AIRCRAFT ACCIDENT REPORT 5/88

Air Accidents Investigation Branch

Department of Transport

Report on the incident to Sikorsky S-76A helicopter G-BHYB near Fulmar A Oil Platform in the North Sea on 9 December 1987.

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Department of Transport
Air Accidents Investigation Branch
Royal Aerospace Establishment
Farnborough
Hants GU14 6TD

14 September 1988

The Right Honourable Paul Channon
Secretary of State for Transport

Sir,

I have the honour to submit the report by Mr R C McKinlay, an Inspector of Accidents, on the circumstances of the incident to S-76A helicopter, which occurred near Fulmar A oil platform on 9 December 1987.

I have the honour to be
Sir
Your obedient servant

D A COOPER
Chief Inspector of Accidents

Contents

Air Accidents Investigation Branch

Aircraft Accident Report No: 5/88
(EW/C1051)

Registered owner and operator:		British International Helicopters Ltd
Aircraft:	*Type:*	Sikorsky S-76A helicopter
	Nationality:	British
	Registration:	G-BHYB
Place of incident:		Near Fulmar A oil platform, in the North Sea, 150 nm east of Aberdeen Latitude 56° 29.6' N Longitude 002° 09.3' E
Date and time:		9 December 1987 at 1848 hrs All times in this report are UTC

Synopsis

The incident was notified to the Air Accidents Investigation Branch on 9 December 1987, and the investigation began the following day. The AAIB team comprised Mr R C McKinlay (Investigator in Charge), Mr R G Matthew (Operations), Miss A Evans (Cockpit Voice Recorder) and Mr R D G Carter (Engineering).

The aircraft was conducting a series of Shuttle flights between the Fulmar A and the Auk oil production platforms. The evening's flying, during which the incident occurred, comprised six Shuttle flights, each of two sectors.

On the fourth sector, whilst descending on an approach from a height of about 500 feet to the Fulmar platform and at about a quarter of a mile from the helideck, the aircraft lost all forward speed and entered a steep descent towards the sea. At a very late stage, the co-pilot managed to arrest the descent just as the aircraft touched the water. The flight was continued to a normal landing on the Fulmar helideck.

The report concludes that the incident was caused by the following:

1. The commander suffered a temporary incapacitation.

2. The co-pilot's response to the emergency situation was delayed partially by insufficient flightpath and instrument monitoring and partially by the difficulty of appraising the situation. The proportion of each is not known.

3. The company Operations Manual contained no procedures for the use of the Automatic Voice Alerting Device during visual approaches.

1. Factual Information

1.1 History of the flight

The Sikorsky S-76A helicopter, G-BHYB (YB), was fulfilling a charter contract with an oil company, shuttling maintenance workers between their place of work and their accommodation. To this end, it was engaged in a series of Shuttle flights between the "Fulmar A" oil platform (shown at Appendix 1), where it was temporarily based, and the "Auk" platform, a distance of 6.4 nm. Although the aircraft is approved for single pilot operation in all conditions of flight, the oil company contract required two pilots to be on board. In this case, two captains fulfilled the functions of commander and co-pilot and it was decided between them who was to be commander for these flights. Because the prevailing wind dictated that all the approaches would be made from the left side of the helidecks, it was also decided that the commander, on the right side of the aircraft would be the handling pilot throughout. The pilots remained in these respective roles throughout the evening's flying, with the commander as handling pilot.

The weather that evening was well within the requirements for a visual flight and approach to the platforms, the wind was 350°/11 kt, the visibility unlimited and the cloud 4 oktas at 2500 feet. Although the sky was nominally less than half obscured by the cloud, it was totally dark, and this darkness was emphasised by contrast to the platform illuminations. On the approach from the south, no other platform or rig was visible to the crew and the sole source of visual reference was the brightly illuminated platform, with its attendant brilliant and pulsating flare.

Three sectors of the evening Shuttles had already been completed without event, and YB lifted off from the Auk helideck, with eight passengers aboard, at 1843 hrs. Because one of the crane jibs had been protruding from the west side of the Fulmar during the first Shuttle, the approach had been made from a direction slightly to the west of south. For the second arrival at the Fulmar platform, the jib had been re-stowed and the approach was therefore made, more directly into the prevailing wind, from the south. It is apparent, from reference to Appendix 1, that this line of approach put the flare and the drill derrick closer to the pilot's line of sight to the helideck. Both of these structures are illuminated by the necessary obstruction lights and the flare itself which, together with the platform's working lights, combine to produce a significant contrast to the otherwise dark environment.

In accordance with normal practice, the cruise phase of the flight was conducted at about 140 kt, some 500 feet above the sea, and the commander elected to begin the deceleration phase, prior to landing, from a point about 1 nm distant from the platform. This was abeam a Fuel Storage Unit vessel (FSU) moored at that position. Up to this point, the flight had been normal and the co-pilot had been preparing the necessary paperwork for that sector and the next. At some point during the deceleration, approximately 1/4 nm from the platform, all forward speed was lost and a very high sink rate was established. Replay of the cockpit voice recorder (CVR) showed that, during this descent, the two automatic voice alerting device (AVAD) warnings sounded, activated by the radio altimeters, but the crew have stated that these were not heard.

In the company's S-76A aircraft, the AVAD provides two audio (spoken) warnings: "CHECK HEIGHT" and "100 FEET". The former is activated by the aircraft descending through a height selected by the pilot on his radio altimeter bug, and the latter automatically when passing through 100 feet. On this occasion, the relevant altimeter bug had been set at fractionally below 100 feet and so the "100 feet" preceeded the "Check height" warning (shown at Appendix 2).

