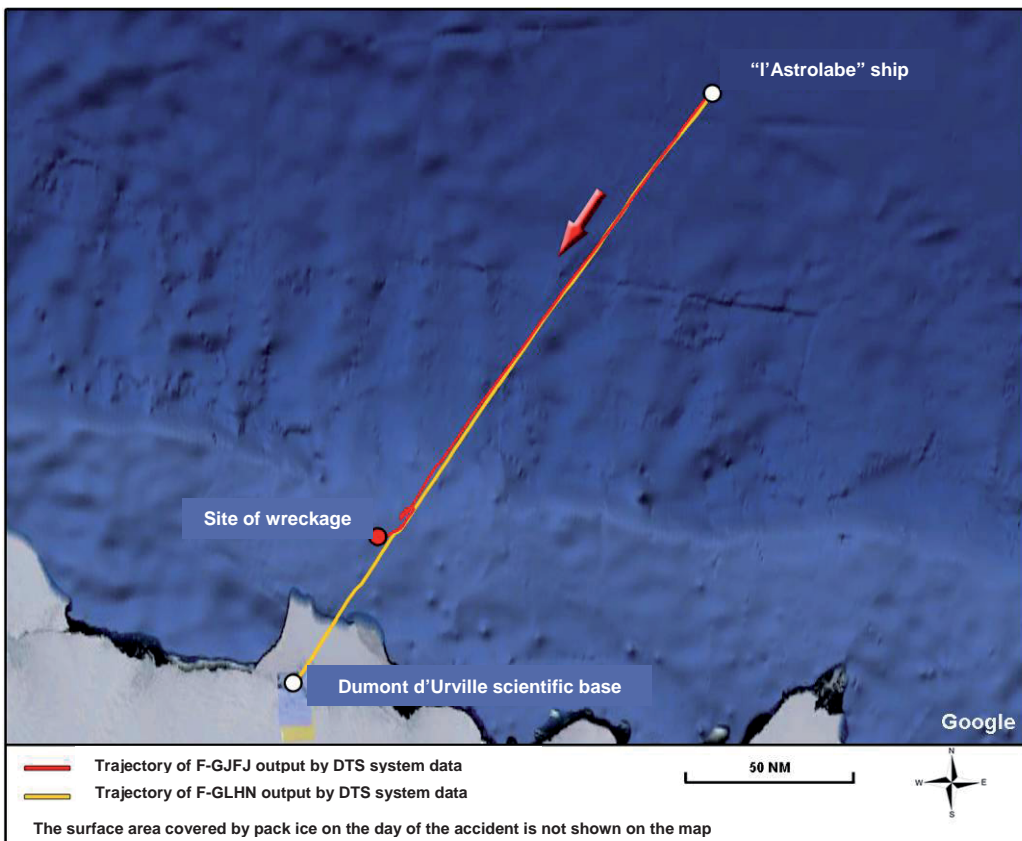
On the day before the accident, the progress of the ship "l'Astrolabe" towards the Dumont d'Urville base was halted by damage to the propeller. For maintenance purposes, the ship had to turn back no later than the morning of 31 October.

On 28 October, the pilots of the two helicopters on-board the ship agreed to transport the passengers and any equipment that could fit into the cabin to the Dumont d'Urville base, 207 NM away. The decision to undertake these flights was made in conjunction with the IPEV logistics manager. The flights would relieve the personnel from the base for the first time after 9 months winter residence

At about 6 h 30, the pilot of the first helicopter, registered F-GLHN, took off from the Astrolabe's helideck with 3 passengers and some cargo.

Fifteen minutes later, the pilot of F-GJFJ took off with cargo and 3 passengers, including the operator's mechanic.

Both pilots used GPS to navigate to Dumont d'Urville (see figure below).



Flight path recorded for helicopters F-GJFJ and F-GLHN

Shortly after 7 h 50, the pilot of F-GJFJ made a 360° turn, during which he descended from 2,500 to about 800 ft. While performing this manoeuvre, he informed the first pilot by radio that he was turning to fly under the cloud layer.

At about 8 h 00, he made a second 360° turn, during which he flew at altitudes of between 300 and 50 ft. He reduced his speed from 130 kt to about forty knots.

At 8 h 09, the pilot of the first helicopter landed at the Dumont D'Urville base.

The last data point recorded was at 8 h 15 m 46, at an altitude of about 30 ft. Two minutes previously, two speeds recorded 30 seconds apart were less than 8 kt.

At 08 h 28, Cospas-Sarsat detected the triggering of F-GJFJ's emergency locator beacon.

On 30 October 2010, an Australian search and rescue aircraft located the wreckage.

1.2 Injuries to Persons

Injuries	Crew members	Passengers	Other persons
Fatalities	1	3	-
Serious	-	-	-
Light/None	-	-	-

1.3 Damage to Aircraft

The helicopter was destroyed.

1.4 Other Damage

There was no other damage.

1.5 Personnel Information

Male, 36 years old

- Date of joining SAF HELICOPTERES: June 2004
- Commercial pilot licence (helicopter) (CPL (H)) issued in 1998, converted to an FCL⁽²⁾ in December 2009
- Rating as a flying instructor (helicopter) (FI-H) on 20 February 2007, valid until 31 January 2013
- Class 1 medical certificate valid until 31 August 2011
- Type ratings: AS350, AS355 SP, SA316/319/315

⁽²⁾Flight Crew
Licence

- Aeronautical qualifications:
 - helicopter winching
 - dropping parachutists
 - load lifting
 - taking aerial photos
 - rescue (Alpe d'Huez, Val d'Isère)
 - transport and release of explosives

Line and base checks were performed on 1st October 2010.

- Experience:
 - total: 3,122 flying hours
 - on type: 1,664 flying hours
 - in the previous six months: 130 hours
 - in the previous three months: 66 hours
 - in the previous thirty days: 2 hours

Note: This pilot had once held an IFR rating obtained in Canada. It expired on 1st July 2000.

1.6 Aircraft Information

1.6.1 Airframe

Manufacturer	Eurocopter
Type	AS 350 B3 "Squirrel"
Serial number	4312
Registration	F-GJFJ
Entry into service	23 August 2007
Certificate of airworthiness	Valid until 23 January 2011
Hours flown up to 1 st October	1,857 heures
Since last inspections	<input type="checkbox"/> 245 hours since 600-hour inspection performed on du 21/02/2010 <input type="checkbox"/> 1 hour since 100-hour inspection, performed on 20/08/2010

Note: The helicopter should be overhauled every 12 years.

