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Ship's Changing Heading Cited in AS 332's Rollover on Helideck

The final report by the U.K. Air Accidents Investigation Branch said that as the ship drifted, the helicopter was subjected to an increasing crosswind component, which — combined with factors such as the lifting force generated by the main rotor and the natural movements of the ship — forced the helicopter onto its side.

FSF Editorial Staff

At 1254 local time Nov. 10, 2001, a Eurocopter (formerly Aerospatiale) AS 332L Super Puma rolled onto its right side during refueling with the rotors operating on the helideck of a drilling ship in the North Sea, about 80 nautical miles (148 kilometers) west of Scotland's Shetland Islands. The helicopter was damaged substantially. The copilot, who was outside the helicopter on the helideck, was seriously injured by flying debris. The pilot was not injured.

The U.K. Air Accidents Investigation Branch (AAIB), in its final report, said that the following were causal factors:

- "Unknown to the crew on the bridge, the ship's dynamic positioning [DP] system[1] reverted to manual heading control, and the ship's heading began to drift to the right;
- "The increased lateral wind component, to which the helicopter was consequently subjected, generated increasing aerodynamic forces to the right due to the change in the relative wind, and these forces provided the most significant toppling moments of all the forces acting on the helicopter;
- "The 'static' roll attitude of the helicopter adopted after landing, relative to the helideck, of 2.5 degrees to the right — together with the lift force generated by the main rotor in the prevailing wind, the one-degree list of the ship to the right at the time of the accident and the natural motion of the ship — contributed to the destabilization of the helicopter; [and,]
- "The lack of procedures on the ship to transmit the change in the alert status to the crew of the helicopter and of any specified procedure available to flight crews concerning action to be taken if control of the ship is lost or degraded while on the helideck, denied the pilot an appropriate course of action to ensure the safety of the helicopter."

The helicopter pilot held an air transport pilot license (helicopters), an instrument rating and a Class 1 medical certificate with no limitations valid until May 14, 2002. He had about 7,800 flight hours, including 1,800 flight hours in type.

The copilot held a commercial pilot license, an instrument rating and a class 1 medical certificate with no limitations valid until May 31, 2002. He had 1,080 flight hours, including 352 flight hours in type.

The helicopter, which was manufactured in 1983 and had 21,022 airframe hours, was owned by Heliworld Leasing, operated by CHC Scotia Helicopters and had a public transport (passenger) airworthiness certificate valid until March 13, 2003.

The AS 332L flight manual does not establish crosswind limits for a helicopter on the ground with the rotors operating. The manual says that in hover flight, the limit is 35 knots "when the wind is aft of 60 degrees right or left of the nose."

The operator's operations manual discusses procedures for helideck operations, including a requirement on the "After Landing" checklist for the autopilot to be disengaged and a statement that,

while operating on a helideck, the pilot "must physically monitor the controls at all times and [must] maintain the cyclic and yaw pedals in a central position."

The report said, "The autopilot is disengaged to prevent it from applying cyclic [control] or yaw control to counter deck movement, and the cyclic should remain neutral for several reasons. Firstly, any movement of the rotor disc from a position horizontal to the helideck has fatigue implications for the main-rotor mast. Secondly, and more importantly, if the main rotor tips, it can become a hazard to passengers and crew on the helideck. Finally, if the pilot tries to 'fly' the rotor disc to counter ship movement and subsequently needs to apply collective control quickly for an emergency liftoff, there is a risk of dynamic rollover."[2]

The operations manual also says that helicopter captains should ensure that when a helicopter is on a helideck with the rotors operating, one pilot should be "looking out at all times, so that the HLO [helideck landing officer] can attract the attention of the pilot in the cockpit and that any helicopter movement may be perceived and corrected immediately." (The report said that "movement" referred to sliding of the helicopter on the helideck and was "not intended to imply that the pilot should use the flight controls to keep the helicopter in position on the deck.")

The report said that this requirement "ensures that much of the pilot's attention is focused outside the cockpit [while] the helicopter is on deck. Inside the cockpit, it might normally be expected that the compass should indicate a change of heading and alert the pilot, in this case, to a change in the ship's heading. However, prior to landing on an offshore installation or vessel, the helicopter gyrocompass is selected to 'DIRECT GYRO' (DG or free) mode, as opposed to 'SLAVED' (magnetic) mode. This is to prevent the mass of steel of the installation structure from inducing a deviation error on the compass reading."

Therefore, when a compass is in the DG mode, the heading indication is not necessarily accurate.

The forecast weather for the northern North Sea below 500 feet at the time of the accident included wind from 260 degrees at 35 knots to 40 knots. An aftercast for the time of the accident included wind from 270 degrees at 32 knots to 42 knots. The aftercast also said that determining wind gusts aboard a ship is difficult because wind typically gusts around some parts of the structure differently than others; the upper estimate of 42 knots was intended as an indication of what type of wind movement was possible in the air mass at that time. Wind information from the ship indicated that wind direction averaged 270 degrees when the helicopter was landed and was 260 degrees when the accident occurred; wind speed averaged 26 knots, with no information on gusts.

