RAAD VOOR DE TRANSPORT VEILIGHEID

FINAL REPORT

97-74/A-25

PH-KHB, Sikorsky S-76B

20 December 1997, near Den Helder

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FINAL REPORT

The Dutch Transport Safety Board is an independent governmental organisation established by law to investigate and determine the cause or probable cause of accidents and incidents that occurred in the transportation sectors pertaining to shipping, civil aviation, rail transport and road transport as well as underground logistic systems. The sole purpose of such investigation is to prevent accidents and incidents and if the Board finds it appropriate, to make safety recommendations. The organisation consists of the Transport Safety Board and a subdivision in Chambers for every transportation sector which are supported by a staff of investigators and a secretariat.

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REPORT 97-74/A-25

Final report of the investigation into the probable cause of the accident with KLM ERA Sikorsky S-76B helicopter, PH-KHB on 20 December 1997 near Den Helder.

In accordance with Annex 13 of the Convention of Chicago as well as the Directive 94/56/EC of 21 November 1994 establishing the fundamental principles governing the investigation of civil aviation accidents and incidents of the Council of the European Union, the purpose of an investigation conducted under the responsibility of the Dutch Transportation Safety Board is not to apportion blame or liability.

Chairman of the Board

Chairman of the Aviation Chamber

Den Haag, januari 2000

De Eindrapporten van de Raad voor de Transportveiligheid zijn openbaar.
Een ieder kan daarvan gratis een afschrift verkrijgen door schriftelijke bestelling bij
SDU Grafisch Bedrijf bv, Christoffel Plantijnstraat 2, Den Haag, telefax nr. 070 378 9744.

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ABBREVIATIONS

AAIB	Air Accident Investigation Branch (UK)
ALT PRE	Altitude preset
ANU	Attitude Nose Up
AOM	Aircraft Operating Manual
ºC	degrees Centrigade
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DH	Decision Height
ETA	Estimated Time of Arrival
FD	Flight Director
FMS	Flight Management System
fpm	Feet per minute
ft	Feet
hPa	Hectopascal
HPZ	Helicopter Protected Zone
HUET	Helicopter Underwater Training
Hz	Hertz
IAS	Indicated Airspeed
IFR	Instrument Flight Rules
IVSI	Instantaneous Vertical Speed Indicator
JAR	Joint Aviation Requirements
lbs	Pounds
M	Meter
MDH	Minimum Descent Height
NDB	Non Directional Beacon
Nm	Nautical mile
Nr	Main Rotor Speed in percentage
OPPLAN	Operational Plan
PF	Pilot Flying
RLD	Rijksluchtvaart Dienst
PNF	Pilot Not Flying
RPM	Revolutions per Minute
SAR	Search and Rescue
SAS	Stability Augmentation System
SARBE	Search and Rescue Beacon
SCD	Subject Captains Discretion
UHF	Ultra High Frequency
UTC	Universal Time Coordinated
UK	United Kingdom
VFR	Visual Flight Rules
VHF	Very High Frequency
VNV	Vereniging van Nederlandse Verkeersvliegers

GENERAL INFORMATION OF THE ACCIDENT

Unless stated otherwise, all times in this report are local time estimates. Local time North Sea (the Netherlands) at the time of the accident was Universal Time Coordinated (UTC) + 1.

Unless stated otherwise, all headings in this report are magnetic.

Because no flight data recorder was installed all altitudes in this report are estimates based on witness reports and statements.

Place	: Near Platform L7-A North Sea Latitude 53° 36' North, Longitude 004° 05' East
Date and time	: December 20th 1997, 17.29
Aircraft	: Sikorsky S-76 B
Aircraft registration	: PH-KHB
Operator	: KLM ERA Helicopters
Flight Crew	: 2, no injuries
Passengers	: 6, one deceased
Type of flight	: unscheduled transport flight
Phase of flight	: final approach
Type of accident	: controlled flight into water

THE INVESTIGATION

The accident was notified to the Accident and Incident Investigation Bureau of the Netherlands Aviation Safety Board on December 20th 1997, and the investigation began the same day. Assistance in the investigation was rendered by Air Accidents Investigation Branch UK (AAIB), National Transportation Safety Board USA (NTSB), Hamilton Standard USA, Pratt & Whitney Canada, KLM ERA Helicopters (KLM ERA), Schreiner Northsea Helicopters, The Flight Safety Committee of VNV Dutch Pilot Association, Dutch State Supervision of Mines, CEDAR Cambridge UK, the Dutch Radio Communications Agency and the Dutch National Aviation Police. The Dutch Police performed the identification of the deceased victim.

The final determination of the report and the safety recommendations have been made by the Dutch Transport Safety Board. At 1 juli 1999 the Netherlands Aviation Safety Board has been merged into this new multimodal Board.
This transition and its preparations is one of the factors that caused delay in the publi-

cation of the report which originally could not be envisaged. Further contributing factors that can be indicated in this connection are understaffing of the Accident and Incident Investigation Bureau of the former Netherlands Aviation Safety Board as well as the long lasting after-effects of the EL AL-Boeing disaster in the Bijlmer.

SYNOPSIS

On December 20th, 1997 the Sikorsky S-76B helicopter PH-KHB was conducting a serie of shuttle flight sorties between rigs and platforms over the North Sea in the K5 and Pentacon field area.

During the fifth sortie, after sunset and in dark night conditions the final approach to production platform L7-A resulted in a go-around. After a left turn a second approach was initiated. After power reduction to loose height and speed in a relatively short time the helicopter lost almost all forward speed and entered a steep descent towards the sea. Realization of this situation was too late and the application of collective power could not prevent the helicopter entering the water. Crew and passengers were able to evacuate the helicopter. After approximately one hour in the water they were picked up by a supply vessel. During this period one passenger deceased.

1 FACTUAL INFORMATION

1.1 History of the flight

On December the 20th, 1997, the flightcrew of the PH-KHB, a KLM ERA Sikorsky S-76 B helicopter was scheduled for a duty time of 12 hours, starting at 06.45, in which 5 sorties of shuttle flights over the North Sea in the K5 and Pentacon field area had to be executed. Both pilots were qualified for the mission. The Captain acted as Pilot Flying (PF) during the first 3 sorties. Starting with the 4th sortie the pilots switched roles and the Co-Pilot became PF. According to company standard practice the PF occupied the right seat.

The first 4 sorties were uneventful. The last sortie started from L7-Q. After take-off at 16.50 the helicopter was scheduled to return to Den Helder Airport with intermediate landings on L4-A, the Noble Ronald Hoope, the L7-A and again the L7-Q. The cloud-base was 2,000 feet with cloudlayers at 500 feet and patches at 400 feet. The wind was light and variable. Visibility was 3 nm., increasing. Take-off was after sunset. The night was dark, moon nor stars were visible.

Start-up and take-off were uneventful and the flightcrew proceeded to L4-A at 500 feet. The Co-Pilot as PF flew the approach and due to obstacles at the PF's side the PNF took over the controls and performed an uneventful landing.

Following part of the History of Flight is a reconstruction using statements and CVR replay. Times are only correct in relation to the sequence of events.

