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AAIB
Air Accidents Investigation Branch

AAIB Bulletin S7/2013 *SPECIAL*

ACCIDENT

Aircraft Type and Registration:	AS332 L2 Super Puma, G-WNSB
No & Type of Engines:	2 Turbomeca Makila 1A2 turboshaft engines
Year of Manufacture:	2002 (Serial no: 2582)
Location	Approximately 1.5 nm west of Sumburgh Airport, Shetland Islands
Date & Time (UTC):	23 August 2013 at 1717 hrs
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 16
Injuries:	Crew - 1 (Serious) Passengers - 4 (Fatal), 3 (Serious)
Nature of Damage:	Helicopter destroyed
Commander's Licence:	Airline Transport Pilot's Licence (Helicopters)
Commander's Age:	51 years
Commander's Flying Experience	TBA
Information Source:	AAIB Field Investigation

The investigation

At 1717 hrs UTC on 23 August 2013, an AS332 L2 Super Puma helicopter, with 18 persons on board, crashed into the sea whilst on approach to Sumburgh Airport in the Shetland Islands. Four of the passengers did not survive.

The AAIB immediately despatched a team of investigators and support staff to Aberdeen and the Shetland Islands. In accordance with the normal protocols, the AAIB invited representatives from the French accident investigation authority (the Bureau

d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation civile (BEA)), the helicopter manufacturer, and the engine manufacturer, to participate in the investigation. Representatives from the European Aviation Safety Agency (EASA) and the UK Civil Aviation Authority (CAA) were also invited to participate.

AAIB Special Bulletin S6/2013, published on 5 September 2013, provided initial information on the circumstances of the accident. This bulletin provides an update on the significant investigation findings to date.

History of the flight

The flight, which was the third leg of a four-leg rotation out of Aberdeen Airport, was between the Borgsten Dolphin semi-submersible drilling platform and Sumburgh Airport. The intention was to refuel the helicopter at Sumburgh, before returning to Aberdeen. The helicopter lifted from the Borgsten Dolphin platform at 1612 hrs, with the commander acting as the Pilot Flying (PF) and the co-pilot as the Pilot Not Flying (PNF)[1].

The flight towards Sumburgh was uneventful, except for the commander experiencing a problem with his collective pitch trim release switch on a number of occasions when adjusting the collective lever position. The problem appeared to have been resolved by both pilots exercising their respective switches and did not significantly affect the conduct of the flight. It did not occur during the approach phase.

Whilst en-route, the crew requested radar vectors to the final approach course for Runway 09; the request was acknowledged by Sumburgh Air Traffic Control (ATC).

Footnote

[1] These terms are used in the operator's Operations Manual to describe the role of each pilot during a flight.

At 1626 hrs the crew listened to the 1620 hrs Sumburgh ATIS information 'Whisky'. This gave the weather conditions as: surface wind from 150° at 18 kt, visibility 4,000 m in haze, scattered cloud at 300 ft, broken cloud at 500 ft, temperature +15°C, dew point +14°C and pressure 1014 hPa.

At 1648 hrs, Sumburgh ATC informed the crew of the latest weather. The visibility was 2,800 m in mist, with few clouds at 200 ft and broken cloud at 300 ft. The commander briefed for the 'SUB' LOC/DME Non-Precision Approach[2] to Runway 09 at Sumburgh Airport. The Minimum Descent Altitude (MDA)[3] for the approach was 300 ft and the Automatic Voice Alarm Device (AVAD) bugs were set accordingly. The plan was that the commander would fly the approach while the co-pilot monitored the vertical descent profile with reference to the published approach chart. The commander briefed that he would reduce the airspeed to 80 kt for the latter stage of the approach.

At 1702 hrs, the 'Approach' and 'Before Landing' checklists had been completed. The helicopter, receiving a radar control service from Sumburgh ATC, was vectored to the north of Sumburgh before being turned onto a south-easterly heading and being cleared to intercept the localiser[4] for Runway 09.

The autopilot was engaged in Heading (HDG) and Altitude (ALT) modes, with the APP push button selected on the Automatic Flight Control Panel (AFCP). The localiser was captured at 1714 hrs. At 6.4 DME 'SUB', the commander initiated the descent using the

Footnote

[2] This is an approach flown without the aid of an electronic glideslope; the descent profile must therefore be managed by the pilot.

