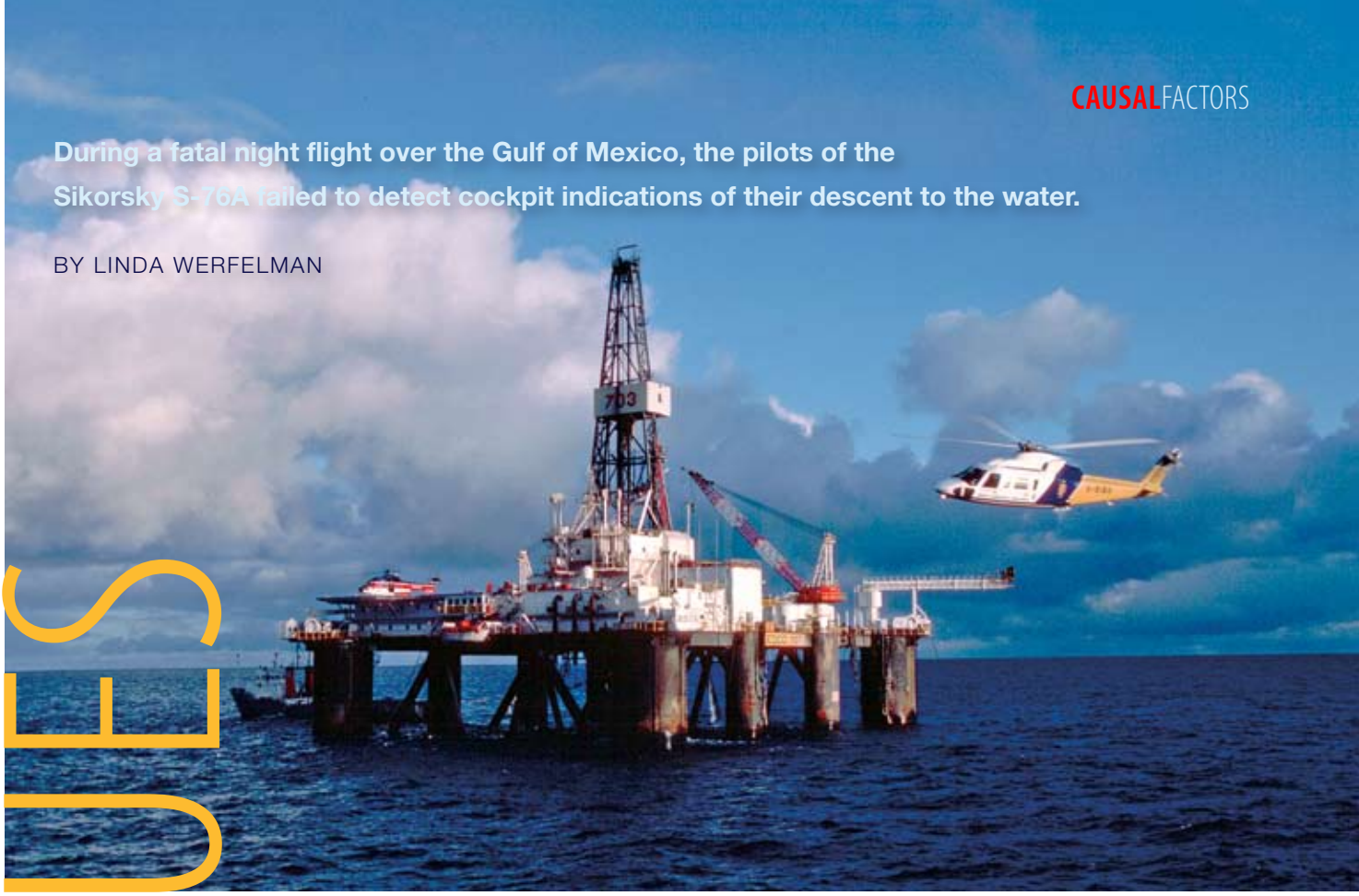
MISSED CUES

During a fatal night flight over the Gulf of Mexico, the pilots of the Sikorsky S-76A failed to detect cockpit indications of their descent to the water.