There was little relevant comment on the flight deck prior to the "100 feet" call, although the co-pilot has since stated that he noticed the speed to be very low at about 350 feet, but, in the 2-3 seconds before contact with the sea, the co-pilot queried the commander's appreciation of the situation and then applied a large amount of power, by raising the collective pitch lever, thereby causing the impact with the sea to be so slight as to result in no structural damage to the helicopter. The necessary severity of this lever application, although causing the rotor rpm to drop from the indicated 100% to slightly less than 79%, enabled the aircraft to make an almost immediate lift-off from the water. Following the lift-off, the commander stated that he had become "disorientated" and so the co-pilot, being unsure whether the commander was yet fully aware of the situation and having established the aircraft in a climb, remained on the controls and initiated a right hand circuit to the east of the platform. However, as the climb progressed, he felt the commander come back onto the controls, saying again that he had become "disorientated" but now felt "fine". Nevertheless, the co-pilot followed through on the controls whilst the commander carried out a normal landing on the Fulmar helideck.

As YB landed, the Helideck Landing Officer noticed fluid pouring from the underside of the aircraft and, fearing that it may have been fuel, drew it to the attention of the crew. The crew realising that it was sea water, said that extra fire cover was not needed. The aircraft was then shut down, pending investigation of possible damage, and the eight passengers disembarked.

Following the landing and the disembarkation of the passengers, the commander stated that he had become "mesmerised" and had seen two rigs, side by side.

1.2 Injuries to persons

There were no injuries.

1.3 Damage to aircraft

1.3.1 Main-rotor spindle assemblies

Inspection after the incident showed that, on all four spindles, the strap and sleeve had suffered minor bruising by contact with the outer face of the elastomeric blade-retention bearing, indicating excessive upward flapping of the rotor blade during recovery from the rapid descent. All four spindle assemblies were removed, inspected and overhauled before being returned to service.

1.3.2 Engines

The crew did not report observing any excessive indications on the Power Turbine Inlet Temperature (T5) gauges during the incident, but the operator was advised by the engine overhaul agency to remove the engines and return them for investigation. Although there were no indications of excessive heating in the turbine sections of the engines, the first stage compressor turbine wheels were replaced as a precaution and over-torque inspections carried out on the power and accessories gearbox of each engine. These inspections did not reveal any indication of excessive torque having been transmitted through the drive-train.

1.4 Other damage

None

1.5 Personnel information

1.5.1	*Commander:*	Male, aged 47 years
	Licence:	Airline Transport Licence, re-issued 4 November 1987.
	Certificate of Test:	Renewed October 1987, valid for 6 months

Ratings:	Aerospatiale Gazelle, Sikorsky S-61 and S-76A
Instrument rating:	Renewed April 1987, valid for 13 months
Medical Certificate	Class 1, renewed July 1987, valid for 6 months
Total helicopter pilot hours:	6540
Total hours on type:	870
Total hours in the last 90 days:	53
Total hours in the last 28 days:	29
Total hours in the last 24 hours	2.5
Night North Sea hours:	210
Previous rest period:	10 hours

The commander was very enthusiastic about physical fitness and had taken part, with notable success, in both physically and mentally demanding television and social competitions. During the day on which the incident occurred, he had, most unusually, lost several recreational games.

During the week preceding the incident, he had flown about 17 hours which comprised all night landings on rigs or platforms. The duty day began at 0600 hrs and ended at approximately 2000 hrs, and included a "split-duty" rest period between 0745 hrs and 1745 hrs. He normally retired to bed at about 2200 hrs, and did so the night before the incident.

On the day of the incident, he awoke at 0540 hrs, breakfasted and prepared for the morning Shuttle, comprising 12 sectors beginning at 0630 hrs. For the morning flights, he acted as co-pilot to another captain. Between the end of the morning flights and lunch, he spent some time in the gymnasium and the rest relaxing. For lunch he ate, amongst other things, some smoked mackerel, the significance of this being that he subsequently stated that it appeared to be coloured with the same dye which he believed had caused an allergic reaction some years earlier. Between lunch and the evening meal, apart from relaxing, he spent a half hour in the gymnasium which he has described as very concentrated to the point of maximum possible effort. At the evening meal, he ate the same mackerel course.

At 1745 hrs, he began his evening flying duty period, this time as commander and handling pilot, and believes that he was fully medically fit to perform the task.

1.5.2	*Co-pilot:*	Male, aged 39 years
	Licence:	Airline Transport Pilot's Licence, re-issued 7 September 1987
	Certificate of test:	Renewed June 1987, valid for 6 months
	Ratings:	Aerospatiale Gazelle and AS332L, Sikorsky S-61N and S-76A
	Instrument rating:	Renewed June 1987, valid for 13 months
	Medical Certificate:	Class 1, renewed August 1987, valid for 6 months
	Total helicopter pilot hours:	5662
	Total hours on type:	518
	Total hours in last 90 days:	91
	Total hours in the last 28 days:	57
	Total hours in last 24 hours:	1.25
	Previous rest period:	5 days

Following his five rest days, the co-pilot reported for his flight from Aberdeen to the Fulmar platform at 1300 hrs on the day of the incident, arriving there at about 1500 hrs. He relaxed until his evening meal and then prepared for the evening

Shuttles, at 1745 hrs, for the duration of which he was to act as co-pilot. Subsequent to the incident, the co-pilot has stated that he was medically fit to carry out his duties.