[3] The MDA is the altitude below which an aircraft may not descend on an approach unless the crew has acquired the required visual reference for landing.

[4] This provides electronic guidance to the final approach course.

autopilot vertical speed (V/S) mode with a selected rate of 500 ft/min. A cross-check by the co-pilot at 5 nm and 1,670 ft indicated to the crew that they were on the correct vertical profile. There were further checks at 4 nm and 3 nm, which confirmed that the vertical profile was being maintained.

At 3 nm the airspeed was 110 kt and reducing. At approximately 2.3 nm, the commander noted that the airspeed was 80 kt and increased the collective pitch, intending to maintain this speed. However, the helicopter's airspeed reduced below 80 kt and continued to reduce, unobserved by the crew.

At 2.0 nm the co-pilot advised the commander that the height at 1 nm should be 390 ft. The co-pilot made a call at 100 ft above the MDA (300 ft); the commander acknowledged. There was then an automated audio call of "CHECK HEIGHT", an acknowledgement by the commander, and then a comment by the co-pilot to draw the commander's attention to the airspeed. At this time the helicopter's airspeed was 35 kt and reducing. Shortly thereafter, there was a second automated audio call of "CHECK HEIGHT", followed by a "100 FEET" automated call two seconds before impact with the surface of the sea.

At some point the commander saw the sea, but he was unable to arrest the helicopter's descent and it struck the surface shortly thereafter, at 1717 hrs. The co-pilot, realising that the helicopter was about to enter the water, armed the helicopter's flotation system. After striking the surface the helicopter rapidly inverted, but remained afloat, the flotation equipment having successfully deployed.

Of the 18 occupants, 14 survived. The survivability aspects of this accident are the subject of ongoing investigation.

Standard Operating Procedures

The operator publishes its Standard Operating Procedures in the Operations Manual.

The procedure for a Non-Precision Approach, flown in conditions where the cloud base and visibility are reduced, requires the PF to fly the approach by reference to instruments. The PNF is required to monitor the approach and to look outside in order acquire the visual reference for landing. If the visual reference is sufficient, the PNF will advise the PF and take control from him for the landing phase. If visual reference is not acquired then there is no handover of control and the missed approach profile is flown by the PF.

Aircraft information

The AS332 L2 variant of the Super Puma helicopter is a large twin-engine transport helicopter, developed as a derivative of earlier AS332 models. The fuselage is 16.5 m long, 3.4 m wide and 5 m high. The diameter of the four-bladed main rotor is 16.2 m. It is certified for a maximum seating capacity of 25, but the accident helicopter was configured with 19 passenger seats. The helicopter has a maximum takeoff mass of 9,300 kg.

G-WNSB was manufactured in 2002. The last recorded total flight hours for the airframe was 13,749 hrs.

Wreckage recovery

Witness evidence showed that the helicopter's fuselage was largely intact following impact with the sea. It then drifted northwards onto the shoreline of Garth's Ness headland, to the west of Sumburgh Airport. Over the ensuing hours, significant damage was caused by wave action driving the fuselage onto the rock outcrops of the cliffs along the headland. This caused the fuselage to break up and also caused damage to the

engines and main rotor head/gearbox assembly which became detached from the fuselage. The rear part of the fuselage was the only section to remain on the surface, held afloat by a flotation bag; the only one of the four flotation bags that had remained inflated. This section of wreckage was towed offshore and secured to a coastguard vessel prior to recovery.

The tail section of the helicopter, containing the Combined Voice and Flight Data Recorder (CVFDR), became detached from the fuselage at some point after the impact with the sea and was found at a location further to the south of the main fuselage wreckage. The CVFDR was equipped with an Underwater Locator Beacon (ULB). The ULB was difficult to detect however, as its detection range was significantly reduced due to the physical environment.

After an extensive search, and difficult salvage operation, significant items of wreckage were successfully recovered from the seabed. These included the tail section, with the CVFDR in situ, two sections of the cockpit instrument panel, both engines and the main rotor gearbox with the main rotor head attached. A number of smaller items of floating wreckage were also recovered from the shoreline. The wreckage was transported to the AAIB's headquarters for further examination.