At 17.01 the flightcrew took off from L4-A and proceeded at 1,000 feet to the Noble Ronald Hoope, a drilling rig with a well lit vertical structure. The approach and landing were uneventful. However a replay of the CVR showed that the PF made the remark that she found the landing, her first night landing this day "vervelend, met zo weinig wind", (rather difficult with almost no wind). The CVR also showed that she used more than normal power changes during the last part of the final approach.

After taking 6 passengers on board the flightcrew took off from the Noble Ronald Hoope at 17.15 and proceeded on an easterly course to the L7-A, a production platform with no superstructure. The elevation of the helideck is 100 feet and the helicopter landing area is marked with yellow lights. The PF flew the helicopter using flight director and autopilot. Halfway between the Noble Ronald Hoope and L7-A the PF selected 500 feet on the AL 300 Command Display and started a coupled descent to 500 feet to continue the flight below the cloudbase. Speed was reduced to 120 kts. Somewhere at this point the PNF adjusted the setting of his pressure altimeter so as to match the pressure altimeter reading with the read out of the radio altimeter. During the initial approach the crew received deck clearance for L7-A together with a reference wind for the area of 180° from the radio operator of L7-Q. Approach and landing direction were however based on FMS wind information. Since the average wind read out was from an easterly direction a straight-in approach was planned and executed. At 17.24 approximately 2 nautical miles from L7-A the height on the radio altimeter was 200 feet with an indicated airspeed of 70 kts. Shortly hereafter the PF decoupled the flight director. At 17.26 just before decision point, normally 50 feet above the elevation of the helideck with an IAS of 30 kts, the PF initiated a go-around because she considered the helicopter too high and too fast. After the call "go around" the PF increased collective, continued straight ahead and started the climb. Eleven seconds after the call "go around" the PNF advised the PF to turn. The PF started a left climbing turn and again coupled the flight director. During the climb the PNF called: "okee, blijf maar op deze hoogte hoor, niet hoger" (okay, stay at this altitude, not any higher). The PF reacted by levelling off and pressed the ALT HOLD button on the flight director control panel. The landing gear was not retracted during the go-around.

The PF made a left hand circuit coached by the PNF who had visual contact with L7-A. At 17.27 the flight crew started the approach to L7-A for the second time. The helicopter turned to final and at that moment the PF became visual with L7-A. Once again she indicated she was unhappy with the situation but the PNF convinced her to continue. In this turn, at approximately half a nautical mile out the PF decoupled the flight director to be able to decelerate faster than the use of the flight director system permitted. Shortly thereafter the PF said:"nee wordt ook maar niks want dat gaat veel te hoog en veel te snel" (no, this is also not going to work, because we are much too high and much too fast). The PNF said he judged the situation normal and convinced her to continue, after which the PF lowered the collective pitch lever and at the same time raised the nose of the helicopter. The PNF called: "the gear is down and I have 60 knots" and four seconds later:"100 niet lager" (one hundred not lower).

The following events where exclusively reconstructed from interviews:

The PF was surprised because, at that moment, she had not the intention to descent to and below 100 feet. The PF stated that she looked at her flight instruments and read 100 feet on her pressure altimeter. In response she applied a large amount of power by raising the collective pitch lever. The PNF stated that he suddenly read 50 feet height on his radio altimeter. He also pulled collective. Both pilots stated that they did not positively feel the helicopter react to the power application before the helicopter made impact with the water. The impact took place at 17.29 and the helicopter almost immediately rolled to the right to an inverted position.

All occupants evacuated from the helicopter. After approximately 10 minutes the aircraft sank.

After approximately one hour a supply vessel took the crew and passengers on board. One passenger died some time after evacuating the aircraft.

1.2 Injuries to persons

Injuries	**Crew**	**Passengers**	**Others**
Fatal	0	1	0
Serious	0	0	0
Minor/None	2	5	

1.3 Damage to the aircraft

The aircraft was substantially damaged.

1.4 Other damage

None.

1.5.1 Personnel information

1.5.2 Captain

Age	: 55 years
Nationality	: Dutch
Sex	: Male
Company position	: Chief Pilot
Seniority	: Senior captain
Licence	: Airline Transport Pilot Licence-Helicopters (B1 Hef)
Ratings	: HK2, IR, RT
Type qualification	: Sikorsky S-61 N, Sikorsky S-76 B
Valid until	: 01-06-98
IR valid until	: 01-06-98
Last Medical Check	: 28-11-97
Total helicopter pilot hours	: 12407
Total hours on type	: 2629
Total hours on type since 01-10-97	: 98
Duty time since 01-10-97	: 408 hours
Day landings as PF since 01-10-97	: 239
Night landings as PF since 01-10-97	: 47
Last proficiency check S-76 B	: 16-05-97
Joined KLM ERA	: 01-12-75

The captain started his flying career in the Royal Netherlands Air Force in April 1966. After finishing the initial training he flew the Alouette III until he joined KLM in December 1975. At KLM he started instructing Sikorsky S-61 N system theory in September 1976. He was assigned Technical Pilot in 1985 and Chief Pilot in 1994.

1.5.2 First officer

Age	: 32 years
Nationality	: Dutch
Sex	: Female
Seniority	: Senior Co-Pilot
Licence	: Commercial Pilot Licence-Helicopters (B3 Hef)
Ratings	: HK2 IR RT
Type qualification	: Sikorsky S-76 B
Valid until	: 01-07-98
IR valid until	: 01-07-98
Last Medical Check	: 13-06-97
Total helicopter pilot hours	: 796
Total hours on type	: 514
Total hours on type since 01-10-97	: 151
Duty time since 01-10-97	: 413
Day landings as PF since 01-10-97	: 514
Night landings as PF since 01-10-97	: 57
Day landings as PF on 20-12-97	: 5
Night landings as PF on 20-12-97	: 1
Last proficiency check S-76 B	: 09-06-97
Joined KLM ERA	: 01-12-96

The first officer commenced flight training at the State Flight School ”Rijksluchtvaartschool” (RLS) in October 1992. She did not finish the training program and left the RLS in 1995 with a private pilot licence restricted to ”RLS aircraft only”.

From February 1995 until July 1995 the first officer joined the flightschool ”Rob van den Sigtenhorst” in Teuge, the Netherlands. The private pilot licence was amended ”Rob van den Sigtenhorst aircraft only” and flying fixed wing aircraft she passed her Commercial Pilot License (B3) exam on April 5th 1995. She passed the exam for the Instrument Rating on June 6th 1995.

After joining KLM ERA in December 1995 the first officer started her helicopter training in Febuary 1996 in the USA. After finishing type training on the Sikorsky S-76 B she started flying offshore in January 1997 and became Senior Co-Pilot in November 1997 after having flown approximately 500 hours offshore.