This helicopter was equipped for VFR flight at night or in the day.

1.6.2 Engine

Manufacturer	Turbomeca
Type	Arriel 2B1
Serial number	46258
Installation date	3 March 2010
Total run time (in hours)	735
Run time since installation (in hours)	245
Cycles since installation	301

1.6.3 Weight and balance

The helicopter's weight and balance documents were only kept in the helicopter. They could not be recovered.

The pilot of F-GLHN reported that the two pilots had agreed to carry the same quantity of fuel on the two helicopters, i.e. 100% or 540 l, weighing 427 kg. This quantity provided 3 h of flight autonomy for a flight expected to last 1 h 45.

Note: He stated that the load carried by the two helicopters (of the same type) was similar. The first helicopter's weight and balance documents show that it was within the limits defined by the manufacturer.

1.6.4 Radio altimeter

The helicopter was fitted with a radio altimeter manufactured by Thales. This instrument enables the helicopter's height above the ground to be measured, and allows a reference height to be selected. If the helicopter descends below this value, this value is highlighted on the instrument and an audible alarm sounds three times consecutively in the pilot's helmet.

The investigation was unable to establish the height selected by the pilot prior to the accident.

1.7 Meteorological Conditions

Météo France personnel and equipment at the Dumont d'Urville station issue meteorological observation messages. Météo France personnel provide information to pilots regarding any expected changes to the weather, but are not required to produce TAF's.

1.7.1 Description of the meteorological situation

On 26 and 27 October (i.e. the two days before the accident) a storm passed over the Dumont d'Urville base.

On 28 October, the wind eased (a few gusts reaching 45 km/h), the visibility was approximately 40 kilometres and it was sunny, with temperatures varying from 10°C to -4°C. At the end of the afternoon (local time), high clouds gradually covered the sky then the height of the cloud base dropped, with the clouds originating from the north-west to north-east horizon.

The weather then deteriorated more rapidly, with a cloud base of less than 3,000 ft. Snow started to fall and the visibility dropped to 8 kilometres. The weather continued to deteriorate during the course of the evening, with stronger winds and greater snowfall, and the visibility dropped to 3 kilometres. A storm then arrived: the wind speed was between 110 and 130 km/h (gusting to 160 km/h). Visibility fell to 40 metres.

On Friday 29 October, at the start of the evening, a lull was noted.

Note: A satellite map provided by Météo France and made on 28 October at 0 h 40 (i.e about 7 hours before the accident) indicated very low cloud in a zone between the ship and the Dumont d'Urville base. The term "very low cloud" can include stratus and banks of fog.

1.7.2 Pilots' knowledge of the meteorological situation

Data available

When preparing their flights on Thursday 28 October, the pilots could access the following data:

- ❑ Messages from Météo France: observation and forecast made at Dumont d'Urville,
- ❑ SIGWx chart (valid at 6 h 00 on 28 October, for FL 250 to 630),
- ❑ Observations from the ship.

The messages from Météo France were sent by email to the IPEV logistics manager on board the ship, and then to the pilots of the two helicopters:

- ❑ **27 October at 6 h 54**, this message was a forecast for 28 October for the zone around the ship: no precipitation, a little cloud, with the sky clouding over in the afternoon, winds from west-south-west, force 8 to 9, then from the north-east sector, and weakening in the afternoon. This message also contained a forecast of unsettled weather for Friday 29 October at Dumont d'Urville with almost zero visibility.
- ❑ **27 October at 11 h 00**, this message confirmed the forecast in the previous message.
- ❑ **28 October at 5 h 35**, i.e. about one hour before the take-off time of the accident helicopter. The message reported the observation made at Dumont d'Urville at 5 h 30:
 - very calm weather,
 - winds of less than 10 kt from the north-west,
 - visibility of 40 km, sky covering slowly,
 - confirmation of an expected deterioration.

The SIGWx chart was valid for altitudes above FL 250. It did not indicate anything particular for the zone in which the accident occurred.

The pilots had no access to satellite images or data describing the meteorological situation between the ship and Dumont d'Urville, about 200 NM away. These images were not available on the ship or at Dumont d'Urville.

Conditions encountered during the flight

The pilot of the first helicopter reported that the conditions encountered were very good, and agreed with the forecasts for about 150 NM. When 53 NM from Dumont d'Urville, he encountered difficult conditions associated with a cloud ceiling of about 200 ft and visibility of 1,500 metres, for about 15 NM. The conditions subsequently improved and continued to be good until their arrival at Dumont d'Urville.

When this pilot took off again to conduct a search at about 9 h 25. He reported that during this flight he encountered very poor meteorological conditions which forced him to turn back when approximately 18 NM from the accident site.

1.8 Aids to Navigation

There is no radio-navigation equipment in Adélie Land. Pilots have to rely on GPS. The helicopter was equipped with a Garmin GNS 430 GPS and a portable Garmin GPSMAP 496 GPS.

The proximity of the magnetic south pole to the Dumont d'Urville base makes it impossible to follow magnetic headings in this region. Pilots navigate using a true heading provided by the GPS.

1.9 Telecommunications

The pilots and the personnel aboard the ship and at the Dumont d'Urville base were equipped with marine VHF radio (channel 16) and aircraft VHF radio (123.45 MHz). The pilots used the latter band exclusively when communicating with each other.

The pilot of F-GLHN was flying about 15 minutes ahead of the second pilot, with whom he was in permanent contact. He stated that the transmission quality deteriorated when he was about thirty nautical miles from Dumont d'Urville. He contacted the pilot of F-GJFJ several times before receiving confirmation that the latter had received his messages.

The dialogue exchanged via radiotelephone was not recorded by the ship or at Dumont d'Urville.