BY LINDA WERFELMAN



The flight crew of a Sikorsky S-76A failed to "identify and arrest the helicopter's descent" before it struck water in the Gulf of Mexico, killing all 10 occupants, the U.S. National Transportation Safety Board (NTSB) said in its final report on the accident.[1]

The controlled-flight-into-terrain (CFIT) accident occurred about 1918 local time March 23, 2004, in night visual meteorological conditions (VMC) about 70 nm (130 km) south-southeast of Scholes International Airport in Galveston, Texas, U.S. The Era Aviation helicopter was transporting eight service personnel to an oil-drilling ship that was en route to a location 180 nm (333 km) south-southeast of the airport. The helicopter was destroyed by impact forces.

"The helicopter crashed into the water at a high airspeed, a shallow descent angle and a near-level roll attitude," the report said. "The flight crew was not adequately monitoring the helicopter's altitude and missed numerous cues to indicate that the helicopter was inadvertently descending toward the water."

Era Aviation records showed that the S-76 departed from Galveston at 1845 for what was expected to be a 45-minute flight to an oil and gas platform where the helicopter was to be refueled before continuing the flight to the ship. Radar data showed that after takeoff, the helicopter was flown on a south-southeasterly course. The crew flew the helicopter to 1,800 ft and maintained that altitude until about 1858, when radar data showed a 300 fpm rate of descent. At 1900, radar data showed that the helicopter was about 35 nm (65 km) south-southeast of Galveston at 1,100 ft, with a 250 fpm rate of descent. No further radar returns were received because the helicopter was beyond the 60 nm (111 kilometer) radar-coverage range.

At 1914, the crew radioed a company dispatcher to make a position report, told the dispatcher that the helicopter had enough fuel to continue to the drilling ship and requested updated coordinates for the ship. There were no further communications from the crew.

At 1918:25, the helicopter's cockpit voice recorder (CVR) — whose recording was described as "mostly unintelligible" — recorded "the sound of decreasing background noise." The CVR recording stopped at 1918:34.

The dispatcher's records showed that she radioed the crew at 1923 to provide the updated ship coordinates but received no response. She tried again at 1931, when her records said that she was going to ask ship personnel to make radio contact with the crew. At 1934, the records indicated that someone on the ship was attempting to contact them. The dispatcher tried again at 1946 and 2008. There was no response to any calls. The report said that the dispatcher told investigators that during her communications with the crew, "everything sounded normal, with no strange background noises," and that she had received no emergency calls or distress calls from the crew.

The wreckage of the helicopter was found March 25 in waters about 186 ft (57 m) deep.

First Flight for Accident Crew

The captain of the accident helicopter, who held an airline transport pilot certificate with a rotorcraft rating, had 7,288 flight hours, including 5,323 flight hours as pilot-in-command (PIC) of multiengine helicopters, 3,913 flight hours in operations in the Gulf of Mexico, 1,489 flight hours in S-76s and 1,028 flight hours at night. He also held a first-class medical certificate. He was a U.S. Army pilot from 1980 until 1988 and a U.S. Coast Guard pilot from 1988 until 1999, when he was hired by Era Aviation.

The dispatcher told investigators that during her communications with the crew, "everything sounded normal."

The captain usually worked from 0530 until 1930, but he was told — before he began five days off before the accident flight — that when he returned to work, it would be on a night shift. The day of the flight, he reported for work at 1700. The accident flight was the first flight of his workday and his first flight with the copilot.

