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Sikorsky S-76B Strikes Water During Approach to North Sea Oil and Natural Gas Production Platform

The flight crew was conducting a go-around in dark-night conditions and did not observe the high rate of descent that followed a large power reduction during the turn to final approach. The crew's application of collective to reduce the sink rate came too late to prevent the helicopter from striking the water.

FSF Editorial Staff

At 1729 local time Dec. 20, 1997, a Sikorsky S-76B helicopter operated by KLM ERA Helicopters struck the water while on final approach to an oil and natural gas production platform in the North Sea. The two crewmembers and six passengers evacuated the helicopter, which sank; one passenger died after being rescued from the water.

The Dutch Transport Safety Board said in its final report that the probable cause of the accident was the "large power reduction during the turn to final [approach] to platform L7-A." The power reduction resulted in a high rate of descent, "which went unnoticed by the crew," the report said.

"When the crew realized the situation, the application of collective … reduced the sink rate but … too late to prevent the helicopter [from] hitting the water," the report said.

The day of the accident, the flight crew began work at 0645 and was scheduled for a 12-hour shift during which five series of shuttle flights were to be flown to landing sites on oil and natural gas production platforms and drilling rigs in the North Sea. [Production platforms and drilling rigs are structures used in offshore oil and natural gas exploration and production. The primary difference between them is that production platforms are permanent, stationary structures, and drilling rigs float and can be moved to new locations.] The captain flew the helicopter on the first three series of flights; then the captain traded seats with the first officer to allow her to fly the helicopter from the right seat. (Standard company practice was for the pilot flying [PF] to occupy the right seat.)

The fifth series of flights began with takeoff from platform L7-Q at 1650, after sunset, in dark-night conditions, with neither the moon nor the stars visible. Visibility was three nautical miles (six kilometers) and increasing; scattered clouds were reported at 400 feet and 500 feet, with an overcast cloud base at 2,000 feet. The temperature was 5 degrees Celsius (C; 41 degrees Fahrenheit [F]), and the water temperature was 7 degrees C (45 degrees F). Although the first officer was flying the helicopter, the captain conducted the first landing because of obstacles on the first officer's side of the helicopter.

The cockpit voice recorder (CVR) showed that, at the second landing site, a drilling rig with a lighted vertical structure, the first officer said that the landing — her first night landing during the shift — was "rather difficult, with almost no wind."

The report said, "The CVR also showed that she used more than normal power changes during the last part of the final approach."

Six passengers boarded the helicopter for the flight from the drilling rig to L7-A, a production platform with no superstructure. The helideck at platform L7-A had an elevation of 100 feet. The landing area was marked with yellow lights; there was no visual landing aid. The radio operator on platform L7-Q told the flight crew that wind in the area was from 180 degrees, but the crew conducted the approach and landing based on the helicopter's flight-management-system wind information, which indicated that the wind was from the east.

About two nautical miles (four kilometers) from the platform, the radio altimeter indicated that the helicopter was at 200 feet, and the indicated airspeed (IAS) was 70 knots. The first officer disengaged the flight director and then, "just before decision point, normally 50 feet above the elevation of the helideck with an IAS of 30 knots, the [first officer] initiated a go-around because she considered the helicopter too high and too fast," the report said.

"After the call 'go-around,' the [first officer] increased collective, continued straight ahead and started the climb. Eleven seconds after the call 'go-around,' the [captain] advised the [first officer] to turn," the report said.

The first officer initiated a climbing left turn, engaged the flight director and — after the captain said, "OK, stay at this altitude, not any higher" — leveled the helicopter and pressed "ALT HOLD" on the flight director control panel. The landing gear was not retracted.