1.6 Aircraft information

1.6.1 General

Manufacturer	: Sikorsky Aircraft, Division of United Technologies
Type	: Sikorsky S-76 B
Registration	: PH-KHB
Operating weight	: 8183 lbs
Construction number	: 760340
Year of Manufacture	: 1988
Certificate of Registration	: Nr 5059 Date of first issue 4 July 1995
Certificate of Airworthiness	: Nr 5059 Valid until 1 December 1998
Total airframe hours	: 5504
Engines	: 2 Pratt & Whitney PT6B-36A turboshaft engines
Main Rotor	: Four-blade fully articulated with elastomeric bearings
Tail Rotor	: Four-blade semi-articulated
Landing gear	: Retractable tricycle wheels
Floats	: pop-out type (helium)

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

1.6.2 Aircraft characteristics

The S-76 B, when flying in the lower speed ranges, has a pronounced (up to 20 degrees ANU is normal) nose-up attitude. During deceleration, it is even more pronounced. This together with a fairly high instrument glare shield, may, for a short period of time during the final approach to an offshore platform, interfere with the cross-cockpit view of the landing area.

1.6.3 Maintenance history

The aircraft was maintained in accordance with an RLD (CAA-The Netherlands) approved maintenance schedule (KLM ERA/S76/1), by KLM ERA a JAR-145 approved maintenance organisation (approval number: RLD-1149). On December 11th 1997 25, 50, 100, and 500 hours inspections were completed. The records indicate that the aircraft was serviceable at the start of the accident flight.

1.6.4 Weight and balance

The mass and the centre of gravity were within the prescribed limits during the phase of operation related to the accident.

Maximum authorized take off and landing weight:		11,700 lbs
Estimated take off weight previous start (departure L7-Q):		10,903 lbs
Estimated weight at the time of the accident:		10,513 lbs
Centre of gravity limits at accident weight:	forward	196.3 inches
	aft	206.2 inches
Centre of gravity at 10,513 lbs (estimated accident weight):		200.5 inches

1.7 Meteorological information

The weather forecast available to the crew at the day of the accident mentioned a stationary ridge along 53° North, a rising barometric pressure from 1002 hPa to 1006 hPa; variable winds backing from 150° with 10 knots in the morning to 020° with 5 knots in the late afternoon; visibility 5 to 8 Nm with locally 2 to 3 Nm due to haze and mist; cloudbase 2,000 feet, locally 400 to 500 feet; outside air temperature +5 °C; seawater temperature +7 °C; wave height 1,5 to 2 metres.
Uniform daylight period was defined from 07.30 to 15.45.

The weather aftercast for the L7-A area at the time of the accident (16.00 to 17.00): Winds variable between 090° and 120° with 5 knots; visibility 2 to 3 Nm in haze; clouds scattered 500 feet with patches at 400 feet; no precipitation; outside air temperature +5 °C; barometric pressure 1006 hPa; illuminous range 10 Nm, dark, no horizon. Moon nor stars visible.

Note: The wrong wind direction of 180° given to the crew by the radio operator of L7-Q was caused by a stuck anemometer.

1.8 Aids to navigation

L7-A is equipped with a non-directional beacon (NDB) transmitting on 323 kHz , and coding ”EK”. The NDB is operated by the radio operator of the L7-Q on request. The NDB located on L7-A was not used during the accident flight.

1.9 Communications

The Sikorsky S-76 B was fitted with approved two-way radio communication systems appropriate for the flight being undertaken. All communications were performed on VHF frequencies.
During the accident flight and the search and rescue action the performance of all communications aids used, was satisfactory.

1.10 Aerodrome information

The landing site concerned, L7-A, a fixed platform, operated by Elf Petroland, is positioned at Latitude 53° 36.00' North and Longitude 004° 05.00' East. The elevation of the helideck is 100 feet, the highest permanent obstacle within 5 Nm is L7-B with an obstacle height of 144 feet. The required obstacle free track for landing and take off is on tracks 202° and 022°. This is needed to keep the tail rotor of the helicopter free from the entrances of the two stairways to the helideck. The helideck measures 16.0 m x 13.4 m. A visual landing aid was not available on L7-A.

Radio contact with the L7-Q radio operator has to be established to obtain deck clearance for the L7-A.

The marine navigation aids consist of marine lanterns, emitting white light visible 10 Nm on each corner of the platform signalling morse code "U" every 15 seconds. The helicopter landing area is marked by omnidirectional (vertical) yellow lights. Red warning lights are fitted to all obstructions above the landing deck. A windsock is illuminated near the helideck.

For details see Appendix A

At the time of the accident L7-A was approved for helicopter operations and fully serviceable.

1.11 Flight recorders

1.11.1 Flight data recorder

A flight data recorder was not required for this flight and none was fitted. The lack of flight data made it inevitable to reconstruct the sequence of events with only CVR and available statements of the survivors.

1.11.2 Cockpit voice recorder

1.11.2.1 General

A Loral Data System A100A cockpit voice recorder, with an endless loop of magnetic tape, was fitted.

Part number	: 93A100
Serial number	: 25128
KLM ERA code number	: 96885
KLM ERA sequence number	: 007
Total hours at time of accident	: 4100 hrs.

The track allocation was as follows:

Track 1 – Captain’s microphone and headset signals
Track 2 – Co-Pilot’s microphone and headset signals
Track 3 – Cockpit area microphone
Track 4 – Encoded rotor RPM

The cockpit voice recorder was recovered from the aircraft after salvage. At the AAIB, Farnborough (UK) the tape was removed and cleaned for investigation. At that time the intelligibility turned out to be very poor. Only an estimate of 15 % of the recorded speech could be retrieved. The original cockpit voice recorder tape was recleaned at the AAIB and a digital copy on tape (DAT) was made. After processing the digital copy, at CEDAR Cambridge (UK), an estimate of 90 % of the recorded speech was intelligible.

1.11.2.2 Audio tones

Seventeen and a half seconds before impact (at 12:12 on DAT tape) there are two audible tones at a frequency of 2700 Hz corresponding with the altitude alert signal. Just after impact there is an audible tone for approximately 2 seconds corresponding with the engine out signal.

1.11.2.3 Examination of area mike recording

The area mike recording has been examined by the AAIB (UK) in order to try to retrieve information on rotor and gas turbine operation.

The first examination is of a snapshot 12 minutes and 30 seconds before the end of data, to be used as a reference (at that time the helicopter was fully serviceable and flying in a normal cruise situation). The two evident frequencies were found at 746 Hz and 540 Hz, the two frequencies remain approximately constant. The frequency 746 Hz relates to the rotor shaft gear. The frequency 540 Hz relates to the engine drive shaft. The two frequencies are directly linked.

The second examination is of the data from around 35 seconds before impact (at time 12:29.25 on DAT tape) until and beyond impact. Two evident frequencies were found at 756 Hz and 542.5 Hz. The engine drive shaft frequency disappears for a few seconds (at around time 12:06 on DAT tape) but there is no change in frequency when it reappears. At the same time there is a small rise in the rotor shaft gear frequency which then returns to the previous value. The small rise in the rotor shaft gear frequency can be explained by the lowering of the collective lever during the last part of the second approach.

No other frequencies were evident.

From these findings it could be concluded that at the time just prior to impact there were no significant deviations with regard to rotor and gas turbine operation with respect to technical malfunctions.