Wreckage examination

Despite the extensive post-impact damage caused by repeatedly striking the rocks, examination of the main rotor head and the remains of the main rotor blades revealed evidence of high-speed rotation at impact. Similar evidence was found on the tail rotor blades and the tail rotor drive shaft. The main rotor shaft was intact, as was the main rotor gearbox. The main rotor gearbox was inspected internally via access panels; no evidence of any pre-impact damage was found. The engines also showed no evidence of pre-impact damage.

The CVFDR, removed from the tail boom immediately after being recovered from the seabed, was transported to the AAIB flight recorder laboratory for the data to be downloaded. Specific items of avionics equipment, within the recovered sections of the cockpit instrument panel, were identified as containing Non-Volatile Memory (NVM). The NVM data was successfully recovered for analysis with the assistance of the BEA.

Recorded data

The recorded data was successfully downloaded from the CVFDR on the evening of 1 September 2013 after 48 hours of drying in controlled conditions. The CVFDR had recorded the most recent 78 hours of flight data and two hours of audio into a crash-protected solid-state memory. A complete record of the accident flight was available.

The CVFDR audio record consisted of the commander and co-pilot communications, radio transmissions and passenger announcements. These were recorded into two channels, and ambient sound from a cockpit area microphone (CAM) was recorded to a third channel.

Figure 1 presents the salient recorded data for the final approach to Runway 09.

Final Approach to Runway 09

The recorded data show that the approach was conducted with the autopilot in 3-axes mode. At 6.4 nm, the commander advised that he was starting the descent and, with a selected vertical speed of 500 ft/min[5], engaged

Footnote

[5] The selected vertical speed parameter is only recorded every 64 seconds.

