AIRCRAFT INCIDENT REPORT

(Cf. Aircraft Accident Investigation Act, No. 59/1996)

Icelandic Coast Guard
Registration: TF-SIF. Type: Aerospatiale SA-365N, Dauphine.
Near Urdarmuli, Snaefellsnes, Iceland (App. at 64°52´70´´N 022°53´10´´W)
On 25th May 2001.

The aim of aircraft accident investigation is solely to identify mistakes and/or deficiencies capable of undermining flight safety, whether contributing factors or not to the accident in question, and to prevent further occurrences of similar cause(s). It is not up to the investigation authority to determine or divide blame or responsibility. This report shall not be used for purposes other than preventive ones.
(Law on Aircraft Accident Investigation, No 59/1996, para 1 and para 14.)

Aircraft: Aerospatiale SA-365N, Helicopter Normal/General/Coast Guard. **Registration:** TF-SIF.

Registered owner: Landhelgissjóður, Seljavegur 32, Reykjavik, Iceland **Operator/user:** Icelandic Coast Guard (ICG)

Crew: Five. **Number of passengers:** None.

Place of accident: Urdarmúli, Snaef. App. 64°52´ 70´´N 022°53´10´´W **Date/time:** 25 May 2001 / 20:57 hrs UTC. 1)

SYNOPSIS. The incident was reported to the Air Traffic Control Centre in Reykjavik, which notified the AAIB at 21:35 hours, and an investigation was immediately initiated by the AAIB. Notification of the incident was sent to the State of manufacture, and the French Bureau Enquetés Accidents (BEA) designated an Accredited Representative at its Paris office to the investigation. A representative from the Manufacturer was also assigned.

The helicopter experienced a sudden upset in low-level flight through a mountain pass in the Snaefellsnes mountain ridge. Immediately after recovery, main rotor vibration was observed and the Commander decided to make a precautionary landing in a nearby grass field in order to inspect the helicopter. It was observed that the main rotor blade tips had passed through the leading edge of the vertical fin and chopped the tops off the stabiliser side fins.

The investigation indicates that the most probable cause for the upset was that the helicopter flew into turbulence at low level close to a mountain ridge where northerly winds and southwesterly winds met. Apparently the helicopter went through rapid pitch up and pitch down motions which the flying pilot tried to counteract with cyclic application. The main rotor blades seem to have made the strikes with the tail section when the fuselage was in the rapid pitch down motion and the "rotor disc" was tilting back.

Two safety recommendations are made during the course of the investigation.

1.1 History of the flight. See page 2.

1.2 Injuries to persons. None.

1. 3 Damage to Aircraft. The leading edge of the vertical fin, the stabiliser side fins, the main rotor blades and the top part of the main gearbox cowling were damaged.

1.4 Other damage. None.

1.5 Personnel information. See page 2.

1.6 Aircraft information. See page 3.

1.7 Meteorological info.: See page 3.

1. 8 Aids to navigation: Not relevant.

1.9 Communications. Not relevant.

1.10 Aerodrome information. Not relevant.

1.11 Flight recorders. The Cockpit Voice Recorder (CVR) proved to be useful to the investigation. See page 3.

1.12 Wreckage and impact information. See page 4.

1.13 Medical and pathological information. Not relevant.

1.14 Fire. There was no fire.

1.15 Survival aspects. The upset caused no harm to the occupants as all were using safety harnesses.

1.16 Tests and research. See page 4.

1.17 Organisational and management info. Not relevant.

1.18 Additional information. Incident in Norway. - See page 4.

1.19 Useful and effective investigation techniques: Not relevant.

2. ANALYSIS.

See page 5.

3. CONCLUSIONS. Probable causal factors marked with an asterisk. *

3.1 The helicopter was airworthy and its documentation was in order.

3.2 The flight crew was properly licensed and medically fit to operate the flight.

* 3.3 The helicopter was flown at low level into turbulence on a mountain ridge causing a sudden up pitch to which the flying pilot acted with a forward cyclic input. The helicopter pitched rapidly forward and the flying pilot reacted with a rearward cyclic and the main rotor blades struck the vertical stabilizer and the stabiliser vertical fins.