The copilot had a commercial pilot license with a rotorcraft-helicopter rating; he also held a first-class medical certificate. He had 1,941 flight hours, including 1,371 flight hours as PIC, 1,027 flight hours in operations in the Gulf of Mexico, 438 flight hours in S-76s and 63 flight hours at night. He received a flight instructor certificate in 1999 and worked as a flight instructor in 2000 and 2001, until he was hired by a Grand Canyon, Arizona, U.S., operator in March to be a line pilot; three months later, he was hired by Era Aviation.

The copilot had worked the night shift for several duty periods and had been off duty March 4–17, 2004; on March 18–20, he attended daytime ground school for the Bolkow 105 in Lake Charles, Louisiana, U.S.; on March 21–22, he drove his car about 630 mi (1,014 km) from Lake Charles to Galveston. He resumed work on the night shift on March 23; the accident flight was his first flight of the new duty period.

Era Aviation, with headquarters in Anchorage, Alaska, U.S., began operating in the Gulf of Mexico in 1979. The company had 87 pilots, including the accident pilots, and seven S-76A helicopters, including the accident helicopter, in the Gulf, as well as six other helicopter models.

The accident helicopter was a transport category, twin-engine helicopter manufactured in 1984 and exported to a South African operator. The helicopter was transferred to Era Aviation in 2001. At the time of the accident, the helicopter had accumulated 10,075 flight hours and 2,882 cycles.

The helicopter was equipped with an electronic flight instrument system (EFIS) and a Honeywell SPZ-7000 dual digital automatic flight control system (DDAFCS), which includes autopilots, flight directors, flight control computers, air data components and autotrim.

The dual autopilots provide stability through two modes: the stability augmentation system (SAS) and the attitude retention mode (ATT). Only one mode may be selected at a time. Both modes provide heading hold, yaw damping and autotrim, and automatic turn coordination. The SAS mode — which is selected for extensive maneuvering, typically during the initial and final phases of flight and during hovering — also provides short-term rate damping during manual flight. The ATT mode provides pitch and roll attitude retention during manual flight to automatically return a helicopter to the reference attitude after an in-flight disturbance.

The dual flight directors — flight director 1 (FD1) for the left-seat pilot and flight director 2 (FD2) for the right-seat pilot — aid in

maintaining flight path or attitude by providing command cues on the attitude director indicators (ADIs), the top screens on EFIS displays. The flight director is selected by pressing the "FD1/2" button on the autopilot controller. When the button is pressed, FD1 or FD2 is automatically coupled to the autopilot (AP1 or AP2) and remains coupled as long as the autopilot and its ATT mode are engaged.

"Coupling allows the flight director's computed pitch and roll attitude corrections to be input to the autopilot so that the pilot does not have to manually control the helicopter according to the command cues on the ADIs," the report said. "The 'CPL' button on the autopilot controller automatically illuminates in green and indicates 'ON' when the autopilot and the flight director are coupled. The primary method to decouple the autopilot and the flight director is by pushing the CPL button. Once decoupling occurs, the pilot must fly the helicopter manually. No aural warning occurs when the autopilot and flight director become decoupled.

"During normal operations, the illumination, or absence of illumination of the CPL button is the only direct annunciation of the status of the couple function. Because of its location on the center pedestal, the CPL button is out of the pilots' routine instrument scan."

The report said that during the accident investigation, Era Aviation pilots, including the chief pilot and the director of training, were "not able to fully explain the flight director and coupling status annunciations and command cue presentations associated with the SPZ-7000" and a successor unit, the SPZ-7600.

The helicopter was certified, equipped and maintained in accordance with U.S. Federal Aviation Regulations (FARs), and — except for its CVR — there were no structural, engine or system failures involving any of its components.

'Background Noise'

Accident investigators analyzed the CVR recordings and found that three of the four audio channels contained no usable audio information and the fourth audio channel contained information of poor audio quality from the cockpit area microphone, with most of the recording "obscured by a high level of background noise," the report said. The problem apparently resulted from incorrectly positioned configuration switches, which were located outside the pilots' view.