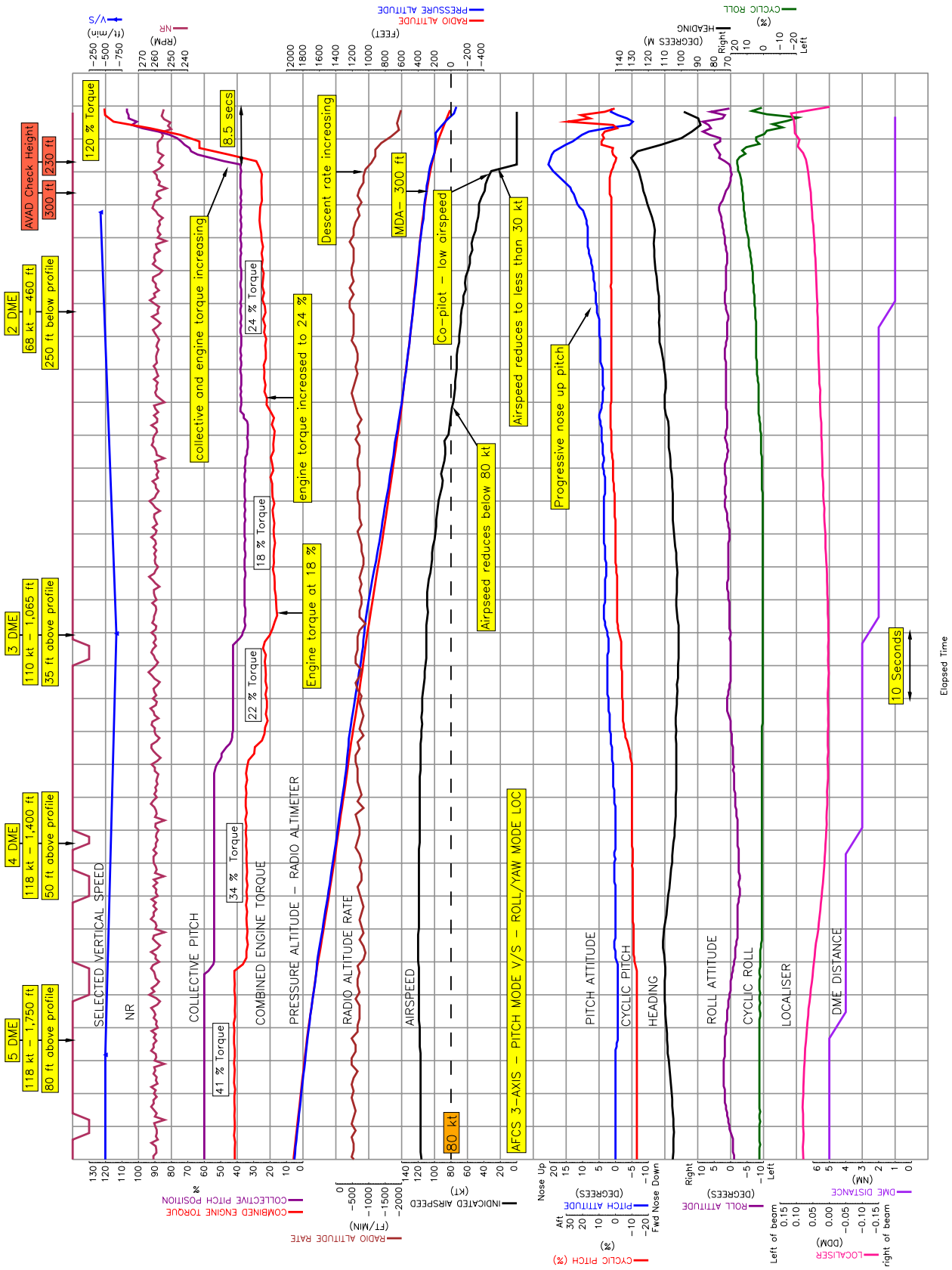

Figure 1

Recorded data parameters for the Final Approach

the autopilot V/S mode. The autopilot ALT.A (Altitude Acquire)[6] mode was not used for the approach.

At 3 nm, the collective pitch was reduced and the engine torque stabilised at 18%. The airspeed was reducing at a rate of about 1 kt per second.

At approximately 2.6 nm and an altitude of 800 ft, the co-pilot advised they had 500 ft to go to the MDA, which the commander acknowledged. The airspeed was 87 kt and the descent rate was about 700 ft/min. When the airspeed reached 80 kt the collective pitch was increased, with an accompanying increase in engine torque to 24%.

At 2.2 nm, the helicopter was at an altitude of 560 ft and the airspeed was 74 kt. The helicopter's pitch attitude started to increase slowly as the autopilot maintained the selected vertical speed, whilst the airspeed continued to decrease.

With the co-pilot having advised that the target altitude at 1 nm was 390 ft, the commander stated that he was reducing the rate of descent; the rate reduced from about 700 ft/min to about 500 ft/min. Several seconds later, the co-pilot advised they had 100 ft to go to their MDA and the commander acknowledged. The descent rate was being maintained at about 500 ft/min, but the airspeed had by then decreased to 54 kt and the pitch attitude was 8° nose-up with engine torque stabilised at about 24%.

The AVAD aural "CHECK HEIGHT" function activated at a height of 300 ft above the sea. The airspeed had reduced to 43 kt and the pitch attitude was now 12° nose-up. The co-pilot alerted the commander to the airspeed.

Footnote

[6] In this mode the autopilot will level the helicopter at a pre-selected altitude.

At a height of 240 ft, the helicopter's pitch attitude was 20° nose up, the airspeed 32 kt and the rate of descent about 1,000 ft/min and increasing. There was then an increase in collective pitch and engine torque and the cyclic stick was moved forward. A second AVAD "CHECK HEIGHT" callout occurred at this time. The helicopter was at 230 ft and the airspeed had reduced to below 30 kt (airspeeds of less than 30 kt are not recorded on the CVFDR).

In response to the increase in collective pitch, engine torque increased at a rate of about 14% per second. The helicopter's descent rate nevertheless continued to increase. As it descended through 100 ft, the AVAD 100 ft call was recorded. Engine torque was now at 115% and the descent rate was approximately 1,800 ft/min.

The helicopter impacted the surface of the sea approximately 1.5 nm from the threshold of Runway 09, yawing to the right and in an approximately level attitude. The exact rate of descent at impact is not known, but the impact was survivable.

Manufacturer's review of recorded data

The helicopter manufacturer was provided with a copy of the recorded flight data for analysis. They concluded from their analysis that, in the last 30 minutes of flight prior to impact with the sea, the helicopter had behaved as expected based on the recorded control inputs, and no pre-impact malfunction was evident.

This initial analysis also showed that the combination of the nose-high attitude, low airspeed, high rate of descent and high power placed the helicopter in a vortex-ring state[7] entry condition (VRS) during the final stages of

Footnote

[7] In this condition (also known as 'settling with power') the effectiveness of the main rotor is significantly reduced due to the associated airflow characteristics.

the flight. The manufacturer's modelling indicated that, in this condition, the reduced helicopter performance, together with the limited height available, meant that the impact with the sea was unavoidable.