1.11.2.4 Encoded rotor rpm

Channel 4 of the Cockpit Voice Recorder was used to store encoded rotor rpm data. The restored rotor rpm from this source did not show any anomalies.

1.12 Wreckage and impact information

1.12.1 Salvage

The salvage operation was carried out by the crew of salvage vessel Smit Orca together with specialists of KLM ERA and the Netherlands Aviation Safety Board. The helicopter was salvaged without inflicting further substantial damage.

1.12.2 External

Damage to the fuselage of the helicopter was limited to the lower end of the tail cone where the pylon is attached to the tail cone (mostly caused by the recovery). The aft pylon spar was cracked at a position half way between the intermediate and tail gearbox. At station 300 (where the tail is attached to the fuselage) some buckling was found on the left side of the fuselage. Some buckling was also found on the lower end of the tail cone below the registration marks and the static ports. The right hand door window was shattered. The right hand nose wheel door was broken.

1.12.3 Flight controls

Samples of hydraulic fluid were taken from the pressure and return filterbowl of both hydraulic modules. There was no visual contamination. A flight control check was carried out which proved that the flight controls could be moved through their full range without any restrictions.

Tail rotor control cables were found intact. The attachment to the tail rotor was torn loose.

1.12.4 Engines and power train

Both Pratt & Whitney PT6B-36A turboshaft engines did not show any damage other than the corrosion caused by the submersion in salt water. There was no visual damage on compressor rotor blades and stator vanes. The bleed valves were found in the open position and could be moved freely by hand. The engine drive shafts to the main gearbox were still intact and there was no visible torsion. The flex couplings and attachments were intact. The shafts could not be rotated by hand. The main gearbox did not show any damage other than the corrosion caused by the submersion in salt water. The tail driveshafts 1 to 5 were still intact and there was no visible torsion. The flex couplings and attachments were intact. The intermediate gearbox did not show any damage other than the corrosion caused by the submersion in salt water. The tail gearbox was split in two. The input housing was attached to the pylon. The other part, the output housing, was hanging on the servo's.

All four rotor blades broke off approximately 50 centimetres from the spindles. The remaining parts were slightly bent upwards. At all 4 blades a witness mark was visible on the rear mounting bolt of the flap stop caused by the donut locknut. All 4 damper to blade attachments were damaged in a downward direction; one attachment failed in a downward direction. The damage pattern on the teflon bushings around the spindles showed that forces opposite to blade rotation had been present. The 4 surface areas where blade separation occurred indicated overload.

All four tail rotor blades were separated from the tail rotor hub. One blade was still hanging on its pitch change rod.

1.13 Medical and pathological information

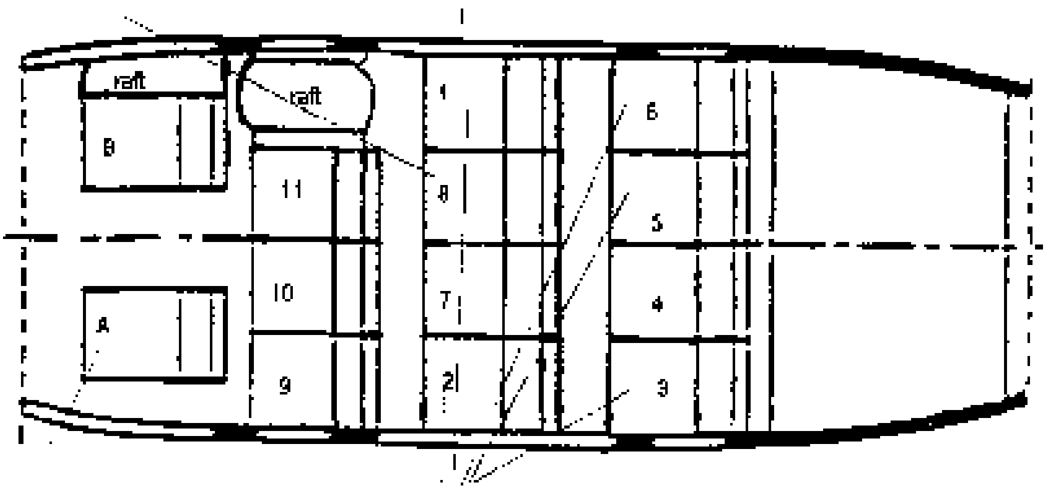
An autopsy was carried out on the deceased passenger. The autopsy report showed that the passenger died from hypothermia and drowning.

1.14 Fire

There was no fire.

1.15 Survival aspects

1.15.1 Evacuation



During the accident flight positions A, B, 1, 2, 3, 5, 6 and 8 were occupied.

After impact the aircraft immediately rolled over right to an inverted position and rapidly started to fill with water through the broken right front door window. The emergency

lighting in the aircraft activated just after impact, which according to statements of the occupants was of great help during the evacuation The lines drawn in the seating plan point out the routes via which the crew and the passengers evacuated the helicopter. The passenger on seat 1 could not remember whether he escaped via the left or the right door.
Neither of the two life-rafts available on board were launched.
A number of passengers reported that the HUET training had helped in evacuating the helicopter.
After the evacuation all occupants had inflated their lifevests successfully. The lifevest of the Co-Pilot was too large and the Captain had to help her to inflate the vest The Captain had activated his SARBE beacon.
Crew and passengers climbed on the belly of the helicopter. After approximately 10 minutes the helicopter started to sink and had to be abandoned. The group stayed together in the water with one passenger who showed signs of fading away in their middle. All occupants were wearing helicopter transportation suits, which eventually all started to fill with water. None of the occupants was wearing thermal underwear. Not all occupants were wearing gloves. Hoods were not used.
The crew did not use their strobe lights.

1.15.2 Opplan SAR

The Opplan uses three rescue options:

Primarily airplanes should carry sufficient lifesaving equipment to take care of all occupants;
Secondly assistance from units in the neighbourhood will be called upon;
In third instance on shore rescue units will be called upon to assist.

On working days between 16.30 and 08.00 and during weekends the dedicated on shore rescue helicopters based on Naval Air Station De Kooy are on 60 minutes standby.

Apart from the rescue equipment on board the rescue helicopters, extra liferafts are available on among others L7-Q and Naval Air Station De Kooy.

1.15.3 Search and rescue action

The ditch took place at 17.29. The radio operator of L7-Q who was responsible for the flight watch was informed at 17.30 by personnel on platform L7-A that the PH-KHB had crashed into the sea. He immediately alerted two helicopters (Schreiner 4 and Schreiner 6) and the supply vessels Smit Lloyd 55 and Smit Lloyd 57 who were all operating in the Pentacon field area. At 17.32 he notified the Coast Guard.
The Coast Guard raised SAR alarm at 17.36 for two helicopters. The SAR helicopters took off from Naval Air Station De Kooy at 18.18 for Pedro 2 and 18.35 for Pedro 4.

The Schreiner helicopters only carry VHF and were therefore not able to receive the UHF Sarbe signal. At 17.36 the crew of Schreiner 4 visually spotted the lifevest lights of the survivors. Because of problems with the helicopter searchlight, Schreiner 6 was called to assist. Schreiner 6 arrived at the scene of action at 17.55 and while circling over the survivors guided the Smit Lloyd 55 to the position of the survivors.