"The [first officer] made a left-hand circuit, coached by the [captain], who had visual contact with L7-A," the report said. "At 1727, the flight crew started the approach to L7-A for the second time. The helicopter turned to final, and at that moment, the [first officer regained] visual [contact] with L7-A. Once again, she indicated she was unhappy with the situation, but the [captain] convinced her to continue. In this turn, at approximately half a nautical mile [0.9 kilometer] out, the [first officer] decoupled the flight director to be able to decelerate faster than the use of the flight director system permitted. Shortly thereafter, the [first officer] said, 'No, this is also not going to work, because we are much too high and much too fast.' The [captain] said he judged the situation normal and convinced her to continue, after which the [first officer] lowered the collective pitch lever and at the same time raised the nose of the helicopter. The [captain] called, 'The gear is down and I have 60 knots,' and four seconds later, '100 [feet], not lower.'"

When the first officer observed that the barometric (pressure) altimeter indicated that the helicopter was at 100 feet, she applied "a large amount of power by raising the collective pitch lever." The captain observed a reading of 50 feet on his radio altimeter and also raised the collective pitch lever.

"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 report said. "The impact took place at 1729."

After striking the water, the helicopter rolled right until it reached an inverted position and filled with water, which poured through a broken window in the right front door. Neither of the two life rafts on the helicopter was launched. Passengers and crew climbed onto the helicopter's lower fuselage and inflated their life vests; the captain also activated his search-and-rescue beacon (SARBE). About 10 minutes after striking the water, the helicopter began to sink and was abandoned.

"The group stayed together in the water with one passenger, who showed signs of fading away, in [the] middle [of the group]," the report said. "All occupants were wearing helicopter transportation suits, which eventually … 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."

At 1730, one minute after the helicopter struck the water, personnel on platform L7-A told the radio operator on L7-Q about the accident. The radio operator called for help from crews of two helicopters (Schreiner 4 and Schreiner 6) operated by another helicopter company (Schreiner Northsea Helicopters), two supply vessels in the area and the Dutch Coast Guard, which assigned two more helicopters to the search-and-rescue effort. The Schreiner helicopters were not equipped to receive the SARBE signal, but the Schreiner 4 crew observed life-vest lights at 1736. One of the supply vessels arrived at the accident site at 1806, and at 1830, the captain of the supply vessel told the L7-Q radio operator that all of the helicopter's occupants were aboard and that one of the passengers was unconscious. A physician, who was flown to the supply vessel by a Coast Guard helicopter, performed cardio-pulmonary resuscitation (CPR) on the unconscious passenger beginning at 1845.

The report said that at 1858, "L7-Q was informed that the [CPR] had not been successful." An autopsy showed that the passenger had died of hypothermia and drowning.

Platform L7-A had an inflatable "man-overboard" boat that carried three people to four people and a lifeboat that carried 13 people. After observing the accident, a worker on the platform was unable to start the engine on either rescue boat. The report said that after the Schreiner 4 helicopter returned from the accident site, two Schreiner 4 passengers disembarked and started the lifeboat's engine at 1750.

"After informing the radio operator of L7-Q [that the engine had been started], they were informed — on behalf of the installation supervisor — to stay on board the L7-A since the [first supply vessel] was expected to arrive at the scene … within 10 minutes," the report said.

The 55-year-old captain had an airline transport pilot license and had accumulated 12,407 helicopter flight hours, including 2,629 flight hours in S-76Bs. He was KLM ERA's chief pilot and had been employed by the company since December 1975.

Before that, he was a helicopter pilot in the Royal Netherlands Air Force.

The 32-year-old first officer held a commercial pilot license and had accumulated 796 helicopter flight hours, including 514 flight hours in S-76Bs. She was hired by KLM ERA in December 1995 and began helicopter training in February 1996 in the United States. She began flying offshore in January 1997 and became senior copilot in November 1997.

The helicopter was manufactured in 1988 and was maintained by KLM ERA's maintenance organization — a Joint Aviation Regulations (JARs)-145-approved maintenance organization. The maintenance schedule was approved by the Dutch Civil Aviation Authority (CAA). The 25-hour inspection, 50-hour inspection, 100-hour inspection and 500-hour inspection were completed Dec. 11, 1997, and records showed that the helicopter was serviceable when the accident flight began. Weight and center of gravity were within limits during the accident flight.