Search and Rescue aspects

General

Numerous airborne and surface rescue assets were deployed to the accident location to search for the helicopter and rescue survivors. The first to arrive was the Maritime and Coastguard Agency (MCA) Search and Rescue (SAR) helicopter, which was on scene 26 minutes after the accident. (As a Category 1 responder under the Civil Contingencies Act, the MCA is responsible for providing the primary emergency response.)

Five of the survivors were rescued from the water. Of the 10 occupants who had boarded the two life rafts deployed from the helicopter, one did not survive.

Sumburgh Airport surface rescue facilities

ICAO Annex 14 and UK Civil Aviation Publication (CAP) 168 (Aerodrome Licensing) require airport operators to make arrangements for the rescue of survivors of aircraft accidents that occur on airport approach and departure paths. Although Annex 14 does not define a specific distance, CAP 168 states that the area within 1,000 m of a runway threshold should be assessed.

There is sea beyond each end of Runway 09/27 at Sumburgh Airport. The airport is therefore required to have an appropriate resource for open water rescue to the east and west of the airport to respond effectively to incidents within 1,000 m of the runway threshold. The accident location was beyond the aerodrome response area.

The Airport Fire Service (AFS) has an 8.6-metre rigid inflatable Fast Rescue Craft (FRC) equipped to operate within the areas of sea near the runway thresholds. The FRC has to be towed on its trailer to the launch site by a suitable vehicle.

Rescue response time

There is no specified rescue response time in CAP 168; however, in order to be effective, a rescue has to occur within the time frame that a person can survive in the environment from which they require rescuing. The majority of Sumburgh Airport's passengers travel on fixed-wing aircraft and therefore do not wear survival suits. The passengers on G-WNSB were wearing survival suits, but the crew were not.

The AAIB investigation has determined that the slipway near the Runway 09 threshold is both shorter and narrower than optimum. The narrowness of the slipway requires the launch vehicle to be connected to a safety winch, adding a six minute delay. Furthermore, an airport safety survey, conducted in 2010, indicated that the slipway could be used typically in only 11% of tidal conditions.

The nearest alternative launch site, intended for the protection of Helicopter Runway 06/24, is to the south of the airport. The Runway 09 threshold is a 4 nm sea transit from this launch site. The site is located on a soft, sand beach, which poses a risk of the FRC launch vehicle becoming bogged down.

The FRC could not be launched from the slipway near the Runway 09 threshold in response to this accident due to the unfavourable tidal conditions that prevailed. An attempt was made to use the alternate launch site, but the FRC became bogged down in the soft sand and had to be recovered. The FRC was launched from the

Runway 27 slipway, requiring a 6 nm open sea transit around the peninsula to the accident location. It arrived at the accident location 58 minutes after the accident. Two of the three FRC crew members sustained injuries due to the difficult sea conditions encountered during the transit.

This accident has highlighted that, in the majority of tidal conditions, the FRC may not be able to respond to aircraft accidents in the sea on the western side of Sumburgh Airport within the available survival time.

The following Safety Recommendations are therefore made:

Safety Recommendation 2013-021

It is recommended that the operator of Sumburgh Airport, Highlands & Islands Airports Limited, provides a water rescue capability, suitable for all tidal conditions, for the area of sea to the west of Sumburgh, appropriate to the hazard and risk, for times when the weather conditions and sea state are conducive to such rescue operations.

Safety Recommendation 2013-022

It is recommended that the Civil Aviation Authority (CAA) review the risks associated with the current water rescue provision for the area of sea to the west of Sumburgh Airport and take appropriate action.

Published 18 October 2013

Summary

To date, the wreckage examination and analysis of the recorded data have not found any evidence of a technical fault that could have been causal to the accident, although some work remains to be completed. The ongoing AAIB investigation will focus on the operational aspects of the flight; specifically on the effectiveness of pilot monitoring of instruments during the approach, operational procedures and the training of flight crews.

The survivability aspects of this accident will also be examined in detail.

Safety actions

The operator of G-WNSB has undertaken a review of its operational guidance on the use of automation and has further enhanced the guidance to support the full use of automation as the default, whilst allowing for the maintenance of essential degraded-mode/manual handling flying skills.