1.6 Aircraft information

1.6.1 Aircraft details

Manufacturer:	Sikorsky Aircraft, Division of United Technologies Corporation
Model:	Sikorsky S-76A
Airframe serial number:	760079
Date of construction:	9 May 1980
Engines:	2 Allison 250-C30S turboshafts
Seating configuration:	2 side-by-side pilot seats plus 12 passenger seats arranged in 3 rows of 4 abreast
Certificate of Airworthiness:	Issued on 7 March 1981 in the Transport Category (Passenger); renewed on 23 May 1987 and valid for 12 months until 22 April 1988
Certificate of Registration:	Certificate valid; registered as G-BHYB on 29 July 1980. Owner registered as British International Helicopters Ltd., Wood Aviation Centre, Aberdeen Airport, Dyce, Aberdeen.
Airframe hours at time of incident:	3488

1.6.2 *Aircraft weight and balance*

Maximum authorised take-off and landing weight:	10500 lb (4763 kg)
Actual take-off weight (+/_ fuel gauge error):	10500 lb (4763 kg)
Estimated weight at time of incident:	10440 lb (4736 kg)
Centre of gravity limits at incident weight:	198.2--204.25 ins aft of datum
Centre of gravity at 10440 lb:	199.0 ins aft

1.6.3.1 *General*

The Sikorsky S-76A is a commercial transport helicopter powered by two turboshaft engines; the transmission system is conventional,with the engine free-turbines driving into the main gearbox via freewheel units and thence to the intermediate and tail gear boxes. The four main rotor blades are retained through fully articulated elastomeric bearings and the four bladed tail rotor is of composite construction. The aircraft is equipped with a retractable tricycle-type landing gear, and an emergency flotation system is installed for over-water operation.

The S-76A, when flying in the slower speed ranges, has a pronounced nose-up fuselage attitude. During deceleration, it is even more pronounced. This, together with a fairly high instrument glare shield, may, for a short period of time during the final approach to an offshore platform, interfere with the cross-cockpit view of the landing area.

At the weight and temperature estimated for the incident, with the landing gear down, the power required to maintain level flight is at a minimum of 45.2% torque at 68kt and rises again as the speed falls below that figure. At zero airspeed and out of ground effect (OGE), the power required to maintain level flight is 94.3% torque.

1.6.3.2 *Main rotor spindle assemblies*

On the S-76A, each main rotor blade is attached to the main rotor head by an integral spindle/cuff assembly. A spindle nut retains this assembly against the inner face of the elastomeric bearing assembly, which allows the blade freedom of motion in the pitch, flap and lead/lag senses.

1.6.3.3 *Emergency flotation system*

The emergency flotation system is designed to allow flotation time for the immediate evacuation of personnel and survival equipment following a forced landing on the water. The unit consists of 4 pop-out type floats, inflated by bottles of compressed nitrogen.

The only means of actuation is by crew operation of one of the FLOATS switches mounted on the the collective levers. These switches are armed by moving the arming panel FLOATS switch, on the centre console, to ARMED; this action also illuminates the FLOTATION ARMED light on the Caution/Advisory panel. The arming switch is normally kept in the OFF position during the cruise, to avoid accidental inflation of the floats, but ON for take-off and landing at speeds below 75 kt.

1.6.3.4 *Automatically Deployable Emergency Locator Transmitter (ADELT)*

The aircraft was equipped with an ADELT system which, when released from the aircraft, will transmit continuously on VHF and UHF distress frequencies.

The control panel for the ADELT system is located on the centre console in the cockpit. The deployment system is armed by moving the arming switch to the ARM position and deployment may then be initiated in one of 3 ways:

i) Operation of the guarded DEPLOY switch on the control panel, to be operated after ditching;

ii) Actuation of the submersion switch in salt water. This switch is mounted in a position at the rear of the passenger cabin, about half-way up the fuselage;

iii) Actuation of either of the frangible switches, mounted in the fuselage and designed to sense distortion of the structure around the lower fuselage.

In over-water operations the operating company requires that the ADELT deployment system should be kept in an armed state throughout the flight, and disarmed after landing. The crew have stated that it was armed during the incident flight, but did not deploy because the contact with the water did not accord with the required criteria.

1.6.3.5 *Maintenance history*

The aircraft was maintained in accordance with a CAA approved maintenance schedule, based on checks at intervals of 100, 500 and 1000 hours, with additional items at 1000 hours or annually. A 500 hour cycle had been completed on 21 August 1987 at 3405 hours and a 1000 hour/Annual check on 1 November 1987 at 3443 hours. The records indicate that the aircraft was serviceable at the start of the incident flight and that it had accumulated a total of 3488 hours.

1.7 Meteorological information

The preflight briefing supplied 1600 hrs to 2200 hrs forecasts from the Glasgow Weather Centre for the Scottish mainland, and also the forecast for the Fulmar platform which was presented verbally; these showed a generally westerly airstream of 10-15 kt with around half cover of medium level cloud. The METARS (present weather) were also supplied for the same areas, giving a westerly airstream pattern with winds of about 10 kt.

Whilst airborne, the crew recorded the 1825 hrs Fulmar weather as:

Wind:	350°/15 kt
Visibility:	Greater than 10 km
Cloud:	4 oktas at 2500 feet
Temperature:	+7°C
Pressure:	1023 mb

The weather recorded at the time of the incident was:

Wind:	350°/11kt
Visibility:	Greater than 10 km
Cloud:	4 oktas at 2500 feet
Temperature:	+7°C
Pressure:	1022 mb

Whereas the visibility during the four sectors undertaken was more than adequate to allow fully visual flight, the cloud cover made the darkness very intense.

1.8 Aids to navigation

The Fulmar A platform is equipped with a non-directional radio beacon radiating on 386 MHz, and coding 'FM'. This, however is not relevant to the incident, as the entire 6 nm flight was conducted visually.