1.10 Aerodrome Information

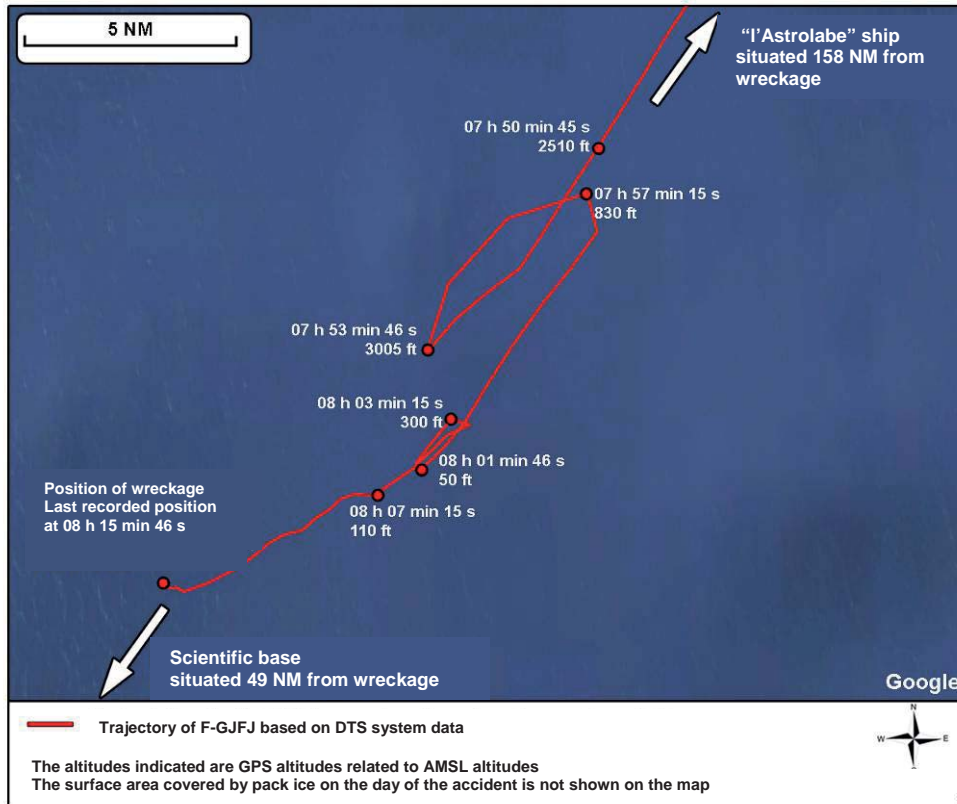
The ship's helideck is not large enough to allow two helicopters to leave simultaneously. It takes about 15 minutes to prepare a helicopter for take-off.

1.11 Flight Recorders

The helicopter was not fitted with crash-protected flight recorders; they are not required by the regulations.

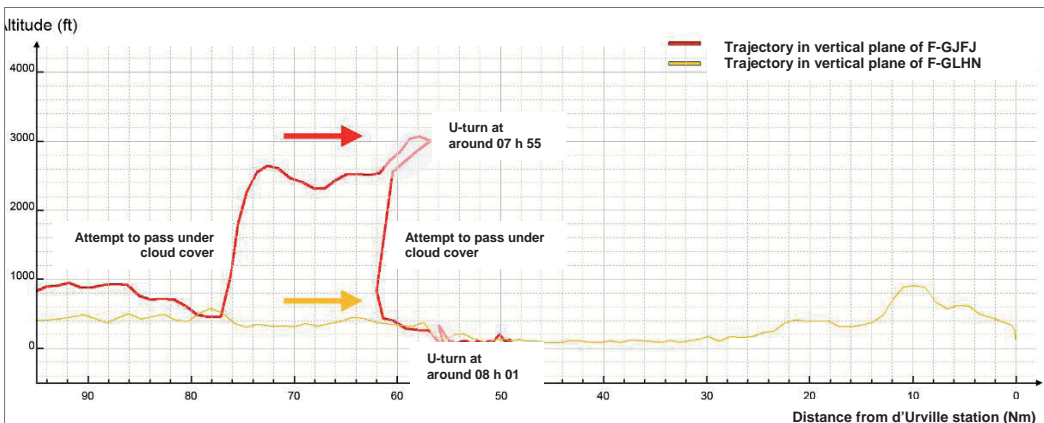
It was, however, fitted with a DTS that recorded and regularly transmitted its position via satellite, and a Brite Saver system that recorded the flight data onto a memory card.

It was not possible to recover the Brite Saver memory card from the accident site. The data transmitted by satellite to the operator was used to reconstitute the helicopter's flight path prior to the accident (see figure on following page).



End of F-GJFJ flight path

These data were also used to produce figure 3 below. The graph shows the altitude of the two helicopters as a function of their distance from the Dumont d'Urville base.



Altitude of the two helicopters as a function of their distance from Dumont d'Urville.

This graph shows the zone in which the first pilot flew under the cloud layer, whereas the second pilot initially decided to fly over the cloud layer before turning back to lose height.

The data recorded also shows that when the pilot of F-GJFJ performed the second 360° turn he gained altitude as he headed towards the ship, and lost altitude as he headed towards the Dumont d'Urville base.

1.12 Wreckage and Impact Information

The risks associated with the break-up of the pack ice at the accident site made it impossible to examine the wreckage. The information below was provided by the pilot of the first helicopter, who was accompanied on the flight by IPEV personnel.

The helicopter crashed onto the pack ice, whose surface was flat and even. The wreckage was spread linearly, over an east-to-west strip, covering a distance of between 100 and 150 metres, based on the observations made by the rescue teams.

The helicopter's left skid was buried in the snow, probably at the point at which the helicopter first hit the ground. Spread between this point and the main item of wreckage were small pieces of debris, and the helicopter's two front doors. The helicopter's cabin was resting on its left side; the structure had sheared off behind the cabin.

The tail boom, horizontal stabiliser and tail rotor were embedded in the snow in line with the flight path, about 25 metres from the cabin.

The traces of the impact, and the size and distribution of the debris indicate that the helicopter hit the ground with a low vertical speed and a high horizontal speed.



1.13 Medical and Pathological Information

A witness reported that the pilot had taken Mercalm® during the sea crossing since he was prone to motion sickness (also known as kinetosis).

Toxicological analyses of blood samples were performed in February 2012. They revealed the presence of diphenhydramine, the active ingredient in anti-seasickness drugs such as Mercalm®, which confirmed that this drug had been taken.

The levels measured were infra-therapeutic. The analysis report noted, however, that since a long period of time had elapsed before the analysis could be performed, the blood concentration of this active ingredient might have been higher at the time of the accident.

Mercalm® is an antihistaminic drug used to prevent and treat motion sickness. It is an over-the-counter medicine. It induces a significant sedative effect at normal doses. Since the drug can cause drowsiness, a warning is provided for drivers and the operators of machinery intending to use the drug. This restriction is indicated on the packaging by the inclusion of a level 2 pictogram: "Be very careful. Take advice from a health professional before driving". The rate at which the individual eliminates the drug can result in an accumulation of the product in the organism.

Certain side effects, notably the sedative effect, reduce a pilot's ability to adapt to flying conditions when there are few visual references.