The helicopter was not equipped with a flight data recorder; one was not required. Analysis of the CVR recording revealed that the engine drive-shaft frequency and the rotor-shaft gear frequency were heard until the impact.

"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," the report said.

An inspection conducted after the helicopter was salvaged revealed that the flight controls could be moved without restriction through their full range of movement, that there was no visible contamination of hydraulic fluid and that the engines were undamaged (except for corrosion caused by salt water). Tests of the contents of the fuel tank on platform L7-Q, which had been used to refuel the helicopter, showed that the fuel was within the Jet A1 specifications, the report said.

Inspection of the subscales of the pressure altimeters revealed that the reading was about 80 feet higher on the first officer's pressure altimeter than on the captain's pressure altimeter. The captain said that he had adjusted his pressure altimeter subscale to conform to the reading of his radio altimeter, but he had not informed the first officer.

The radio altimeter was equipped with a decision height (DH) "bug" and a yellow caution light that illuminated when the helicopter descended to or below the altitude selected with the DH bug. The DH bug for the first officer was set to 260 feet, 60 feet higher than the captain's DH bug setting.

The helicopter also was equipped with a height-alert system, which was incorporated into the electronic attitude-direction indicator and which used data from the radio altimeter. Different visual warnings appeared when the helicopter descended within 100 feet of a preselected altitude, when the helicopter reached the preselected altitude and when the helicopter descended below the preselected altitude.

The accident helicopter's emergency flotation system — four pop-out floats inflated by four bottles of compressed helium — was designed to enable immediate evacuation of personnel with survival equipment after a forced water landing. The system could be activated only by the flight crew's selection of one of the floats switches, which were mounted on the cyclic levers. The floats switches were armed only when the "FLOATS ARMED" switch on the center console was selected in the "ARMED" position.

The "FLOATS ARMED" switch normally is in the "OFF" position during cruise flight to avoid accidental deployment of the floats and — during two-pilot operations — is selected, at the captain's discretion, in the "ARMED" position for over-water takeoffs and approaches. During the accident flight, the switch was in the "OFF" position.

The report said that 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 takeoffs and approaches over water."

Nevertheless, because the accident helicopter struck the water unexpectedly, the crew probably would have been unable to activate the floats, even if the "FLOATS ARMED" switch had been in the "ARMED" position, the report said.

The helicopter also was equipped with two 10-person rafts, each stored on the right side of the helicopter and each requiring that the adjacent door (either the right cockpit door or the right cabin door) be jettisoned before the raft could be launched into the water.

All six passengers wore membrane-type helicopter transportation suits. Several passengers said that, as soon as they evacuated the helicopter and were in the sea, the suits filled with water. Rescue personnel said that all of the suits contained large amounts of water and that the water slowed the boarding of the survivors onto the supply vessel. Post-accident tests of the suits revealed that neck seals and wrist seals were in "acceptable condition," but there were slight leaks in the socks. All suits had been maintained and inspected regularly; during the last inspection, all were considered serviceable.

Dutch aviation regulations allow for a maximum total duty time of 12 hours, with a maximum flight time of nine hours and a maximum of 35 landings. The duty time for the flight crew of the accident helicopter was to have totaled 12 hours; they had accumulated 2.5 hours of flight time with 18 landings. Because the flight hours and the number of landings were well below the maximum allowed, they were not considered a contributing factor to the accident, the report said.

Nevertheless, schedules planned by the oil and natural gas exploration and production company for almost all helicopter operations used all available duty time; the report said that "this way of planning may result in a wrong sense of urgency by the crew at the end of a mission [and] could be detrimental to a safe conduct of the flight." (In Norway and the United Kingdom, where similar offshore helicopter operations are conducted, maximum allowable duty times were 11 hours.)

The report said that the absence of information from a flight data recorder "severely hampered the capability of the investigation to define either the sequence of events or possible failures." Nevertheless, the investigation revealed no technical malfunction of the helicopter that could have caused the accident.