1.9 Communications

Radio telephony (RTF) communications with the aircraft, within the oil field, was conducted by the "Auk Log", on 122.05 KHz. The Fulmar Advisory Flight Information Service also operates on this frequency, as does the Helideck Landing Officer (HLO). All communications on the day of the accident were satisfactory but only the communications with Auk Log were recorded. The communications have no relevance to the accident except that they provided the information that water was coming from the underside of the aircraft when it landed on Fulmar.

1.10 Aerodrome information

The Fulmar A, a fixed platform, is positioned at Latitude 56° 29.6'N and Longitude 002° 09.3'E. The elevation of the helideck is 215 feet and the flare tower, 444 feet. The required obstacle free sector is between approach tracks from 213°M to 063°M. The helideck is of an area 22.4 m x 27.17 m.

All the tall obstructions to flight, the drill derrick, the cranes and the flare tower are illuminated by standard obstruction lights. The helideck is marked with amber and blue glim lamps, the working area is lit by shaded flood lights and the whole area by the flare itself.

Apart from the normal helideck amber and blue marking lights, there is no visual aid to assist with the approach to the final landing. Nevertheless, the working and hazard lights, together with the very bright floodlight effect of the flare, provide visual aspect cues.

At approximately 1.3 nm from the platform, a few hundred metres to the west of track, the FSU was moored with an attendant tanker.

1.11 Flight recorders

A Flight Data Recorder (FDR) was not required for this flight and none was fitted. The lack of flight recorder information available severely hampered the capability of the investigation to define either the sequence of events, or possible failures. Had a fatal accident occurred, this lack of FDR data would have made determination of the cause unlikely. A recommendation that FDRs should be fitted is made in paragraph 4.1.

A Fairchild A100 Cockpit Voice Recorder (CVR), with an endless loop of magnetic tape, was fitted.

The track allocation was as follows:

Track 1 Co-pilot's microphone and headset signals

Track 2 Cockpit area microphone
Track 3 Main Rotor rpm
Track 4 Captain's microphone and headset signals

The recorder was removed from the helicopter and a satisfactory replay was obtained.

Analysis of the rotor rpm track showed a drop in rotor rpm from 103% just before the helicopter contacted the sea, to a minimum value of 78.7% probably due to the large collective input demanded. The drop in rotor rpm lasted for approximately nine seconds before the rotor speed returned to 100% as the helicopter climbed away.

Appendix 2 contains a detailed analysis of the audio and rotor speed content of the CVR tape.

The helicopter's Automatic Voice Alerting Device (AVAD), described in detail in paragraph 1.17.1, is set up to give two audio messages, one of "ONE HUNDRED FEET" and the other, "CHECK HEIGHT" which is repeated after 4.5 seconds.

Both the "ONE HUNDRED FEET" and "CHECK HEIGHT" messages are preceded by chimes to alert the pilot and which, together with the warning messages, can be heard on the CVR.

The chimes occurred almost simultaneously with the start of the drop in rotor rpm that resulted from the rapid power demand and were signalled by the helicopter passing through one hundred feet on the radio altimeter. The chimes were followed by a three quarters of a second pause and the "ONE HUNDRED FEET" warning and, simultaneously, the co-pilot's first expression of concern about the flight path. A further three quarters of a second later, the first "CHECK HEIGHT" message sounded. This sequence of warnings indicated that the height selected by the co-pilot on his radio altimeter bug was less than one hundred feet.

From the CVR it was not possible to identify exactly the point at which the helicopter contacted the sea, however a change in the amplitude of the signal on the area microphone track occurred two and a half seconds after the chimes were heard, and this is thought to be the point at which impact took place.

The recorded rotor speed had been 100 to 101% until approximately twenty-three seconds before the chimes were heard, when a gradual increase in rotor speed occurred, with a maximum of 103%, indicative of a power-off condition.

1.12 Wreckage and impact information

The helicopter struck the water almost vertically, with no forward speed and the water contact caused no damage to either the airframe or the engines. However, minor bruising of the rotor spindle assemblies occurred as a result of the sudden and severe application of rotor pitch applied in an attempt to prevent the incident.

1.13 Medical and pathological information

Following the incident, the commander stated that he had suffered double vision and "disorientation". It was therefore requested that he subject himself to a series of tests applicable to the cause(s) of such symptoms. Examinations were carried out by a neurologist, an opthalmologist and the company GP, who arranged for an allergy test.

The results of these examinations did not suggest any pre-existing mental or medical condition likely to cause the commander's disorientation. However, the tests did reveal a latent tendency to squint but, whereas this was so slight and normal as to have no effect upon his suitability to exercise the privileges of a flying licence, it could possibly contribute to the occurrence of double vision in certain circumstances of reduced mental awareness.

The commander was also interviewed by the Head of the Flight Skills Section of the Royal Air Force Institute of Aviation Medicine (IAM). His report, given at Appendix 3, analyses the possible reasons behind the behaviour of the commander, with his likely reaction to given visual stimuli. During the course of these interviews, the commander stated that he had suffered double vision of the platform and that both images, so formed, were in clear focus, but that he did not have any visual recollection of the subsequent descent into the water. He also stated that he "didn't know which one (platform image) to go for".

1.14 Fire

There was no fire.

1.15 Survival aspects

The incident was fully survivable.

1.16 Tests and research

Two flights in an S-76A helicopter were conducted making approaches to the

Fulmar platform, with firstly an AAIB Inspector, and then with the Head of the Flight Skills Section of the IAM, in the co-pilot seat.

The purpose of the flights was to investigate the effects of various types of approach, with the intention of finding one which, as closely as possible, matched that of the incident aircraft. This was achieved by studying a normal approach, to discover whether the Fuel Storage Unit (FSU) was a suitable point at which to begin the descent/deceleration phase of the flight, and then varying it such that:

(a) The lowering of the landing gear was either delayed or made earlier than normal, in order to observe the power reduction necessary to achieve an appropriate landing speed.