3.4 Less cyclic input and application of appropriate collective at the critical moment could possibly have prevented the rotor blade strike.

3.5 Flight at the appropriate altitude above ground, i.e. 500 feet or more, could have prevented the encounter of the type of turbulence that most probably initiated the upset.

4. SAFETY RECOMMENDATIONS:

See page 6.

5. APPENDICES:

5.1 Report from the Icelandic Meteorological Office.

5.2 Map showing the location of the incident.

5.3 Photographs of the damages to the helicopter.

5.4 Rotorspeed analysis from the CVR.

1) All times in this report are Icelandic time or UTC.

1. FACTUAL INFORMATION.

1.1 History of the flight:

Friday 25. May 2001, TF-SIF an Icelandic Coast Guard SA-365N helicopter was dispatched for a survey and patrol flight over the northern Faxafloi bay and Breidafjördur bay on the west coast of Iceland with refuelling at Rif on the western tip of Snæfellsnes peninsula that separates the two bays.

The crew consisted of the Commander, the First Officer, two Coast Guard Officers occupying the seats aft of the pilots and a Hoist Operator/Flight Mechanic occupying the rear seat. The take-off from Reykjavik airport was at 17:25 hrs. The operation was then according to the plan and the helicopter landed at Rif airstrip at 19:17 hrs where it was refuelled.

The take-off from Rif was at 20:01 hrs and a survey flight was carried out over southern Breidafjördur bay. Then the course was set southeast through the valley from the fjord Hraunsfjordur. The helicopter climbed to 1500 feet staying below clouds that covered the Snaefellsnes mountain ridge and the plan was to resume the patrol flight over the bay Faxafloi south of the mountains.

The weather was good and according to the Commander, there were no indications that turbulence might be expected. The helicopter flew south over Hraunsfjördur, then southeast over lake Hraunsfjardarvatn and lake Baulárvallavatn. Then a slight right turn south was made over the hills at the western slopes of the valley. The land rises slightly towards Urdarmuli, a rather steep hill at the south end of the slopes, which is about 1000 feet above sea level. The helicopter was climbing slightly, according to the Commander, and height above ground was maintained between 30 and 50 feet. A slight tailwind was observed after the turn and indicated airspeed was kept at approximately 120 knots.

As the helicopter reached the southern ridge, without a warning, the helicopter pitched up and the Commander applied forward cyclic as an immediate reaction. The rotor speed went up and the helicopter pitched rapidly forward so the Commander immediately applied rearward cyclic. The helicopter levelled off with a slight left roll. The crew, however, noticed rotor vibration after the incident and a landing site was selected on a grass field adjacent to the nearest main road that is about 60 feet above sea level. There an uneventful landing into the southwesterly wind was made about two minutes after the incident. After landing, damages to the tail section and main rotor blades were discovered.

During the investigation into the incident the Cockpit Voice Recorder examination revealed that a high-speed warning, a thud and a momentary low speed warning were recorded, none of which was perceived by the crew.

1. 5 Personnel information.

1.5.1 The Commander.

Male 45 years old. Holding an Airline Transport/Helicopter Licence, issued 29. December 1999 by the Icelandic CAA, valid until 29. December 2004. Last Medical Certificate, 1st Class, no limitations, Issued 29. March 2001.

Type ratings: SA-350B, SA-365N, AS-332.

SA-365N Co-pilot, 16. June 1989. Captain on SA-365N, 2. September 1997. Total flying time 6621:45 hrs. Total flying time on SA-365N, 860:35 hrs. Total flying time during the 90 days prior to the incident, was 50:25 hrs and on SA-365N, 25:55 hrs.