The AFSSAPS⁽³⁾ defines Tier 2 as follows:

"Tier 2 drugs may, in certain cases, impair the ability to drive a vehicle or operate machinery. It is therefore essential to seek advice from a health professional, such as the doctor who prescribes the medicinal product, or the pharmacist who supplies it. [...] However, the requirement to seek advice from a doctor or pharmacist before driving also applies to a number of common treatments (such as drugs to control allergies, hay fever or motion sickness)".

OPS 3 states that commercial helicopter pilots performing passenger transport activities must not self-medicate.

This prohibition is reiterated in the SAF HELICOPTERES operations manual.

Self-medication has been identified as a contributory factor in an accident investigated by the BEA: <http://www.bea.aero/docspa/2009/f-r1091009/pdf/f-r1091009.pdf>

1.14 Fire

There was no fire during the flight or after the accident.

1.15 Survival Aspects

At 8 h 28, Cospas-Sarsat received the signal from the helicopter's emergency locator beacon. At 9 h 25, the pilot of the first helicopter took off again in an attempt to rescue the occupants of F-GJFJ, but had to turn back before arriving at the accident site due to adverse weather conditions.

⁽³⁾The French public agency responsible for the safety of health products

At 19 h 20 on 29 October, an Australian Air Force C17 took off from Christchurch and flew over the crash area at 23 h 20. Adverse weather conditions prevented the crew from finding the crash site. On 30 October, the crash site was located by the crew of an Orion P3 aircraft. A survival kit was dropped. The crew of this aircraft indicated that none of the helicopter's occupants appeared to have survived.

On Saturday 30 October, the pilot of the first helicopter returned to the accident site, accompanied by a doctor and other persons. The bodies of the occupants were recovered over the course of two flights.

1.16 Tests and Research

Loss of visual references in a whiteout

A whiteout is a meteorological phenomenon that occurs when the sky is covered with a uniform layer of cloud, and the ground is covered in snow. Visual flying in whiteout conditions is difficult, since this phenomenon significantly reduces the contrast between the sky and the ground, such that the pilot is surrounded by a uniformly diffuse environment in which all reference points are obscured. The loss of visual references generates optical illusions and makes it impossible to control the aircraft's attitude, and thus its flight path. It should be noted that, in certain cases, the visibility and ceiling encountered in whiteout conditions make flying under visual flight rules possible.

Note: The term "brownout" refers to a similar phenomenon encountered when flying helicopters in the desert or above dusty surfaces.

These phenomena have caused many accidents and incidents:

- ❑ Brownout was the most common cause of air accidents during the war in Iraq, according to a US Air Force report published in 2004.
- ❑ Whiteout and brownout caused 13 and 25 % respectively of helicopter accidents related to spatial disorientation, according to two studies published in 1998 by the US Air Force.
- ❑ Whiteout was the primary or contributory cause of 22 accidents according to a database compiled by the CATAISB between 1990 and 2005. Half of these related to helicopters.
- ❑ 79 events relating to whiteout are listed in the database compiled by the NTSB between 1978 and 2006, 26 of them relate to helicopters.

1.17 Information on Organisations and Management

1.17.1 The Paul Emile Victor French polar institute (IPEV) and its mission in Antarctica

The IPEV is a funding agency that conducts scientific missions in the Arctic, on Antarctica and on the sub-Antarctic islands. On the Antarctic continent, the IPEV operates two permanent bases: Dumont d'Urville, in Adélie Land, located on Petrels Island, 5 kilometres off the continent, and Concordia located 1,100 kilometres from Dumont d'Urville, on the continental shelf.



© IPEV

The over-wintering period lasts for 9 months (March to November), during which time no supplies can be delivered. Some of the personnel are relieved and limited supplies are delivered during an initial change-over (or rotation), called R0, generally involving the "Astrolabe" ship. At the time of the year when this change-over is carried out, the pack ice has started to break up, but has not broken up sufficiently to allow the ship to reach the base. Two helicopters on-board the ship transfer personnel and equipment from the ship to the base. The distances flown are generally fairly short, with the ship about 80 kilometres from Dumont d'Urville. The programme in place prior to the accident was that, on completion of the R0 change-over, a helicopter, a pilot and a mechanic would remain at Dumont d'Urville to make short flights to transfer personnel and equipment, or to assist in conducting scientific missions. The ship would then perform four more changeovers at regular intervals between December and March (R1 to R4). For these trips, the sea conditions allow the ship to moor at the dock on Petrels Island.

Helicopters are used by the IPEV to conduct aerial work missions (primarily) and to transport passengers. An IPEV manager at Dumont d'Urville decides which missions should be carried out.

In May 2010, the IPEV issued a request for proposals for helicopter operation services for 5 "summer" seasons relating to these R0 to R4 changeovers.

The candidate selection process was based on a financial score and on a technical score. The technical score was attributed based on the operator's ability to satisfy several criteria, including notably:

- the type of helicopter proposed,
- the crew's experience (in mountainous or hostile environments and in aerial work),
- the operator's experience in working at remote sites and in mountains.

1.17.2 SAF HELICOPTERES

SAF HELICOPTERES has held an AOC since 1995, which is valid until 31 December 2010. The operational specifications state:

- ❑ Area(s) of operation: World-wide
- ❑ Special limitations: VFR only
- ❑ Hostile environment located outside congested area: single-engine helicopters.

The two helicopters operated in Adélie Land are identified in this AOC.

In August 2010, SAF HELICOPTERES was awarded the contract by the IPEV, gaining the maximum technical score. For the season starting in spring 2010, two AS 350 B3 helicopters were to participate in R0, with one being based thereafter at Dumont d'Urville until March 2011. To execute this contract, SAF HELICOPTERES recruited a pilot (who subsequently was the pilot of F-GLHN) who had worked for the operator contracted the previous year to participate in the R1 to R4 changeovers. This pilot and the IPEV logistics manager asked the operator to equip the two helicopters with radio altimeter equipment.

SAF HELICOPTERES had planned to amend its operations manual as required for the renewal of its AOC. On the day of the accident, the operations manual had not been amended to include instructions specific to missions conducted in Adélie Land, and this new operations base had not been reported in a specific declaration.

The following points are taken from the SAF HELICOPTERES operations manual:

- ❑ Minimum flying altitude:

In accordance with the Rules of the Air, pilots will fly at 500 ft above the ground or above water.

- ❑ Radio altimeter:

Since no flight is to be performed at altitudes of less than 500 ft AGL during the day and 1,000 ft AGL at night, the low-altitude index is to be set to one or other of these values during the cruise flight phase.