(b) The descent was delayed or commenced earlier than normal, again to observe the power reduction necessary and the variation in deceleration with the resulting pitch attitudes.

(c) The power necessary to recover from the approach to level flight could be observed, in each of the above situations;

(d) The effect upon the co-pilot's cross-cockpit view of the platform, and particularly the helideck, could be observed during the various consequent cockpit attitudes and angles of approach.

In order to achieve this, the cruise towards the top of the descent, or the deceleration point, was made at about 135 kt, and the speed was then reduced to 130 kt, in order to lower the landing gear.

The first approach was made using the normal approach technique, reducing the power to about 30% torque whilst decelerating and allowing the aircraft to drift down the requisite 2-300 feet. Although, on this occasion, the wind was rather more favourable than during the incident, the approach demonstrated that the FSU mooring point was a perfectly adequate marker for the top of the descent, and the start of the deceleration phase.

A number of abnormal approaches were then made. When the undercarriage selection point was delayed, only a few seconds of delay had an appreciable effect on the degree of power reduction needed to arrive alongside the platform at the speed required to achieve a landing.. The same effect was also noted when the descent was either delayed or steepened. In most of the abnormal approaches demonstrated, the torque had to be reduced to nearly zero in order to achieve the desired arrival at the helideck. It was also apparent that considerable anticipation of the large amount of power needed to regain level flight was required in these circumstances. Furthermore, any delay in its application produced a more rapid onset and greater degree of downwards vertical acceleration.

The co-pilot stated that during the relevant stages of the approach, he was unable to see anything of the platform structure except the flame tower. This evidence is supported, in part, by the experience of three S-76A Training Captains, although the stated period and degree of obscuration varied. For this reason, particular note was taken of the view from the co-pilot's seat during all the various approaches made. The higher deceleration necessitated by the abnormal approaches provided a greater nose-up aircraft attitude than would be experienced on a normal approach. Despite an intentionally lower seat position than that used by the operating crews, sight of the platform was obscured from the view of the co-pilot for only the last 2 or 3 seconds of the approach as the helicopter manoeuvred alongside the helideck prior to touchdown. It must however be noted that in order to maintain a useful view of the platform, a positive effort to do so must be made by the occupant of the left seat. The period of obscuration might also have differed from that stated by the co-pilot of the incident flight as the test aircraft was lighter, although the CG was further aft providing an even greater nose-up attitude.

It was also observed that visual assessment of distance from the platform was very difficult, but that the visual cues as to aircraft height, with reference to that of the helideck, was not. The prime reason for this is that the platform is built in storeys, well illuminated by linear rows of lights. When looking along the side of the structure, particularly from below the level of the platform, the sight of passing downwards, from being aligned with one storey to the next lower one, provided a strong clue to descent and descent rate.

1.17 Additional information

1.17.1 The Automatic Voice Alerting Device (AVAD)

AVAD is capable of providing 14 different voice warnings to the operating crew, and the height related functions are slaved off the radio altimeters. The operating company had chosen to include a "CHECK HEIGHT" warning as well as the "100 FEET" warning required by the CAA. Neither of these warnings had been selected to take priority over the other and both are preceded by chimes, each with a slightly different rate and tone from the other. The individual message immediately follows the appropriate chimes, and CHECK HEIGHT, with its associated chimes, is repeated after an interval of 4.5 seconds. The 100 FEET message is not variable and occurs as the aircraft descends through that height, but the height at which CHECK HEIGHT occurs depends upon the height to which the relevant radio altimeter bug is selected. A switch in the cockpit allows the selection of either SINGLE PILOT or TWO PILOT operation; the former selection slaves the AVAD to only the commander's radio altimeter; the latter to both altimeters, choosing the lower of the two individual altimeter bug settings for the CHECK HEIGHT warning. At the time of the incident, TWO PILOT was selected. Finally, the AVAD is fitted with an automatic inhibit facility which de-activates both warnings when the radio altimeter senses a descent rate of 5000 feet/minute or greater. This facility prevents the spurious warnings which would otherwise occur whenever the aircraft crosses the lip of a helideck.

The prime purpose of the altitude related warnings is to guard against inadvertent 'drift down', when flying over a featureless surface, and to warn the crew of arrival at specific heights. During the very short sectors of Shuttle flights, the necessary bugging and re-bugging of the altimeters, together with the thus promoted audio warnings, was considered by the crews to be detrimental, rather than advantageous, to the safe conduct of the flight.

It was reported by several company pilots that, in order to avoid this during Shuttle flights, some co-pilots would select 100 feet on their altimeter bugs as, when landing on helidecks of greater height, the AVAD would not then function. This was the case on the incident flight. However, this is not the recognised method of avoiding such intrusive warnings: For this purpose, the equipment includes a button operated SUSPEND facility, whereby the CHECK HEIGHT message can be delayed by three minutes. The button, which is situated on the cyclic stick, may be operated repeatedly, each time restarting the 3 minute delay. Furthermore, if the selected check height is passed during the delay period, the warning will be cancelled; this facility does not apply to the 100 FEET warning. Finally, when two warnings overlap, one of the sets of chimes will not sound.

Since the incident, the company have issued a Flying Staff Instruction stating that, whilst on final approach, both altimeter bugs will be set at helideck height.