The West Navion, the ship on which the accident occurred, is a drilling vessel that operates in deep waters without anchors. The ship was inspected by the British Helicopter Advisory Board (a trade association for the civilian helicopter industry) on March 22, 2001, and its helicopter landing area certificate was valid until March 21, 2004.

The West Navion is classified as a Code C large ship; the report said, therefore, that the movements of the AS 332L were "limited to 2.5 degrees of helideck movement either side of the pitch and roll axes and four meters [13 feet] of heave in the vertical axis."

The computer-controlled DP system maintained the West Navion's position over the drilling-well head on the ocean floor. The DP system used information from navigation satellites and seabed transponders to determine the ship's position, taking into account the prevailing current and the prevailing wind, and used electrically powered thrusters to maintain the ship's station (its precise orientation over the drilling-well head).

"In 'AUTOMATIC' mode [the most frequently used mode], the DP system gives the operator a warning if the ship's heading deviates more than plus or minus two degrees and an alarm when it deviates by more than plus or minus three degrees," the report said. "In 'MANUAL' mode, no warnings are given and the only indication to the DP operator that the system is operating in 'MANUAL' mode is the absence of a heading window on one of his DP screens. The 'out of position' alarm that eventually alerted the DP operator to a problem on this occasion, is set to provide [a] warning that the vessel has moved off station to the point where there is a risk of problems with the drilling riser,[3] the connection from the wellhead to the vessel. The operation of the DP system is monitored by a DP operator."

If a DP system failure results in a loss of heading, a "timely disconnect from the riser" must be made to ensure that the ship is not damaged. (In this event, the disconnect was conducted about five minutes after the helicopter rollover.)

At the time of the accident, the U.K. Offshore Operators Association (U.K. OOA), in its *Guidelines for the Management of Offshore Helideck Operations*, said that offshore operations "should have a procedure whereby any helicopter on deck is informed of any change in installation alert status," such as a gas leak, which might result in orders for the helicopter crew to conduct a takeoff or to shut down the engines. At the time of the accident, the West Navion did not include this emergency procedure in its helicopter procedures document.[4]

The day of the accident, the crew flew the helicopter from Aberdeen, Scotland, to Wick, and then to the West Navion to transport 12 crewmembers to the ship. The helicopter was landed on the ship at 1242 on a magnetic heading of about 296 degrees; the true heading was 289 degrees. The surface wind was from 285 degrees (true) at 34 knots; the ship's heading was 259 degrees true. The report said that helideck movements were within the helicopter's limits.

"It was standard procedure to carry out passenger disembarkation/embarkation and refueling with the helicopter rotors running," the report said. "The helicopter crew therefore carried out the 'After Landing' checklist, which included disengaging the autopilot. The passengers commenced disembarkation, and the copilot left the cockpit to assist the ship's helideck crew with the refueling. The commander [captain] remained on board the helicopter. At

about 1245, the commander became concerned about the ship's movement and requested the pitch, roll and heave readings from the ship's radio operator. After some confusion over exactly what the commander had requested, the radio operator provided the readings, all of which were within the helicopter's operating limits. Nevertheless, the commander remarked that his flight instruments appeared to be showing greater movements than those recorded by the ship. Some time later, the helideck crew noticed a shift in the direction of the wind."

At 1247, the West Navion's DP system switched to "MANUAL" heading control, and about two minutes later, the ship's heading began drifting to the right.

"No external visual cues, such as land or a stationary ship, were available to draw the pilot's attention to this change of heading, and the windsock, which would have been indicating the change in the relative wind, was not within the commander's field of vision," the report said.

At 1254:14, the DP system sounded an alarm that the ship's position was out of limits.

"The crew responded to this alarm in accordance with their procedures and training, but the helicopter commander was not informed," the report said. "Twelve seconds later, at 1254:26, the helicopter toppled over to the right."

By then, refueling had been completed, and the copilot, who had checked that the fuel cap was secure and was conducting a visual inspection of the aircraft, was the only person outside the helicopter on the helideck.

"He noticed out of his peripheral vision the tail rotor starting to move towards him," the report said. "He threw himself on the deck and began crawling towards a gangway that connected the helideck with the upper bridge … . As he crawled, he became aware of the main-rotor blades striking the deck, the engines screaming and the deck vibrating, and [became aware] of high-velocity flying debris. At some point, he felt a heavy immobilizing blow to his left leg."

The captain observed an indication of five degrees right bank on the helicopter attitude indicator before the helicopter rolled onto its right side. The report said that the captain, lying on his right side, was unable to reach the "general cut-out handle" above his left shoulder to shut down the helicopter's engines and systems. As fire fighting foam began entering the cockpit, he operated the two fuel-shut-off levers on the overhead panel and vacated the helicopter.