Technical Refresh Course on SA-365N with CHC Helicopter Service AS Training Centre, 13. February 2001. Last Proficiency Checks on AS-332L/L1: 15.-16. October 2000. Last Proficiency Check on SA-365N: 2. August 2000.

1.5.2 The Co-pilot.

Male 30 years old. Holding an Airline Transport/Helicopter Licence, issued 31. August 2000 by the Icelandic CAA, valid until 31. August 2005. Last Medical Certificate, 1st Class, no limitations, Issued 2. August 2000.

Type ratings: B-206BII, B-206BIII, B-206L1, R-22, SA-365N co-pilot, AS-332.

SA-365 Co-pilot, 9. August 1998. Total flying time 1933 hrs. Total flying time on SA-365N, 222 hrs. Total flying time during the 90 days prior to the incident was 40:30 hrs and on SA-365N, 19:18 hrs.

Technical Refresh Course on SA-365N with CHC Helicopter Service AS Training Centre, 13. February 2001. Last Proficiency Checks on AS-332L/L1: 12.-13. May 2001. Last Proficiency Check on SA-365N: 18. May 2000.

1.6 Aircraft information.

1.6.1 The Aircraft. Aerospatiale, SA-365N, Dauphin helicopter, built in November 1985 and fitted with two Arriel-1C turbo shaft engines. It was registered in Iceland 27 August 1985. The helicopter airframe and both engines had 5600 hrs total time since new at the time of the incident. The helicopter has been operated and maintained by the Icelandic Coast Guard since new.

1.6.2 Centre of Gravity. The Maximum authorised take-off weight is 4000 kg. According to the aircraft documents, the weight of the helicopter at the time of the incident was approximately 3710 kg, whereof fuel was 610 kg. The Centre of gravity was 3,87 inches aft of datum. The forward limit is 3,81 inches and the aft limit is 4,02 inches.

1.7 Meteorological Information. At 15:00 hrs there was light wind (approximately 10 knots) from south and southwest on the Snæfellsnes peninsula. At 20:00 hrs the wind was more westerly on the south side of the mountains but had turned to northeasterly and increased substantially at the automatic weather observation station in Kerlingarskarð mountain pass just north of the incident site. The wind had increased to approximately 20 knots at 21:00 hrs.

This was also shown by the recording of the Global Positioning System (GPS) in the helicopter that indicates that the helicopter had picked up tailwind just prior to reaching the ridge. From the debris on the ground that was spread in northwest-southeast direction it can be deduced, that wind shear could have existed at the point of the incident, which was further supported by the south-westerly wind on the landing location just south of the incident spot.

The full report and analysis of the Icelandic Meteorological Office is attached to this report.

1. 11 Flight recorders.

1.11.1 Cockpit Voice Recorder (CVR) Data. The helicopter is fitted with CVR and its recording was examined after the incident in the laboratory of UK-AAIB in England. The recording supported the crew's account of the event and by analysing the frequency of the sound from the main rotor, the rotational speed was recorded and analysed.

From the average of about 355 RPM, the speed exceeded 380 RPM in 4 seconds, high RPM warning sounded within a second and 17 beeps were recorded, lasting about 2 seconds. The RPM started to drop immediately after reaching its peak and dropped to about 335 RPM in 3 seconds when a thud was recorded. Low RPM warning sounded just over a second later but lasted only for two beeps. The RPM had started to increase again immediately after reaching the minimum when the thud was recorded. The main rotor speed stabilised at about 355 RPM just over 2 seconds after reaching the minimum. The whole upset lasted about 9 seconds according to the CVR data.

1.11.2 Global Positioning System (GPS) Data. The helicopter was fitted with a GPS system and the computer data was transcribed to give time, position and ground speed. This data indicated varying ground speed during the passage through the valley crossing the peninsula. This would be expected as the flight altitude was following the landscape and also the wind component would have been changing. This data indicated that the groundspeed of the helicopter increased by approximately 15 knots about one minute prior to the incident after it took a slight turn to heading 165 degrees.