Actions taken after being awarded the contract:

The pilot of F-GLHN, since he already had experience in flying in Adélie Land with another operator, performed a flight test prior to his recruitment. He extended his AS 350 type rating with the operator before leaving for the season's work, but did not attend a conversion course.

Subsequent to his recruitment, he gave a presentation of the operations in Adélie Land to SAF HELICOPTERES senior management. During a meeting held on 2 August 2010, he met with the designated maintenance manager to discuss what equipment should be fitted to the helicopters (notably: blade folding kit, radio equipment, satellite monitoring).

A SAF HELICOPTERES manager reported that both pilots had read the contract between SAF and the IPEV.

No mission manager was formally designated by SAF HELICOPTERES.

1.17.3 "DSAC Centre-Est"

DSAC for central-eastern France ensures oversight over SAF HELICOPTERES in the context of the oversight of aerial work and public transport activities. It mandates the renewal and current applicability of the operator's AOC. For this purpose, it conducts an annual programme of audits and inspections.

During an audit conducted in February 2010 that focused on "quality system" and "flight safety", the oversight authority for SAF HELICOPTERES identified several deficiencies in these two areas that constituted a major deviation⁽⁴⁾. The operator was informed of these deficiencies by a letter sent in February. The authority also informed the operator that requests for action relating to minor deviations had not been acted on in the months since the requests were first made, despite several reminders. This prolonged failure to respond also constituted a major deviation. The minor deviations related primarily to the following points:

- ❑ organisation of managerial staff,
- ❑ operations manual,
- ❑ the initial training and practice sessions provided for flight crew, and crew checks,
- ❑ the operation of the quality control system and of the accident prevention and flight safety programme.

The authority therefore required that the operator correct the major deviations identified in the shortest possible time under threat of revocation of the AOC.

In response to this notification, the operator provided an action plan and a six days implementation schedule. No communication between the operator and DSAC could be found indicating that this action plan and this schedule satisfied the authority's requirements. However, DSAC's representatives reported that the issues that prompted the major deviations were raised orally during a meeting held on 5 March 2010, of which there is no record.

On 16 September 2010, the oversight authority conducted a new audit, the last one before the accident. On 26 October 2010, the audit report sent to the operator stated that its operations manual was not adopted by all personnel since it provided an unsatisfactory description of the operational methods practiced by the SAF group. It also indicated that the content and form of part C of the operations manual was unsatisfactory. The authority also noted that it did not have access to the whole of the SAF HELICOPTERES operations manual.

DSAC for central-eastern France was not informed of SAF HELICOPTERES activities in Adélie Land until after the accident. Consequently, and in the absence of an update to the operations manual, DSAC suspended passenger transport flights in Adélie Land pending the necessary amendments by the operator to its operations manual, and notably to section C relating to specific missions in Adélie Land.

In December 2010, the operator amended its operations manual to include missions in Adélie Land. The authority lifted its suspension of the AOC for this area of operations.

On 23 December 2010, the oversight authority renewed SAF HELICOPTERES AOC for a period of 6 months. The renewal was subject to enhanced monitoring by the oversight authority.

⁽⁴⁾A deviation is major when the authority observes a non-conformity with regard to the regulations or to the operator's reference documents drawn up to satisfy the requirements stated in the regulations, and that requires immediate or very prompt action in order not to create a potentially hazardous situation. A minor deviation exists when this non-conformity does not require immediate or very prompt action.

1.18 Additional Information

1.18.1 Statement from the IPEV logistics manager

Operations at sea during the R0 change-over

The IPEV logistics manager explained that the ship's propeller was damaged on Wednesday 27 October 2010. The ship's progress to Dumont d'Urville was slowed. The ship's captain informed him that the damage had to be repaired in Tasmania, and that, for this reason, the ship would have to turn back no later than the morning of 31 October. He also explained that the disembarking of equipment and personnel would have the advantage for the damaged ship of reducing the weight and the number of persons on board. He added that the sea conditions still allowed progress to be made towards the pack ice.

The Dumont d'Urville meteorological station sent the logistics manager a weather report forecasting poor conditions for 29 October 2010. Based on this information, the logistics manager decided to continue sailing towards the base to get as close as possible between 28 and 30 October.

On 28 October, the two pilots on board the ship were informed of the damage to the ship. The logistics manager asked them to each prepare 5 flights, carrying 3 passengers on each flight, for the day after next. Although the helicopters' flying autonomy was adequate, the pilots considered that they could not perform all the flights in one day due to the 170 NM separating them from Dumont d'Urville. They proposed making two trips on the same day, since the meteorological conditions seemed to allow this.

The logistics manager approved this proposal and the helicopters were prepared. Before leaving, the pilot of F-GLHN stated that, in fact, the flight time required meant that it would not be possible to make two return trips in what remained of the day. In addition, he wanted the helicopters to remain at the Dumont d'Urville base to protect them from the adverse weather conditions forecast for the next day.

He stated that SAF HELICOPTERES had not formally appointed a mission manager, but that the first pilot's experience in Adélie Land was the reason why he was the main contact person in dealings with the IPEV.

Helicopter F-GLHN took off first, followed 20 minutes later by helicopter F-GJFJ.

Operation in Adélie Land

The logistics manager explained that he had no aeronautical qualifications. He provided a document for the crews that gave information about the flight corridors. This document contains charts showing the routes that should be taken in order not to disturb the colonies of protected species near Dumont d'Urville. He believed that the pilot of the accident helicopter was not yet familiar with these "flight corridors".

Preparation for the season of work in Adélie Land

The IPEV logistics manager explained that once SAF HELICOPTERES had been selected, he had visited the operator between the end of July and the beginning of August 2010. During their meeting, they discussed specific issues such as the choice of helicopter, how they would be transported, the crews selected and certain commercial details. The specifics of operations in Adélie Land were not raised during this meeting.

The logistics manager's knowledge of the pilot of the first helicopter

The logistics manager had flown with the pilot of the first helicopter during the R1 change-over of the previous year. This pilot had explained to him that the radio altimeter would allow them to fly when they could not see the ground. The logistics manager reported that during previous flights flown in 2009, this pilot had used the radio altimeter to fly through banks of clouds over short distances.

1.18.2 Pilot of the first helicopter

Information on this pilot

- Date of joining SAF HELICOPTERES: 13 October 2010
- This pilot had not attended a conversion course at SAF HELICOPTERES.
- Professional helicopter pilot licence (CPL (H)) awarded in 2001, converted to a FCL license in December 2008.