A separate investigation of the DP system failure and a similar failure Nov. 10, 2001, did not determine the cause of the system failure. Nevertheless, a report on that investigation said that "if the DP incident is in any way a contributory cause in the air accident, then it is reasonable to suggest that preventative actions taken post 12 October to prevent the heading-loss incident may have prevented the air accident."

The AAIB report said that after the October incident, "actions had been identified" for changes on the West Navion, including installation of a new switch to "prevent inadvertent mode changes of the DP system." The switch had not been installed when the AS 332L accident occurred.

The investigation revealed that there was no problem with the helicopter that caused or contributed to the accident and that weather conditions were "demanding but within specified operating limits," the report said.

"The helicopter toppled over 12 seconds after the DP system warning, after the ship had yawed through some 35 degrees to the right," the report said. "As far as could be determined, [while] the helicopter was on deck, the West Navion's pitch [excursions] and roll excursions remained within IVLL [installation/vessel limitations list, now known as the helicopter limitations list (HLL); the IVLL/HLL categorizes helidecks according to their likely movement characteristics and provides pitch limits, roll limits and heave limits for helicopter types likely to be operating there] limits for the AS 332L. Mathematical analysis of the forces acting on the helicopter indicates that the most significant toppling moments were caused by the aerodynamic forces arising from the increasing lateral wind component to which the aircraft was subjected as the ship yawed to the right."

IVLL limits are not derived scientifically and are determined without considering wind, rates of movement or accelerations. The U.K. Civil Aviation Authority (CAA) is conducting research to measure the severity of helideck motion, which may result in creation of a motion severity index to be used instead of IVLL limitations. The report said that the main-rotor thrust that developed at the minimum pitch on ground position contributed to the helicopter destabilization.

As a result of the investigation, AAIB made the following safety recommendations to CAA:

- "The CAA should require operators conducting offshore operations to publish crosswind limitations for helicopters when operating to, and when positioned on, helidecks, incorporating these limits into their company operations manuals."

  In response, CAA said that information would be published informing offshore operators of "the need to publish crosswind limitations for helicopters when operating to and when positioned on helidecks, and [the need to incorporate] these limits into their company operations manuals"[5]; and,

- "The CAA [should] require offshore operators to review their landing procedures such that, after landing on moving helidecks, the helicopter's roll attitude, relative to the helideck, is neutral."

  In response, CAA said that offshore operators would be required to "review their landing procedures such that, after landing on moving helidecks, the helicopter's roll attitude, relative to the helideck, is neutral."[6]

AAIB made the following safety recommendations to the U.K. OOA:

- "The U.K. OOA [should] revise their guidelines for the management of offshore helideck operations to include a requirement for significant changes in environmental conditions, particularly wind speed and relative wind direction, to be communicated [to] the pilot of a helicopter when parked, with rotors turning, on a helideck"; and,
- "U.K. OOA should include in its guidelines for the management of offshore operations a requirement that, following an accident or incident (regardless of whether or not it involved a helicopter at the time), operators of vessels, mobile offshore drilling units and fixed installations should consider in their subsequent installation safety investigations the potential safety implications for helicopter operations on helidecks."

The CAA response said that U.K. OOA would convene a committee to deal with offshore matters and that both recommendations would be presented to the committee. Members of the committee were to include representatives of CAA, U.K. OOA, U.K. National Air Traffic Services (NATS) and U.K. offshore operators. Future members may include the Norwegian Civil Aviation Authority and the Norwegian Offshore Operations Association, CAA said.[7]♦

[FSF editorial note: This article, except where specifically noted, is based on the U.K. Air Accidents Investigation Branch report *No. 3/04 — Eurocopter AS 332L Super Puma, G-BKZE, near Shetland Isles*. The 35-page report contains illustrations and appendixes.]

Notes

1. A dynamic positioning system is defined by the U.K. Marine Accident Investigation Branch as a computer-controlled arrangement of propellers that allows a vessel to remain precisely over one location on the seabed.
2. Dynamic rollover is a lateral rolling tendency that begins as a helicopter pivots around its skid and progresses to the critical rollover angle beyond which recovery is impossible.
3. A riser is a large metal pipe that extends from the seabed to the floor of a ship (or some other drilling platform). The pipe is wide enough to enclose the drill pipe and the fluids used in drilling.
4. After the accident, the U.K. Offshore Operators Association guidelines were changed to add the following: "A loss of heading control … or a significant change in motion characteristics must immediately be notified to the flight crew. This change in conditions may require the flight crew to prepare for immediate liftoff if the helideck motion limits or helicopter limits of operability are likely to be exceeded."
5. U.K. Civil Aviation Authority (CAA). *Follow-up Action on Occurrence Report: Accident to AS 332l, G-BKZE, On-board West Navion Drilling Ship, 80 NM West of Shetland Islands on 10 November 2001.* F29/2004. June 18, 2004.
6. Ibid.
7. Ibid.

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Contact Ann Hill, director, membership and development,
by e-mail: hill@flightsafety.org or by telephone: +1 (703) 739-6700, ext. 105.

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