1.12 Wreckage and Impact Information.

1.12.1 Debris from the helicopter. At the site of the incident the AAIB investigators collected information about the spread of debris from the helicopter and the geographical details of the area. Debris was found along the top of a small ridge that is an extension of small hills (Rauðhólar) and is formed by a small river bead south of it, both having west-northwest and south-southeast direction.

The debris was spread from a point in a cone shape between the general directions 135 degrees and 150 degrees for about 150 meters. From the GPS information it seems that the heading of the helicopter was about 165 degrees when it encountered the upset changing to about 150 degrees. As the main rotor of the helicopter has a clockwise rotation as seen from above, the spread of the debris is commensurate with it falling down to the left of the helicopter heading, and the fanning out being due to the height of the adjacent rising ground.

1.16 Tests and research.

At the time of the upset, the Stabilisation System (Autopilot) was selected “ON” and the Autopilot (Coupler) was selected “OFF”. The Stabilisation System is used either to damp low amplitude motion (SAS function (Stability Augmentation System)) or to hold attitude and heading at the reference values selected by the crew (ASE function (Auto Stability Equipment)). According to the crew the ASE function was selected “ON” during the flight.

A functional test was performed on the Stabilisation System under the supervision of the AAIB and it was found to function normally.

A functional test of the hydraulic system and lower body main rotor servos was also carried out, using the emergency electrical pump pressure also a functional test (self test) of the autopilot system. All hydraulic systems were thoroughly tested and inspected. No contamination was found in the filters or the systems.

A rigging check was performed by two AAIB specialists. The results were presented and analysed with a specialist from the manufacturer. The investigation did not reveal any signs of out tolerances or malfunctions that might have caused or contributed to the incident.

After the helicopter had been repaired, a full pre-flight check was carried out. The helicopter was then restored to flying status after extensive functional tests and uneventful test flights 19. July 2001.

1.18. Additional Information.

1.18.1 Search for similar events. The AAIB searched the ICAO ADREP Information system, consulted the helicopter manufacturer and the USA Coast Guard (USCG) for information regarding similar events. Nothing comparable with this was found. The USCG operates a fleet of 94 HH-65 (SA-365) helicopters that have been in service since 1984. There have been five reported mishaps where the main rotor blades have contacted the tail section (the fenstron) resulting in damage. One of the mishaps was formally investigated, an event that occurred during no hover landing executed with excessive aft cyclic flight control application (sufficient to illuminate the main rotor load limit light) and rapidly lowered collective.

1.18.2 An incident occurring in Norway. A Norwegian ambulance helicopter SA-365N with three crewmembers, departed from Tromsö hospital on 17 May 1999. The reported wind was 20 knots and the Stapilistation System was engaged.

Few minutes after departure and flying close to the shore in a fjord at 800 ft and at 150 knots in a moderate turbulence, the helicopter suddenly pitched nose down (30-40 degrees). At the same time heavy turbulence was encountered. The pilot corrected the movement with abrupt use of the cyclic. After regaining control, the flight continued in moderate turbulence at reduced speed of approx. 135 knots. The pilot felt that the helicopter flew with slight nose down attitude, but not so much as to "ring any alarm bells" according to the pilot. Descending at the landing site, the pilot felt that he had to pull back the cyclic more than usual. After landing the crew discovered that the horizontal stabilizer had broken away approx. 25-30 cm on both sides from the tail boom. The investigation of this incident is still going on with the Norwegian AAIB.

2. ANALYSIS.

From the Crew's description of the events, the evidence from the location of the incident, CVR recordings, the GPS data and the IMO weather analysis; the following scenario is proffered as the most probable cause of the incident.

The helicopter was flown at relatively low level above ground. At the location of the upset there was considerable updraft or turbulence, perhaps like a narrow rotor similar to wing tip vortices that trail behind aircraft wings during take-off runs and in flight. This type of turbulence is quite possible where winds meet on a ridge and components of it could have similar size as the helicopter and produce strong non-uniform forces over it. For the helicopter, however, to enter such turbulence it would have to be very close to the ground.