It should be noted that the available life-rafts from L7-Q were not used. In this respect it was furthermore noted that the Coast Guard presumably being in overall charge there was no mention of who was "On Scene Commander".

At 18.06 Smit Lloyd 55 arrived at the scene of action, launched a Zodiac rescue craft and a few minutes later started to pick up the survivors. In the end all survivors were taken on board Smit Lloyd 55 and at 18.30 the captain of the vessel reported to L7-Q that all survivors were on board and that one of them was unconscious.

Pedro 2 arrived at the scene of action at 18.37, initially overhead Smit Lloyd 57 and from there proceeded to Smit Lloyd 55 and at 18.40 hoisted a doctor on board. A second doctor was lowered by Pedro 4 at 19.03. CPR on the unconscious passenger started at 18.45. At 18.58 L7-Q was informed that the reanimation had not been successful.

It was then decided that the survivors would stay on board Smit Lloyd 55 together with one of the doctors and would disembark at Den Helder, ETA 22.30.

1.15.4 L7-A

Production platform L7-A is equipped with a rigid inflatable "man over board" boat that can carry 3 to 4 persons and one lifeboat that can carry 13 persons.
After observing the crash, one of the crewmembers of the L7-A tried to start the lifeboat. Several attempts were made but the engine would not start. He then tried to start the "man over board" boat but again did not succeed.
After Schreiner 4 had landed, two passengers disembarked and they were able to start the lifeboat at approximately 17.50. After informing the radio operator of L7-Q they were informed – on behalf of the installation supervisor – to stay on board the L7-A since the Smit Lloyd 55 was expected to arrive at the scene of action within 10 minutes.

1.16 Test and research

After the accident the fuel tank on L7-Q, which had been used to refuel the PH-KHB, was closed and a fuel sample was send to Intertek Testing Service Caleb Brett for testing. The test results showed that the fuel was within the "Jet A 1" specifications.

1.17 Organization and management information

1.17.1 Flight crew training

A customised training program is developed by the Chief Instructor of KLM ERA, based on the experience of a new pilot. The training program is in accordance with chapter 3 and 5 of the Helicopter Instruction Manual. When assessed necessary by the Chief Instructor, the training program can be extended to reach the required level.

The training program for pilots without previous helicopter experience consists of:

- Basic helicopter training with Flight Safety, Fort Worth, Texas
- B1 helicopter theory
- S-76 B groundschool
- S-76 B simulator training at West Palm Beach Florida
- S-76 B aircraft training
- Deck landing training offshore
- Route training with route check
- Night flight training
- Night route training with route check
- Advanced aircraft training
- Additional short courses concerning flight safety

The PF had not yet received the advanced aircraft training.

For recurrent training the training department yearly writes a new recurrent training syllabus.

1.17.2 Crew resource management

Within KLM ERA pilots of several backgrounds are employed. These pilots were trained in military or in civil training programs. In the past the majority of the KLM ERA pilots had a military background. Today more and more pilots have a non-military background with various experience in helicopter flying.

During the investigation it became clear that within KLM ERA knowledge of crew resource management (CRM) was not readily available to all pilots, only a few pilots within KLM ERA obtained CRM courses. At the time of the accident a CRM document written by a member of KLM ERA was not yet implemented.

1.17.3 Duty times

With a duty starting at 06.45 and in the case of dual pilot operations Dutch law allows for a total duty time of 12 hours, with a maximum flying time of 9 hours and with a lowest maximum of 35 landings for a combination of day- and night landings.
The crew of the accident flight was with a flying time of 2 hours 30 minutes and 18 landings well within legal limits. The planned duty time from 06.45 to 18.45 was the maximum allowable.
It was noted that in the United Kingdom and Norway, countries with similar off shore operations, a duty time starting at 06.45 would allow for a total duty time of 11 hours.

1.17.4 Relevant AOM procedures

Radio altimeter bug setting: During all phases of flight (except off-shore instrument approaches) – 200 ft.
Off shore instrument approaches – MDH

PNF shall call ”Sink Rate” when rate of descent below 500 ft exceeds 500 fpm.

If the Captain decides to execute a shuttle flight he will ensure that (among others)
- destination is within a relatively short distance or within the boundaries of a HPZ;
- en route weather conditions permit a shuttle flight.

Approach and landing: the description of the visual approach only covers the situation where a full circuit is required. There is no description for a straight-in approach.

A visual approach may only be executed when full visual reference to the helispot and surrounding terrain can be maintained. (there is no further explanation about the criteria for "full visual reference").

There are no procedures laid down for night operations. Operations are defined for IFR and VFR flights only.

1.18 Additional information

1.18.1 Autopilot and flight director system

The SPZ-7000 Digital Automatic Flight Control System (DAFCS) is composed of two integrated digital autopilot flight director computers (FCC), two flight director mode selectors and one autopilot controller. The four basic modes of operation are stability augmentation (SAS), attitude retention (ATT), automatic flight path control (CPL) and hover augmentation (HOV)

According to the AOM the DAFCS should be operated in a coupled mode in order to have a better overall control on aircraft system operation, navigation, separation to other aircraft and passenger comfort. Deviation from this procedure (e.g. for self training purposes in raw data flying) is subject to Captains discretion (SCD). Coupling and decoupling of the FD, as well as selections made on the navigation switch panel, shall always be announced by the PF.

1.18.2 Pressure altimeter settings

After salvage of the helicopter the subscales of the pressure altimeters were found set on :
- left pressure altimeter (PNF) : 1008 hPa
- right pressure altimeter (PF) : 1005 hPa

The Captain (PNF) stated that he had adjusted his pressure altimeter subscale in order to match his pressure altimeter reading with the reading of his radio altimeter. He did not inform the PF.
Hystereses and other small misreadings excluded the result would be that the PNF would have an approximately 80 feet higher reading on his pressure altimeter than the PF.

18.3 Altitude and height alert systems

The PH-KHB was equipped with two types of alert systems, a barometric altitude alert system (AL-300) and a radio altimeter alert system.

1.18.3.1 Barometric altitude alert system

When an altitude is set on the AL-300 command display the barometric alert system is activated. The system uses the altimeter setting of the right seat as a reference (in this case 1005 hPa). When reaching the pre selected altitude the numbers in the window will change into dashes. When the aircraft deviates more than 250 feet from the pre selected altitude the window will again show the pre selected altitude, an alert light will illuminate and there will be a chime. Returning back into the band will dim the alert light.
During the final approach to L7-A the altitude alert sounded twice. It should be noted however that the system is not used below 1,000 feet height above water. Associated chimes and warning lights are therefore disregarded.

1.18.3.2 Radio altimeter alert system

The radio altimeter is fitted with decision height bug and a yellow caution light. When the DH bug is set on a specific height the light will illuminate when the helicopter descends to or below this height. After recovery of the aircraft it was found that the DH bug selection of the PF was 260 feet and the PNF 200 feet.
The PH-KHB was furthermore equipped with a height alert system, incorporated in the electronic attitude direction indicator (EADI), using radio altimeter data. The EADI is provided with a selector on the flight director control panel to set the digits in the EADI decision height box. Approaching the pre selected height during a descent a white box will appear when flying within a range of 100 feet. When reaching the pre selected altitude the box will disappear and the pre selected height will change into the letters DH. The colour of these letters is white. When descending below the pre selected altitude the colour of the letters DH will change into amber.