1.17.2 Two crew operation

Although the aircraft is certificated for single pilot operation, and indeed frequently operated in this mode for other companies, the chartering oil company required that there should, for reasons of safety, be two pilots on board during all their IFR and night flights. It was therefore the responsibility of the operating company to ensure that their Operations Manual included direction as to crew duties in this mode. However, the operating company stated that in considering a two pilot operation it was felt that, since the S-76A would continue to be operated in other conditions, in the single pilot mode, it might be dangerously confusing for a given pilot to have to cope with two sets of operating procedures for the same aircraft.

Two of the volumes of the Operations Manual, which pertain to the operation of the S-76A, are Volume 1 (General) and Volume 9 (S-76A). Volume 1 contains, amongst other matters, "Flight deck management standard operating procedures, two pilots" which, "Unless specifically replaced in the Type Flight Management Volume (9, in this case), will be used on all types". It goes on to state that "Full handling and non-handling pilot (H/NH) duties will be specified in the Type Volume 9, "Flight Management".

Volume 9 does contain instructions specific to the S-76A, such as crew emergency procedures and checklists, although in the latter, with the exception of one reference in the Initial Approach checks for the commander to "Brief" the co-pilot, the co-pilot's physical participation in the flight is restricted to altimeter and altimeter bug settings. Volume 9 does not contain the "Full H/NH duties" as suggested by Volume 1.

It is apparent, therefore, that if the co-pilot brief is omitted, as it was on the incident flight, the aircraft is operated in a manner very little different from a single pilot operation.

Since the incident, the operating company have revised the S-76A checklists to give the co-pilot a more active participation in the conduct of the flight and which re-inforce the flight safety aspects of the commander's responsibilities, without diluting them in the absence of another pilot.

1.17.3 *Crew incapacitation*

Actions to be taken in the event of subtle incapacitation of the handling pilot are well documented within operating companies' Operations Manuals. The problem, however, lies not within the reactions of the non-handling pilot to that event, but in his realisation that it has occurred.

Appreciation of the event can result from an unexpected lack of dialogue between the two crew members, an unexpected lack of response to a flying instruction, non adherence to departure or approach procedures, or excessive deviations from the flight path. These points are covered in the Operations Manual.

However, shuttle flying in the S-76A, although nominally a two pilot operation is in reality mostly a single pilot task and, with the exception of RTF calls, the non-handling pilot has no requirement to engage in a dialogue with the commander.

There are few, if any, flying instructions passed by ATC to the aircraft and such clearances as are passed are usually acknowledged by the non-handling pilot.

Therefore there are very few cues which could alert the non-handling pilot to a subtle incapacitation of the handling pilot in this type of operation.

1.17.4 *Rig approaches*

Approaches to helidecks, particularly at night, require a very high degree of precision. Standardisation of approaches is a clear objective and, despite the many factors of weather and visual assessment which work against it, training is carried out with this in mind. However, each pilot interviewed, formally or otherwise, during the investigation into this incident, declared his own method of approaching a helideck, and there appeared to be little standardisation of planned approach paths.

Another factor, adding to the difficulty of making these approaches, has been highlighted by a number of Mandatory Occurrence Reports. On several occasions, the heat generated by the platform's flare has produced a micro weather system in the form of a heat engine. The very strong downdraughts which can be produced by this mechanism can persist over a considerable distance down wind of the flare, in the area from which most approaches to land are made. On one occasion reported, the downdraught exceeded the helicopter's climb capability.

Another difficulty, which is peculiar to some platforms and rigs at night, is that they may be the only light source in an otherwise totally dark environment. The single light source phenomenon has long been recognised by the aviation community as one which contributes nothing to the pilot's judgement of distance from it. In this context, although the rigs and platforms have considerably more than one light, when viewed from a distance, they may be considered as a single light source. The usual effects of this phenomenon are that the pilot is deprived of the visual cues normally associated with daylight vision:

1. The relationship of the object to the horizon;
2. Other objects and the surface texture between himself and the object in view;
3. The use, for ranging, of the angle subtended at the viewer's eye by the object, because;

    (a) The absolute size of the object is uncertain,
    (b) The judgement of this angle when it is very small is difficult.

However, as the approach to the Fulmar platform was initiated at a little over 1 nm and beside the well lit FSU and tanker, it is unlikely that this phenomenon had any appreciable effect during the night in question.

Finally, whilst the brilliance of the flare might be slightly dazzling to the pilot, it does provide a quite bright illumination of the whole structure and the sea surface immediately surrounding it.

Despite these conditions, a visual approach guidance, which would greatly ameliorate the problems, is not provided on any rig or platform.

2. Analysis

2.1 Conduct of the flight

The three factors which appear to be central to the event of the helicopter touching the sea are the loss of speed, the loss of height, and the delay before either crew member noticed these deficiencies.

The flight tests showed that, for the aircraft to have decelerated from its 140kt cruising speed to the final manoeuvring speed alongside the platform in about 3/4nm, the collective lever must have been lowered almost completely. Therefore, as the speed reduced, the power should have been restored in time to anticipate the consequent loss of lift, and thus to reduce the rate of descent.

As no evidence was found to suggest any malfunction of the aircraft or its systems, the reason for the descent rate demonstrated in the incident must be attributed to either a downdraught which exceeded the helicopter's climb capability, and/or to the actions of the handling pilot. Had a significant downdraught, caused by the flare, been the only reason for the descent, firstly it is unlikely that all forward speed would have been lost and secondly, it is almost certain that the commander would have made some comment to the co-pilot, which he did not. However, the possibility that it contributed to the rate of descent cannot be ruled out.