As the helicopter picked up speed going south to the ridge it is quite evident that there was substantial wind going in that general direction. The wind south of the ridge, however, was most probably from west or southwest, which was observed within minutes of the incident when the helicopter landed. This wind, which was relatively calm at sea level, may have been substantially stronger at the ridge due to the funnelling effect of the landscape and the elevation above sea level.

When the helicopter encountered the updraft it pitched up. The reaction of the flying pilot was as recommended to push the cyclic forward to compensate for this. The immediate response of the helicopter was to pitch forward at which time it would perhaps have been prudent to apply some collective to increase the load on the disc and increase the altitude. The CVR recorded high rotorspeed warning for two seconds, a warning that should also have been audible in the Internal Communication System (ICS) headphone circuit. The rapid forward pitching of the helicopter and the closeness to the ground, however, caused the pilot to apply aft movement of the cyclic. At this moment the helicopter tail section and the main rotor blades would have been moving rapidly towards each other, aggravated by the sudden increase in inflow into the disk from the pitch down attitude and the relatively high forward speed of the helicopter.

When all these factors came together the retreating main rotor blades tracked so low as to hit the vertical stabilizer and the stabilizer side fins. The rotor RPM dropped momentarily and caused a low RPM warning, but the crew never heard the warnings so their reaction was not influenced by that. Caution lights, however, illuminated but the flight crew was too busy gaining control and the event was so short that their memory of which lights came on was unreliable. With excessive fore or aft cyclic flight control application and low collective the main rotor load limit light (amber) would illuminate on ground, but in the air it would indicate that load threshold on the right hand roll channel servo would have been reached.

Examination of the flight controls and the hydraulic system did not reveal any defects. Normal control of the helicopter was also available after the incident further supporting the conclusion that this was not brought on by a mechanical fault. After repair of the helicopter that included new main rotor group components, the helicopter had extensive functional tests and uneventful test flights and no further clues to this event were discovered.

The manufacturer of the helicopter has not issued any specific recommendations to flight crews regarding a situation like this, apparently due to lack of recorded events similar to this. Consequently the recommended reaction by the manufacturer to pitch deviations is cyclic application only.

The AAIB considers it interesting to compare this incident to the Norwegian incident where an abrupt movement of the cyclic to correct a sudden nose down pitch at high forward speed did not generate a strike on the tail. Perhaps the additional collective required to maintain the much higher speed in the Norwegian case made a difference and also that the upset did not commence with an abrupt pitch up attitude. It is also interesting to consider that a high forward speed (150 knots) that is suddenly translated into a heavy download on the stabilizer can cause it to break off without any other alarming consequences.

The AAIB considers it unlikely that the incident to TF-SIF would have developed the way it did, had the recommended minimum altitude above ground of 500 feet been maintained. Due to the very nature of the ICG operations, however, it is perhaps understandable that low level flying take place albeit for training purposes as flight simulators have not been available for this type of helicopters until very recently.

As of February 2002, a flight simulator will be available for SA-365N, and the ICG is planning to make use of it in training their crews.

4. SAFETY RECOMMENDATIONS.

Due to the multiple roles of the ICG and the “all weather operation” required, where superior knowledge and training to that of commercial aviation is necessary, the Aircraft Accident Investigation Board recommends that:

4.1. The Icelandic Coast Guard reviews the training curriculum for their flight crews regarding specific helicopter aerodynamics and the recommended responses to unusual situations that could arise due to low level turbulence.

Due to the apparent lack of re-current training requirements in meteorology in commercial aviation training curriculum, the AAIB recommends that:

4.2 The Icelandic Civil Aviation Administration issue an Aeronautical Information Circular on the risks of encountering hazardous wind shear in low-level turbulent flow, based on the analysis of the Icelandic Meteorological Office.

Reykjavik, 12. December, 2001

Aircraft Accident Investigation Board