AIRCRAFT ACCIDENT REPORT 7/2008

Air Accidents Investigation Branch

Department for Transport

Report on the accident to Aerospatiale SA365N, registration G-BLUN near the North Morecambe gas platform Morecambe Bay on 27 December 2006

This investigation was carried out in accordance with
The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996

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This report contains facts which have been determined up to the time of publication. This information is published to inform the aviation industry and the public of the general circumstances of accidents and serious incidents.

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Department for Transport
Air Accidents Investigation Branch
Farnborough House
Berkshire Copse Road
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September 2008

The Right Honourable Ruth Kelly
Secretary of State for Transport

Dear Secretary of State

I have the honour to submit the report by Mr R J Tydeman, an Inspector of Air Accidents, on the circumstances of the accident to Aerospatiale SA365N registration G-BLUN approximately 450 metres south-south-east of the North Morecambe gas platform, Morecambe Bay, Irish Sea on 27 December 2006.

Yours sincerely

David King
Chief Inspector of Air Accidents

Contents

GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

AAIB	Air Accidents Investigation Branch
ADF	Automatic Direction Finder
ADELT	Automatically Deployable Emergency Locator Transmittor
AFCS	Automatic Flight Control System
agl	above ground level
amsl	above mean sea level
AOC	Air Operations Certificate
AP	autopilot
ARCC	Aeronautical Rescue Co-ordination Centre
AVAD	Automatic Voice Alert Device
BHAB	British Helicopter Advisory Organization
CAA	Civil Aviation Authority
CAM	Cockpit Area Microphones
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
CVFDR	Combined Voice and Flight Data Recorder
DF	Direction Finding
EASA	European Aviation Safety Agency
FDM	Flight Data Monitoring
fm	feet per minute
FOI	Flight Operations Inspector
FRC	Fast Response Craft
FS	Flight Safety
FSI	Flying Staff Instruction
FSO	Flight Safety Officer
ft	feet
GA	Go-around
GPS	Global Positioning System
HCA	Helideck Certification Agency
HLO	Helicopter Landing Officer
HRL	Hydrocarbon Resources Limited
hrs	hours (clock time as in 12:00 hrs)
hPa	hectopascal (equivalent unit to mb)
HSE	Health and Safety Executive
HSI	Horizontal Situation Indicator
Hz	hertz
IAS	indicated airspeed
IEM	Interpretative and Explanatory Material
IHUMS	Integrated Health and Usage Monitoring System
JAA	Joint Aviation Authorities
JAR	Joint Aviation Requirements
JHSAT	Joint Helicopter Safety Analysis Team
kg	kilogram(s)
km	kilometre(s)
kt	knot(s)
LHS	left-hand seat
LPC	Licence Proficiency Check
m	metres
MDR	Maintenance Data Recorder
METAR	a timed aerodrome meteorological report
MHz	megahertz
min(s)	minutes
MOB	man overboard
MOR	Mandatory Occurrence Report
MRCC	Maritime Rescue Co-ordination Centre
nm	nautical mile(s)
NUI	Normally Unattended Installations
ORB	Occurrence Review Board
OM	Operations Manual
OPC	Operator Proficiency Check
PLB	Personal Locator Beacons
PNF	Pilot not flying
QNH	pressure setting to indicate elevation above mean sea level
RA	Radio altimeter
REWS	Radar Early Warning System
RHS	right-hand seat
RNAV	Area Navigation
ROD	Rate of descent
ROV	remotely operated vehicle
SAR	Search and Rescue
SAS	Stability Augmentation System
SMS	Safety Management System
SOP	Standard Operating Procedures
STD	Synthetic Training Device
TAF	Terminal Aerodrome Forecast
TRTO	Type rating Training Organization
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
US	United States (of America)
UTC	Co-ordinated Universal Time (GMT)
V_{TOSS}	Takeoff Safety Speed
V_Y	Airspeed for best rate of climb
ºC, M,	Celsius, magnetic

Air Accidents Investigation Branch

Accident Report No: 7/2008 (EW/C2006/12/03)

Operator:	CHC Scotia Limited
Aircraft Type and Model:	Aerospatiale SA365N, Dauphin 2
Manufacturer's Serial No:	6114
Nationality:	British
Registration:	G-BLUN
Location:	Approximately 450 metres south-south-east of the North Morecambe gas platform, Morecambe Bay, Irish Sea Latitude N 53º 57·361' Longitude W 003º 40·198'
Date and Time:	27 December 2006 at approximately 1833 hrs All times in this report are UTC (coincident with local time)

Synopsis

The London Air Traffic Control Centre notified the Air Accidents Investigation Branch of the accident at 1906 hrs on 27 December 2006; the investigation commenced the next day. The following Inspectors participated in the investigation:

Mr R Tydeman	Investigator-in-Charge
Mr M Cook	Operations
Mr K Conradi	Operations
Mr M Jarvis	Engineering
Mr S Moss	Engineering
Mr P Wivell	Flight Data Recorders
Mr A Burrows	Flight Data Recorders

The helicopter departed Blackpool at 1800 hrs on a scheduled flight consisting of eight sectors within the Morecambe Bay gas field. The first two sectors were completed without incident but, when preparing to land on the North Morecambe platform, in the dark, the helicopter flew past the platform and struck the surface of the sea. The fuselage disintegrated on impact and the majority of the structure sank. Two fast response craft from a multipurpose standby vessel, which was on position close to the platform, arrived at the scene of the accident 16 minutes later. There were no survivors amongst the five passengers or two crew.

The investigation identified the following contributory factors:

1 The co-pilot was flying an approach to the North Morecambe platform at night, in poor weather conditions, when he lost control of the helicopter and requested assistance from the commander. The transfer of control was not precise and the commander did not take control until approximately four seconds after the initial request for help. The commander's initial actions to recover the helicopter were correct but the helicopter subsequently descended into the sea.

2 The approach profile flown by the co-pilot suggests a problem in assessing the correct approach descent angle, probably, as identified in trials by the CAA, because of the limited visual cues available to him.

3 An appropriate synthetic training device for the SA365N was available but it was not used; the extensive benefits of conducting training and checking in such an environment were therefore missed.

Six Safety Recommendations have been made.

1 Factual Information

1.1 History of the flight

1.1.1 Background information

Blackpool Airport is one of the helicopter operator's bases within the UK, and from which helicopter support is provided for offshore gas operations in the East Irish Sea area. Hydrocarbon Resources Limited (HRL) operates the following production platforms in this area:

- Four remote, normally unattended installations (NUI), (DP3, DP4, DP6 and DP8) in the South Morecambe field, each being a conventionally braced four-legged production platform. The topsides structure consists of two levels; the drill deck and the cellar deck. The helicopter landing deck is an extension of the drill deck.

- The North Morecambe platform NUI (DPPA), being a conventionally braced, four-legged production platform. The topsides structure consists of four levels; the weather deck, the upper mezzanine deck, the lower mezzanine deck and the cellar deck. The weather deck incorporates the helicopter landing deck which is 136 ft above mean sea level.

- The Millom West and the Calder minimum facilities NUI are each supported by four unbraced vertical legs. The topsides structure consists of two levels; the weather deck and the cellar deck. The helicopter landing deck is an extension of the weather deck.

These platforms have marine support from the 'Highland Sprite'; a multipurpose standby vessel providing emergency and logistic support.

1.1.2 Flight details

On the day of the accident the helicopter was scheduled to operate eight flights from Blackpool. The two crew members involved in this accident had been rostered to fly the last two of these flights and reported for duty at 1200 hrs. They completed the first flight without incident. The eighth and final flight was scheduled to depart Blackpool at 1810 hrs. It consisted of eight night sectors all to be flown with the co-pilot as the handling pilot. The route was planned to depart Blackpool and land on AP1, Millom West, North Morecambe, AP1, North Morecambe, DP8, and AP1 platforms before returning to Blackpool.

Five passengers were on board the helicopter for the first sector to the AP1 platform. There were no passengers for the sector from AP1 to Millom West. Five passengers boarded the helicopter for the third sector from Millom West; they were destined for the AP1 platform but were routing via the North Morecambe platform where an additional passenger and some freight were to be collected.

The relevant times and distances are shown in Table 1.

Sector	Departure Time (UTC)	Arrival Time (UTC)	Flight time (hrs : mins)	Sector Distance (nm)
Blackpool to AP1	1800	1811	0:11	20
AP1 to Millom West	1814	1823	0:09	15
Millom West to North Morecambe	1826	N/A	0:07	8
Totals			0:27	33

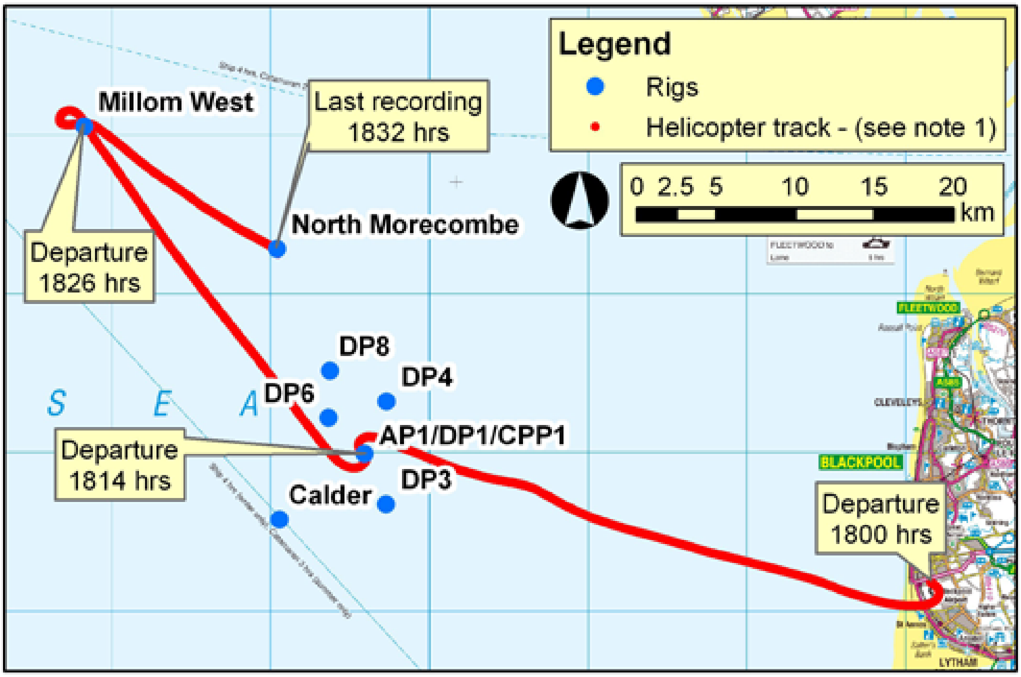
Table1

Sector Distances and Times

1.1.3 Conduct of the flight

The following description of events was created from an amalgamation of recorded data; only pertinent communications are included. Altitudes are above mean sea level (amsl) unless the height of the helicopter is defined by its radio altimeter (RA). Figure 1 provides an overhead view of the flight from Blackpool up to the location of the accident.

The final flight of the helicopter commenced at 1748 hrs; there were five passengers and two crew on board, with 40 kg of baggage, 60 kg of freight and 410 kg of fuel. The co-pilot was the handling pilot throughout the flight. The crew completed the pre-flight checks in accordance with their Standard



Notes:
1 - The helicopter track was derived from the CVFDR recorded heading and speed data in combination with a wind model. This was adjusted to coincide more accurately with the rigs and intermittent radar returns.
2- All times are in UTC.

Figure 1

Overview of the helicopter movements

Operating Procedures (SOPs) and there were no indications of any technical problems. The helicopter departed Blackpool at 1800 hrs and climbed to 1,000 ft on a westerly heading. At 1,000 ft, and at an initial IAS of 135 kt, the autopilot altitude mode was engaged; it was disengaged at 1807 hrs and the altitude and speed started to reduce. The flight crew used GPS data to monitor their range from the AP1 platform and confirmed when the range was 5 nm; 70 seconds later they reported that they were visual with the platform. Given the average ground speed derived from the radar, and assuming that the GPS distances were accurate, the platform became visible at a range of approximately 4,400 m: the windshield wipers were audible in the background.

The helicopter landed on the AP1 platform at 1811 hrs and the landing was conducted with the windshield wipers ON. No Automatic Voice Alert Device[1] (AVAD) annunciations were recorded but the transition through the radio height of 100 ft occurred rapidly as the helicopter transitioned from being over the sea to over the helideck.

The next sector, to the Millom West platform, was flown without any passengers, baggage or freight and with 360 kg of fuel. The helicopter took off at 1814 hrs, climbed to 500 ft on a north-westerly heading and accelerated to an initial IAS of 145 kt. The rig became visible 25 seconds after the 5 nm GPS call; this equates to a visual range of approximately 7,100 m. At 1820 hrs the helicopter initiated its descent whilst reducing speed and turned left onto a heading of 105ºM before landing on the Millom West at 1822 hrs. During the final approach and landing the AVAD "ONE HUNDRED FEET" automatic annunciation was recorded, but no "CHECK HEIGHT" call was recorded.

The audio recordings suggest a relaxed atmosphere in the cockpit throughout the first two sectors and indicate that the normal checklists were being followed. The crew discussed the visual conditions and their experiences with similar conditions during their previous military flying.

The helicopter lifted-off from Millom West for the third sector at 1826 hrs with five passengers, 41 kg bags, no freight and 330 kg of fuel. The helicopter climbed to a height of approximately 500 ft on a heading of 120ºM and accelerated to an initial IAS of 125 kt. The Automatic Flight Control System (AFCS) was engaged, with all channels ON in the Attitude Hold mode; this is the normal stabilisation mode for flight and is engaged prior to take off. In response to a request by the commander they received confirmation that all the lights were operating on the North Morecambe platform and that the lights on the crane were working correctly. Shortly after the 4 nm GPS call made by the commander, the crew became visual with the rig and the co-pilot said "I GOT THE DECK NOW"; allowing for the speed of the helicopter at the time, this equates to a visual range of about 6,800 m. The commander then completed the before landing checks, which included arming the floats. The cockpit voice recorder (CVR) did not record the sound of the windscreen wipers being used on this sector. Soon after becoming visual, the height reduced to 270 ft; the helicopter then climbed back to just over 400 ft before starting a further descent approximately 30 seconds later.

1 See section 1.18.1 for a description of the AVAD.

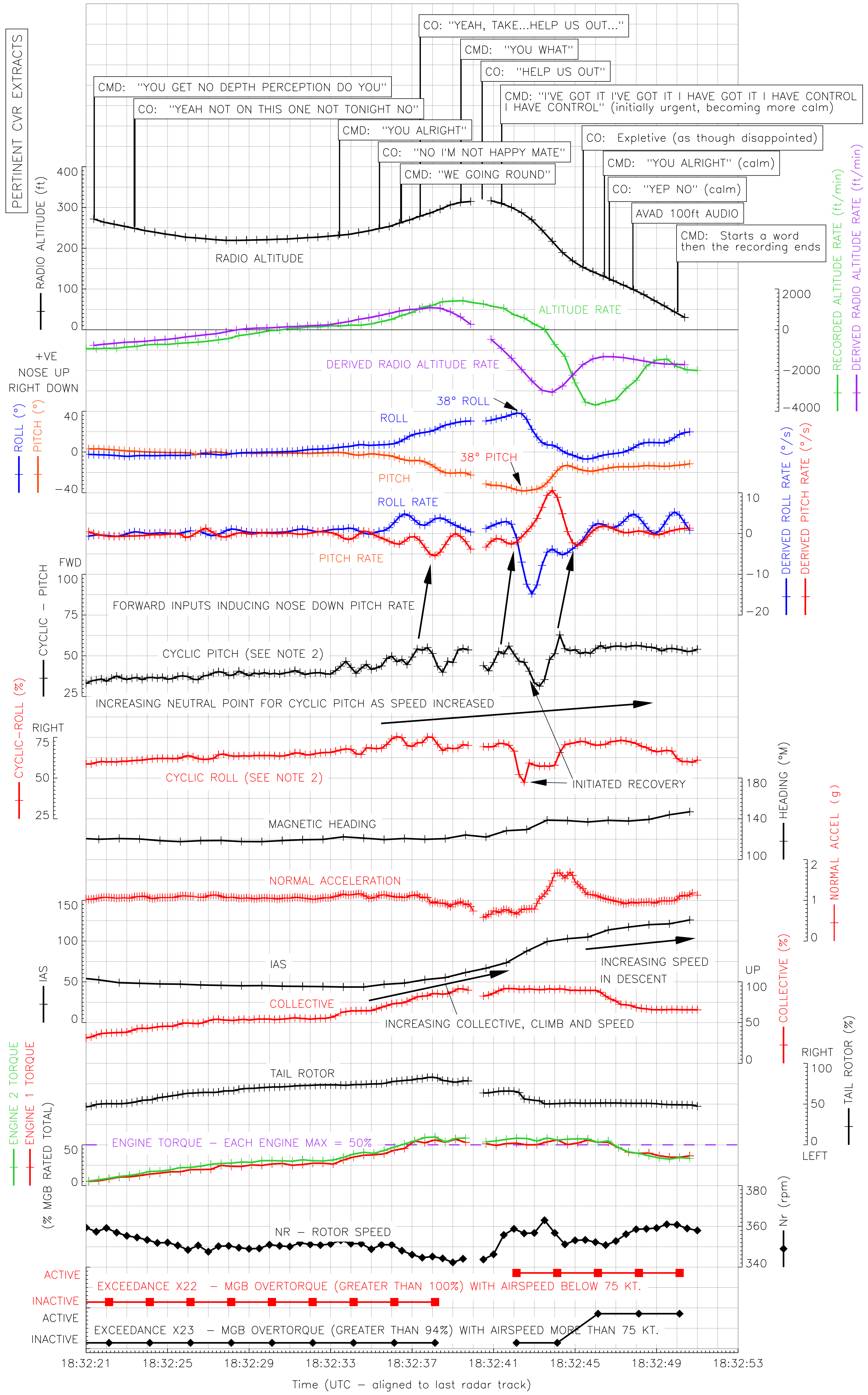
Pertinent data and audio extracts from the final portion of the flight, commencing at 18:32:21 hrs, are presented at Figure 2. The crew had already established visual contact with the platform and the commander had called 55 kt. At 18:32:21 hrs, the commander said "YOU GET NO DEPTH PERCEPTION DO YOU", and the co-pilot replied "YEAH NOT ON THIS ONE NOT TONIGHT NO". The first part of the approach was then marked by steady increases in the collective, tail rotor input, cyclic pitch and cyclic roll input; the radio height initially decreased then increased.

At 18:32:33 hrs, the commander asked "YOU ALRIGHT". At this stage the cyclic pitch and roll inputs started to oscillate, whilst still increasing, and the collective increased at an accelerated rate. The helicopter started to pitch nose down and roll to the right as the altitude increased.

At 18:32:35 hrs, the co-pilot replied "NO I'M NOT HAPPY MATE". The commander asked "WE GOING ROUND": at about this time the combined engine torques exceeded 100%. The co-pilot replied "YEAH TAKE... HELP US OUT ….."; however, this request was not initially understood by the commander; and the co-pilot reiterated his request saying "HELP US OUT". The commander took control approximately four seconds after the initial request for help and said "I'VE GOT IT I'VE GOT IT I HAVE GOT IT I HAVE CONTROL I HAVE CONTROL". The helicopter attitude had now reached a maximum of 38º nose down and 38º angle of bank to the right, the IAS was approaching 90 kt and increasing, and the radio altitude, which had peaked at 315 ft, was reducing through 290 ft with a rate of descent of 2,000 ft/min. One second after the commander stated that he had control, a large left cyclic roll input was made followed one second later by an aft cyclic pitch input. The helicopter rolled through the wings level attitude to about 7º angle of bank to the left and the pitch attitude reduced to 13º nose down. The helicopter was now descending through 180 ft and the IAS was increasing through 100 kt.

During the next six seconds the pitch attitude altered only slightly as the helicopter rolled slowly to the right, the IAS continued to increase as the helicopter descended; the derived vertical speed was initially 1,320 ft/min, increasing to 1,690 ft/min. During this period the collective was reduced and the engine torques decreased so that their combined input no longer exceeded the 100% level.