Experience:

- total: 3,800 flying hours,
- on type: 350 flying hours.

This pilot had flown in Adélie Land (during the R1 change-over, see section 1.17) during the previous year.

Testimony

The pilot of F-GLHN reported that, due to the damage to the ship's propeller, he studied with the pilot of F-GJFJ the various options for transporting equipment and personnel by helicopter to Dumont d'Urville. Due to the distance involved, they agreed that they could not transport cargo using a sling, but could transport passengers and equipment in the cabin. In addition, they considered that the meteorological conditions were highly conducive to undertaking the flight. The estimated flight time was 1 h 40.

The pilot of F-GLHN took off first, about 15 minutes before the pilot of F-GJFJ. He reported that he encountered good meteorological conditions for about 150 NM. When he was about 53 NM from Dumont d'Urville, he encountered whiteout-type adverse meteorological conditions, for about 15 NM. These conditions forced him to fly under the cloud layer, whose base he estimated to be at about 200 ft. The visual contrast in his surroundings reduced markedly, with a grey horizon and a uniformly white ground. The conditions then improved and were good for the rest of the journey.

The pilot reported that, when he encountered these adverse weather conditions, he had passed the point of no return, which he had defined before the start of the flight as being about 120 NM from the ship. If the reserve tank of fuel carried is included, he had the flying autonomy necessary to return to the ship⁽⁶⁾. He nonetheless decided to continue with the flight since he was not sure that he could locate the ship again quickly. In addition, he did not consider landing on the pack ice at that time of the year to be an option, since it would have been weak and would not have provided a safe refuge.

⁽⁶⁾The fuel reserves carried are not taken into consideration when determining the PNR.

He reported that he suggested to the pilot of F-GJFJ that he should stay at 3,000 ft in order to fly over this zone of bad weather; however, the pilot of F-GJFJ reported shortly afterwards that he was not comfortable with this and preferred to turn back to lose altitude and fly under the cloud layer. He added that if the weather conditions were unsuitable he would turn round and return to the Astrolabe. The pilot of F-GLHN told him that he had reduced his speed to 90 kt and had set the radio altimeter to 30 ft during the passage through the area of bad weather.

The pilot of F-GLHN also reported that when the second pilot was flying in the area of bad weather he had to repeat his questions several times before obtaining an answer from the pilot of F-GJFJ. His explanation for this was the poor communication quality during this part of the flight. He added that they remained in contact permanently, in particular in order to pass on messages to the ship or to Dumont d'Urville.

The pilot of F-GLHN reported that he arrived at Dumont d'Urville at 8 h 09 with 40% of his fuel remaining, after flying for 1 h 39.

With regard to the preparatory work for the mission with the operator, the pilot reported that he was not aware of any specific preparations undertaken by SAF HELICOPTERES for the mission in Adélie Land. At his initiative, he gave a presentation of the operations in Adélie Land to the company. He reported that he had been told that this mission would be aerial work only. He was surprised by this, since he had carried out passenger transport duties the previous year while working in Adélie Land for the former operator. Before leaving France, he met only briefly with the pilot of the accident helicopter. SAF HELICOPTERES did not formally appoint a mission manager for the work on Adélie Land.

The pilot of F-GLHN reported that during the sea crossing from Hobart (Tasmania) to Adélie Land, the pilot who crashed took anti-sea sickness medication. He did not know if he took this type of medication on the day of the accident.

The pilot of the accident helicopter had expressed his concerns to him regarding taking-off from and landing on the helideck. He had never previously performed these manoeuvres.

1.18.3 Flying conditions on the day of the accident

The rescue teams recovered the passengers' cameras. The camera belonging to the passenger in the front left seat contained photos taken during the flight.



Photo taken a few minutes after take-off



Photo taken more than 1 h 10 after take-off.

1.18.4 Applicable regulations

The French decree of 23 September 1999 relating to the technical requirements for commercial air transport operations with helicopters (OPS 3) is applicable to the transport of passengers by helicopter. This regulation includes the following specific points:

Hostile environment

OPS 3 defines a hostile environment as an environment in which:

- (a) a safe forced landing cannot be accomplished because the surface is inadequate,*
- (b) or, the helicopter's occupants cannot be adequately protected from the elements,*
- (c) or, search and rescue response/capability is not consistent with the anticipated exposure (following an engine failure),*
- (d) or, there is an unacceptable risk of endangering persons or property on the ground.*

Flying in Adélie Land and above the pack ice must be considered as operation in a hostile environment, and accordingly the operators must comply with the specific provisions stated in appendix 1 to section 3.005(e) and hold a special authorisation.

Performance class 3 operations

A class 3 performance helicopter, such as the AS 350 B3, cannot be operated when the ceiling is below 600 ft.

OPS 3.540 also stipulates that the operator must ensure that operations are not conducted from/to helidecks.

The operator did not request an exemption from its oversight authority that would allow it to operate the AS 350 from the ship.

Note: This provision has since been removed from OPS 3.

Operations manual

OPS 3.1040 stipulates that:

(a) An operator shall ensure that the Operations Manual contains all the instructions and information necessary for operations personnel to perform their duties.

[...]

(g) An operator shall ensure that the Operations Manual is amended or revised so that the instructions and information contained therein are kept up to date. The operator shall ensure that all operations personnel are made aware of such changes to the sections of the manual that are relevant to their duties.

[...]

(i) An operator shall supply the Authority with intended amendments and revisions in advance of the effective date.

1.18.5 Contractual terms agreed between the IPEV and SAF HELICOPTERES

The IPEV and SAF HELICOPTERES are bound by a contract that contains the following specific items:

Helicopters shall transport personnel and goods:

- When both helicopters are present on the ship, the transport activity may be carried out within a maximum distance of 250 km, on the implicit understanding that for the majority of this distance the helicopters fly over sea ice that is preventing the ship's progress,
- When there is only one helicopter, the maximum distance is 50 km

The helicopters must be fitted with the specific equipment necessary for survival, including life jackets, an emergency floatation system and a radio altimeter,

An Iridium® satellite telephone must be provided for the duration of the campaign

The helicopters shall be operated from a ship,

Both pilots and a mechanic must be present if both helicopters are operated, and a pilot and mechanic must be present if one helicopter is operated

- ❑ The operator must draw up special procedures, notably in part C of its operations manual, for the missions concerned.
- ❑ The helicopter may take part in scientific missions over distances of up to a maximum of 150 km, so long as the ship is nearby and able to provide emergency assistance within 1 hour.
- ❑ The helicopter may fly over the Antarctic continent for the purpose of transferring personnel and equipment, or if required for rescue purposes.