No audio warning is incorporated in the radio altimeter alert systems.

1.18.4 Emergency floatation system

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

The only means of activation is by crew operation of one of the FLOATS switches mounted on both cyclic levers. These switches are armed by moving the FLOATS ARMED switch, on the centre console, to ARMED. In the ARMED position a green advisory light on the master caution panel will illuminate.

The arming switch is normally kept in the OFF position during cruise to avoid accidental inflation of the floats. In case of single pilot operation the FLOATS switch should be placed at ARMED when taking off or making an approach over water at speeds below

75 kt. In case of dual pilot operations the decision to ARM the FLOATS switch was left to "captains discretion".

During the accident flight the FLOATS ARMED switch was in the OFF position and therefore the system had not been ARMED.

After the accident KLM ERA published a flight department notification by which the shuttle checklist was amended in such a way that the use of ARMING the floats was made mandatory for all take-off's and approaches over water. Full implementation depends on further evaluation.

1.18.5 Rafts on board the PH-KHB

The aircraft was equipped with two 10 person rafts of the RFD 10R "Heliraft" type.

One raft is located in the cabin and secured on the right hand side of the front row seat frame (raft no.1). In the cockpit the second raft is secured between the pilot's seat and the pilot's exit at the right hand side of the aircraft (raft no. 2).
To launch raft no.1 a passenger sitting in the middle row of seats must jettison the right hand door first. The buckle of the restraining strap must be released, and the valise must be manhandled to the door and thrown into the water.

To launch raft no. 2 the pilot must jettison the right hand cockpit door first. The buckle of the restraining strap must be released, and the valise must be pushed into the water.

There are no special provisions for launching the rafts from outside the aircraft.

1.18.6 Helicopter transportation suits

In accordance with Elf Petroland regulations, all passengers were wearing a Viking helicopter transportation suit of the membrane type. Many passengers complained that from the moment they were out of the helicopter the suits rapidly filled with water. The crew on Smit Lloyd also stated that all suits contained a large amount of water, which hampered the recovery of the survivors onto the deck of the Smit Lloyd 55. According to statements by the survivors one suit was damaged at the neck seal during the previous shuttle flight. One other suit was most likely damaged during escape from the helicopter. The remaining suits were tested at Viking facilities in Haarlem. Small leakage was noted at the socks; neck and wrist seals were in an acceptable condition. All helicopter transportation suits had been maintained and inspected on a regular basis and were found serviceable at the last inspection. The suit of the deceased passenger was damaged when carrying out the autopsy.

1.18.7 Life vests

The life vests were examined after the accident. Two batteries were not activated and one press button, keeping the left and right front of the vest connected, was working but would open too easy.

2 ANALYSIS

2.1 General

The lack of flight data recorder information severely hampered the capability of the investigation to define either the sequence of events or possible failures. Had the accident been fatal to the flight crew the lack of flight data recorder data would have made determination of the cause(s) very difficult.

2.2 Technical

Records indicate that the helicopter was serviceable at the start of the accident flight; mass and centre of gravity were within the prescribed limits; fuel used for refuelling was within "Jet A1" specifications.

Damage to the main and tail rotor indicate normal rotor rpm's during impact with the water. Furthermore rotor and engine rpm's from the area mike recording and rotor rpm from the encoded rotor rpm recording all indicate that the engines, power train and rotors were fully serviceable until the helicopter hit the water.

No indications were found that the flight controls suffered any malfunction during the accident flight.

In conclusion it can be stated that no evidence was found that would suggest a technical malfunction of the helicopter as a cause for this accident.

2.3 Operational

2.3.1 Rig approaches

One of the difficulties when approaching rigs and platforms at night is that they may be the only light source in an otherwise totally dark environment. This so called single light source phenomenon has the effect that the pilot is deprived of the visual clues normally available during daylight approaches and the judgement of range and descent angle therefore becomes very difficult.
Approaches to helidecks at night therefore require a very high degree of precision. Standardization of these approaches should therefore be a clear objective.

In the KLM ERA operating manuals no procedures are published for visual approaches at night nor is a description given of a standard straight-in approach.

2.3.2 Conduct of the flight

After take-off from the Noble Ronald Hoope a visual straight-in approach and landing for the L7-A was planned and executed. According to the AOM a visual approach may only be executed when full visual reference to the runway/helispot and surrounding terrain can be maintained at all times. The AOM does not further specify the criteria for full visual reference.

The Co-Pilot (PF) had made her first night landing that day on the Noble Ronald Hoope, a drilling rig with a well lit superstructure. She had found this difficult.
The next landing was planned on the L7-A, a production platform, with no superstructure. At night the landing area yellow light markings are the only visual reference. An ideal situation to experience all the difficulties related to the so called single light source phenomenon. The fact that there was almost no head wind made the landing manoeuvre even more difficult. Furthermore the wrong wind information reported by L7-Q may have resulted in some confusion with a negative influence on the flight performance.

The first approach for the L7-A resulted in a go-around, initiated by the Co-Pilot (PF) because on short final she judged the helicopter to be too high and too fast. After the go-around a left turn was made which resulted in the fact that she lost visual contact with the platform and had to be coached by the Captain for the next set-up.

The time between the initiation of the go-around and the moment the helicopter struck the water was approximately 2 minutes and 13 seconds. A normal rate one 360º would have taken 2 minutes. It is therefore reasonable to assume that the set-up for the second approach was very tight and that the Co-Pilot (PF) only regained visual contact with the platform at a position where immediate actions were required.

She again felt unhappy with the situation, which she judged again as too high and too fast. The Captain (PNF) however convinced her to continue the approach at which point she lowered the collective pitch lever and at the same time raised the nose of the helicopter.
It is very likely that in this situation she overreacted on the controls and applied a large power reduction, thereby creating the onset for a high rate of descent. The helicopter was not equipped with an instantaneous vertical speed indicator so the beginning of the decent was not directly shown on the vertical speed indicator.
Furthermore the commencement of the increasing rate of descent probably went unnoticed due to the fact that the negative vertical acceleration resulting from decrease of the collective pitch was compensated by the positive vertical acceleration resulting from both the turn and the pitch-up initiation.

Further proof of the high rate of descent is the fact that with the trigger altitude at 500 feet, related to the 1005 hPa setting of the Co-Pilot, the altitude alerter sounded 17.5 seconds before impact, indicating a descent through 250 feet. The pressure altimeter setting of the Captain was 1008 hPa and most probably the more accurate setting. This would indicate that the actual height of the helicopter at the moment the alerter sounded was approximately 80 feet higher than 250 feet(=330 feet). This would mean an average rate of descent of 60*(330/17.5) = 1131 feet per minute. A "sink rate" call was not given by the PNF.