At 18:32:45 the co-pilot uttered an expletive, as though disappointed, and the commander asked "YOU ALRIGHT"; the co-pilot replied "YEP… NO", in a resigned manner. At 18:32:47 the AVAD provided its automatic "ONE HUNDRED FEET"



NOTE: 1) SOME DATA WAS LOST DUE TO CORROSION OF THE MAGNETIC TAPE DUE TO CONTAMINATION WITH SEA WATER. THIS IS INDICATED BY THE LACK OF A SAMPLE POINT

2) THE CYCLIC POSITIONS FOR TRIMMED FLIGHT ARE NOT 50% BUT VARY WITH OTHER PARAMETERS

Figure 2

call. Cockpit communications were calm and there were no indications of additional problems. The last recorded radio altitude was 30 ft; at this time the helicopter attitude was a 12º nose down, with 20º bank to the right and the IAS was 126 kt. The recording ended at 18:32:50 hrs.

1.1.4 Witnesses

Interviews were carried out with the passengers who travelled in G-BLUN during the sector from Blackpool to AP1 and with the Helicopter Landing Officer (HLO) on AP1. Everyone described the helicopter's operation as completely normal.

The three-man helideck team on the North Morecambe platform were positioned on the south-eastern edge of the helideck on steps, just below the level of the helideck (see Figure 3 for a diagram of the North Morecambe platform and the location of the helideck team). They were waiting for the helicopter to pick up a passenger and some freight. When they first saw the helicopter they estimated the visibility to be about 1,500 m. Everything appeared normal, and they assumed that the helicopter would complete a standard approach and landing on the platform. After what seemed to be a controlled turn to its right the helicopter appeared to initiate a go-around, although it seemed to be faster and closer to the platform than normal. The helicopter was then seen to bank slightly right as it continued past them, maintaining a steady rate of descent.

They lost sight of the helicopter in the dark approximately three seconds before they heard an impact. They added that there were neither strange noises nor any sudden movement from the helicopter. One of the witnesses estimated that the helicopter must have hit the water between 80 and 100 kt.

The HLO raised the alarm immediately, whilst the other witnesses kept a lookout for survivors, in accordance with their training. Two Fast Response Craft (FRC), launched from the Highland Sprite, arrived on scene 16 minutes later.The HLO stated that after the initial radio contact, requesting clearance to land on the platform, there were no other transmissions from G-BLUN to indicate any problem.

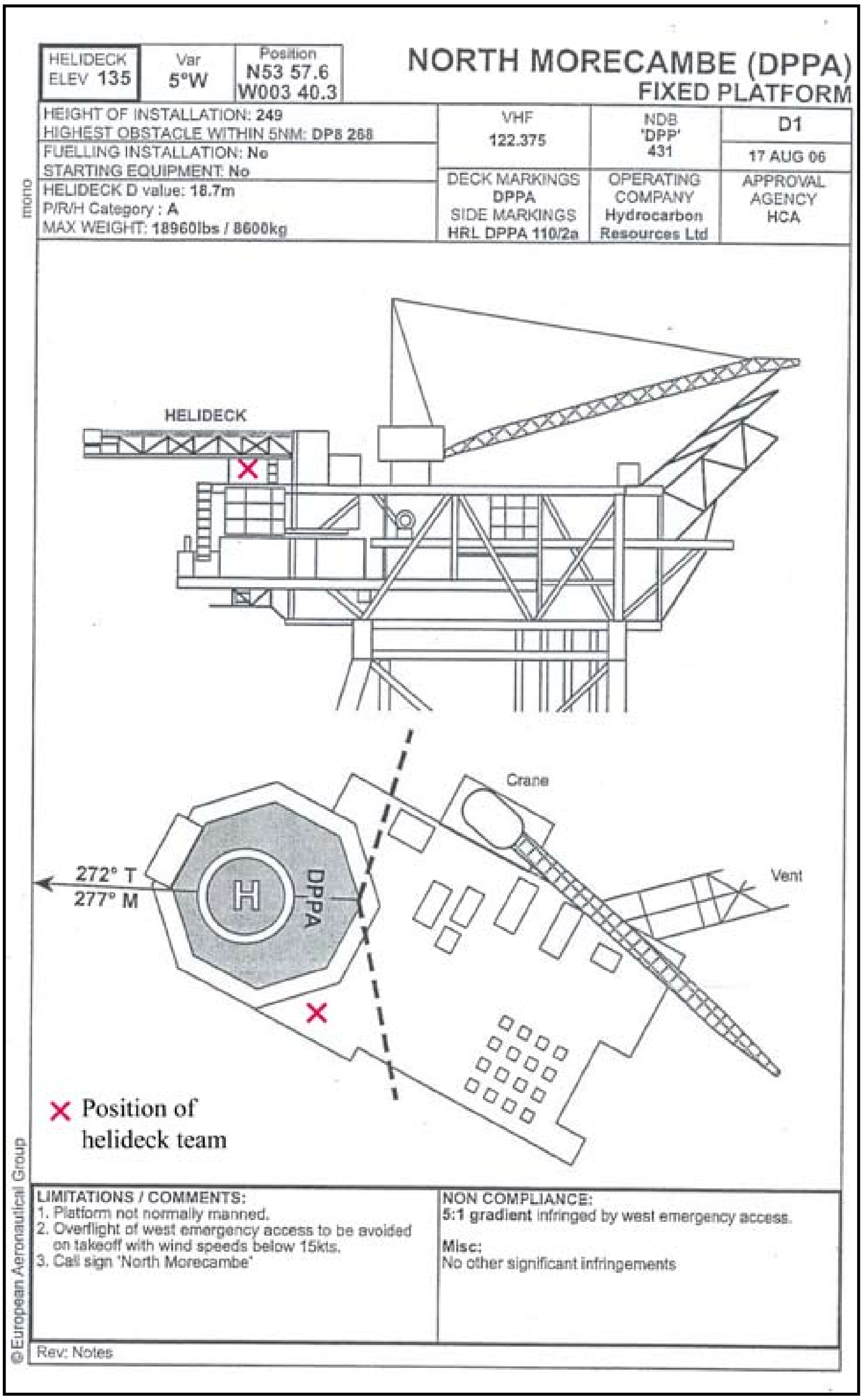


Figure 3

Location of helideck team

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	2	4 Fatal (1 Missing)	None
Serious	None	None	None
Minor/None	None	None	None

1.3 Damage to the helicopter

The helicopter was destroyed.

1.4 Other damage

There was no other damage.

1.5 Personnel Information

1.5.1 Commander

Age:	51 years	
Licence:	Airline Transport Pilot's Licence	
Helicopter Ratings:	SA365/N, SA341/342, AS332/EC225 LP	
Licence Proficiency Check:	Valid to 30 June 2007	
Instrument Rating Renewal:	Valid to 30 June 2007	
Line Check:	Valid to 30 November 2007	
Medical:	Valid to 14 June 2007	
Emergency and Safety Equipment Check:	Next due on 31 December 2007	
Flying Experience:	Total all types:	8,856 hours
	Total on type	6,156 hours
	Last 90 days:	97 hours
	Last 28 days:	29 hours
	Last 24 hours:	32 mins
Previous rest period:	One day and 23 hours	

The commander had been operating in the Morecambe Bay gas field, as a helicopter pilot, for 20 years. At the time of the accident he was the base Chief Pilot, a Line Training Captain, and a Crew Resource Management Instructor. His primary responsibilities were:

- The standards and co-ordination of all flight operations.
- The conduct, discipline and welfare of all aircrew.
- General supervision of operating standards of all pilots on the fleet.
- Conducting line training for new pilots and for pilots engaged in command training.
- Conducting annual line checks.

He had completed a one day Crew Resource Management (CRM) Instructor course on 30 November 2006. This course was for Type Rating Instructors and Examiners and Line Training Captains and was valid until 31 December 2009.

1.5.2 Co-pilot

Age:	33 years	
Licence:	Commercial Pilot's Licence	
Helicopter Ratings:	SA365/N, SA341/2, BO105, AS355/N	
Licence Proficiency Check:	Valid to 30 June 2007	
Instrument Rating Renewal:	Valid to 30 June 2007	
Line Check:	Valid to 31 January 2007[2]	
Medical:	Valid to 8 November 2007	
Emergency and Safety Equipment Check:	Next due on 30 November 2007	
Flying Experience:	Total all types	3,565 hours
	Total on type:	377 hours
	Last 90 days:	62 hours
	Last 28 days:	19 hours
	Last 24 hours:	2 hours
Previous rest period:	18.5 hours	

The co-pilot had been trained to fly helicopters whilst in the British Army. He left the Army in January 2003 and then flew helicopters for the Air Ambulance service for two and a half years, initially based at Caernarvon and then at Blackpool. He had been with his present company for 13 months.

He had completed all of the required flying training. He had also completed a two-day foundation CRM course on 23-24 November 2005. He had recorded a total of 467 hrs of night flying, however, he had recorded only 3 hrs of night flying in the previous three months. Although this flight was with the Chief Pilot it was neither a training flight nor an assessment flight.

2 Since the co-pilot was in his first year with the operator, the company required that he complete a 6-monthly line check until he had successfully completed three such checks.

1.5.3 Night flying and instrument flying recency.

Joint Aviation Requirements (Operations (JAR-OPS)), Part 3 paragraph 3.970 states:

> *'(2) For night VMC operations:*
>
> *(ii) a pilot with a valid instrument rating satisfies the night recent experience requirement if he has carried out at least three instrument approaches in the preceding 90 days. This recency may be obtained in a Synthetic Training Device.*

Table 2 shows the commander's and the co-pilot's recency for instrument approaches and night helideck landings.

	Instrument Approaches		Night Deck Landings	
	90 Days	365 Days	90 Days	365 Days
Commander	34	66	37	64
Co-Pilot	9	38	7	104

Table 2

Flight crew recency

1.6 Aircraft Information

1.6.1 General information

Manufacturer:	Aerospatiale
Type:	SA365N
Serial No:	6114
Date of construction:	6 June 1985
Number and type of engines:	Two Turbomeca Arriel 1C turboshaft engines
Total airframe hours:	20,469
Total airframe cycles:	130,038
Certificate of Registration:	UK Registered on 20 December 1994
Certificate of Airworthiness:	Certificate of Airworthiness in the Large Rotorcraft Category issued by the UK Civil Aviation Authority on 6 March 2005 and expiring on 5 March 2008
Certificate of Release to Service:	Issued on 26 December 2006

1.6.2 SA365N (Dauphin 2) helicopter description

The SA365N is a twin engine helicopter designed to carry up to 12 passengers and two pilots. Developed from the single-engined Aérospatiale Dauphin variant, the Dauphin 2 is widely used as a corporate transport, police, emergency medical services and search and rescue helicopter; it is also used extensively in support of off-shore gas and oil production.

Four large doors provide access to the cabin. Baggage is stowed in a separate compartment aft of the cabin, which has a door on the starboard side. The four-bladed main rotor is mounted on the main gearbox, which is directly above the cabin. The two Turbomeca Arriel 1C gas turbine engines are mounted side-by-side aft of the main gearbox. Both engines have separate drive inputs to the main transmission, which reduces engine rpm and distributes torque upward to drive the main rotor, and aft through a tail gearbox to drive the fenestron tail rotor. The tricycle-type landing gear is hydraulically retractable. A photograph of G-BLUN is shown at Figure 4.

Figure 4

G-BLUN

1.6.3 Flight controls

The flight controls modify the pitch angles of the main and tail rotors, allowing the pilot to control the helicopter's flight by modifying its altitude, speed and heading. The collective pitch lever controls the main rotor lift by collectively modifying the lift of all four blades. The cyclic stick varies the tilt of the rotor disk forwards and backwards, for pitch control, and left and right, for lateral control. The yaw pedals control the tail rotor thrust, and thus the helicopter's heading.

The control forces are reduced by a duplex (left and right) hydraulic servo system at the main rotor and a simplex (left) system at the tail rotor. The main rotor flight controls have a stick positioning and force gradient system.

1.6.4 Automatic flight control system

The automatic flight control system (AFCS) is designed to assist the pilot in controlling the helicopter. It provides the following primary functions, seeking to follow reference values selected by the pilot:

- Attitude and heading hold
- Altitude hold
- Airspeed hold
- Co-ordinated turns (no sideslip)

When coupled to certain radio navigation systems it permits automatic capture and tracking of radio guidance beacons.

The AFCS incorporates a 'fly-through' control provision that allows the pilot to resume control and override the system, and an attitude reference modification system. The AFCS transmits electrical signals to electrical control actuators, which are series-mounted in the flight control linkage. The system also includes electric trim actuators mounted in parallel in the control linkage and connected to the AFCS computer.

The auto pilot (AP) is a 3-axis system (pitch, roll and yaw) in which each axis is controlled by two mutually monitored lanes in a fail passive configuration. The AP is used either to damp low amplitude motion (Stability Augmentation) or to hold the reference values selected by the pilot. The AP coupler is a 3-axis unit (pitch, roll and yaw) which delivers attitude command signals to the AP and a processed signal to the flight director. There was no guidance in the Operator's Operations Manual (OM) regarding the use of the AP in coupled modes.

1.6.4.1 Automatic Trim

The pilot's control commands using the AFCS are transmitted to the flight controls through series-mounted actuators. The automatic trim then returns the flight control actuators to the neutral position, through the use of parallel-mounted actuators, and it is therefore possible for the pilot to fly 'Hands-off'. If the automatic trim function is not available the pilot has to return the flight control actuators to the neutral position himself; the automatic trim function can be deselected by selecting the 'trim' push-button to OFF.

1.6.4.2 'Fly Through' Steering

Without modification of the reference:

> Moving the cyclic stick against the trim loads actuates the load-sensing contact in the trim actuator. This inhibits the automatic trim function. When the stick is released, the automatic pilot restores the reference attitude.

With modification of the reference:

> The pilot can use the beep-trim control to obtain a slow and even modification of the attitude reference (pitch and/or roll). If the pilot simultaneously moves the cyclic stick against the trim loads and presses the beep-trim switch, he places the reference memory circuit in synchronizing mode and makes the trim motor run to cancel the loads. Operation of the stick trim release push-button disengages the stick trim loads and places the reference attitude memory circuit in synchronizing mode. This control is used for fast reference changes.

1.6.4.3 Go-around Function

The Go-around (GA) function is controlled from a push-button located on the collective lever handgrip. The GA light on the function annunciator panel illuminates and the reference airspeed of 75 kt, is shown in the digital display window. This reference cannot be changed by the trim function and has priority over the other functions of the coupler, except the selected heading hold function. The rate of climb will vary depending upon the power applied by the pilot. The vertical speed limits for engagement are ± 1,500 ft/min. There was no guidance in the OM regarding the use of the GA function.

1.6.4.4 Maintenance History /Technical Records

The helicopter had undergone normal maintenance on the day of the accident, which had included a routine 50 hour check and scheduled inspections of the main gearbox drive couplings, the tail rotor drive shafts, main gearbox suspension and the 'Starflex' rotor head bearings; there were no reported defects. In the preceding two days scheduled inspections of the rotor mast, engine compressors and the hydraulic flight control systems had also been completed, again with no reported defects. The helicopter Technical Log contained four carried forward defects of a non-operational nature, there were no recorded defects relating to operational systems or equipment. Examination of the helicopter's technical records confirmed that it had been maintained in accordance with its CAA Approved Maintenance Schedule and that it was in compliance with the applicable Airworthiness Directives in force at the time of the accident. A review of the preceding 12 months of helicopter Technical Log entries and maintenance work cards showed that there had been no defects reported which had a bearing on this accident.

1.7 Meteorological information

1.7.1 General

The Met Office provided an aftercast of the weather situation for the area. The synoptic situation at 1800 hrs on 27 December 2006 showed a moist south-south-easterly flow covering the eastern Irish Sea, with a slack area of low pressure embedded within the flow pattern. Moderate rain had probably recently cleared to the north-east of the accident area by 1834 hrs, leaving outbreaks of light rain or drizzle and misty conditions. The surface visibility was 3 to 7 km in mist and light rain or drizzle; the air to ground visibility is unknown. The mean sea level pressure was 1021 hPa. Cloud was SCATTERED to BROKEN stratus with a base at 700 ft and BROKEN to OVERCAST stratus with a base at 1,200 to 1,500 ft. The surface wind was from 130º at 15 kt, and the wind at 2,000 ft was from 150º at 20 kt. The sea state was likely to have produced wave heights of approximately 1.1 m from the south-south-east every four seconds. The sea temperature was +11.5ºC.

1.7.2 Terminal area forecasts (TAFs)

The Blackpool TAF timed at 1505 hrs, and valid from 1600 hrs to 2300 hrs:

Surface wind	From 130º at 12 kt
Visibility	7,000 m
Cloud	Broken at 3,500 ft

Between 1600 hrs and 1700 hrs there would be a temporary reduction in visibility to 3,000 m in rain with broken cloud at 800 ft. Between 1700 hrs and 2100 hrs there was a 30% probability of a temporary change to 4,500 m in haze, with broken cloud at 900 ft. There would then be a temporary improvement of visibility to greater than 10 km between 2100 hrs and 2300 hrs.

The Ronaldsway (Isle of Man) TAF timed at 1500 hrs, and valid from 1600 hrs to 2200 hrs:

Surface wind	From 110º at 15 kt
Visibility	6,000 m in light rain
Cloud	Scattered at 600 ft,
	Broken at 1,500 ft

Between 1600 hrs and 1700 hrs there would be a temporary reduction in visibility to 3,000 m in rain with broken cloud at 800 ft.

1.7.3 Actual weather reports

The actual weather reports for Blackpool were as follows:

1750 hrs	Surface wind	From 110º at 12 kt
	Visibility	3,000 m in haze
	Cloud	Scattered at 800 ft
		Broken at 1,800 ft
	Temperature/dew point	+4ºC/+3ºC
	QNH	1022 hPa
1820 hrs	Surface wind	From 120º at 13 kt
	Visibility	3,000 m in haze
	Cloud	Scattered at 800 ft
		Broken at 1,500 ft
	Temperature/dew point	+5ºC/+3ºC
	QNH	1022 hPa
1850 hrs	Surface wind	From 120º at 11 kt
	Visibility	3,500 m in haze
	Cloud	Scattered at 800 ft
		Broken at 2,300 ft
	Temperature/dew point	+5ºC/+4ºC
	QNH	1021 hPa

The actual weather reports for Ronaldsway (Isle of Man) were as follows:

1750 hrs	Surface wind	From 090º at 17 kt
	Visibility	6,000 m
	Cloud	Few at 400 ft
		Broken at 700 ft
		Overcast at 1,100 ft
	Temperature/dew point	+7ºC/+6ºC
	QNH	1021 hPa
1820 hrs	Surface wind	From 090º at 19 kt
	Visibility	6,000 m
	Cloud	Scattered at 400 ft
		Broken at 600 ft
		Overcast at 1,100 ft
	Temperature/dew point	+7ºC/+7ºC
	QNH	1021 hPa
1850 hrs	Surface wind	From 090º at 17 kt
	Visibility	6,000 m
	Cloud	Scattered at 400 ft
		Overcast at 700 ft
	Temperature/dew point	+7ºC/+6ºC
	QNH	1021 hPa

1.7.4 Additional weather observations

The Logistics Supervisor[3], located on AP1, reported the following conditions:

1700 hrs	Surface wind	From 150º at 22 kt
	Visibility	4,000 m in rain
	Cloud	Sky obscured
	Temperature/dew point	+5ºC/+4ºC
	QNH	1020 hPa

He was unable to make an accurate assessment of the cloud base because there are no ceilometers[4] on the AP1 platform. A ceilometer is located on top of the terminal at Blackpool.

3 See section 1.18.2 for a detailed description of the Logistics Supervisor's responsibilities.
4 A ceilometer is a device that uses a light source to measure the height of a cloud base.

The Highland Sprite, stationed approximately 1 nm south-west of the North Morecambe platform at the time of a weather observation at 1810 hrs, recorded the surface visibility as 3 to 5 nm (5.5 km to 9.3 km), with the surface wind from 130º at 20 kt.