The operators contracted to work in Adélie Land in previous years were subject to some of the same terms. They had taken them into consideration when developing suitable procedures and had amended their operations manual.

2 - ANALYSIS

2.1 Scenario

Decision to undertake and continue with the flight

The following elements constituted a powerful incentive to undertake the flight on the Thursday:

- ❑ due to the damage to the ship, the Captain's desire to off-load cargo and passengers,
- ❑ ship's departure on the Sunday,
- ❑ the poor weather forecast for the Friday,
- ❑ the desire to save time so that the flights scheduled for the Saturday could be completed,
- ❑ the good weather conditions on the ship and at Dumont d'Urville,
- ❑ the flying autonomy and performance of the helicopters was sufficient to fly more than 200 NM,
- ❑ the expectations of the over-wintered personnel on the Dumont d'Urville base.

The meteorological data available to the pilots did not, however, allow them to detect the presence of the zone of cloud that was visible on the satellite map for the region. This map would have allowed them plan ahead for an area of bad weather; and could have persuaded them to cancel their flight. This hypothesis is strengthened by the fact that calculation of the point of no return would have shown that, based on the helicopters' flying autonomy, they could not have cancelled their flight at any point in the planned route. Moreover, the hostile environment meant that they could not land and remain safely on the pack ice.

Note: Although not available on the ship, the satellite map could have been obtained from Météo France.

When the pilots encountered the area of bad weather, the first pilot chose to continue with the flight to avoid a hazardous landing on the pack ice, and to avoid the potential difficulties of locating the ship if he turned back. The second pilot changed direction several times, on one occasion in order to fly under the cloud layer. These actions may have been motivated by his fear of not being able to land at his destination, or by it being impossible to fly above the cloud layer. He continued his flight at low altitude, even though the meteorological conditions were incompatible with visual flight. His frequent changes of direction appear to be indicative of his search for visual reference points or better meteorological conditions. His time in the air increased, leading to a situation in which his autonomy became such that he could not return to the ship. His concerns regarding landing on a helideck at sea may also have been a factor in his decision to continue his flight. In addition, the fact that the first pilot had managed to negotiate the area of bad weather by flying at low altitude was a strong but effective incentive to continue with the flight.

Loss of external visual reference points

The search for visual references consumed a great deal of the pilot's attention, and may explain his delays in responding to the radio messages from his colleague.

In the absence of a radio message indicating a technical problem, it is likely that the meteorological conditions were such that the pilot had to fly in whiteout conditions and as a result was disorientated by losing all his visual references. Under these conditions, and since the pilot was flying at a very low altitude, the helicopter probably hit the pack ice during a descent that the pilot failed to notice due to his preoccupation with searching for visual reference points.

The presence of the radio altimeter, even if its use has not been possible to establish at the time of the accident, did not prevent the pilot from crashing onto the ice. Its use in this context should not thus be seen as a safety barrier reliable enough to avoid a ground collision during visual flight in poor weather conditions.

It is likely that the habits picked up by the pilot during aerial work, combined with the operational flexibility offered by the helicopter, motivated his decision to fly outside the operational limits specified in the regulations for the transport of passengers.

Contextual elements

Part C of the operations manual does not provide the operator's pilots with objective criteria to use when deciding whether to undertake or continue passenger transport flights in Adélie Land. These criteria should notably include the definition of minimum flying altitudes, a reminder of the rules of the air regarding visual flight, and the use of radio altimeters. The pilots' unfamiliarity with the contractual clauses agreed between SAF HELICOPTERES and the IPEV meant they had no alternative information that they could use to fill in these gaps in the documentation.

On the other hand, the known expectations of the over-wintering personnel and the packed programme of flights scheduled for the following days added pressure to undertake the flights starting on October 28.

The two pilots could not seek support from a precise operations manual, and were not able to take a step back and consider the whole picture when deciding to undertake the flights in this particular context. They did not therefore search for any additional information that might have influenced this decision.

The investigation could not formally establish how familiar the pilots were with the contract, and notably if they knew the permitted range stated therein for two helicopters. In any case, this restriction stated in the contract was not considered when deciding whether or not to undertake the flights.

2.2 Operator's Mission Preparation

Once the IPEV had selected SAF HELICOPTERES, the operator's sales manager met with the IPEV, primarily to discuss logistic and commercial issues. The context for this one-off meeting meant that specific details of operations in Adélie Land could not be discussed.

SAF HELICOPTERES did not consider that the nature of the missions in Adélie Land differed from those conducted in the mountains of mainland France. Accordingly, the operator did not consider it necessary to address the following points when preparing the mission in Adélie Land:

- ❑ preparation of specific instructions,
- ❑ amendments to the operations manual,
- ❑ consultation with the IPEV regarding lessons learnt during previous years,
- ❑ organisation of a conversion course for the pilot of the first helicopter,
- ❑ designation of a mission manager for the work in Adélie Land.

The failure to provide a conversion course for the first pilot meant that he was unable to become familiar with the company culture, notably in terms of operational procedures and flight safety. In addition, opportunities to make up for this failure to provide a conversion course were missed: no instructions specific to Adélie Land were provided, and a preparatory meeting with the pilots was not arranged.

The operator did not inform the oversight authority that it was opening a new base of operations in Adélie Land. The operator considered that it was not required to notify the authority since its AOC states: "Area(s) of operation: World-wide". If this declaration to the authority had been made, the latter could have detected the deficiencies in the operations manual.

During SAF HELICOPTERES's preparatory work, the operator did not identify all the risks associated with operating in Adélie Land, and did not provide the pilots with the information that was needed to make an objective decision.

2.3 Oversight of the Operator by DSAC

At the start of 2010, the oversight authority noted various shortcomings in SAF HELICOPTERES "quality system" and in their accident prevention and flight safety programme. Since other deviations remained unanswered, notably with respect to the deficiencies in the operations manual, the authority considered that flight safety was compromised. It then threatened to withdraw the operator's AOC in order to oblige it to rapidly adopt corrective measures.

The investigation was unable to determine formally whether or not DSAC was satisfied with the action plan and implementation schedule that the operator submitted to address the shortcomings that had been detected. SAF HELICOPTERES AOC was not withdrawn and the oversight authority did not put in place measures to allow stricter oversight of the operator.

Two months after this warning, DSAC identified further shortcomings at SAF HELICOPTERES. They related to a failure to provide the authority with certain sections of the operations manual and to documentation that was still incomplete. The operator was notified of these shortcomings a few days before the accident.