Under these circumstances a timely and aggressive collective input is required to regain level flight. Any delay in the application of power will result in a greater downwards acceleration. When both pilots realised the situation, the application of power reduced the sink-rate but came too late to prevent the helicopter hitting the water.

The following factors had a negative influence on a safe conduct of the flight:

Insufficient coverage of night flying operations in the AOM, especially with regard to visual approaches at night and the potential dangers relating to so called dark hole approaches;

The KLM ERA Sikorsky S-76 B helicopters are not fitted with an Automatic Voice Alerting Device. The altitude related warnings of such a device could have alerted the crew against inadvertent drift down as well as the arrival at specific heights. The fitted barometric alert system is not suitable as an altitude warning system during approach and landing operations;

The platform was not equipped with a visual approach aid.

2.3.3 Flight crew performance

Analysis of the CVR transcript shows that crew resource management techniques were not used in an optimal way.

During the last 30 minutes of the flight (the length of the CVR recording) the Captain (PNF) was frequently announcing his ideas of how the flight should proceed by making decisions and telling the Co-Pilot (PF) where to go or what to do. The remarks and comments by the Co-Pilot seem to be made mainly to receive confirmation and reassurance from the Captain. The relationship within the crew was more instructor/student than PF/PNF related. It is considered likely that the Captain by frequently taking the initiative created a situation whereby the Co-Pilot had to work faster than her experience would justify.

The Co-Pilot had found the landing on the Noble Ronald Hoope to be difficult. This could and should have been noted by the Captain from the Co-Pilots comment "rather difficult with such low wind speeds" and the Co-Pilots aircraft handling at that time making considerable power changes. Also the go-around after the first approach to L7-A should have been an indication that the Co-Pilot had difficulties with landing the helicopter under the prevailing conditions. By coaching the Co-Pilot into a very tight go-around pattern the Captain showed that he was insufficiently aware of this situation. On the other hand the Co-Pilot – other than the decision to make a go-around after the first approach – failed to let the Captain know in a positive way that she felt uncomfortable.

In a two pilot crew concept, one of the duties of the PNF is flightpath monitoring with the purpose to detect unsafe deviations from the range of normal aircraft operations and bring them to the attention of the handling pilot (PF) before the situation deteriorates unacceptably. After the go-around a left turn was made. Therefore only the PNF was able and had to keep visual contact with the platform to coach the PF for the next approach set-up. This most probably at the expense of his flightpath monitoring duties. When he called "100 feet, not lower" he had not realised that the helicopter had developed an excessive descent rate.

CRM should be a standard part of the training, especially so when there is a great difference in background and experience of the pilot community which was the case within KLM ERA and also during the accident flight.

2.4 Flight crew duty times

Apart from a one hour difference in total duty time the systems used in the United Kingdom, Norway and the Netherlands are fairly similar. The fact that the crew was operating far below the limits for maximum flying hours and landings would indicate that the duty time was not a contributing factor in this accident.
However it was noted that almost all of the so called ”full use helicopter” missions planned by Elf Petroland were using the total available duty time. This was also the case in the accident flight. It should be realised that this way of planning may result in a wrong sense of urgency by the crew at the end of a mission which could be detrimental to a safe conduct of the flight.

2.5 Survivability

The helicopter hit the water unexpectedly. It is therefore doubtful if in this case – even if the Floats Armed switch had been in the ”armed” position – the crew would have come to the point to activate the floats. It is therefore understandable that the system was not used.

Most probably the tail hit the water first almost immediately followed by a roll over right to an inverted position. Due to the broken front window the interior compartment rapidly filled with water. Crew and passengers were nevertheless able to escape from the helicopter. Some passengers did mention that their HUET training had been a great help.

It is understandable that the helirafts were not used, given the time available and the necessary and rather cumbersome actions required to get the life-rafts outside the helicopter.
It should be noted however that the two available rafts are both on the same (right-hand) side of the helicopter which does not seem the most optimum solution.

After the evacuation all occupants successfully inflated their lifevests and up to this point the accident was survivable.

A whole range of potential factors did further affect the survivability. It is unrealistic to assume that any prediction of survival times can be regarded as being precise and accurate. However the following aspects are of interest.

Literature studies indicate that for a group of uninjured survivors immersed in the North Sea in typical winter conditions and wearing twin-lobe lifejackets and membrane immersion suits, the first individuals will probably begin to succumb within a time range defined by the first few minutes of immersion to half an hour later. Survival estimates which are significantly above this time range for similar conditions probably include an unjustified degree of optimism.

It is therefore important to realise that for a great part of the continental shelf and with the present organizational set-up, rescue times of approximately one hour – which was the case in this accident – are most probably more rule than exception.

In view of the above every effort should be made to shorten the time of immersion in the water. In this respect it is of utmost importance that clear and unambiguous command relationships are established and that all parties involved in a SAR action have full knowledge of the availability and possible use of all survival assets in the area.

In this case greater awareness of the existence and use of available survival assets could have shortened the time of immersion in the water and better knowledge and use of the available personal survival equipment could have decreased the amount of body cooling.

3 CONCLUSIONS

3.1 The crewmembers were properly licensed and qualified to conduct the flight;

3.2 The aircraft had been maintained in accordance with an RLD approved maintenance schedule;

3.3 The aircraft was fully serviceable prior to the accident flight. Mass and Centre of Gravity were within the prescribed limits;

3.4 No evidence was found that would suggest a technical malfunction as a cause for the accident;

3.5 During the first approach to platform L7-A the Co-Pilot as Pilot Flying judged the helicopter on short final to be too high and too fast and initiated a go-around;

3.6 On final for the second approach the Co-Pilot again had the impression that the helicopter was too high and too fast. The Captain convinced her to continue the approach. It is very likely that in this situation the Co-Pilot overreacted and applied a large power reduction, resulting in a high rate of descent;

3.7 The onset of the high rate of descent most probably went unnoticed due to the lack of an IVSI and the counter balancing g-force from the turn and the pitch up;

3.8 When both pilots realised this situation it was too late and the application of collective power could not any more prevent the helicopter hitting the water;

3.9 Time of day, weather conditions combined with the platform lighting made the judgement of range and descent angle difficult. Wrong wind information may have led to some confusion;

3.10 KLM ERA Operations Manuals did not cover night visual rig approaches, especially with respect to the problems associated with the so-called single light source phenomenon;

3.11 There is no description of a standard straight-in approach including height bug settings and mandatory height calls;

3.12 Because of the left hand pattern after the go-around only the Captain (who was PNF occupying the left seat) could and had to keep visual contact with the platform to coach the Co-Pilot to a position where she could visually pick-up the platform. This may have contributed to his insufficient flight-path monitoring;

3.13 The barometric altitude alert system fitted in the KLM ERA Sikorsky S-76 B helicopters is not suitable as a warning system during approach and landing operations. The provision of an Automatic Voice Alerting Device could most likely have warned the crew in time to take corrective action;

3.14 The platform was not equipped with a visual approach aid. By providing a standardised approach the provision of a flight path guidance system would have made the occurrence of the accident less likely;