1.7.5 Weather minima for flight at night in uncontrolled airspace

Part A, Section 8, paragraph 8.1.3.1 of the operator's OM states that the absolute minima for night VFR operations are 5,000 m visibility with a cloud base of 1,200 ft. For helidecks less than 10 nm apart, at night, the minimum forward visibility is 5 km and the cloud base must be such as to allow flight at 500 ft whilst clear of cloud. However, this limit does not preclude flying between helidecks if the cloud base is lower as long as it is above the Airborne Radar Approach (ARA) limit of 300 ft at night and the crew are flying the ARA procedure. An ARA can be flown to ¾ nm from a platform as measured on the helicopter's radar. The crew were not conducting an ARA during the flight to the North Morecambe platform and their previous approaches, to the AP1 and the Millom West platforms, were conducted visually.

1.7.6 Celestial information

At the time of the accident it was night; moonrise was around 1200 hrs. At 1830 hrs, there was approximately 51% of a full moon; its elevation was 39.6º and its bearing was 185º. It was a particularly dark night with the overcast cloud completely obscuring any celestial illumination.

1.8 Aids to navigation

1.8.1 Surface based navigation aids

The North Morecambe platform is equipped with a non-directional beacon, transmitting on 431 MHz, to assist with navigation, but this was not being used by the crew.

1.8.2 Airborne navigation aids

The operator's SA356N fleet is fitted with Trimble 2101 Navigator Plus Global Positioning Systems (GPS), cleared as a primary means of navigation in instrument conditions. The fleet helicopters are also fitted with an Automatic Direction Finder (ADF) and a Sperry Primus 500 colour radar system. The GPS is the primary means of off-shore navigation, with the radar being used as a back up and to cross-check the GPS data when required.

The radar is primarily a weather radar, but it also has a air-to-ground mapping mode. It has a selectable display from a maximum range of 200 nm to a minimum achievable range, on the 2.5 nm scale, of 0.3 miles; this minimum range is due to clutter. Prior to becoming visual with the North Morecambe platform the commander was using the radar and the GPS to provide range information to the co-pilot. Once they had established visual contact with the platform the commander provided no further range information.

1.9 Communications

Records of radio transmissions between the helicopter and other agencies were available but all relevant transmissions were recorded on board the helicopter.

1.10 Aerodrome information (offshore helicopter installations)

The criteria for the design of offshore helicopter installations are published in Civil Air Publication (CAP) 437 '*Offshore Helicopter Landing Areas – Guidance on Standards*'. CAP 437 forms part of the guidance issued by the Civil Aviation Authority (CAA) to UK helicopter operators. Helidecks, used in operations on the UK Continental Shelf (UKCS), are regarded as being 'unlicensed landing areas', and offshore helicopter operators are required to satisfy themselves that each helideck to which they operate is suitable for purpose and is properly described in their OM. UK offshore helicopter operators have chosen to discharge this duty by accepting Helideck Landing Area Certificates based on inspections undertaken by the Helideck Certification Agency (HCA), formerly known as the British Helicopter Advisory Board (BHAB) Helidecks. The HCA acts on behalf of the interests of all of the UK offshore helicopter operators who have each given an undertaking to use the HCA system of authorization.

All offshore helidecks on the UKCS are inspected by the HCA every three years. The last inspection of the North Morecambe platform was on 13 March 2006. The report identified that the perimeter lights were yellow and added the following note:

> *'The criteria for helideck lighting has changed. The International Legislation will become effective on 1 January 2009. We are advising UK helideck operators to make this change at the earliest practical opportunity. See CAP 437 Edition 5, Appendix C for details.'*

This change in the criteria for helideck lighting was one of the recommendations that resulted from flight trials and research conducted by the CAA[5]. The specific recommendation was that the perimeter lighting be changed from yellow to green. The flight trials showed that changing the colour of these lights from yellow to green significantly increased the range at which the pilot could visually locate the helideck amongst other platform lighting. Green perimeter lighting also provided a strong colour contrast to the existing platform lighting, which enhanced the situational awareness of the pilot and promoted greater confidence in the conduct of the approach. This recommendation was incorporated into the fifth edition of CAP 437.

Two further sets of trials were reported in CAA Papers 2005/01 and 2006/03. The new helideck lighting developed by the CAA, and now under trial on offshore installations, consists of an illuminated circle and 'H' as well as the improved perimeter lighting. The improved perimeter lighting is mandated by ICAO (from Jan 2009) and the circle and 'H' lighting is described in ICAO Annex 14, Vol 2, as an acceptable alternative to flood lighting.

1.11 Flight recorders

The helicopter was fitted with an Integrated Health & Usage Monitoring System (IHUMS). Part of the IHUMS system gathers selected flight parameters and sends them to a Combined Voice and Flight Data Recorder (CVFDR)[6]. This records five hours of data and one hour of 3-channel audio, incorporating the commander's, co-pilot's and cockpit area microphones (CAM).

IHUMS also collects data from accelerometers positioned on the helicopter to monitor the operation of the rotating components. This data is stored separately from the CVFDR in a Maintenance Data Recorder (MDR) and is downloaded routinely. The downloaded data is then analysed to identify vibration trends that might signify a need for maintenance action.

The recovered recordings do not provide information on all system selections or indications. The helicopter was not equipped with image recorders and none of the avionic systems fitted were designed to record data; in particular the GPS data was not recorded.

5 CAA PAPER 2004/01 Enhancing Offshore Helideck Lighting – NAM K14 Trials.
6 Penny & Giles CVFDR, part number 900/D51506.

1.11.1 Data from the G-BLUN flight

The recorder uses magnetic tape to store the data and audio recordings; unfortunately, the tape was exposed to corrosive sea water until it was cleaned at the AAIB facilities. As is usual in such circumstances, the corrosion was most aggressive where the tape came into contact with the metal tape heads used to read, write and erase the recordings. Therefore, in a number of small areas near the end of the tape the data and audio recordings were lost.

The MDR was not recovered from the sea after the accident; however, the operator had IHUMS data from the helicopter that had already been downloaded and this was available for analysis.

1.11.1.1 Flight data

The majority of the data recorded during G-BLUN's flight is reported in the section describing the History of the flight. Other items of interest are presented below.

The recorded parameters that indicate system faults remained inactive throughout the flight; these include the master warning, engine and gearbox low oil pressure, electrical generators, fuel pressures, hydraulic pressures, cargo and engine fire, the rotor brake and the recorder functionality. The recorded data included the triggering of two main gearbox exceedances that would not have been annunciated to the crew. The first exceedance occurred when the combined engine torque exceeded 100% whilst the helicopter was below 75 kt; a further exceedance was triggered with the helicopter above 75 kt and the torque exceeding 94%. These both occurred during the attitude upset and recovery. No other exceedance parameters were recorded as being triggered.

Recorded parameters relating to the autopilot functions were limited. Those that were recorded indicated that the autopilot heading hold, IAS hold, altitude hold and RNAV modes were not used, except that the altitude hold function had been engaged for the transit during the first sector from Blackpool to the AP1 platform. The Stability Augmentation System (SAS) function remained inactive throughout. The autopilot fault parameter indicated a fault shortly after each of the landings on the rigs and cleared shortly before taking off, indicating that the autopilot was disengaged when the helicopter was not flying. The AFCS actuator activity, the use of trim functions by the pilot, trim feel switching and fault indications associated with the AFCS were not recorded.

The helicopter was flown with the landing gear up during the transit on the first two sectors and with the landing gear down for the short flight from Millom West to the North Morecambe platform.

1.11.1.2 Parameter sources

With no recordings of the information provided to the crew via their cockpit instrumentation the sources of key recorded parameters were established in an attempt to correlate them with the instrumentation.

The recorded pressure altitude correlated with the recorded radio altitude both in magnitude of altitude changes and in relative values for the given atmospheric pressure. The recorded pressure altitude and airspeed parameters were sourced from the DIGITAS unit fitted to the helicopter. This utilised tubing used to supply the pitot/static pressures to the co-pilot's instruments. However, whilst the DIGITAS uses the same pressure sources as the co-pilot's instruments, the flight test results indicate that the DIGITAS and the flight instruments apply different levels of damping, affecting the rate of change of the indications and recordings as well as the peak values when in short term dynamic motion.

The commander's horizontal situation indicator (HSI) was the source of the recorded heading information. The recorded airspeed and heading parameters demonstrate reasonable values when compared to the recorded radar data and the reported wind conditions. The co-pilot's artificial horizon was the source of the recorded pitch and roll parameters. The control inputs were sourced from potentiometers associated with the collective, cyclic and tail rotor. Of these, the cyclic potentiometers were the only ones dedicated for use by the recorder; the others were associated with the autopilot.

1.11.1.3 Parameter validity

The maintenance records showed that a calibration check of the recording system was conducted on 31 August 2006. This showed that all parameters were within limits and the errors in measuring the control input position varied between 1.9% and 3.8%.

Experienced helicopter pilots at the CAA and AAIB, and technical experts from the helicopter manufacturer, reviewed the data for consistency between the sense of the control inputs and resultant helicopter behaviour; no inconsistencies were found.

In addition, the helicopter manufacturer processed the data through their aerodynamic simulation tool. The limitations of this method include the fact that some important parameters for simulation were not recorded; these included the ambient wind conditions when the final manoeuvring took place and directional parameters pertaining to the drift of the helicopter. A nominal drift was used which was based on average heading and average track during the final sector but this did not take into account local variations around the rig during the period covered by the simulation. Other limitations are that the vertical parameters recorded were subject to normal instrument delay and damping, and there was some loss of data during this period. Three of the simulation results, with variations of initial assumptions, are presented in Appendix A.

1.11.1.4 Audio data

The audio recording commenced at the time of the approach and landing at Blackpool, at the end of the flight prior to the accident flight. This flight had been conducted by the same crew that were subsequently involved in the accident.

A review of the recordings identified no audible warnings in the cockpit.

Spectral analysis of the CAM showed that throughout the recorded period, the relationship between the gear meshing frequencies of the first gears driven by the engine correlated with the gear meshing frequencies of the last gears driving the rotor. Harmonics of the frequency at which the main rotor turned were evident throughout the recording; the frequencies were consistent with the rotor speed operating within limits.

A further signature was observed at the end of the recording, just prior to the impact, which was not related to gearbox meshing, engine or rotor frequencies. Reviewing other periods of the recording during the previous successful sectors showed that, in addition to the audio signatures from the gears meshing, other signatures were identified that stepped up in frequency in a manner that appears to be related to the engine input rotation speed, in the region of 100 Hz. The steps in frequency correlated in time with changes in airspeed and did not correlate with any other recorded parameter. These spectral signatures were only detectable at higher air speeds. This spectral anomaly was evident when the helicopter had previously been flying at the same speed.

1.11.1.5 IHUMS

The purpose of IHUMS is to note trends in the performance of components in the power train, ideally identifying the need for maintenance actions before failures occur. The IHUMS data that had been previously recovered by the operator, covering flights up to 24 December 2006, were analysed to establish whether any such trends were evident. The operator of the helicopter and the manufacturer of the IHUMS data reviewed the data and found no indications of impending mechanical failure.

1.11.1.6 Radar information

The St Annes radar installation recorded the initial leg from Blackpool to the AP1 platform and the beginning of the next leg; however, due to its relatively low altitude the radar lost track of the helicopter towards the end of the second leg. Only a number of scattered radar returns of the third leg were recorded, however, the radar data that was recorded was used to align the CVFDR recorded times to UTC, and were combined with the airspeed and heading data from the CVFDR to calculate the wind conditions at the start of the flight.

1.11.2 Data from the test flight

A flight test was conducted on a similar helicopter to review the helicopter handling characteristics and to assess the lighting of the platform at night. (See paragraph 1.16). The recorded data and audio, together with video recordings made during the flight, were analysed for additional information.

1.11.2.1 Audio data

During the test flight, specific controls were operated to generate a recording of any audible effect of the control; no useful audio signatures were identified. The recordings captured clearly each of the AVAD "ONE HUNDRED FEET" and "CHECK HEIGHT" callouts. The audio was also analysed for mechanical signatures similar to the stepped frequency signatures found in the recording from the accident helicopter. Similar characteristics were present, albeit at slightly lower air speeds.

1.11.2.2 Flight data

Data from the accident flight indicated that the engine torque inputs into the gearbox exceeded allowable torque limits. It was clearly not acceptable to deliberately recreate these levels of torque for flight test purposes, therefore, the flight test data cannot replicate precisely the flight characteristics during the phase of flight when the torque limits were being exceeded. Nevertheless, comparisons can still be made and a review of the differences analysed.

1.11.2.2.1 Entry into pitch upset

Whilst the flight test did not replicate the extreme pitch attitude achieved prior to the accident, it did replicate many of the characteristics for the entry into the pitch manoeuvre. A comparison of one of the flight test manoeuvres with the accident data is shown in Figure 5. The roll parameters demonstrate a close match as does the initial pitch deviation. The differences are that the test flight was approximately 8 kt faster and was entered whilst in a climb of approximately 500 fpm instead of roughly level. This resulted in the use of approximately 3% more cyclic pitch input to maintain neutral pitch with no change in helicopter motion. The test flight data indicates that with an additional 5% cyclic pitch input a 2.5º per sec nose down pitch rate was produced. The initiation of the pitching motion during the accident flight is less smooth but the peaks indicate a similar relationship in the order of 5% increased cyclic to 2.5º per sec nose down pitch rate. The pitch parameters deviate from each other when the accident data shows additional cyclic pitch inputs. Additional cyclic pitch input on the accident flight resulted in a pitch rate response similar in ratio to that recorded on the test helicopter. Given the variables that actually affect the helicopter's longitudinal characteristics it is acknowledged that this is only a crude comparison, but one that yields similar behaviour.

1.11.2.2.2 Pitch control during final moments

The flight test data was used to establish a broad relationship between the cyclic pitch inputs and the associated pitch responses of the helicopter, under steady state conditions. This was to assess whether there was any significant difference between the behaviour of the test helicopter and that of the accident helicopter during its last few seconds, when it was in an approximately stable descent. The flight test data showed that for a given pitch attitude relative to the vertical flight path of the helicopter, more forward cyclic pitch inputs are required at higher speeds. The recorded vertical path, speed, pitch attitude and cyclic pitch input during the last few seconds of the accident flight were consistent with the relationship between these parameters drawn from the data recorded during the flight test.

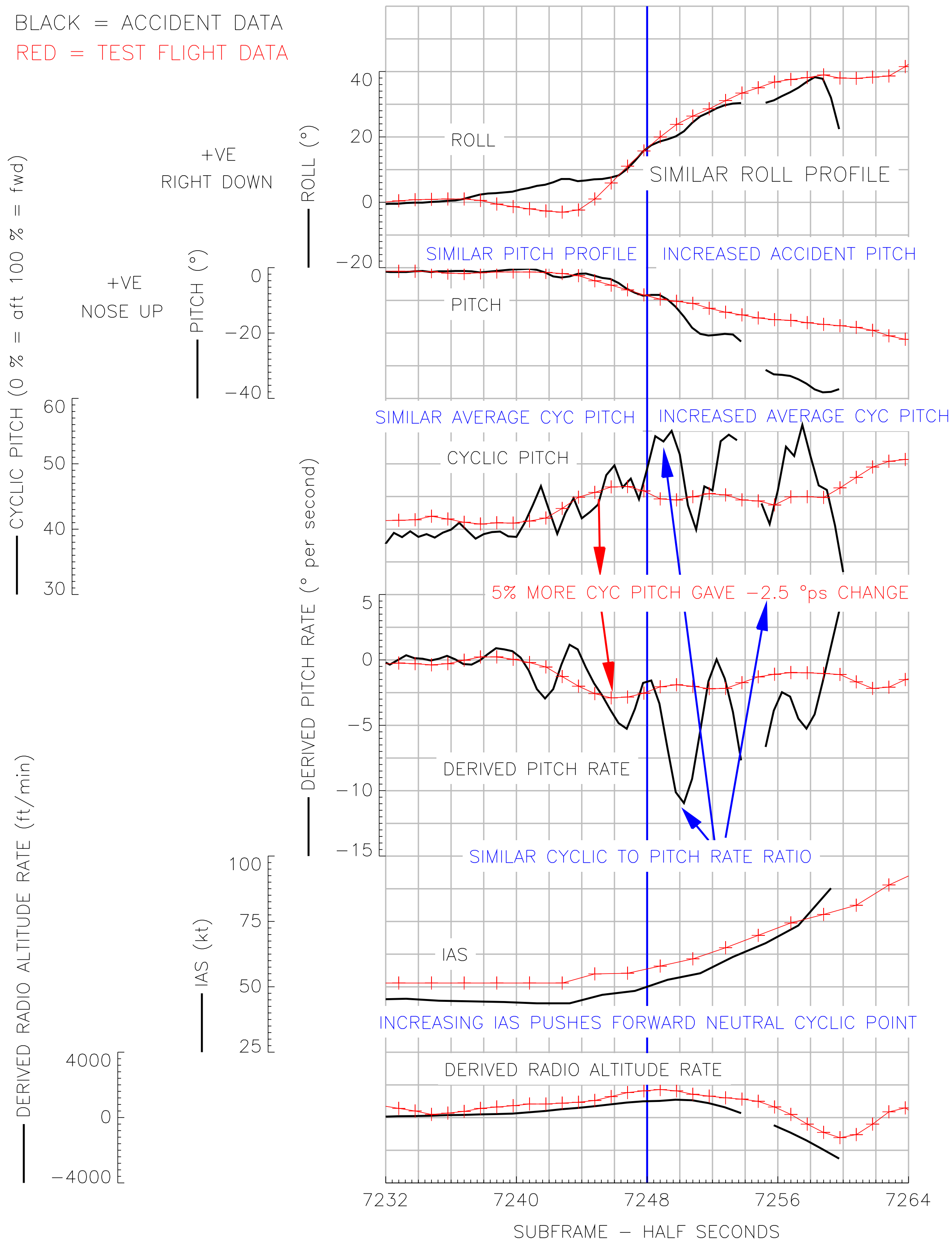


Figure 5

Comparison of pitch and roll parameters of the accident flight with the flight test data

1.12 Wreckage and impact information

1.12.1 Wreckage distribution and recovery

The first items of wreckage to be recovered were found floating on the surface by the two FRCs launched from the Highland Sprite, stationed approximately one mile to the south-west of the platform. Much of the floating debris included engine and transmission cowlings, fuselage panels, passenger seats and an inflated life raft. The most significant item recovered at this stage was the tailboom, complete with the fenestron tail rotor and gearbox. The condition of this wreckage suggested that the helicopter had impacted the sea at high speed, and that the remainder would be scattered on the sea bed. This wreckage was recovered to shore on the morning of 29 December 2006.

Prolonged gales and associated rough seas significantly impeded location and recovery of the wreckage. However, on 5 January 2007 an approximate location of the CVFDR was established using the AAIB's towed microphone array, which detected the signal from the locator beacon on the recorder. This location was some 450 m south-south-east of the North Morecambe platform and a subsequent sidescan sonar survey of the location showed several large objects on the seabed at this position: this became the focal point for the recovery effort using the diving support vessel, the Vos Sympathy.

The diving support vessel confirmed that the sonar contacts were indeed substantial pieces of G-BLUN, lying amongst a field of smaller debris (see Figure 6). The most substantial piece was a section of transmission deck with the main rotor gearbox, main rotor head with varying lengths of blade still attached, and the engines. The engine mounts were disrupted but, when the gearbox was raised on 10 January 2007, the engines remained attached by fuel pipes, wiring looms etc and were also recovered. Throughout this period, attempts were made to locate precisely the locator beacon using detection equipment mounted on a Remotely Operated Vehicle (ROV); however, this was not successful.