The report said that, when flown at slow speeds — and especially during deceleration — S-76Bs have a "pronounced nose-up attitude."

"This, together with a fairly high instrument glareshield, 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," the report said.

Although night approaches to helidecks require "a very high degree of precision" (largely because platforms may be the only source of light and because pilots are without the visual cues available during daytime approaches — a factor that complicates judgment of range and descent angle), KLM ERA operating manuals did not discuss procedures for visual approaches at night and did not describe standard straight-in approaches. Night helideck approaches should be standardized, the report said.

The first officer had difficulty with her first night landing that evening, conducted on a drilling rig with a well-lighted superstructure. She then flew the helicopter to the L7-A production platform, which had no superstructure and where yellow lights in the landing area were the only visual reference. The platform had no visual approach aid.

"[This was] an ideal situation to experience all the difficulties related to the so-called single-light-source phenomenon," the report said. [Single-light-source phenomenon, or autokinesis, occurs in darkness when there is a single source of light and the visual cues that are present in daylight are nonexistent. If an individual stares at the light for more than a few seconds, the light appears to move.]

"The fact that there was almost no head wind made the landing maneuver even more difficult," the report said. "Furthermore, the wrong wind information reported by L7-Q may have resulted in some confusion with a negative influence on the flight performance."

During the go-around, the first officer lost visual contact with the platform and followed the captain's instructions to position the helicopter for the second approach.

"The time between the initiation of the go-around and the moment the helicopter struck the water was approximately two minutes and 13 seconds," the report said. "A normal-rate … 360[-degree turn] would have taken two minutes. It is therefore reasonable to assume that the set-up for the second approach was very tight and that the [first officer] 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, 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 descent was not directly shown. … 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."

The captain did not make a "sink-rate call," although the helicopter had an average rate of descent before impact of 1,131 feet per minute (fpm). The aircraft operating manual says that the pilot not flying (PNF) "shall call 'sink rate' when [the] rate of descent below 500 feet exceeds 500 fpm."

The report said that KLM ERA S-76B helicopters were not equipped with an automatic voice-alerting device that would have alerted the crew to an inadvertent descent or to arrival at a specific altitude.

Analysis of the CVR transcript revealed that during the accident flight, CRM was "not used in an optimal way," the report said.

"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 [first officer] (PF) where to go or what to do," the report said. "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 [first officer] had to work faster than her experience would justify."

The report said that the captain should have observed — because of her comment about the "rather difficult" landing and because of her handling of the helicopter during that approach, with more than the typical number of power changes — that the first officer found her first night landing that evening to be difficult.

"Also, the go-around after the first approach to L7-A should have been an indication that the [first officer] had difficulties with landing the helicopter under the prevailing conditions," the report said. "By coaching the [first officer] into a very tight go-around pattern, the captain showed that he was insufficiently aware of this situation. On the other hand, the [first officer] — 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."

During most of the go-around, only the captain had visual contact with the platform, and he instructed the first officer on how to maneuver the helicopter for the next approach.

"This most probably [occurred] at the expense of his flight path-monitoring duties," the report said. "When he called '100 feet, not lower,' he had not realized that the helicopter had developed an excessive descent rate."

The report said the shortage of time and the complicated actions required to deploy the helicopter life rafts made it understandable that the life rafts were not used. Nevertheless, the report said that storing both life rafts on the same side of the helicopter "does not seem the most optimum solution."

Some passengers told investigators that their helicopter-underwater training had helped them in evacuating the helicopter. After evacuation, all helicopter occupants inflated their life vests, and the report said that, "to this point, the accident was survivable."

Nevertheless, other factors affected survivability after that point, the report said.

"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 … the first few minutes of immersion to half an hour later," the report said. "Survival estimates [that] are significantly above this time range for similar conditions probably include an unjustified degree of optimism."

The report said, however, that rescue times of one hour probably are typical.