3.15 The Captain showed that he was insufficiently aware of the fact that the Co-Pilot felt uncomfortable during the execution of night approaches. The Co-Pilot failed to inform the Captain in a positive way about this fact. It is likely that the lack of formal CRM training by the crew contributed to this aspect;

3.16 The lack of Flight Data Recorder information hampered the capacity of the investigation to define either the sequence of events, or possible failures. Had the accident been fatal for the flight crew this lack of FDR data would have made the determination of the cause unlikely;

3.17 The helicopter hit the water unexpectedly, rolled over right to an inverted position and rapidly filled with seawater. Crew and passengers nevertheless were able to evacuate the helicopter uninjured and up to this point the accident was survivable;

3.18 Because of the unexpectedness of the crash and the inverted position of the helicopter shortly thereafter it was not any more possible to use the helicopter floats and very difficult if not impossible to free the liferafts. As a result the survivors had to stay immersed in seawater till they were picked-up by rescue units, which took approximately one hour;

3.19 The deceased passenger died from hypothermia and drowning;

3.20 It is likely that a more efficient use of the available rescue assets could have shortened the time of immersion in the seawater;

3.21 Proper use of all personal survival equipment i.e. hoods and gloves could have decreased the degree of body cooling.

4 PROBABLE CAUSE

The accident most probably was initiated by a large power reduction during the turn to final to platform L7-A thereby creating the onset for a high rate of descent, which went unnoticed by the crew.

When the crew realised the situation, the application of collective power reduced the sink rate but came too late to prevent the helicopter hitting the water.

5 RECOMMENDATIONS

It is recommended that:

6.1 The RLD should require that helicopters operated in the Public Transport category (Passenger) are equipped with flight data recorders;

6.2 The RLD should consider the feasibility for an approach guidance system for use on platform and rig helidecks and if not feasible reconsider the minimum requirements for helideck markings for use as visual cues;

6.3 The RLD should require that helicopters operated off-shore in the Public Transport category are equipped with an Automatic Voice Alerting Device. In the mean time an IVSI should be a minimum requirement;

6.4 The RLD should require that helicopter operating companies introduce CRM training to form an integral part of crew training. This is especially important when within the pilot community there is a great difference between background and experience between individual pilots;

6.5 The RLD should require that helicopter operating companies especially those operating in the off-shore will cover in their Operating Manuals, the different aspects of night flying in general and standard night visual approach procedures in particular;

6.6 The RLD, in conjunction with helicopter operating companies, should consider the requirement for an automatic emergency floatation system;

6.7 Helicopter operating companies, especially those operating offshore, should review stowage of on board life-rafts in order to improve accessibility and deployment;

6.8 Offshore mining companies should require that all passengers regularly being heli-transported offshore should follow the HUET training. In addition special briefings should stress the dangers of hypothermia and the necessity for correct and full use of personal survival equipment;

6.9 The Dutch State Supervision of Mines in conjunction with the Coast Guard should review existing plans and procedures with regard to the organisation, availability and use of rescue assets in order to minimise the immersion time of survivors in the seawater after a crash on the continental shelf.

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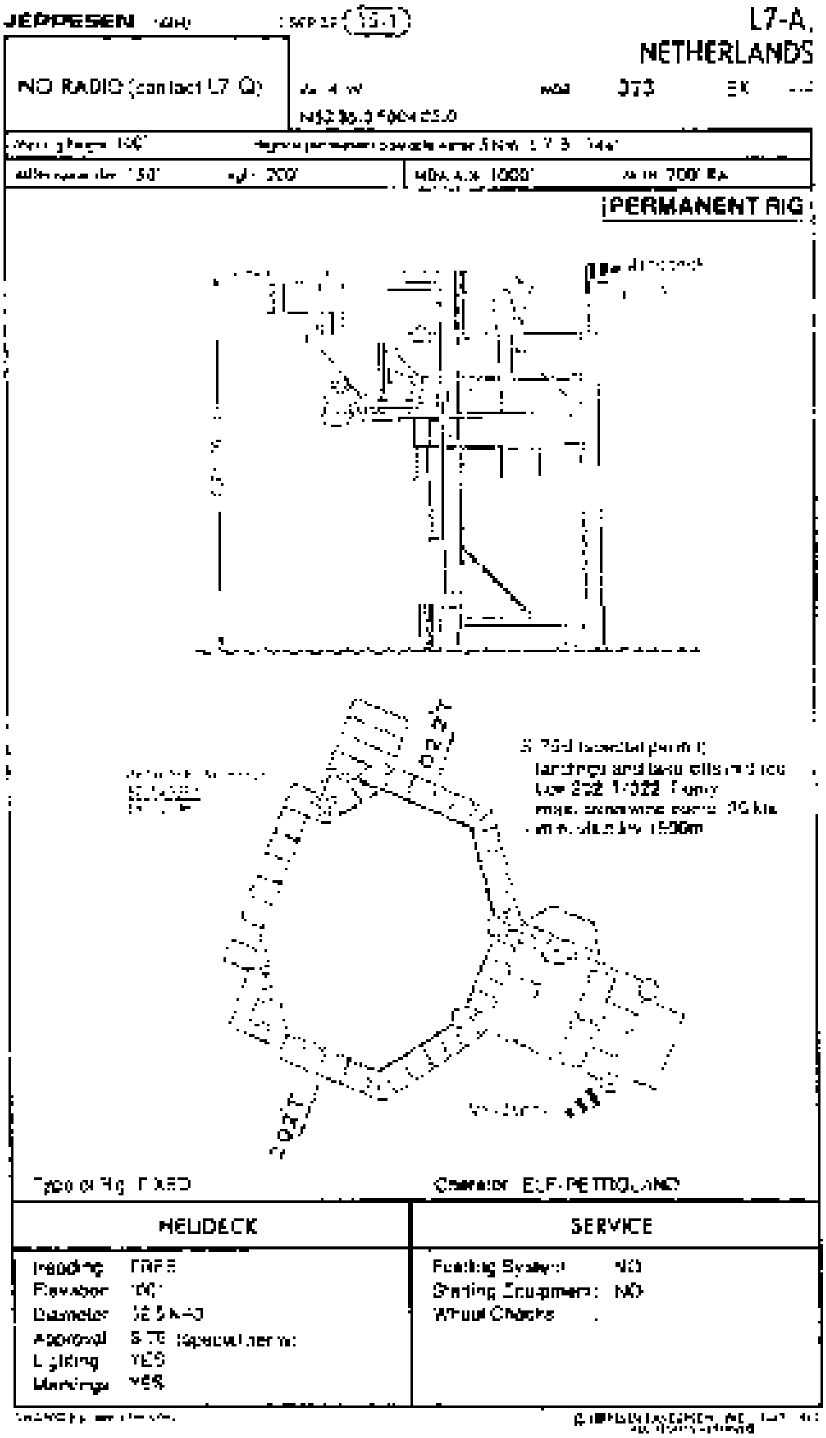
APPENDIX A

Photograph and Aerodrome plate platform L7-A

Photograph platform L7-A

Aerodrome plate L7-A



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APPENDIX B

Route PH-KHB during last shuttle flight

Route PH-KHB during last shuttle flight