Bad weather delayed further salvage attempts but eventually all the parts depicted in Figure 6 were recovered, plus a number of smaller items. Meanwhile, slightly improved conditions allowed an accurate location of the CVFDR to be completed. It was recovered on 16 January 2007, still within its rack in the baggage compartment, located in a large intact section of the lower rear fuselage. This section of the structure also housed the main landing gears, which were locked in the extended position. As can be seen from Figure 6, it was found about 1.3 km west-north-west of the main debris field and was the

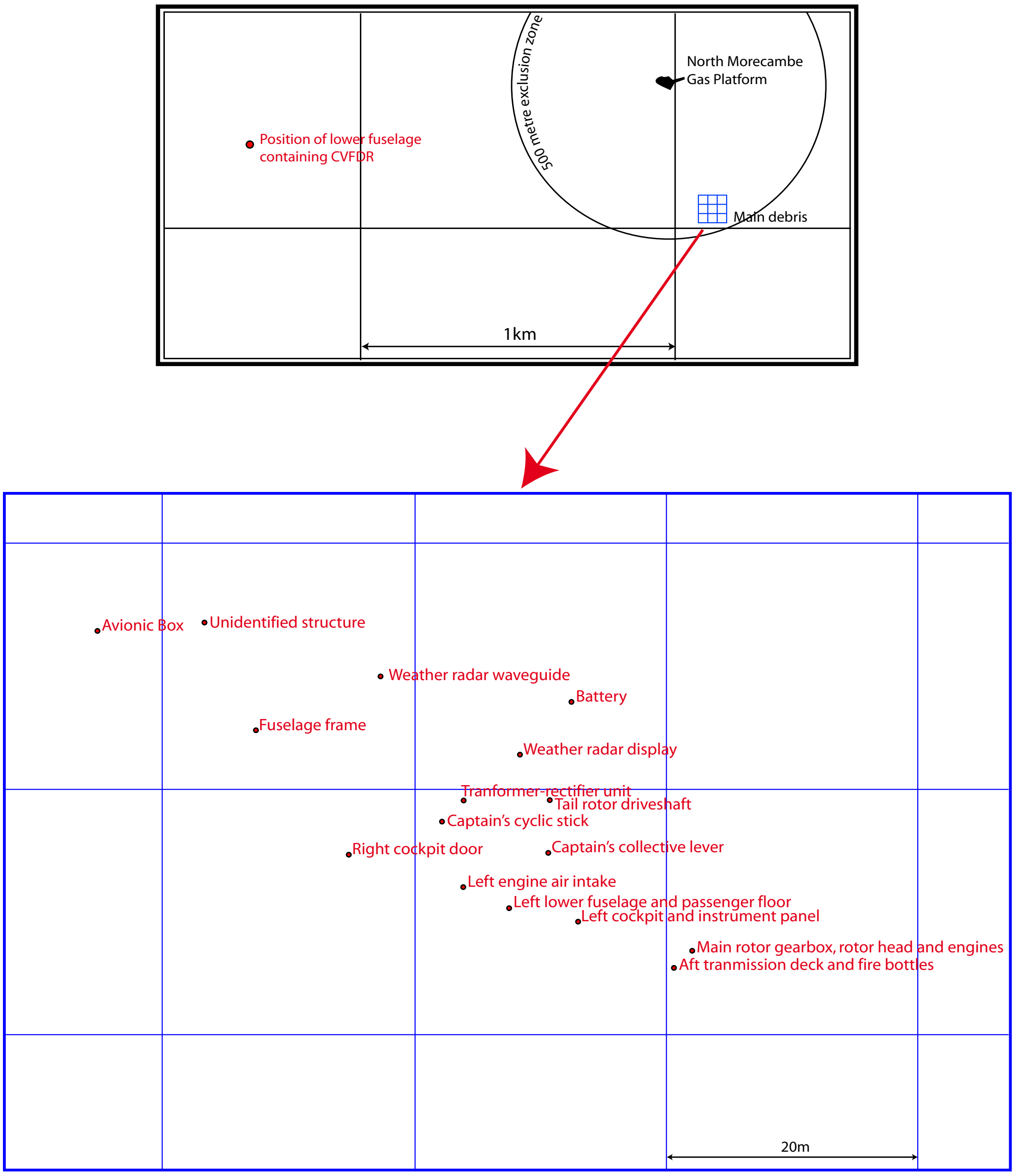


Figure 6

Map of debris field showing main identifiable wreckage and (inset) location of debris field relative to North Morecambe gas rig

only piece of the helicopter recovered from that location. The reason why it should be so far removed from the rest of the wreckage is not clear; however, considering that at the start of the search it was detected with the main debris it had probably drifted with the current, perhaps assisted by some residual buoyancy from the intact fuel tank which was located within the structure.

In all, it is estimated that more then 90%, by weight, of the helicopter was recovered. The only significant elements which were not found were the two crew seats, the IHUMS recording device and the missing passenger.

1.12.2 Engine examination

The two engines were recovered as part of the main transmission assembly. Although the engine mounts and power couplings had broken, the engines were still attached to the transmission deck by wiring harnesses and hoses. The broken couplings bore evidence that torsion had been a primary component in the forces which had caused their final failure.

After an external visual examination by the manufacturer's representative, both engines were shipped to a Turbomeca facility in France for a strip examination under AAIB supervision. This examination found that there were no pre-impact anomalies with the engines, which appeared to be in good condition consistent with the hours they had run. Of particular significance was the displacement of 'tell-tale' witness marks etched on components of the 'muff coupling', which connects the power turbine shaft to the reduction gearbox input shaft. These marks are applied after final assembly of the coupling to assist in any subsequent case of sudden rotor stoppage as a coarse indicator of overtorque of the engine (This is not 'overtorque' as might be inadvertently applied by the pilot, but the shock load experienced through, for example, a main rotor strike on a medium such as water.)

Information from Turbomeca advised that a displacement of one millimetre between the two marks represented about twice the nominal torque having been experienced. Both engines showed displacements slightly less than 2 mm, indicating that an overtorque by a factor of nearly four had occurred, suggesting that both engines were delivering high power at the time the main rotor struck the sea.

1.12.3 Main and tail rotor transmission

The main rotor gearbox, together with the rotor head and the remains of the rotor blades, was recovered still attached to the transmission deck. Damage to the three gearbox support struts indicated that the transmission system had been subject to a significant overtorque loading, as might be experienced through, for example, a main rotor strike on water. The inboard sections of the four rotor blades were still attached to the rotor head, which had been severely damaged; all of the elastomeric bearings had failed allowing the blade attachment beams to separate from the outboard ends of the rotor head star (see Figure 7). Although severely distorted, all of the blade control linkages remained connected. After removal of the rotor blades, the transmission deck, gearbox and rotor head were shipped to the manufacturer in France for disassembly under AAIB supervision.

Figure 7

Main rotor head

During disassembly, impact marks observed on the lower gearbox suspension torque stops indicated that the transmission system had been subject to a very high torque load, consistent with the rotor system striking the water whilst under moderate to high power. Prior to disassembly of the transmission system the gearbox driven hydraulic pumps, used to power the main and tail rotor actuators, were removed and examined. The presence of corrosion products prevented the units being bench-tested; however, disassembly confirmed that they had not suffered any internal failure and after clearing they could be rotated freely. The rotor head hydraulic actuators were also removed for testing and examination by their manufacturer under AAIB supervision. Examination of the components of the main rotor gearbox confirmed that there was no evidence of any pre-existing defects or failures within the system.

As noted in paragraph 1.12.1, the fenestron tail rotor and its gearbox were still attached to the tailboom and empennage structure, which had been recovered floating on the surface by rescue vessels on the night of the accident. A long section of the tail rotor centre driveshaft had pulled out of its sliding spline connection with the rear shaft (which was still in-situ) and was later recovered from the sea bed. The forward end had failed in bending at the same location where the tailboom had fractured. The remaining section of the centre driveshaft was found still connected to the forward shaft, which had also broken into two pieces in bending. Both flexible couplings in the system were intact.

The fenestron itself was undamaged by impact and turned freely within its shroud, indicating that there had been no seizure of the gearbox or failure of the fenestron hub or blades. The shroud itself had deformed elastically during impact and the tips of the tail rotor blades had gouged material from the shroud, leaving clear evidence that the tail rotor had been turning at speed. It was thus concluded that there had been no pre-impact discontinuity of the tail rotor drive.

1.12.4 Flight controls

Flight control inputs are transmitted to both the main and tail rotors through a series of control rods and bell cranks to three hydraulic actuators on the main rotor gearbox, and a single actuator on the tail rotor gearbox. The main rotor controls pass under the cabin floor before being routed upwards to the transmission deck. The control rods for the right roll actuator are located on the right side of the fuselage and the pitch and left roll actuators on the left side. The tail rotor controls are routed under the right side of the cabin to the tail boom and tail rotor gearbox. Reconstruction of the helicopter control system confirmed that all of the control circuits from the left side of the helicopter and the tail rotor controls had been recovered. All of the control circuit for the right roll actuator had been recovered with the exception of one element approximately 1.5 m in length. No evidence of any pre-impact restriction or disconnection was found within the controls systems. All of the damage observed was consistent with the helicopter's impact with the water. The missing portion of the right roll actuator control circuit was identified as being the centre section of a control rod, both ends of which had been recovered attached to their corresponding bell cranks. Examination of the rod ends confirmed that their separation from the missing centre section had been as a result of severe impact damage.

1.12.5 Flying control actuator examination

Despite the severe damage to the main rotor head and flying control circuits, the three main flying control servo-actuators appeared to be in good condition.

Equally, the single tail rotor servo, despite its immersion in seawater, also appeared to be functional. The main servos were removed during examination of the main rotor gearbox and despatched to their manufacturer for examination and possible testing under AAIB supervision. The tail rotor servo was also removed from the tail rotor gearbox and dispatched to the manufacturer.

At the manufacturer's premises the main servos were placed on a test bench used for testing new and overhauled units for acceptance. An external visual inspection suggested that all three units would function normally and they were put through the acceptance test schedule. The units all passed with the exception of one parameter affecting all three. This was a dual-system synchronisation check which determines whether the null point for the pilot valve is the same for both systems – if it is not, then the actuator will move slightly when switching between the two hydraulic supplies and it indicates that the input mechanism is not rigged correctly. This was almost certainly due to distortion occurring when the control rods on the airframe were torn from the servos – the links from the main input mechanism to the pilot valves are relatively fragile and would be attempting to resist the massive disruptive forces on impact. Even had the condition existed prior to impact, the effects would be transparent to the crew, only manifesting itself in the event of a single system hydraulic failure, when there would have been a slight shift in cyclic and collective stick positions for the same rotor pitch demand.

No bespoke test rig was available for the tail rotor servo, but an improvised test bench confirmed that the unit functioned correctly throughout its range and responded normally to control inputs.

1.12.6 Instrumentation

1.12.6.1 Pitot static system

Both pilots are provided with an independent Air Speed Indicator (ASI), Vertical Speed Indicator (VSI) and barometric altimeter; these use inputs of atmospheric (static) pressure and pitot pressure to provide information to the pilots. In order to prevent a single failure disabling all of these instruments, the commander's and co-pilot's instruments are connected to separate 'pitot static' systems. Each system is provided with two static ports, one on either side of the rear fuselage, and a heated pitot probe under the nose of the helicopter. The co-pilots pitot static system also provides data to the AFCS data unit.

Due to the significant disruption of the helicopter and the difficulties of the salvage operation, the sections of the fuselage which contained both the pitot probes and the static ports were not recovered, however, significant portions of both pitot static systems, together with their respective instruments, were recovered. Detailed examination showed that all of the damage within the systems was consistent with a high energy impact, that there were no obstructions within the systems and that all of the instruments had been connected to their respective systems at the point of impact. Examination of the instrumentation showed no evidence of pre-impact damage or failure. It is therefore considered probable that both sets of 'pitot static' instruments were operational immediately prior to impact.

1.12.6.2 Artificial horizons

The helicopter was fitted with three electrically operated artificial horizons, one in each of the commander's and co-pilot's instrument panels and a 'standby' unit fitted below the glare shield, to the right of the caution advisory panel. Each unit contained an electrically powered gyroscope to provide attitude information to the pilots. All three units had suffered from damage to their cases and had become contaminated with silt. After cleaning and disassembly, 'rub' marks were found on the standby horizon gyroscope. The presence of these marks indicated that the standby horizon had suffered from a significant impact whilst the gyroscope was spinning. This, in turn, indicates that the gyroscope for the standby horizon was operating at the time of impact.

No such markings were found on the gyroscopes for the remaining two units. The position of the standby artificial horizon high on the central instrument panel would have provided little protection from the initial impact forces. Whereas, the main artificial horizons, positioned centrally in each pilots instrument panel, would have been afforded some degree of protection from the initial impact, which may account for the lack of rotational damage to their gyroscopes.

1.12.6.3 Radio altimeter

The helicopter was fitted with two radio altimeters one in each of the commander's and co-pilot's instrument panels, both of these were equipped with moveable height 'bugs'. A radio altimeter 'single/dual' selector switch was positioned on the centre instrument panel. With the switch in the dual position, an aural warning would be triggered as the helicopter descended below the lowest height selected on either the commander's or co-pilot's radio altimeter. In the single position only the position of the commander's radio altimeter bug is used to generate the warning. The 'single/dual' selector switch was found in the single position. Both the commander's and the co-pilot's radio altimeters were examined. The 'bug' on the co-pilot's instrument was set at 500 ft and no damage was observed to the gear mechanism used to adjust the setting of the bug. The height 'bug' was not visible within the bezel of the commander's radio altimeter. On disassembly, its remains were found pushed behind the edge of the instrument face. The arm onto which the bug had been mounted had been pulled from the gear mechanism and the gears had become severely disrupted. There was no evidence of witness marks on either the instrument face or within the gear mechanism and it was not possible to determine the position of the commander's height 'bug' at the point of impact.

1.13 Medical and pathological information

The FRCs from the Highland Sprite, together with the Search and Rescue (SAR) helicopter recovered six bodies; these were identified as being the two pilots and four passengers. Despite an extensive and thorough search of the area surrounding the wreckage the fifth passenger had not been found when this report was published.

Two Home Office pathologists carried out the post-mortems, assisted by a consultant aviation pathologist. It was concluded that five of these six persons had died from multiple injuries consistent with a high vertical impact with some forward motion. One of the passengers showed evidence that he had died of drowning; however, he had sustained multiple injuries and it is almost certain that he was unconscious from the time of the impact. The commander showed evidence of severe coronary artery disease.

Radiological and toxicological examinations of the pilots showed no evidence of drugs or alcohol in their blood.

The overall impact forces were outside the limits of human tolerance and no additional or alternative safety equipment would have been likely to alter the fatal outcome.

1.14 Fire

There was no fire.

1.15 Survival aspects

The accident was not survivable.

1.15.1 Search and Rescue

At 1834 hrs, the North Morecambe Platform 'Man Overboard' alarm was activated and reports of a helicopter ditching were received on a marine radio channel. The Highland Sprite, stationed approximately one mile to the south-west of the platform, launched two FRCs towards the reported area. The Liverpool Coastguard Maritime Rescue Co-ordination Centre (MRCC) initiated full Search and Rescue (SAR) action in liaison with the Aeronautical Rescue Co-ordination Centre (ARCC) at RAF Kinloss, initially deploying two rescue helicopters and two all-weather lifeboats. The MRCC incident log records that the transmission from the Automatically Deployable Emergency Locator Transmitter (ADELT) was first detected, by satellite, at 1835 hrs. This signal, which included a doppler derived position of the beacon, was updated 30 minutes later when the satellite next passed overhead and at routine intervals thereafter.

The FRCs arrived in the area of the accident at 1850 hrs and the first rescue helicopter arrived at 1915 hrs. There was an obvious area of floating wreckage, which became the focus for the search for survivors. Five bodies had been recovered by 2000 hrs with the helicopter using its searchlight to direct the FRCs onto any relevant sightings. A sixth body was recovered at 2230 hrs but, despite a combination of air and surface craft searching the area for a further 36 hours, the remaining passenger was not recovered.

1.15.2 Man overboard alarm system

Guidance from the Health and Safety Executive (HSE) in respect of Vessel Collision Management procedures (that is preventing seaborne vessels colliding with offshore installations) requires that installations be fitted with a Radar Early Warning System (REWS) in order to monitor passing traffic and identify any potential threats from errant vessels. This system incorporates a module, which acts as a 'Man Overboard' (MOB) system. It utilises the frequency of 121.5 MHz, which is the same frequency used by the Personal Locater Beacons (PLBs). All personnel travelling on board the helicopters, or operating in an environment on board the rig, where they may fall overboard, are required to wear a wrist-mounted PLB. Entry into water (either through a helicopter accident or falling overboard) will cause the PLB to begin transmitting automatically. This will activate the 'MOB' module on the REWS system and an alarm in the control room. Rescue resources can then be directed to the beacon using direction finding (DF) equipment. The MOB system will be triggered if a PLB is activated within 500 m of a platform (this coincides with the statutory 500 m exclusion zone around them). Theoretically, the DF equipment should be able to detect the signal up to one nautical mile at sea level and up to 3 nm from higher levels. However, tests have shown that immersion in seawater significantly attenuated the signal and subsequently reduced the detection range.

The five passengers had all been issued with wrist-mounted PLBs prior to boarding the helicopter. Two of the recovered bodies were wearing active PLBs and three were not. The wrist-mounted PLBs are designed to break off easily in order to prevent them snagging on an obstacle and thus becoming a hazard. It is possible that the wrist straps for the missing PLBs may have broken off during the impact, it is also conceivable that they might not have been worn during the flight; however, subsequent search has not located these personal issue devices on the platforms or at Blackpool heliport.

1.15.3 Immersion Suits

The operating crew were wearing dark blue immersion suits which have a reflective strip around the leg just below the knee. Life jackets were also worn which, prior to inflation have a reflective strip on the back of the neck and down each side. Once inflated, the life jacket is bright orange. The immersion suit and un-inflated life jacket are designed to have low reflectivity in order to reduce internal reflections on the instrument panels and windscreens of the cockpit, during helicopter operations. However, the rescue crews commented that the yellow immersion suits worn by the passengers were noticeably more conspicuous, when using the helicopter's searchlight in the darkness, than the blue immersion suits worn by the pilots.

Had the accident been survivable, and the immersion suits sustained no damage, it is expected that the occupants would have had a survivable time of between 6 and 8 hours in the sea with a water temperature of +11.5º C.

EU Regulation 1592/2003, later superseded by Regulation 216/2008, transferred the responsibility for airworthiness issues including the design of immersion suits from the National Airworthiness Authority (CAA) to the European Aviation Safety Agency (EASA).

1.16 Tests and research

1.16.1 CAA Flight Tests

The AAIB requested assistance from the Flight Test department of the CAA in investigating some aspects of the accident, including relevant handling qualities of the helicopter and an assessment of the visual cues during approach and go-around to the offshore platform at night. The flight test report is presented at Appendix B; its summary stated:

> The flight profile of the accident helicopter on the approach to the offshore platform was recreated but with less nose down attitude as this was difficult to achieve. The wind direction / strength was similar to that on the night of the accident which permitted approaches to the platform on the same heading and with similar groundspeed. No handling characteristics / deficiencies were found which would have caused a severe nose down pitching although it was not possible to pull as much torque as on the accident helicopter without overtorquing the test helicopter. The approach path flown by the accident helicopter was apparently shallower than the normal approach angle which reduced the depth perception cues of the helideck.' The flight test produced the following conclusions:
>
> - The SA365N was assessed for any potential handling qualities' deficiencies that could have had a bearing on the accident of G-BLUN. Although less torque was available to the test crew than that used in the accident no handling qualities deficiencies were noted.
>
> - The location of the Radio Altimeter on the LHS (left hand seat) instrument panel was optimised for the final stages of the visual helipad landing and was difficult to include in the instrument scan required during a go-around.
>
> - The torquemeter's size, readability and location meant it was difficult to use by the LHS pilot at any stage during the high workload of the approach and go-around.
>
> - The helipad lighting included a particularly bright amber perimeter light which made it more difficult to discern the circle of amber lights. It is understood that future helipad lighting will use green coloured lamps which will make it easier to discern the helipad circle amongst the additional lighting on the platform.
>
> - Flying a shallower than optimum approach meant the oval appearance of the circle of lights was difficult to discern and "blurred" into a single line of lights. It would appear from the evidence that G-BLUN flew a very shallow approach and probably never saw a discernible oval of lights.