2.2 The commander

It is probable that when the commander used the terms "mesmerised" and "disorientated", he did so in a conversational way, rather than as a clinical description, to describe an event which was both novel and disturbing to him. However, the fact that he did suffer such an event is supported by other evidence. Firstly, the commander's own statement that he remembered that, immediately before the height loss, he was able to see a double image of the rig with both images in clear focus, but had no visual memory of the descent to the water. Secondly, the fact that he failed to respond to the AVAD warnings and, finally, the statement of the co-pilot that, during the short descent to the water, the commander appeared "frozen" and unresponsive.

As the neurological, opthalmological and medical examinations revealed no significant abnormalities, it is left to analysis of the psychology behind his behaviour to try to explain the events which occurred. The report on this examination fully rehearsed the possible reasons behind the commander's behaviour and, although unable to identify any specific cause for it, strongly suggests that he did suffer a temporary incapacitation.
The unavoidable conclusion, therefore, is that commander, almost certainly suffering from temporary incapacitation, failed to control the aircraft in an

adequate manner. Furthermore, from the total lack of evidence of any aircraft system failure, the uncontrolled descent and the absence of forward speed can be attributed only to a lack of anticipation of the required power increase as the aircraft reduced speed.

2.3 The co-pilot

The purpose of flightpath monitoring, by a co-pilot, is to detect unsafe deviations from the range of normal aircraft operation and bring them to the attention of the handling pilot before the situation deteriorates unacceptably. If no response is forthcoming, from the handling pilot, then the co-pilot should intervene to prevent a disastrous situation occurring.

In this case, the monitoring was successful only to the extent that the severity of the impact was considerably reduced by the actions of the co-pilot. Although the commander was incapacitated, the aircraft was fully controllable and therefore the question arises as to why the co-pilot did not intervene to bring it under control in time to prevent contact with the water. There appear to be two possible reasons for this:

(a) The co-pilot was not adequately monitoring the flightpath until it was too late to prevent the event; or,

(b) He was monitoring properly but, having detected an abnormal flightpath deviation, didn't have time to act until it was too late.

As there is some evidence to support both of these hypotheses, it is likely that each played a part in the incident.

Although the co-pilot "noticed" that the speed was very low, when the aircraft was at about 350 feet on the final approach, the fact that he neither made comment nor took any action at that time does tend to indicate that this observation was peripheral and did not constitute flightpath monitoring. Furthermore, although his "obscured" view of the platform might reasonably suggest that he would be concentrating on the flight instruments, it was not until the aircraft had descended another 250 feet, to a height 115 feet below the known height of the helideck, and that the AVAD warning had announced "100 FEET", that he either questioned the commander's flying or took any positive action to intervene.

Examination of the CVR generated graph of the main rotor rpm shows that the rpm was increasing for 14 seconds before the sudden lever application. With the lever down or nearly down, this increase in rotor rpm could be caused by either a flare manoeuvre or an increasing rate of descent in autorotation. However, as both pilots have stated that no such flare occurred, it is most likely that the increase in rotor rpm occurred as a result of autorotational forces, which therefore marks the beginning of the severe accelerating descent rate, 17 seconds before impact with the water.

The instrument indications of departure from the normal flightpath, which were available to a monitoring pilot, were the decrease in height shown on both radio and pressure altimeters, an increasing rate of descent on the vertical speed indicator, an indicated pitch attitude dissimilar to that of normal flight, an airspeed unlikely to be normal except when directly abeam of the platform (when the latter is definitely in view) and finally, the relationship between this lack of airspeed and the absence of engine torque. Nevertheless, it would appear that during the 14 seconds before power was re-applied these indications passed unnoticed.

There are however some factors to be taken into account. BCARs allow 1 second for recognition of a problem and a further 1 second for action to be taken.However, in a situation where the build up of circumstances starts slowly and then escalates rapidly, considerable changes to the flightpath can occur in this period. The intended flightpath already embraced both deceleration and descent and it is therefore understandable that, even if the co-pilot was monitoring properly, it would be a few moments before a small change in these two vectors became noticeable and therefore significant. Although the absence of a flight data recorder makes it impossible to define the exact time at which the departure from the normal flightpath became significant, the CVR graph shows that autorotation had had sufficient time to cause an increase in the rpm for 14 seconds before the power was actually applied. Allowing the full 2 seconds for the realisation and action, this means that the aircraft had been in an autorotative descent for 12 seconds before either pilot realised it.

Exactly how much of this can be ascribed to a disguised initial departure from the intended flightpath, and how much to inattention on the part of the co-pilot, cannot be defined. However 12 seconds of build up to such a precipitous event being totally disguised and unnoticeable to a fully monitoring co-pilot, does seem to be rather a long time and therefore suggests that there was a degree of inattention by the co-pilot to his monitoring duties.

It might however be reasoned that the manner in which the Operations Manual presented the co-pilot's duties did little to encourage active participation in the flight, as perhaps did the lack of a formal briefing by the commander. Furthermore, as he was flying with another captain of equal status and experience, the co-pilot may well have felt disbelief upon seeing what was happening and thus taken longer than expected to rationalise and act upon it.

Nevertheless, in the final analysis, what occurred was a subtle incapacitation of the handling pilot, which is notably difficult for a non-handling pilot to appreciate. Despite this, the co-pilot's actions did prevent a major accident, with probable loss of life, and exemplifies the safety aspect of flying with two pilots. A recommendation to this effect is made in paragraph 4.2.

2.4 Two crew operation

The S-76A is certificated for single pilot operation in the Public Transport mode, and frequently operates in this way. Furthermore, in this company, these flights are flown by the same commanders who fly the two crew operations.

Consistent with this, therefore, there is a requirement for the operating company to re-apportion the tasks of the two crew members, such that the non-handling pilot contributes to the safety of the flight, but that his absence does not detract from it. Since the incident, the operating company has addressed this task by the publication of a checklist which involves the co-pilot in the S-76A operation, and a Flying Staff Instruction to aircraft commanders to brief the co-pilots to carry out specified duties. These instructions also serve to highlight those already stated in Volume 1 of the Operations Manual.