The relationship between the authority and the operator was not sufficient to ensure that SAF HELICOPTERES operated flights safely.

2.4 Regulations

DSAC considered that starting a new activity in Adélie Land effectively created a new base of operations, which should have been the subject of a declaration to the oversight authority. This declaration would have allowed the authority to familiarise itself with part C of the operations manual, or to require that it be drawn up. It should be noted, however, that the obligation to declare a new base of operations to the oversight authority is not explicitly required by OPS 3. Since the operator's AOC indicates "Area(s) of operation: World-wide" it did not consider that it needed to notify its oversight authority of this new base of operations. Furthermore, OPS 3 does not define the concept of a "base of operations".

3 - CONCLUSIONS

3.1 Findings

- ❑ the pilot held the licences and qualifications necessary to undertake the flight,
- ❑ the helicopter was equipped for day and night flight under VFR only,
- ❑ the helicopter was equipped with a radio altimeter,
- ❑ the meteorological conditions on the ship and at the destination were compatible with visual flight rules, but were not known for all of the planned flight,
- ❑ the satellite map of the accident zone indicates the presence of very low cloud in this zone,
- ❑ the contractual clauses limiting the permitted range for two helicopters flying together to 250 km were not respected,
- ❑ the pilots did not have operational documentation that gave specific instructions for flights in Adélie Land,
- ❑ the pilots encountered an area of bad weather that forced them to fly at an altitude of less than 600 ft, the minimum forward-flight altitude for this type of helicopter (performance class 3),
- ❑ the pilot did not mention any technical problems,
- ❑ the two pilots maintained radio contact for the entire duration of the flights,
- ❑ the pilot had never taken off from, or landed on a helideck at sea,
- ❑ the pilot had taken some medicine product to treat motion sickness, the active ingredient in which has a sedative effect,
- ❑ the operator had not requested an exemption from DSAC to allow it to undertake flights from a helideck at sea,
- ❑ DSAC oversight of the operator had identified, on several occasions and prior to the accident, major shortcomings,
- ❑ DSAC had not been provided with part C of the SAF HELICOPTERES operations manual,
- ❑ DSAC was not aware of the creation of a base of operations in Adélie Land,
- ❑ SAF HELICOPTERES AOC was valid on the day of the accident.

3.2 Probable Causes of the Accident

The accident was due to the decision to undertake the flight and to continue it in unfavourable meteorological conditions in a hostile environment that offered few alternatives to the plan of action. This probably resulted in the loss of visual references in whiteout conditions.

The following factors contributed to the accident:

- ❑ the context of the campaign, which gave particular importance to achieving the mission's goals,
- ❑ the absence of operational documentation relating to operations in Adélie Land,
- ❑ the operator's failure to submit to the oversight authority part C of its operations manual, containing instructions specific to Adélie Land.

Taking medicine with a sedative effect may have contributed to the accident.

4 – SAFETY RECOMMENDATIONS

Note: In accordance with Article 17.3 of European Regulation (EU) 996/2010 of the European Parliament and Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, a safety recommendation shall in no case create a presumption of blame or liability for an accident, a serious incident or an incident. The addressee of a safety recommendation shall inform the safety investigation authority which issued the recommendation of the actions taken or under consideration, under the conditions described in Article 18 of the aforementioned Regulation.

4.1 French Decree of 23 September 1999 (OPS 3)

The investigation found that DSAC was waiting for notification from the operator regarding the creation of a base of operations in Adélie Land. As part of this notification process, the oversight authority would have required the drafting of a part C to the operations manual specific to Adélie Land. However, it should be noted that OPS 3 does not explicitly require this notification.

Consequently, the BEA recommends:

- **that DGAC and EASA define explicitly, in the regulations relating to the operation of helicopters for the transportation of passengers, the concept of a “base of operations” and the procedures for notifying the authority of the creation of a new base of operations. [Recommendation FRAN-2012-014]**

4.2 Area of operation

The investigation found that the operator’s AOC stated that its area of operation was “World-wide”, and that consequently the operator did not consider that it needed to notify its oversight authority of starting new activity in Adélie Land.

Consequently, the BEA recommends:

- **that DGAC describe in the operator’s AOC the countries or areas in which the operator has declared a base of operations. [Recommendation FRAN-2012-015]**
- **that DGAC, in consultation with EASA, place an obligation on operators to declare all passenger transport activity in remote environments to the Competent Authorities. [Recommendation FRAN-2012-016]**

4.3 Oversight by the civil aviation authority of air operators engaged in passenger transport activity

The investigation showed that the auditing of the operator performed by DGAC, the oversight authority, identified shortcomings which indirectly contributed to the accident happening. Various action plans and implementation schedules were submitted to the oversight authority by the operator wherein it undertook to modify its procedures and operations. The DGAC does not have the administrative means necessary to oblige the operator to comply with the action plan and the implementation schedule.

Consequently, the BEA recommends:

- **that DGAC, in consultation with the EASA, set up an oversight system to ensure that any shortcomings identified during audits are corrected by the operator. [Recommendation FRAN-2012-017]**

4.4 Self-medication by flight crew

The investigation found that the pilot of F-GJFJ had taken sea sickness medication during the sea crossing. The active ingredient in this type of medicinal product causes drowsiness which is incompatible with driving or operating machinery. A health professional must be consulted before taking this medication if the subject intends to drive or operate machinery.

However, the delay in performing the toxicological analysis made it impossible to precisely determine the blood concentration of this medicine at the time of the accident. The active principle of this type of medicine causes a sedative effect that is not compatible with operators of machinery. Taking the medicine requires consulting a health professional before any use in this context.

Since the drug can cause drowsiness, a warning is provided for drivers and the operators of machinery intending to use the drug. This restriction is indicated on the packaging by the inclusion of a level 2 pictogram: "Be very careful. Take advice from a health professional before driving". The rate at which the individual eliminates the drug can result in an accumulation of the product in the organism.

The investigation into the accident on 9 October 2009 to the helicopter F-GKRL operated by SAF HELICOPTERES found that the pilot had self-medicated. Although this practice is prohibited in the operator's operations manual, these practices persist, without pilots appearing to be aware of the risks associated with self-medication.

Consequently, the BEA recommends:

- **that DGAC conduct a campaign directed at operators and flight crew to provide information about, and raise awareness of, the risks associated with self-medication prior to engaging in aerial activities. [Recommendation FRAN-2012-018]**

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