- The helipad at night gave insufficient cues to allow distance to be judged and without additional information from the weather radar or GPS the crew of G-BLUN would not have known the distance to run accurately.

- When the RHS (right hand seat) pilot took control he would have had no visual cues from the platform.

1.17 Organisational and management information

1.17.1 General

The operator provided helicopter support services for the offshore oil and gas industry from four bases in the UK. They had a fleet of 33 twin-engined, medium and heavy helicopters, of eight different types. The SA365N Dauphin helicopter served the Southern North Sea Sector and the Irish Sea. Operation of the helicopter was based on a two-crew concept with a commander and co-pilot.

The operator was a Type Rating Training Organization (TRTO)[7] and both pilots had completed an SA365 type rating conversion course provided by the operator. Both pilots had received training in night platform approaches and associated go-around procedures. They had approached and landed on the North Morecambe platform on numerous occasions.

1.17.2 JAR-OPS, Part 3, Commercial Air Transportation (Helicopters)

JAR-OPS, Part 3, prescribes the requirements applicable to the operation of any civil helicopter for the purpose of commercial air transportation by any operator whose principal place of business is in a JAA Member State. Each operator has a CAA Flight Operations Inspector (FOI) who is responsible for ensuring that they comply with JAR-OPS 3.

1.17.2.1 Recurrent training and checking

Interpretative And Explanatory Material (IEM) to Appendix 1 to JAR-OPS, Part 3, paragraph 3.965 states:

7 Organisations approved to conduct type rating training for the issue of Joint Aviation Authorities (JAA) type ratings.

'Recurrent training and checking

1 Use and approval of Synthetic Training Devices (STD) training. Training and checking provides an opportunity for the practice of abnormal/emergency procedures which rarely arise in normal operations and is a part of a structured programme of recurrent training. This should be carried out in a Synthetic Training Device whenever possible.

4 Because of the unacceptable risk when simulating emergencies such as rotor failure, icing problems, certain types of engine(s) emergencies (e.g. during continued take-off or go-around, total hydraulic failure etc.), or because of environmental considerations associated with some emergencies (e.g. fuel dumping) these emergencies should preferably be covered in a Synthetic Training Device. If no Synthetic Training Device is available these emergencies may be covered in the helicopter using a safe airborne simulation, bearing in mind the effect of any subsequent failure, and discussion on the ground.'

Using a helicopter as a training device has a number of limitations in that, for safety reasons, only a restricted number of manoeuvres and system failures can be practised; furthermore, the external environment cannot be controlled. In contrast, all system failures and emergencies can be conducted in a controlled environment and in complete safety in a Synthetic Training Device (STD). The use of an STD, which fully replicates the flight deck and all of the associated controls, is therefore an invaluable tool in the training of pilots.

The operator conducted all type training, including Licence Proficiency Checks (LPCs) and Operators Proficiency Checks (OPCs), for its SA365N pilots in a helicopter; no passengers were carried during such flights. However, the AS332L crews conducted their recurrent training almost entirely in an approved STD based in Stavanger, Norway. The AS332L2 fleet conducted annual STD training (normally an Operator's Proficiency Check) at Marignane, France, and crews for the S92, which had recently entered service, conducted almost all of their training in an STD in the USA. Prior to the accident, an annual STD programme was being planned for both the SA365 and S76 crews.

1.17.3 Operations Manuals

1.17.3.1 Normal Landing Procedure Offshore

Part B Section 3 – Normal Procedures, paragraph 3.9.4.2 of the OM states:

'Normal Landing Procedure Offshore

COMMITTAL POINT

This is the point beyond which the pilot is committed to a landing in the event of a single engine failure. The ideal Committal Point is a point on the final approach where the rotor tip path plane is co-incident with the deck edge, the aircraft height is approximately 40 feet above helideck elevation with minimal rate of descent and the closing groundspeed is 10 knots. This ideal point may be modified to take account of factors such as turbulence, visual cues, deck orientation, presence of obstacles and estimated power margin.

TECHNIQUE

The final approach direction should be adjusted to give an unobstructed go around path, as far as possible approximately into wind. In strong wind conditions consideration should also be given to adjusting the approach direction to minimise the effect of likely turbulence.

PNF[8] confirms that deck clearance has been obtained and both pilots confirm the identity of the helideck. HANDLING PILOT then carries out a normal decelerative descending approach to the Committal Point. PNF is to carefully monitor the approach, especially at night or in poor visibility, including visual manoeuvring after an ARA, and announce any excessive rate of descent or closing speed. He is to call "55 KNOTS" and power above 90% torque until HANDLING PILOT announces that he no longer requires such calls.

All approaches should be made with minimal ROD and speed maintained at 30 knots for as long as possible before reaching the Committal Point, remembering that a large flare close to

8 PNF (Pilot Not Flying) refers to the non handling pilot.

the helideck will result in possible loss of visual cues behind the instrument coaming. Below 30 knots a go around following a single engine failure could prove difficult and a water landing adjacent to the installation may be necessary.

The approach should be commenced into wind outboard of the platform and track arranged to place the rotor tip path plane close to the line of the deck edge. This track should be maintained at about 40 feet above deck elevation with approximately 10 knots groundspeed and a minimal rate of descent, until the aiming point is in the 45° position. HANDLING PILOT then manoeuvres the helicopter forwards, sideways and downwards to pass over the deck edge and into the hover over a safe landing area. He should call "COMMITTED" when he considers that, in the event of an engine failure, the safest option is to continue to the deck.'

1.17.3.2 Go-around by sole reference to instruments

Part B, Section 3 – Normal Procedures, paragraph 3.8.5 of the operator's OM states the following:

'GO AROUND BY SOLE REFERENCE TO INSTRUMENTS

If visual reference is lost at low level and with low airspeed, during the final stages of an approach, recovery action is to be carried out as follows:

Assuming the aircraft is on a pre-selected clear overshoot path:

HANDLING PILOT calls "GOING AROUND" and simultaneously increases to take-off power (100% torque or 100% NG, whichever is achieved first), while trimming the aircraft to and maintaining 5 to 10° nose down, maintaining wings level and keeping the ball centred. Use of the beep trim is recommended; use of the cyclic trim release should be avoided.

PNF is to acknowledge the "GOING AROUND" call. PNF is to advise whether the aircraft is climbing or descending and is to call "POSITIVE AIRSPEED", "VTOSS" and "VY" when attained. He is to closely monitor the power parameters and flight path.

Once through VTOSS, HANDLING PILOT continues a climbing acceleration to VY then adjusts to standard climb parameters. HANDLING PILOT will call for the GO AROUND checks once the aircraft has passed VTOSS and is safely established in the climb. Under normal circumstances, the aircraft should be climbed straight ahead to at least 500 feet above the surface before manoeuvring or carrying out any drills.'

There is no direction to the crew regarding further actions after executing a go-around when flying below a low cloud base or when the visibility is poor, nor is there any guidance on the use of the AP coupler during a go-around.

1.17.3.3 Incapacitation

Part A paragraph 8.3.14 of the OM explains that incapacitation may be partial or gradual and symptoms may include disorientation. Incapacitation should be suspected if a crewmember does not respond appropriately to a second verbal communication associated with a significant deviation from a standard operating procedure or flight profile. It adds that crewmembers should closely monitor the helicopter's flight path in the critical stages of take off, initial climb, final approach and landing and immediately question any deviation from the norm. If incapacitation is identified, the able crewmember must assume control and return the helicopter to a safe flight path. There were, however, no definitions of what constitutes a significant deviation from the norm.

The operator has subsequently published a Flying Staff Instruction (FSI), which will be incorporated in the next revision of the OM, adding further clarification of what might be classified as a 'deviation from the norm'.

1.17.4 Accident prevention and flight safety programme

Part B of JAR-OPS, Part 3, states:

'JAR-OPS 3.037 Accident prevention and flight safety programme

(a) An operator shall establish an accident prevention and flight safety programme, which may be integrated with the Quality System, including:

(1) Programmes to achieve and maintain risk awareness by all persons involved in operations; and

(2) An occurrence reporting scheme to enable the collation and assessment of relevant incident and accident reports in order to identify adverse trends or to address deficiencies in the interests of flight safety. The scheme shall protect the identity of the reporter and include the possibility that reports may be submitted anonymously (See ACJ OPS 3.037(a)(2).); and

(3) Evaluation of relevant information relating to accidents and incidents and the promulgation of related information, but not the attribution of blame; and

(4) The appointment of a person accountable for managing the programme.

(b) Proposals for corrective action resulting from the accident prevention and flight safety programme shall be the responsibility of the person accountable for managing the programme.

(c) The effectiveness of changes resulting from proposals for corrective action identified by the accident prevention and flight safety programme shall be monitored by the Quality Manager.'

1.17.4.1 Company Flight Safety Officer

An operator is required to have a nominated Flight Safety Officer (FSO) as part of its Air Operator's Certificate (AOC). Part A of the operator's OM states that the FSO is responsible to the Flight Crew Manager for the collection, collation, editing and dissemination of flight safety information and for the promotion of flight safety awareness amongst all company employees. He is also required to monitor all occurrence reports and, where necessary, ensure that appropriate follow up action is taken.

The role of the FSO, for this operator, was part-time and he had no dedicated assistant. However, his workplace was embedded within the safety and Quality department where administrative and operational support was available. In addition, Base FSOs were appointed for all operating bases, including Blackpool. He was required to work 200 days per annum, and do half of the flying of a standard line pilot; this should therefore have resulted in 91 days of flying and 109 days for administrative work. In the 6 months preceding the accident he completed 69 flying days and 35 administrative days.

1.17.4.2 Flight safety meetings

Company flight safety meetings are an integral part of an operator's accident prevention and flight safety programme. The operator held three 'quarterly' Flight Safety (FS) meetings during 2005; prior to 2005 the flight safety issues had been discussed at the operator's Occurrence Review Board (ORB). In 2006 the FS meetings were again incorporated into the monthly ORB meeting; the Accountable Manager or his deputy attended these meetings. The purpose of these meetings was to review all reported occurrences, including Mandatory Occurrence Reports (MORs). In addition, it incorporated the Air Safety Review Committee which seeks to make pro-active improvements. The manufacturers attend this meeting; both the Flight Operations Inspector and the CAA surveyor are invited to participate.

1.17.4.3 Safety Management System

CAP 712, Safety Management Systems for Commercial Air Transport Operations, defines Safety Management as the systematic management of the risks associated with flight operations, related ground operations and aircraft engineering or maintenance activities to achieve high levels of safety performance. It adds that a Safety Management System (SMS) is an explicit element of the corporate management responsibility which sets out a company's safety policy and defines how it intends to manage safety as an integral part of its overall business.

There is no requirement, at present, to declare a SMS as part of an operator's AOC; however, the operator stated that all their customers require a SMS to be in place. A SMS will be required to be in place, for all commercial air transport operators, by January 2009.

The operator's SMS was defined in a main document, plus separate documents entitled 'Safety Case for Operations at [base name]' for each of its four operating bases in the UK. In the Safety Case for each base, Section 1 – Executive Summary and Introduction, stated:

> *'The goal of this safety case is to provide assurance to the Managing Director (European Operations), Accountable Manager, Business Unit Leader, customers and stakeholders that all major hazards associated with our specific operations have been:*
>
> *a) Identified;*
> *b) Assessed;*
> *c) Controlled; and*
> *d) Adequate recovery plans in place should controls fail.'*

The conclusion to each document is signed by the Accountable Manager and the Business Unit Leader. Although the FSO was listed as one of the 'intended readership', he was unaware of this.

1.17.4.4 Criteria to initiate a review of the safety case

In Section 1, paragraph 1.4 'Criteria to initiate a Review of the Safety Case' one of the situations that warranted a review of a safety case was '*An accident or incident with significant consequences*'. An amendment to the Safety Case for Operations at Blackpool was issued on 21 September 2007. The operator commented that this was an interim amendment and another one will be issued following the publication of this report.

1.17.4.5 Regulatory oversight

On the 23/24 November 2006, the CAA's Flight Operations Inspector conducted a regularly scheduled audit of the Blackpool base which concluded satisfactorily with minor findings.

The MD of the operator called a meeting with the CAA to discuss various aspects of the operator's business structure. During that meeting, which occurred on 18 December 2006, a variety of topics were discussed, including CAA concerns regarding the maintenance and operations aspects arising from recent AOC Variations for new types. The CAA was invited by the operator to a further meeting to be held in Aberdeen at the end of January or early February. Subsequently, in January 2007, the operator was informed that an audit would be carried out in February 2007.

In February 2007, after the accident, the CAA met with the operator to discuss the results of the audit, which raised concerns about the Company's management organisation, training and accident prevention and flight safety programme. Since February 2007 the operator has responded to concerns of the CAA. The CAA is continuing to monitor progress and the Company is still subject to heightened oversight.

1.17.5 Flight Data Monitoring

CAP 739, *Flight Data Monitoring - A Guide to Good Practice* states that Flight Data Monitoring (FDM) is the systematic, pro-active and non-punitive use of digital flight data from routine operations to improve aviation safety.

FDM programmes assist an operator to identify, quantify, assess and address operational risks. Since the 1970's the CAA's Safety Regulation Group (SRG) has helped develop and support such systems and used FDM information to support a range of airworthiness and operational safety tasks. Through this co-operative development work many operators have demonstrated the safety benefits of FDM such that the International Civil Aviation Organization (ICAO) have made FDM a standard for all public transport operations of aircraft over 27,000 kg, with effect from 1st January 2005. The UK, in continuing its policy of applying ICAO standards, has made this a requirement under UK law.

The UK Air Navigation Order, Article 41, requires the establishment and maintenance of an accident prevention and flight safety programme and includes the requirement for FDM. The content of safety programmes, including FDM, will need to be confirmed as acceptable by the CAA's Flight Operations Inspectors.

The operator has had a FDM programme in place since late 2004 and a full time FDM advisor has been employed since early 2005. Since September 2006 the operator has been utilising FDM on its AS332L2 fleet in Aberdeen. The AS332L fleet has now been added to the programme and work is in progress for all fleets and variants to be incorporated into the programme, including the SA/SA365. It is estimated that the programme will be completed by mid to late 2009.

1.17.6 Immediate Safety Actions

On 12 February 2007 the CAA issued a letter to all helicopter operators encouraging them to review their Helideck multi-crew and training procedures and radio altimeter bug setting and usage policy. A copy of the letter is at Appendix C. In response to this the operator reviewed their cockpit and go-around procedures, and their policy for radio altimeter settings and informed their Flight Operations Inspector of the changes. Annual STD training for the SA365 had been planned prior to the accident. Training for SA365 instructors was completed in April 2007 and training for all SA365 pilots, which includes an approach to a platform at night with a subsequent go-around, was completed by Spring 2008.

1.18 Additional information

1.18.1 Automatic Voice Alert Device

The operator's SA365N helicopters were fitted with an Automatic Voice Alert Device (AVAD) to provide voice height warnings. The AVAD messages were routed via the pilot's radio boxes, although the audio level was not adjustable through the volume control.

The AVAD system contained a voice warning unit, with associated cockpit switches and indications. There was a TEST/RESET switch and a SINGLE/DUAL Selector Switch on the instrument panel below the Caution Advisory Panel. There was an AVAD FAIL warning light adjacent to the switch and SUSPEND buttons on each cyclic grip. Aural warnings were provided of a descent below 100 ft RA and a descent below the height selected by the radio altimeter bugs.

1.18.1.1 System operation

During a descent, a "ONE HUNDRED FEET" voice message is transmitted when the helicopter altitude is at, or passes through 100 ft, if the rate of descent is less than 5,000 ft/min. This limit is intended to reduce the number of nuisance warnings caused by spiking, such as when the helicopter passes over a helideck edge.

A "CHECK HEIGHT" voice message is transmitted when the helicopter descends through the lower of the radio altimeter bug settings, with the selector switch set to DUAL, at a rate of less than 5,000 ft/min. This message is repeated after 4.5 seconds. If both bugs are set to the same height, the "CHECK HEIGHT" message will be activated at that height. If the selector switch is set to SINGLE, the warning is triggered by the commander's radio altimeter bug setting alone.

Because "ONE HUNDRED FEET" and "CHECK HEIGHT" messages have the same priority, a "CHECK HEIGHT" warning in progress will delay the "ONE HUNDRED FEET" warning. This can result in the "ONE HUNDRED FEET" warning being heard at heights below one hundred feet.

Operation of the SUSPEND button, will inhibit the "CHECK HEIGHT" warning only, for three minutes, after which it will automatically reset. The "ONE HUNDRED FEET" message cannot be inhibited. The suspend mode may be cancelled at any time by selecting the TEST/RESET switch momentarily to RESET.

In the event of AVAD power or unit failure (FAIL light ON), or in the event of radio altimeter failure, AVAD height warnings will not be available.

1.18.1.2 System operation during final flight

During the approach to North Morecambe there were no AVAD generated radio altimeter calls except 'ONE HUNDRED FEET.' The SINGLE/DUAL Selector Switch on the instrument panel was found in the SINGLE position.

The commander stated, on the approach to AP1, that he set his bug at 200 ft and the co-pilot's bug was found set at 500 ft. No further comment was made by either member of the crew as to them changing or cross checking their bug settings.

During the three approaches, as recorded on the CVR, the commander said "JUST YOUR BUTTON TO DO" once visual with the platform. This is believed to have been a reminder, to the co-pilot, to suspend the AVAD as no 'CHECK HEIGHT' was subsequently heard. The OM contains no guidance on the procedure and calls to be employed when suspending the AVAD warning.

OM Part A section 8.3.4.4 stated 'see OM Part B section 3 for type specific radio altimeter bug setting procedures', however, OM Part B section 3.1.1 stated 'see Part A Section 8 paragraph 8.3.4'. The radio altimeter bug settings were actually found in Appendix A to Section 3, on side two of the cockpit checklist. For a VFR landing offshore the radio altimeter bug should have been set at 200 ft.

The operator stated that a Flying Staff Instruction (FSI) had been issued which provided guidance on the use of the AVAD. This guidance had not been incorporated into the OM and a copy of the FSI could not be found. A new FSI has now been published which provides guidance on the use of the AVAD, and this will be incorporated into the new OM.

1.18.2 Responsibilities of the Logistics Supervisor

The Logistics Supervisor was located on AP1. In addition to other responsibilities he provided weather reports, on request, for outbound pilots and recorded field weather data and submitted regular weather reports to Blackpool Heliport and the Met Office. The visibility and cloud estimates were made by observation of neighbouring platforms. He was not required to hold any formal qualification to complete this task.

1.18.3 Met Office Observer's course

The Met Office trains observers to make fully compliant, accurate aviation weather reports. The acquisition of the necessary skills is achieved through a combination of theory and practical training. Successful trainees are awarded a Met Observing certificate for the production of weather reports and METARs that meet the requirements of ICAO Annex 3.

1.18.4 Oil & Gas UK

Oil & Gas UK is the leading representative organisation for the UK offshore oil and gas industry. Its members are companies licensed by the Government to explore for, and produce, oil and gas in UK waters and those who form any part of the industry's supply chain.

It issued a notice entitled "*Guidance on the Use of Synthetic Training devices (STD's) for Offshore Helicopter Flight crews*" in February 2007. In the notice they suggest that recurrent training in a STD should be carried out at a frequency of not more than 12 months.

1.18.5 Helicopter accident analysis

The United States Joint Helicopter Safety Analysis Team (JHSAT) is a part of the International Helicopter Safety Symposium. It was established in 2005 to address the safety of helicopters by analysing accident reports in detail. It was intended that this analysis would establish patterns and common contributory factors and would develop strategies for the improvement of safety. In a report published in September 2007, the US JHSAT reported on accident data relating to the year 2000, which included the findings on 197 accidents involving US-registered helicopters.

The US JHSAT found that "pilot judgement and actions" was a factor in nearly 80% of the accidents analysed, with failure to follow procedure as its single largest sub-category. The lack of an effective organisational safety culture was cited as a factor in 47% of all US civil helicopter accidents in 2000. It is only after these human and organisational issues that maintenance, engines or systems failures become factors in helicopter accidents.

2 Analysis

2.1 General

This accident occurred during a routine helicopter night flight within the Morecambe Bay gas field in poor weather conditions that were above the required minima and not unusual for such operations.