2.5 The problem of crew incapacitation

Even the most striking events, detailed in paragraph 1.17.3, whereby the non-handling pilot might recognise an incapacitation of the handling pilot, appear to be of little help to the S-76A non-handling pilot.

The lack of response to a flying instruction, given by ATC, will doubtless work very well when such instructions are given. However, during Shuttle flights no instructions are given or expected.

The unexpected lack of dialogue between the two crew members is also a reliable method of recognising the occurrence of an incapacitation. In the S-76A operation, there was no requirement for a formal dialogue between the crew, nor was it practiced.

Finally, the handling pilot's lack of control of the aircraft, as on this occasion, may not be noticed by the non-handling pilot for a considerable time, particularly if his attention is entirely given to the paperwork and the aircraft is well trimmed.

There can be no doubt that one readily available solution to this problem can be provided by establishing a formal dialogue between the two crew members, but this is neither the only, nor the whole, solution. It is therefore considered that the CAA and the operators should address the problem of defining methods of identifying subtle incapacitation, as applicable to this type of operation and a recommendation to this effect is made in paragraph 4.3.

2.6 Use of the AVAD

As a direct result of the recommendations made by the AAIB in the Report No.

8/84, concerning the accident to the helicopter flying between Penzance and the Isles of Scilly, the CAA required that such helicopters carry a minimum height audio warning device.

Whilst it is acknowledged that the main purpose of this equipment is to prevent the 'accidental drift down' event, the system also provides minimum height warnings. Given the environmental workload that is typical of oil field Shuttle flights, it is surprising that crews should have arranged their handling of this system such that it could provide no effective warnings at all. The subject incident would, most likely, not have occurred had the co-pilot's altimeter bug, to which the AVAD was slaved, not been set at a height below that of the helideck. The declared reason for this usage was that the repetitive warnings, occasioned by 'bugging' a height greater than that of the helideck, were more of an irritation than a safeguard.

The company's new Flying Staff Instruction, issued since the incident, has remedied this practice, and other operators were not found to have used the system in this manner.

2.7 Visual approach aids

The difficulties of making approaches to platforms and rigs at night is appreciated, and there are many variables to be taken into consideration. Nevertheless, as stated in paragraph 1.17.4, there appears to have been little standardisation in the method of making these approaches.

The use of a standard approach path would remove one of the variables, thus both improve standardisation and reduce the pilot's workload. This could be achieved by the provision of a specialised version of the visual approach path slope indicators which are commonly available at airfields, Royal Naval ships and even the Army's remote landing sites.

Furthermore, although possibly not in the S-76A, it is probable that their provision would also give the non-handling pilot an early and readily noticeable warning of flightpath deviation and thus alert him to the possibility that the handling pilot had become incapacitated.

It is therefore considered that the CAA, in conjunction with the operating companies, should review the production and provision of a visual approach aid for use on platform and rig helidecks. This is recommended in paragraph 4.4 of this report.

3 Conclusions

(a) *Findings*

(i) The crew members were properly licensed and adequately experienced to conduct the flight.

(ii) Neither crew member had, prior to the flight, reason to believe that he was other than medically fit to conduct that flight, and no evidence has been subsequently adduced to contradict this.

(iii) The aircraft had been maintained in accordance with an approved maintenance schedule and the Certificates of Airworthiness, Registration and Maintenance were valid at the time of the incident.

(iv) The aircraft was fully serviceable prior to the incident.

(v). The only damage to the aircraft, which could be ascribed to the incident, was minor 'bruising' of the main rotor spindle assemblies.

vi) The commander, the handling pilot, suffered a temporary incapacitation, the reason for which could not be identified.

(vii) The layout of the non-handling pilot's duties, in the Operations Manual volumes pertinent to the S-76A, may have led to some confusion as to the co-pilot's required participation in the flight.

(viii) The delay of the co-pilot's attempt to recover from the descent was due partially to insuffient flightpath and instrument monitoring, and partially to the difficulty of appraising the situation. It has not been possible to determine in what proportion.

(ix) The presence of the co-pilot and his intervention, albeit very late, prevented the otherwise almost certain loss of the helicopter.

(x) The Automatic Voice Alerting Device was not being used in a manner advantageous to flight safety.

(xi) It is likely that the provision of a visual flight path guidance system would have made the occurrence of the incident less likely, by providing a standardised approach.

(xii) The lack of a digital flight data recorder severely hampered the capability of the investigation to define either the sequence of events, or possible failures, and had a fatal accident occurred, this lack of FDR data would have made determination of the cause unlikely.

(b) *Cause*

The incident was caused by the following:

1. The Commander suffered a temporary incapacitation.

2. The co-pilot's response to the emergency situation was delayed partially by insufficient flightpath and instrument monitoring and partially by the difficulty of appraising the situation. The proportion of each is not known.

3. The company Operations Manual contained no procedures for the use of the Automatic Voice Alerting Device during visual approaches.

4. Safety Recommendations

It is recommended that:

4.1 The CAA should require that helicopters operated in the Public Transport category (Passenger) are equipped with flight data recorders.

4.2 The CAA should re-consider the need for a two pilot crew in helicopters which are registered and operating in the Public Transport category under the Instrument Flight Rules.

4.3 The CAA, in conjunction with helicopter operating companies, should consider defining methods of identifying subtle incapacitation, as applicable to this type of operation.

4.4 The CAA, in conjunction with helicopter operating companies, should consider the production and provision of a visual approach aid for use on platform and rig helidecks.

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