"Every effort should be made to shorten the time of immersion in the water," the report said. "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."

In this accident, proper use of all personal survival equipment, including hoods and gloves, "could have decreased the degree of body-cooling," the report said.

The report recommended the following:

- The Dutch CAA should require public transport category helicopters to be equipped with flight data recorders;
- The CAA should "consider the feasibility for an approach guidance system for use of platform [helidecks] and rig helidecks and, if not feasible, reconsider the minimum requirements for helideck markings for use as visual cues";
- The CAA should require public transport category helicopters operated offshore to be equipped with an automatic voice-alerting device. Until that requirement can be implemented, an instantaneous vertical speed indicator should be a minimum requirement;
- The CAA should consider requiring helicopter operators to introduce CRM training. Such training is "especially important when, within the pilot community, there is a great difference [in] background and experience between individual pilots";
- The CAA should require helicopter operators, especially those whose helicopters are flown in offshore operations, to include in their operating manuals a discussion of night flying and standard night visual approach procedures;
- The CAA and helicopter operators should consider requiring helicopters to be equipped with automatic emergency-flotation systems;
- Helicopter operators, especially those whose helicopters are flown offshore, should review the stowage of on-board life rafts to "improve accessibility and deployment";
- Offshore mining companies should "require that all passengers regularly being heli-transported offshore should [receive helicopter underwater] training. In addition, special briefings should stress the dangers of hypothermia and the necessity for correct and full use of personal survival equipment"; and,
- The Dutch State Supervision of Mines and the Coast Guard should "review existing plans and procedures with regard to the organization, availability and use of rescue assets in order to minimize the immersion time of survivors in the seawater after a crash on the continental shelf."

In response, the CAA said that:

- Since April 1, 2000, Joint Aviation Requirements — Operations 3 (JAR-OPS 3), *Commercial Air Transportation (Helicopters)*, has required commercial air transport helicopters manufactured after Jan. 1, 1989, to be equipped with flight data recorders;

- The European Joint Aviation Authorities (JAA) helicopter operations and technical working group was considering the requirement for approach-slope indicators on helidecks, as well as related issues involving lighting of offshore installations to improve night visual references for helicopter crews;

- Since April 1, 2000, JAR-OPS 3 has required automatic voice-alerting devices on offshore commercial air transport helicopters. Dutch offshore helicopter operators also use instantaneous vertical speed indicators, and Dutch officials have introduced the subject for discussion by a JAA working group;

- CRM is required by JAR-OPS 3;

- Helicopter operators now are required to include in their operating manuals a discussion of night flying and standard night visual approach procedures;

- A requirement for fully automatic flotation equipment is under consideration, but some Dutch officials have said that they are concerned about risks that the equipment might be activated during flight;

- S-76B helicopters used in offshore operations in the Netherlands have a different life-raft configuration than the configuration on the accident helicopter;

- Helicopter underwater training and special briefings now are required for regular passengers on offshore helicopters; and,

- Search-and-rescue requirements in the Netherlands conform to recommendations of International Civil Aviation Organization Annex 12, *Search and Rescue*. In 2000, oil-producing companies, natural gas-producing companies and the Dutch Coast Guard conducted their first annual an emergency-response exercise. A new type of immersion suit has been introduced with an improved neck seal, and some oil-producing companies and natural gas-producing companies now require additional thermal layers to be worn under the immersion suit.[1]♦

Note

1. Schaap, Christiaan, Unit Strategy and Administration, Civil Aviation Authority of the Netherlands. E-mail communication with Werfelman, Linda. Alexandria, Virginia, U.S. Jan. 8, 2002. Flight Safety Foundation, Alexandria, Virginia, U.S.

[FSF editorial note: This article, except where specifically noted, is based on Dutch Transport Safety Board *Final Report 97-74/A-25, PH-KHB, Sikorsky S-76B, 20 December 1997, near Den Helder*. The 40-page report contains a photograph, diagrams and an appendix.]