There was no evidence of any technical malfunction that may have contributed to the accident and the investigation therefore sought to understand why two experienced pilots were unable to stop a serviceable helicopter flying into the sea. It is therefore necessary to understand the human factors involved in the sequence of events that led to the accident, and to analyse the helicopter's response to control inputs. The organisational factors and the individual and crew actions are then considered.

The SA365N was assessed for any potential handling qualities' deficiencies that could have had a bearing on the accident. Although the crew conducting the flight test used less torque than was utilised in the accident no handling qualities deficiencies were noted.

The post-mortem examination showed that the commander had evidence of severe coronary artery disease. While this could potentially cause incapacitation or sudden death, given that the commander took control of the helicopter in the later stages of the flight, and was entirely lucid throughout, this finding would appear to be entirely coincidental to the cause of the accident.

2.2 Human factors during the approach to the North Morecambe platform

The final approach appears to have had two distinct phases. Between the initiation of the descent, just after the co-pilot said "I GOT THE DECK NOW" and the commander's "FIFTY FIVE" call, and then from the "FIFTY FIVE" call until the co-pilot said "HELP US OUT .....".

Between the start of the descent and the "FIFTY FIVE" call, the descent became progressively steeper, there was a steady reduction in collective demand and a steady, positive change in pitch attitude, rather than the adoption of fixed values. It appears that the intent was to reduce speed throughout the descent until 30 kt was achieved. Conceivably, the pitch change could have been the result, in part at least, of inadvertent activation of the pitch trim. This might have arisen if the co-pilot had already been tense at the initiation of the descent, but the limited evidence from the CVR does not support this concept.

However, as a matter of principle, fixed attitude or power settings simplify glidepath control, particularly when approach angle cues are limited.

The change in strategy after the "FIFTY FIVE" call is clear, as the collective demand increased steadily, the descent rate was arrested and the helicopter began to climb, and this suggests a change in the appreciation of the helicopter's position or motion relative to the deck. It does not appear to represent an attempt to go-around since that decision was not discussed until more than 15 seconds later. Two possible explanations are that the descent was initiated too early or the initial approach angle was too steep, both resulting in the final approach angle becoming too shallow. The commander's comment, "FIFTY FIVE", was a standard call related to airspeed. It is assumed this was not the sole stimulus for the change of strategy. It seems more likely that it was a more complex response based on a revised assessment of the approach angle.

In a period of about 35 seconds, there are two distinct control strategies, rather than a continuous adjustment of one strategy. This could be indicative of a lack of attention but more likely indicates a difficulty in assessing approach angle. Indeed, the crew discussed the difficulty in depth perception at about the time that the change in strategy was initiated.

The approach was flown essentially by reference to visual cues. In dark, overcast conditions, it is likely that some cues were degraded or absent. For example, without a distinct horizon the assessment of pitch attitude and approach angle (by reference to the depression of the deck below the horizon) would be compromised. Without textural cues in the ground plane (in this case the sea surface), judgement of pitch attitude and approach angle by inference from textural perspective would also be compromised, as would the appreciation of the range to the deck.

The illuminated deck would have provided limited cues to roll attitude and, by reference to its apparent size, to range. The crew's judgement of range and rate of closure to the platform would have improved as they approached the platform, but, initially, this would be relatively insensitive.

It is possible however, that had the recommended change in the criteria for helideck lighting, detailed in CAA paper 2004/01 (Enhancing Offshore Helideck Lighting) and incorporated as a recommendation in the fifth edition of CAP 437 and mandated from January 2009 by ICAO, been adopted and installed on the platform helideck, the crew may have been provided with better visual cues increasing their situational awareness and allowing them to detect, at an earlier stage, deviations from a safe approach path.

The aspect ratio of the helideck (the ratio of the subtended angle in elevation to the subtended angle in azimuth) would have been directly proportional to the approach angle and linear with respect to range, until late in the approach, when the rate of change would accelerate. In principle, the aspect ratio would provide a useable cue to approach angle. However, the CAA report (Appendix B) suggested that a bright yellow perimeter light tended to obscure the circle of lights marking the helideck, (although it is uncertain whether this was the case on the night of the accident). This obscuration, if it had been present, may have been more pronounced at longer range making approach angle judgements initially more difficult. However, the presence of a useable cue does not guarantee its use. In normal circumstances, in daylight, there is a redundancy of cues and pilots may develop strategies that rely on some rather than others. Aspect ratio depends on two variables in the appearance of the deck. A simpler judgement of approach angle can be made using only one of them; the subtended angle in elevation. This cue changes rapidly in the later stages of the approach and can be very useful in the last fifteen or twenty seconds, but, at a greater range, the rate of change is low and differing angles of approach are difficult to appreciate.

It is, therefore, possible that the crew's judgement of the approach angle during the first phase of the approach presented them with a significant challenge. One way of meeting this challenge is to standardise the control strategy and minimize the number of variables that change, e.g. by commencing the descent at a specified height and range and maintaining a stable pitch attitude and a fixed relationship to the intended landing area. This can be achieved by holding the aiming point in a stable position with reference to the airframe. The drift in pitch during the first phase of the approach (10°) effectively prevented the crew consistently persuing this strategy, and it would have tended to obscure any changes in approach angle.

The second way of meeting the challenge is to supplement the limited visual cues with instrument references. The test flight by the CAA noted that the radio altimeter was not conveniently placed for inclusion in the co-pilot's scan during the majority of the approach. The CVR recording inticates that the crew were not using range information to determine the initiation of the descent, or cross-checking with height, and, except for the "FIFTY FIVE" call, and one height call at 400 ft, the commander did not provide any information that may have assisted the co-pilot.

The discontinuity in the approach profile suggests that the crew had difficulty in assessing the approach angle and they had to revise their strategy. The nature of the co-pilot's difficulty is open to conjecture; he may have commenced the descent too early or initially too steeply; or he may have used an inappropriate control strategy or inadvertently changed the pitch attitude. The underlying causes however, most likely stem from the limited visual cues available and the paucity of instrument cross-checks. Inadequate monitoring of the approach by the commander must also be regarded as a contributory factor.

Furthermore, the commander appeared ill-prepared to accept control and execute a go-around, and the go-around decision and the subsequent transfer of control from the co-pilot to the commander appear not to have been handled appropriately.

2.3 Helicopter response to control inputs

The results of the aerodynamic simulation indicated that the recorded attitudes of the helicopter during the accident were achievable on a fully functional helicopter, and that the control inputs required to achieve them were similar to the control inputs recorded, but offset by approximately constant values. These values, referred to as offset errors for simplicity, vary between no offset and 12% initially, drifting to as much as 17%. The offset errors were likely to have been the result of a combination of factors including errors in measuring the control inputs during the accident, insufficient data relating to the ambient conditions, the effects of some data loss during the accident flight and simulation inaccuracies. The effect of these errors increased over the duration of the simulation.

An FDR calibration check of the recording of the control inputs, carried out four months before the accident, indicated acceptable measurement errors of between 1.9% and 3.8%, although this is likely to vary slightly over time. The offset errors of the different simulation results provided were different by as much as 10 %, reflecting the sensitivity to alterations to the assumptions associated with the parameters required by the simulation tool, but not recorded on the helicopter. It is difficult to quantify the effects of simulation errors due to a lack of data relating to the ambient conditions in the vicinity of the gas platform. Given these factors, the offset errors of the simulations appear reasonable and the recorded manoeuvres of the accident flight are not inconsistent with the recorded crew inputs.

In particular, a comparison of the entry into the extreme pitch attitude during the accident, with attempts to replicate this during the test flight without exceeding main gear box torque limits, showed no inconsistencies. Furthermore, a comparison of the steady descent of the final few seconds of the accident flight with the speed, pitch, vertical path, and cyclic pitch input relationships derived from the test flight also showed no inconsistencies.

The simulation results, and the comparison of the accident flight with data from the test flight, leads to the conclusion that the helicopter's behaviour was consistent with flight control inputs and that there was no failure in the control mechanisms.

2.4 Organisational factors

2.4.1 Assessment of the approach

The discontinuity in the approach profile suggests a difficulty in assessing the approach angle in difficult visual flying conditions. This problem could have been addressed by commencing the descent at a known, specified range and height and maintaining a stable pitch attitude and a fixed relationship to the intended landing area. Available information from the GPS, together with height calls from the commander, could have provided much of the required information for the co-pilot to fly a stable approach. The height calls from the commander would have been of particular relevance as the radio altimeter was not conveniently positioned for inclusion in the co-pilot's instrument scan during the majority of the approach. It is possible that more positive crew interaction, and a more active participation in approach profile monitoring by the non-handling pilot may have resulted in a positive outcome. Therefore:

> It is recommended that CHC (Scotia) review their Standard Operating Procedures related to helideck approaches, to ensure that the non-handling pilot actively monitors the approach and announces range to touchdown and height information to assist the flying pilot with his execution of the approach profile. This is especially important on the SA365N helicopter when the co-pilot is flying approaches in poor visual conditions and cannot easily monitor a poorly positioned radio altimeter. (Safety Recommendation 2008-032)

The pilot's difficulties in assessing the approach most probably lie in the limited visual cues available to him. For many years, runways have been equipped with instrument landing systems that allow aircraft to follow precisely an electronically generated approach path, and in the final stages of the approach this guidance is supplemented by lighting systems which provide visual guidance. It is clear that such systems would require substantial modifications to allow their use on oil and gas platforms and would have to cater for the tactical freedom necessary in helicopter operations. Although a joint European project on GPS offshore approaches is already underway it is clearly important that there should be no unnecessary delays to its completion. Since the European Aviation Safety Agency are taking responsibility for such operational issues:

> It is recommended that the European Aviation Safety Agency ensure that research into instrument landing systems that would assist helicopter crews to monitor their approaches to oil and gas platforms in poor visual flying conditions and at night is completed without delay. (Safety Recommendation 2008-033)

Flight trials and research conducted by the CAA showed that changing the colour of the helideck perimeter lighting from yellow to green significantly increased the range at which the pilot could visually differentiate the helideck from other platform lighting. Futhermore, this colour change enhanced the pilots' situational awareness and promoted greater confidence in the conduct of an approach. The recommendation effecting this change was incorporated into the fifth edition of CAP 437 and the improved perimeter lighting will be mandated by ICAO from January 2009. This investigation re-affirms this advice to UK helideck operators and encourages them to make this change at the earliest practical opportunity.

Further trials by the CAA led to the development of new helideck lighting which is now under trial on offshore installations. This consists of an illuminated circle and 'H' to supplement the improved perimeter lighting, and this is described in ICAO Annex 14, Vol 2, as an acceptable alternative to flood lighting.

2.4.2 Standard Operating Procedures

Effective SOPs form the bedrock of safe operations for aircraft. To be effective they must be well conceived, well written, and thoroughly trained and practised; they must then be supported by a culture that insists upon strict adherence. It appears that some of these elements were not firmly embedded within the operating company.

During the approach, aside from the "FIFTY FIVE" call and one height call at 400ft, the commander did not provide any information to assist the co-pilot to fly a stable approach path profile especially during the final stages of the approach. This lack of information did not assist the co-pilot's spatial awareness and thereby decreased his overall operating efficiency. The co-pilot however, did not request such information from the commander and there was no mention of this procedure in the SOPs.

Deviation from the intended safe flight profile is predictably more likely to occur at night with limited visual cues and, in such conditions, crewmembers should monitor closely the helicopter's flight path during the critical stages of flight and immediately question any significant deviation from the norm. In this instance, the commander did not draw attention to any of the extreme bank angles and pitch attitudes achieved before the co-pilot requested assistance. Furthermore, there was no guidance material in the OM as to the acceptable deviation limits. Defined requirements for crew procedures in these circumstances, supported by the appropriate training and assessment, would probably have reduced the risks associated with unintended flight profile deviations. Such monitoring and cross-checking of references would then have enabled the non-handling pilot to alert the handling pilot before the helicopter reached a potentially irrecoverable attitude and would better prepare the non-handling pilot to intervene.

The torquemeter's size, readability and location meant that it was difficult to use by the handling pilot at any stage during the high workload of the approach and go-around; however, there was no evidence of any specific SOP to compensate for this.

There was no guidance on the use of the AP coupler during a go-around, nor was there any direction to the crew regarding the actions after executing a go-around when flying below a low cloud base or when the visibility is poor. This was particularly relevant in this accident when the commander, in the right seat, took control, since he would then have had no sight of the platform. Moreover, there was no guidance on the procedure or calls to be used when suspending the AVAD warning and guidance on its use was not incorporated into the OM. Although the operator has taken action to address each of these specific issues, there might be other areas, not directly related to this accident and including other helicopter types, that require amendment. Therefore:

> It is recommended that CHC (Scotia) conduct a thorough review of their Standard Operating Procedures related to helideck approaches, for all helicopter types operated by the company, with the aim of ensuring safe operations. (Safety Recommendation 2008-034)

2.4.2.1 Subsequent actions by the operator

Following this accident, the operator has identified the parameters to be monitored during an approach and has provided more specific guidance on the actions to be taken following disorientation or incapacitation. Procedures for the go-around have been developed which include guidance for use of the AP coupler. A night circuit pattern has been developed and published.

2.4.3 Recurrent training and checking

JAR-OPS Part 3 prescribes the requirements applicable to the operation of any civil helicopter for the purpose of commercial air transportation by any operator whose principal place of business is in a JAA Member State. Each operator within the UK is assigned a CAA Flight Operations Inspector (FOI), who is responsible for ensuring that they comply with JAR-OPS, Part 3. With regard to recurrent training and checking, JAR-OPS, Part 3 states that this *'should be carried out in a Synthetic Training Device whenever possible.'* An appropriate STD for the SA365N was available but it was not used; therefore, the operator's crews were denied the extensive benefits that a STD can provide in both training and checking.

The adoption of a structured training programme, based upon the capabilities of an appropriate STD, has formed the foundation for safe operations of fixed wing aircraft for many years. Whilst the fidelity of helicopter STDs has historically been questionable, this is now no longer the case. Nevertheless, it is clear that commercial advantages can be gained or lost if the decision to use an STD is left to the operator, and it is therefore only the regulator who is in a position to ensure that the intention of JAR-OPS, Part 3, which is to promote the use of a STD if it significantly enhances training and safety, is enforced. Therefore:

> It is recommended that the Civil Aviation Authority should ensure that the recurrent training and checking of JAR-OPS, Part 3 approved operators should be carried out in an approved Synthetic Training Device. (Safety Recommendation 2008-035)

2.4.3.1 Subsequent actions by the operator

Following this accident the operator has continued to develop the implementation of its policy to train all pilots in STDs. By the spring of 2008 all of their SA365 crews had received such training. The status for pilot training for their other helicopter types is variable. All S92 and AS332L crews have received simulator training, as have some of the AS332L2 crews, with the remainder to be completed as soon as possible. All S76 crews will have received training by the spring of 2009.

2.4.4 Accident prevention and flight safety programme

The operator's FSO was employed in his role on a part-time basis, and had no deputy when he was flying, on leave or sick. The intention was that during the year he would fly half of a normal line pilot's roster. However, in the 6 months preceding the accident he only completed 35 administrative days, which was not in accordance with his declared work pattern.

The role of the FSO can be pivotal in providing an effective accident prevention and flight safety programme, as set out in JAR OPS 3, and it would appear that the operator had not provided sufficient dedicated resources to ensure that the FSO post was adequately resourced. Nevertheless, with effect from January 2008 the operator has appointed a full-time FSO. In addition, a full time Accident Prevention & Flight Safety Programme Coordinator has been appointed to provide dedicated support and Base Flight Safety Officers are in place at each of the company's bases. The company is incorporating all of its fleets into its FDM programme.

Company flight safety meetings are an integral part of an operator's accident prevention and flight safety programme. The operator held three 'quarterly' flight safety meetings during 2005 but the Accountable Manager did not attend these meetings. These meetings are now incorporated into the monthly Operational Review Board meeting, which the Accountable Manager or his deputy attend, and to which the CAA are invited.

2.4.5 Flight Data Monitoring

Current regulations require that an aeroplane registered in the United Kingdom with a maximum weight greater than 27,000 kg flying for the purpose of public transport shall include FDM as part of its accident prevention and flight safety programme. This does not include helicopters such as G-BLUN, which have a maximum weight of 4,000 kg. Nevertheless, the operator plans to fit all of its helicopters with FDM equipment, which will enhance their ability to monitor day to day operations in the off-shore environment.

2.5 Individual and crew actions

The recorded data indicates that the helicopter started to oscillate in both pitch and roll as it approached the helideck, and it is probably this that prompted the commander to ask "YOU ALRIGHT"; the co-pilot replied "NO I'M NOT HAPPY MATE". The commander then asked "WE GOING ROUND" and the co-pilot replied "YEAH TAKE... HELP US OUT (NAME)", but this request was not initially understood by the commander and the co-pilot reiterated his request saying "HELP US OUT".

The co-pilot was not able to control the helicopter during the early stages of the go-around but there was no clear decision to go-around and no definitive call to initiate the procedure as required by the OM. It also appears that the commander was not adequately prepared to accept control and continue the go-around and he did not take control until approximately four seconds after the initial request for help. The confusion that was generated contributed to an imprecise handover of control.

The flight crew were in a rapidly deteriorating situation, which initially required a go-around in poor visual flying conditions and then a handover of control. Without the benefit of sound SOPs, and the opportunity to practise regularly these exercises in the controlled environment of an STD, the crew were now reliant upon the flying skills of the commander. It is clear that he was not expecting to take control of the helicopter; nevertheless, his initial actions in rolling the helicopter to a level attitude and reducing the pitch angle were correct. But he was now devoid of any external visual cues and became concerned for the well being of his co-pilot who appeared to be upset at being unable to control the helicopter. This distraction from his instrument scan, albeit brief, probably explains why he did not notice the increasing angle of bank to the right and the continuing descent into the sea and possibly why he did not hear the AVAD warning at 100 ft. His problems would have been compounded by the disorientation induced by the rapid roll to the left during the initial recovery and the inherent instability of the helicopter.

2.6 Search and rescue

The search and rescue crews commented that the yellow immersion suits worn by the passengers were noticeably more conspicuous, when using the SAR helicopter's searchlight in the darkness, than the blue immersion suits worn by the pilots. The flight crew were difficult to locate in this accident because they were neither able to inflate their life jackets nor operate any of their location devices. In this situation, they were completely reliant on the conspicuity of their clothing to be located. However, the immersion suit and un-inflated lifejacket are designed to have low reflectivity in order to reduce internal reflections in the cockpit during night time flight operations. Previous trials have examined ways of enhancing the conspicuity of survival suits but have not reached any definitive conclusions. It is possible that enhancing the infra-red reflectivity of the survival suit would provide the most beneficial results since most SAR helicopters use infra red sensors to assist the search; however, other methods may prove to be more effective. Therefore:

> It is recommended that the European Aviation Safety Agency (EASA) investigate methods to increase the conspicuity of immersion suits worn by the flight crew, in order to improve the location of incapacitated survivors of a helicopter ditching. (Safety Recommendation 2008-036)

2.7 Weather reporting

The weather conditions were clearly poor and close to the operating minima. In such marginal conditions it is only the flight crew that are in a position to assess the prevailing conditions and decide whether it is safe to continue with the flight. They made no comments suggesting that they considered the weather poor enough to conduct a radar approach, or to terminate the flight. Furthermore, their transit speeds indicate that they were reasonably content with the conditions, otherwise they would have flown at slower speeds.

Although the flight crew are able to assess the conditions when airborne, accurate weather information is an essential component of the information used in the flight planning phase, and weather observations from the platforms form an important subset of this data. However, the Logistics Supervisor, who compiled the data used on the evening of 27 December 2006, had no formal training or qualifications, and no equipment to assist him in the production of accurate observations. Therefore:

> It is recommended that the Civil Aviation Authority ensure that personnel who are required to conduct weather observations from offshore installations are suitably trained, qualified and provided with equipment that can accurately measure the cloud base and visibility. (Safety Recommendation 2008-037)

3 Conclusions

(a) Findings

1. The flight crew were properly licensed and qualified to conduct the flight, and were well rested. Their training was in accordance with the operator's requirements.

2. The helicopter was certified, equipped and maintained in accordance with existing regulations and approved procedures. At the time of the accident there were no recorded Acceptable Deferred Defects that might have contributed to the incident.

3. The flight crew had the relevant meteorological information and, whilst the weather conditions were poor, they were above the required minima and not unusual for such operations.

4. The flight crew were familiar with operations onto the North Morecambe platform and the lighting on the platform was serviceable.

5. The co-pilot visually aquired the helideck at a range of about 6,800 m.

6. The crew flew the approach by reference to visual cues that, because of the dark and prevailing poor weather conditions, did not provide adequate information required for the normal perception of distance.

7. The paucity of instrument cross-checks by the commander did not assist the co-pilot in managing the approach profile and there was no evidence of monitoring by the commander.

8. The co-pilot, who became disorientated during the approach, did not positively call 'going around'.

9. The go-around decision and the transfer of control from the co-pilot to the commander were not handled appropriately. The commander, who appeared not to be mentally primed to take control, did not do so until approximately four seconds after the initial request for help.

10. The commander, who took control of the helicopter when it was in an extreme and unusual attitude, rolled the helicopter to a wings level attitude and reduced the pitch angle.

11. During the attempted recovery of the helicopter from its unusual attitude the commander was devoid of any external visual cues and was possibly distracted over concerns for the well being of his co-pilot.

12. Concerns for his co-pilot and some degree of disorientation possibly distracted the commander from his usual instrument scan to the extent that he did not notice the increasing angle of bank to the right and the helicopter's continuing descent into the sea.

13. The impact of the helicopter's fuselage with the sea surface was not survivable.

14. Search and rescue assets at sea and ashore were deployed without delay.

15. The yellow immersion suits worn by the passengers were noticeably more conspicuous in the dark than the blue immersion suits worn by the pilots when illuminated by a helicopter's searchlight.

16. The bodies of the fatally injured crew and four of the passengers were recovered within approximately 4 hours of the accident. The body of the remaining passenger has not been recovered.

17. There was no evidence of any technical malfunction that may have contributed to the accident.

18. There were no handling quality issues identified during the flight testing of another SA365N helicopter that could have had a bearing on the accident.

19. The helicopter's behaviour during the accident flight was consistent with the flight control inputs.

20. The location of the radio altimeter, optimised for reference in the final stages of a visual landing on a helipad was difficult to include in the pilot's instrument scan during a go-around.

21. The torquemeter's size, readability and location made it difficult to use by the pilot in the left seat at any stage during an approach and go-around.

22. The post-mortem examination showed that the commander had severe coronary artery disease but this had no bearing on the cause of the accident.

23. The operator did not train or periodically assess their crews in a synthetic training device although such a device, configured to represent a SA365N helicopter, was available.

24. There is no industry requirement for formal training of those personnel involved in the compilation of meteorological data for aviation weather reports. In addition, the Logistics Supervisor, who compiled the meteorological observation for the gas field used on the evening of 27 December 2006, was not provided with any equipment to assist him in the production of accurate weather observations.

(b) Contributory factors

The investigation identified the following contributory factors:

1. The co-pilot was flying an approach to the North Morecambe platform at night, in poor weather conditions, when he lost control of the helicopter and requested assistance from the commander. The transfer of control was not precise and the commander did not take control until approximately four seconds after the initial request for help. The commander's initial actions to recover the helicopter were correct but the helicopter subsequently descended into the sea.

2. The approach profile flown by the co-pilot suggests a problem in assessing the correct approach descent angle, probably, as identified in trials by the CAA, because of the limited visual cues available to him.

3. An appropriate synthetic training device for the SA365N was available but it was not used; the extensive benefits of conducting training and checking in such an environment were therefore missed.

4 Safety Recommendations

The following safety recommendations were made:

4.1 **Safety Recommendation 2008-032:** It is recommended that CHC (Scotia) review their Standard Operating Procedures related to helideck approaches, to ensure that the non-handling pilot actively monitors the approach and announces range to touchdown and height information to assist the flying pilot with his execution of the approach profile. This is especially important on the SA365N helicopter when the co-pilot is flying approaches in poor visual conditions and cannot easily monitor a poorly positioned radio altimeter.

4.2 **Safety Recommendation 2008-033**: It is recommended that the European Aviation Safety Agency ensure that research into instrument landing systems that would assist helicopter crews to monitor their approaches to oil and gas platforms in poor visual flying conditions and at night is completed without delay.

4.3 **Safety Recommendation 2008-034**: It is recommended that CHC (Scotia) conduct a thorough review of their Standard Operating Procedures related to helideck approaches, for all helicopter types operated by the company, with the aim of ensuring safe operations.

4.4 **Safety Recommendation 2008-035**: It is recommended that the Civil Aviation Authority should ensure that the recurrent training and checking of JAR-OPS, Part 3 approved operators should be carried out in an approved Synthetic Training Device.

4.5 **Safety Recommendation 2008-036:** It is recommended that the European Aviation Safety Agency (EASA) investigate methods to increase the conspicuity of immersion suits worn by the flight crew, in order to improve the location of incapacitated survivors of a helicopter ditching.

4.6 **Safety Recommendation 2008-037:** It is recommended that the Civil Aviation Authority ensure that personnel who are required to conduct weather observations from offshore installations are suitably trained, qualified and provided with equipment that can accurately measure the cloud base and visibility.

R Tydeman
Principal Inspector of Air Accidents
Air Accidents Investigation Branch
Department for Transport
September 2008

APPENDIX A – AERODYNAMIC SIMULATION RESULTS

The recorded data was provided to the manufacturer to be processed through their aerodynamic model of the helicopter to establish the control inputs required to generate the attitudes recorded. Three sets of simulation results are provided. Each set of results has a first page highlighting the main assumptions associated with the simulation, and a second page with the graphs of the results. The following points will help interpreting the results:

- Black is the data recorded during the accident flight.
- The recorded data failed in the period between 847 and 848 seconds and has been smoothed over.
- DDZ% = collective input
- DDM% = cyclic pitch input
- DDL% = cyclic roll input
- DDN% = tail pedal input
- NZ = Normal acceleration
- TETA = pitch
- PHI = roll
- PSI = heading
- VZ = vertical speed
- VI = airspeed
- OMG-RP = rotor speed

The main body of this report discusses limitations to the accuracy of these methods and draws conclusions from the results.

Simulation hypothesis

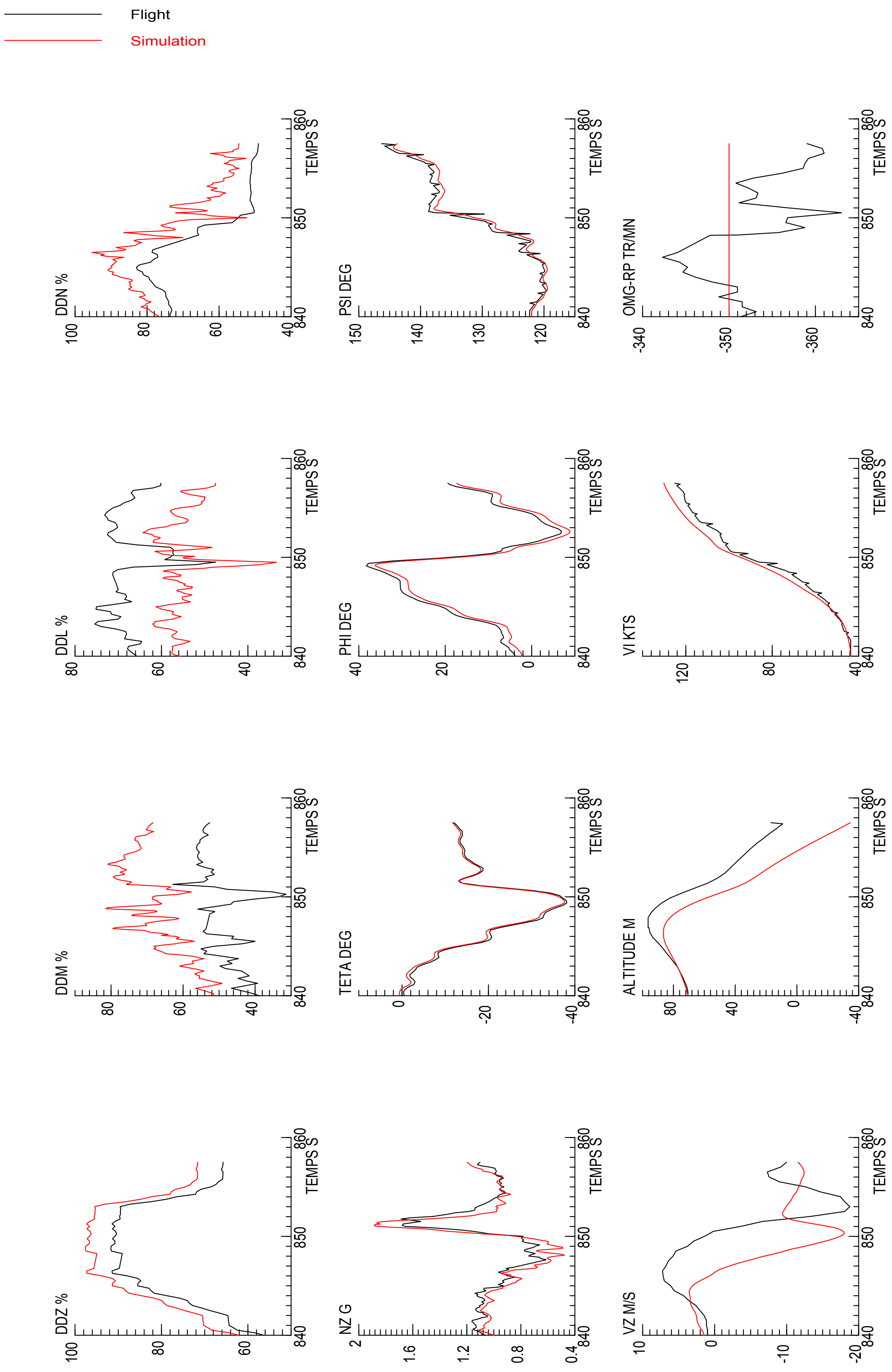
- Perfect engines (no variation on Nr)
- Atmospheric conditions: 0m at ISA -15°C
- Weight: 3863 kg
- Centre of gravity: 0.1m forward
- No wind simulated
- Simulation is initialised with flight data for speed (Vz and Vi)
- Collective stick has been forced to flight values
- Cyclic and tail rotor sticks have been imposed on speed angle variations

Justification of difference between simulation and flight:

- Vz: Flight value of vertical speed is not coherent with altitude variation. It is possible to have a delay on flight altitude rate measurement.

Conclusion

- It demonstrates a capability to pilot the trajectory in normal condition. The presence of wind gusts during the flight are highly probable and may explain differences observed on cyclic stick between simulation and flight.


Flight
Simulation
DDZ %
DDM %
DDL %
DDN %
NZ G
TETA DEG
PHI DEG
PSI DEG
VZ M/S
ALTITUDE M
VI KTS
OMG-RP TR/MN
TEMPS S

Simulation hypothesis

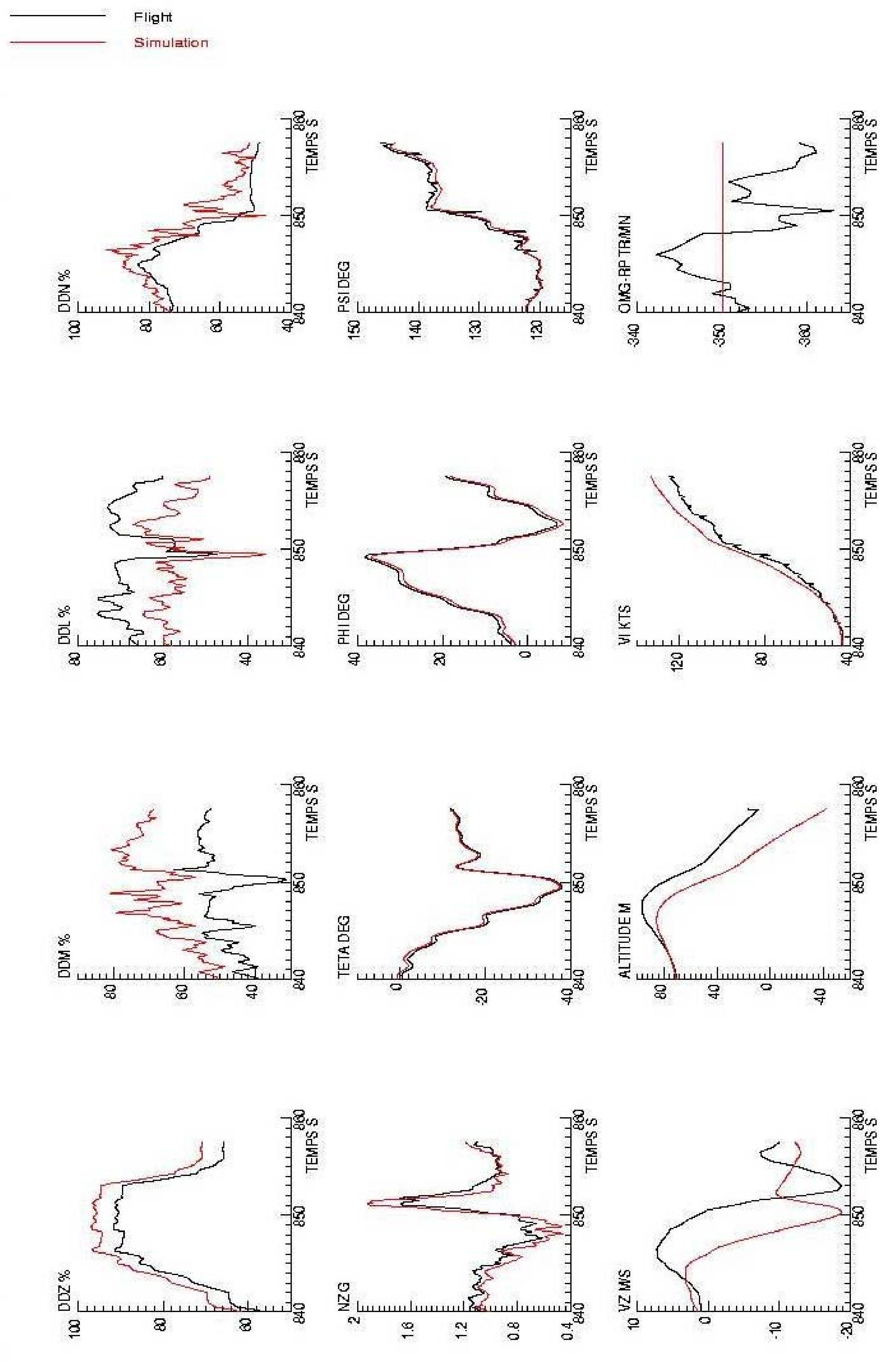
- Perfect engines (no variation on Nr)
- Atmospheric conditions: 0m at ISA -15°C
- Weight: 3863 kg
- Centre of gravity: 0.1m forward
- No wind simulated
- Simulation is initialised with flight data for speed (Vz and Vi)
- Sideslip: 6° on the right
- Collective stick has been forced to flight values
- Cyclic and tail rotor sticks have been imposed on speed angle variations

Justification of difference between simulation and flight:

- Vz: Flight value of vertical speed is not coherent with altitude variation. It is possible to have a delay on flight altitude rate measurement.

Conclusion

- It demonstrates a capability to pilot the trajectory in normal condition. Compared to the previous simulation (Crash G-BLUN - ETAGA conclusions - Corrected time base.doc) the additional sideslip increases the DDN of 3% and the DDL of 2%.


Flight
Simulation
DDZ %
NZ G
VZ M/S
DDM %
TETA DEG
ALTITUDE M
DDL %
PHI DEG
VI KTS
DDN %
PSI DEG
OMG-RP TRMN
TEMPS S

Simulation hypothesis

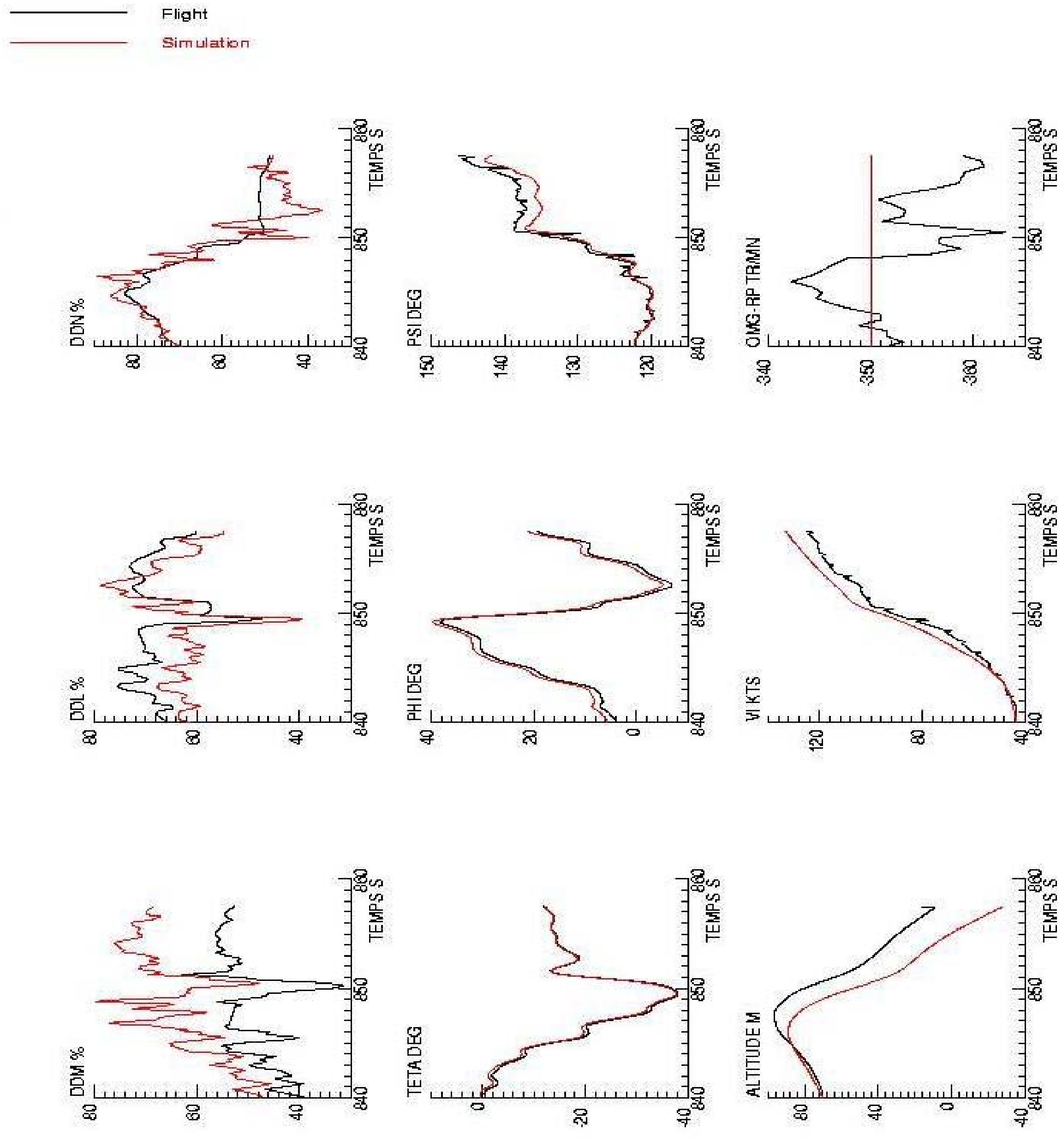
- Perfect engines (no variation on Nr)
- Atmospheric conditions: 70m at ISA -15°C
- Weight: 3700 kg
- Centre of gravity: 0.2m forward (3.8 m)
- 20 kt wind on the right rear
- Indicated speed: 43.688 kt
- Vertical speed: 2.5 m/s
- Sideslip: 6° on the right
- Collective stick has been forced to flight values
- Cyclic and tail rotor sticks have been imposed on speed angle variations

Justification of difference between simulation and flight:

- Vz: Flight value of vertical speed is not coherent with altitude variation. It is possible to have a delay on flight altitude rate measurement.

Conclusion

- It demonstrates a capability to pilot the trajectory in normal condition. Simulation is not well tuned and which can explain some difference. The JAR FSTD H (level D) regulation allows tolerance on command stick of +/- 10%.


Flight
Simulation
DDZ %
DDM %
DDL %
DDN %
NZ G
TETA DEG
PHI DEG
PSI DEG
VZ M/S
ALTITUDE M
VI KTS
OMG-RP TR/MN
TEMPS S

Appendix B

Civil Aviation Authority

Airworthiness Division

FLIGHT TEST REPORT

Date of Report: 21st May 2007 **Report Reference: FTR12713Z**

Aircraft/Equipment ....…	AS 365 N	G-BKXD
Date of Test............…	1st May 2007	
Flying Time.............…	1:30, 1:00	
Place.......................…	Blackpool Airport	
Maintenance Organisation…	CHC	
Weather........................	CAVOK wind 150/16 kts	
Condition of Aircraft……	Good, A sister aircraft of G-BLUN	
Object of Test(s)……….	Investigation at request of AAIB of fatal accident to AS 365 N G-BLUN	

Summary……………….. The flight profile of the accident helicopter on the approach to the offshore platform was recreated but with less nose down attitude as this was difficult to achieve. The wind direction/strength was similar to that of the night of the accident which permitted approaches to the platform on the same heading and with similar groundspeed. No handling characteristics/deficiencies were found which would have caused a severe nose down pitching although it was not possible to pull as much torque as on the accident aircraft without overtorquing the test aircraft. The approach path flown by the accident helicopter was apparently shallower than the normal approach angle which reduced the depth perception cues of the helideck.

1. INTRODUCTION

On 27th December 2006 AS 365 N G-BLUN crashed offshore (0.25 nm south of the North Morecambe platform) with loss of all on board. AAIB requested CAA assistance in investigating some aspects of the accident, including possible handling qualities related aspects and visual cues during approach and go-around to the offshore platform. AAIB removed the FDR following the flight test for analysis; this had not been seen by CAA at the time of writing this FTR. G-BKXD was to a similar build standard as G-BLUN.

The AAIB Special Bulletin 1/2007 stated that there appeared to be no pre-impact malfunction and the helicopter had attained a maximum nose down pitch of 38° coincident with a bank angle of 38° right about 8 seconds before impact. Rate of descent was about 1400 fpm at 170 ft on radalt. Last recorded parameters were pitch attitude of 12° nose down, roll 20° right and 126 KIAS.

2. TESTS CARRIED OUT

- Cockpit Assessment.
- Handling characteristics during go-around with take off power applied and trying to follow flight profile from FDR (last 18 seconds) with progressive build up. Day at safe altitude over land.
- Day assessment of approaches to North Morecambe platform, GA's with right turn and then progressive build up to follow FDR profile.
- Night assessment, steep approaches and shallow approaches. Assessment of visual cues. Progressive build up to follow FDR profile.

Take off weight was 3870 kg for the day flight and 3640 kg for the night flight.

CAA pilot occupied the co pilot's left hand seat (LHS) for both flights as the handling pilot for the accident had also occupied the LHS.

3. RESULTS AND DISCUSSION

3.1 Cockpit Assessment

The cockpit was assessed throughout both flights from the left hand seat (LHS) as this had been the position of the handling pilot of G-BLUN. The cockpit was equipped with flying instruments on both LHS and RHS stations. It was noted that the layout of instruments differed between LHS and RHS panels. In particular in each case the rad alt was positioned at the bottom outboard corner of the panel. Additionally it was noted that the engine/power instruments were biased towards the right hand side of the central panel. Although a duplicate Nr tacho had been installed in the Field of Regard (FOR) of the LHS pilot the aircraft's only torquemeter was a small 4cm instrument fitted at the right hand side of the central panel and was well outside the FOR of the LHS occupant.

Fig 1. AS 365N Cockpit

3.1.1 Location of Rad Alt

Although positioned appropriately to assist the pilot with a visually conducted task such as a helipad landing or aborted take off the location did not lend itself well to be incorporated easily into a normal radial instrument flying scan.

3.1.2 Location of Torquemeter

The small torquemeter was difficult to read and was positioned well outside the LHS occupant's normal FOR. The higher power figures required to hover or go-around were situated in the arc from 6 o'clock to 10 o'clock and were partially obscured by the instrument bevel when viewed cross cockpit. It was not possible to conduct a normal scan on the LHS instruments while monitoring or setting torque. From the transcript of the accident aircraft CVR and in discussions with the CHC TRE there did not appear to be any procedural method of the RHS occupant calling torques to assist the LHS handling pilot.

Rad Alt →		**← Torque Meter**

Fig 2. The LHS Panel and position of the torquemeter

3.2 Handling Assessment

3.2.1 Go Around Simulation On-Shore

The accident aircraft initiated the GA from a speed of 48 KIAS by a simultaneous application of collective and forward cyclic. The collective application resulted in an overtorque to about 111% total torque for 8 seconds (take off torque limit was 100%). Application rate was about 6 seconds from approach torque (about 55%) to 111%. In order to determine if a large torque application resulted in a nose down coupling, collective pulls were carried out. Due to the warm ambient conditions and the test altitude of 1500-3000 ft Hp the engine 100% Ng take off limit was reached before the torque limit was achieved and only 95% torque was available. Tests were carried out with the auto pilot (AP) in ASE mode (attitude hold) which would be the normal mode of operation.

3.2.1.1 Cross Coupling

There was no significant pitch change during the collective pulls, the nose tended to drop by a couple of degrees. A significant input of right pedal was required to maintain heading. Although the maximum torque that could be set on the trial was 16% less than pulled on the accident aircraft, the lack of any significant cross coupling indicated that it was unlikely to be significant at the higher torques than tested. In addition, the FDR does not appear to indicate any collective to pitch cross coupling as the pitch attitude followed the cyclic pitch input and the nose down attitude had only reached 8° when 111% torque was achieved.

The AS 365 N AP had a collective link function which inputs signal into the pitch, roll and yaw channels to reduce the cross coupling affects of collective inputs. With the link switched off the there was only a small difference, instead of the nose dropping by a couple of degrees it would raise by a couple of degrees.

3.2.1.2 Trimming

Collective inputs with forward cyclic were assessed. A significant amount of forward cyclic was required to attain 15° nose down pitch attitude, the force was such that re-trimming would be necessary. The AS 365 could be trimmed either by use of a beep switch or a force trim release (FTR) button both mounted on the cyclic. For large movements it would be common to use the FTR which temporarily released all loads. Progressively larger cyclic inputs with the FTR held in were made, stopping at about 27° nose down. The cyclic would have to be moved further forward to achieve the 38° nose down of the accident aircraft. The accident aircraft FDR showed an increase of cyclic of about 10% (but erratic due to over-controlling) held for about 6 seconds to achieve 38° nose down. Further test points introducing roll inputs were flown with the FTR held in to remove all force. This had the effect of losing any straight and level datum and increased the likelihood of inappropriate control inputs being made. In good visual references it is extremely unlikely that the pitch and roll attitudes would have been intentionally commanded, in poor conditions the use of FTR would have allowed large attitudes to be commanded with little tactile feedback to the crew.

3.2.1.3 Effects of Roll

Collective pulls, with forward and right cyclic inputs to achieve 38° roll were then assessed. It was easier to allow the nose to drop with a bank angle than in straight flight but nose down attitude was still far less than the 38° on the accident aircraft. Rates of descent up to 3000 fpm were observed even at the more modest nose down attitude.

On the accident aircraft the right bank angle was reduced to wings level 7 seconds before impact whilst pitch reduced to about 17° nose down. This part of the accident profile was assessed but from only 22° nose down. The helicopter had a natural tendency to want to reduce the nose down attitude due to rotor flapback and a positive effort had to be made to actually maintain a nose down attitude. In addition the action of rolling wings level also produced a tendency for the aircraft to reduce the nose down attitude.

3.2.2 Approach and Go Around Simulation Off-Shore ~ Day

Approaches were flown to the North Morecambe platform in daylight good visual conditions. See attached approach plate. Deck height was 135 ft.

The wind was similar to the night of the accident at 130°/16 (at Blackpool) compared to 150°/22 (reported from a platform 7.5 nm from North Morecambe platform) to 130°/20 (reported from a standby vessel near to North Morecambe platform). Approaches were flown on a heading of 120° as per the accident. The CHC pilot commented that this approach heading was one of the better headings with a good view of the deck. The approach with the left seat pilot handling was offset in the latter stages to the right to allow the best view and an overshoot path.

Approaches at a 'normal' descent angle were carried out first with the CHC pilot demonstrating including SOP calls, a GA was made at approximately the same point as the accident aircraft (close to the platform, approximately 0.3 to 0.5 miles). Typical speed/heights were 50/360 and

42/300. In the GA, 12° pitch nose down was used. (The CHC pilot commented that on a GA pilots tend to use too much nose down pitch and not select enough power.) The CAA test pilot made a number of approaches and GA's, typical speed/heights being 55/380 and 48/280 (CHC pilot in right seat stated that he could not see the deck at this last point). For the GA, 90% torque, 10° nose down and 20° right roll was used. An approach and GA simulating the accident scenario was flown: the descent was commenced at 65/400, at 55/220 (same height but 7 kts faster than accident) power was applied for the GA and pitch nose down/roll right. The CHC pilot commented that the approach was extremely flat, well outside of normal approach angle.

Repeat shallow approaches were flown, typical speed/heights were: 63/340, 55/270, 50/220. In the GA up to 90% torque was used and 12° nose down, 30° right roll. This resulted in a rate of descent of about 600 fpm at a speed of 95 KIAS (accident aircraft last recorded speed 126 KIAS). One of the approaches was flown by CAA pilot with FTR held in for all of the approach. It was noted that there was a lot of pedal activity required during the circuits (the AS 365 N requires considerable right pedal to oppose the main rotor torque).

It was noted that the AS 365 N was not the easiest helicopter to fly on instruments and that the autopilot was quite 'soft', giving the impression that it would not be advisable to take hands off the controls.

3.2.3 Approach and Go Around Simulation Off-Shore ~ Night

Weather conditions were very good (compared to poor for the accident night) with a full moon just behind the platform and at approximately 30° elevation at the beginning of the assessment. Approaches were flown on a heading of 120°.

A steep approach starting at 500 ft was flown to speed/height 50/400, at this point it was noted that more of the deck could be seen to judge the approach (compared to a shallow approach) but even in the good conditions there was little 3D cueing. The approach angle was judged on the relative appearance of the 'oval' ring of helideck lights. A bright yellow perimeter light on the helideck tended to occlude the ring of lights. A shallow approach starting at 400 ft was flown; depth perception was difficult as the helideck lights tended to align losing the 'oval' which provided most of the cueing.

If the helicopter was too high there would be a cue as the ring of lights becomes a rounder oval but there are few cues from the lights (or other visual sources) for the too low or shallow approach. At about 0.5 miles the lights could be seen individually which then gave some depth perception. Speed/height of 70/350 and level at 220 ft were noted on the approach. At 0.5 miles a gentle GA was commenced.

Two further shallow approaches were flown including GA's partially simulating the accident. Given the evidence from the AAIB and the known flight path during GA it was possible to approximate the accident flight approach path. The accident flight commenced an approach from 400 ft and would appear to have commenced a descent before being close enough to the platform to be able to discern a distinct oval pattern of lights. On reproducing the accident flight's descent to 220 ft amsl the helideck lights failed to become a discernible oval until approx 0.2 nm. It was assessed that the accident aircraft commenced a GA before closing to 0.2 nm.

3.3 <u>Theory for Means of Establishment of Suitable Approach Path</u>

To make any kind of approach to a landing an aircraft has to be flown along a suitable approach path or glide-slope. In good visual conditions the human brain is very capable of using visual cuing of size, shape, perspective, texture etc to give angle, height and range information. In poor visual cueing the information is still required but can be provided in a different manner. For example an ILS approach is normally flown using a localiser and glide-slope indicator. By cross checking an altimeter the pilot can, in effect, determine distance. So out of the 3 pieces of information (distance, height, angle) the pilot can make do with 2. On the accident flight at night the weather was poor with low visibility and probably moisture on the windscreen reducing the visual cues from the platform, the weather radar had been secured as part of the approach/pre-landing checks and no GPS information was discussed on the CVR. This left the crew with no range information. The Rad Alt was working correctly although not well placed in the scan when trying to view the platform through the windscreen. By commencing an early descent from 400 ft (lower than the normal transit height of 500 ft amsl) the aircraft descended below the flight path that would have allowed use of the circle of helipad lights to give approach angle information. With only one of two essential pieces of information it seemed unlikely that the approach path could have been flown with the normal desired accuracy.

3.4 Consideration

During the Go Around (GA) the aircraft was apparently manoeuvred very aggressively. It was difficult for the assessing test pilot to understand why such a control strategy might have been used. It is a conjecture that both pilots might have had a very strong compulsion to remain VMC below the cloudbase of around 500 ft.

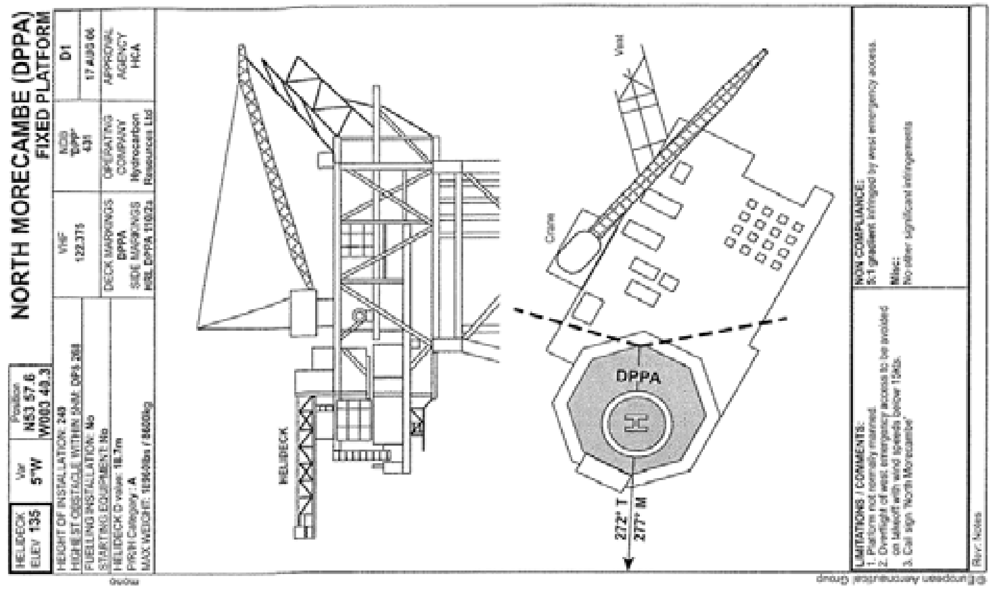
3.5 Disorientation

There appear to be a number of factors within the aircraft and the landing platform identified that conspired to contribute towards possible disorientation of the LHS handling pilot. Having asked the RHS pilot to take control following the go-around it was difficult to determine additional factors that would have affected the RHS pilot particularly, although it is almost certain that the RHS occupant would have a very degraded, if any, view of the platform and was probably not expecting to have to take control.

4. CONCLUSIONS

- The AS365N was assessed for any potential handling qualities' deficiencies that could have had a bearing on the accident of G-BLUN. Although less torque was available to the test crew than that used in the accident no handling qualities deficiencies were noted.
- The location of the Rad Alt on the LHS instrument panel was optimised for the final stages of the visual helipad landing and was difficult to include in the instrument scan required during a Go-Around.
- The torquemeter's size, readability and location meant it was difficult to use by the LHS pilot at any stage during the high workload of the approach and Go-Around. (There was no evidence of any procedural compensation for this among the CHC crews).
- The helipad lighting included a particularly bright amber perimeter light which made it more difficult to discern the circle of amber lights. It is understood that future helipad lighting will use green coloured lamps which will make it easier to discern the helipad circle amongst the additional lighting on the platform.
- Flying a shallower than optimum approach meant the oval appearance of the circle of lights was difficult to discern and "blurred" into a single line of lights. It would appear from the evidence that G-BLUN flew a very shallow approach and probably never saw a discernible oval of lights.

- The helipad at night gave insufficient cues to allow distance to be judged and without additional information from the weather radar or GPS the crew of G-BLUN would not have known the distance to run accurately.
- When the RHS pilot took control he would have had no visual cues from the platform.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HELIDECK
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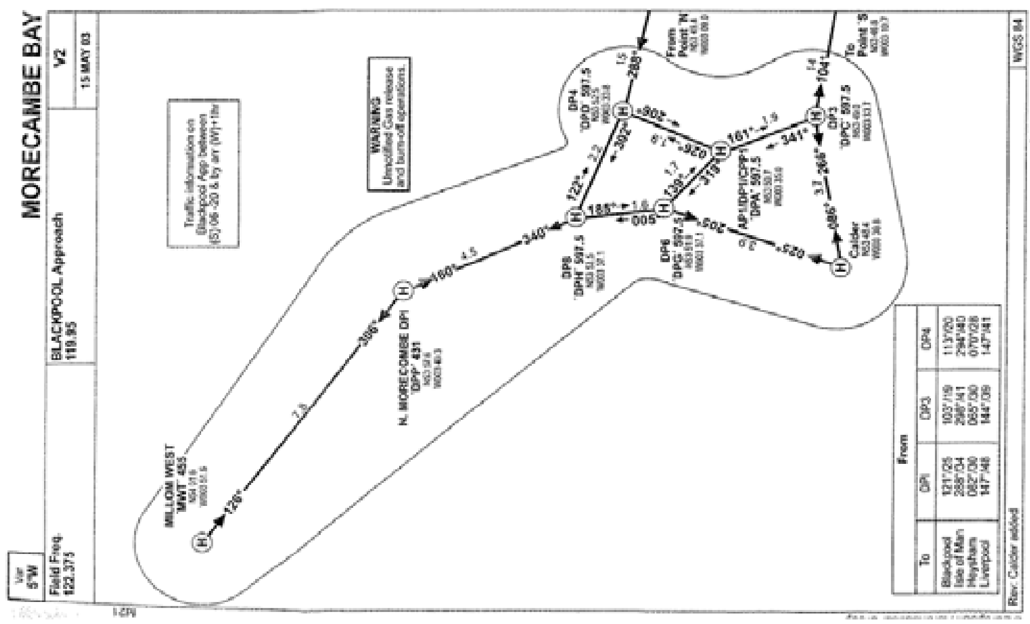
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BLACKPOOL Approach
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Field Freq.
122.375
MILLOM WEST
N. MORECAMBE DPI
WARNING
Unnotified Gas release and burn-off operations.
Calder
WGS 84

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Flight Operations Inspectorate (Helicopters)

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12 February 2007

Dear Captain Paine

OFFSHORE PROCEDURES

In light of the fatal SA365N accident and in advance of the publication of the full AAIB report, the Authority has been reviewing relevant offshore procedures to identify areas that might benefit from further consideration.

We would, therefore, encourage offshore operators to review the following aspects of Company Operations and keep their assigned FOI advised.

a. Helideck multi-crew procedures:

(1) for visual approach and departure to/from offshore helidecks, including use of autopilot if appropriate;
(2) standard calls between crewmembers if flight path deviation is identified;
(3) specific requirements for the Non Handling Pilot to monitor primary flying instruments, and the policy for assuming control, if required;
(4) specific requirements for go around procedures, making use of autopilot, if appropriate; and
(5) Sterile cockpit (no paperwork) during approach and take off.

b. Helideck training procedures:

(1) night training and checking regime, including go around procedures, and use of simulator, if appropriate; and
(2) unusual attitude recovery techniques and training, including use of simulator, if appropriate.

c. Rad alt bug setting & usage policy.

Yours sincerely

Captain R M Jones
Head of Flight Operations Inspectorate (Helicopters)

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