Weather conditions in Galveston seven minutes after the helicopter's departure included visibility of 10 mi (16 km); few clouds at 2,800 ft, overcast at 4,000 ft and winds from 110 degrees at 11 kt. At the time of the accident, about 8 percent of the moon was illuminated. The report said that, although VMC prevailed, there would have been few visual references outside the helicopter.

The Era Aviation dispatcher said that the pilots had called her on the radio after takeoff but had been unable to hear her, probably because the helicopter was not high enough. No audio

Sikorsky S-76A

The Sikorsky S-76 — whose development benefited from research and design on the military Sikorsky UH-60 Black Hawk — is a twin-turbine commercial helicopter configured to accommodate 12 passengers and two pilots. The helicopter was first flown in 1977.

The S-76A has a maximum takeoff weight of 10,300 lb (4,672 kg), a maximum cruising speed of 145 kt and a service ceiling of 15,000 ft. It has a maximum range of 404 nm (748 km) with 12 passengers, standard fuel and 30-minute reserves. The S-76A is powered by two Allison 250-C30 turboshaft engines, each rated at 650 shaft horsepower (485 kw).

Source: *Jane's All the World's Aircraft*

U.S. National Transportation Safety Board

Wreckage of the S-76A is pulled from the Gulf of Mexico.

record was available because the tape deck in the company's Gulf Coast headquarters was not functioning the night of the accident.

The helicopter was not equipped with a flight data recorder (FDR), and one was not required. The S-76A was one of several helicopter models exempt from U.S. Federal Aviation Administration (FAA) requirements for FDRs.[2]

Training Emphasized Control Systems

During initial ground training, the pilots received 40 hours of classroom instruction, including four hours on the flight control and automatic flight control systems, two hours on the avionics system, three hours of familiarization with aircraft flight manuals and four hours on the caution warning, electrical power and lighting systems. The training incorporated information from the Era Aviation S-76 *Pilot Training Manual*, including detailed discussions of both analog and digital flight control systems.

Initial ground training included discussions of aeronautical decision making, crew resource management (CRM) and CFIT. The training director described the accident captain as the "most vocal and active participant in the class" during the CFIT portion of training, noting that he had discussed his U.S. Coast Guard flight experience as well as risk factors associated with night flight to an offshore platform.

S-76 pilots received 10 hours of initial flight training, including a flight check; 36 hours of recurrent ground and instrument training; and at least six hours a year of recurrent simulator flight training, including approaches to oil rigs, instrument procedures, weather factors and CRM procedures. At least two hours of night instrument flight rules (IFR) flight and at least two approaches to an oil rig to 200 ft with visibility of 0.6 mi (1.0 km) were included.

The report said, "Era Aviation's simulator coordinator, who was also an S-76A check airman, stated that, before the accident, coupling indications and related issues were not a focus of the DDAFCS portion of ground or simulator flight training. He also stated that, after the accident, Era Aviation focused the DDFACS portion of the training on improving a pilot's situational awareness regarding the system and decreasing the possibility of confusion between pilots."

FAA radar data were available — through land-based radar sites — for a portion of the flight, while the helicopter was within range of the FAA's Houston radar site, which provides maximum radar coverage of 60 nm. Radar data were unavailable as the helicopter was flown 35 nm farther southeast.

FAA plans to implement the automatic dependent surveillance–broadcast (ADS–B) system to aid in surveillance of low-flying aircraft in areas such as the Gulf with little or no radar coverage. ADS–B relies on position information transmitted by individual aircraft using global positioning system (GPS) technology to provide air traffic controllers and operators with surveillance of aircraft in areas with little or no radar coverage.

Initially, plans were for the ADS–B system to be in place in the Gulf in fiscal 2013, which begins Oct. 1, 2012; in March 2006, however, FAA said that implementation of the program would begin in fiscal 2007, which begins Oct. 1, 2006.

Simulated Accident Scenarios

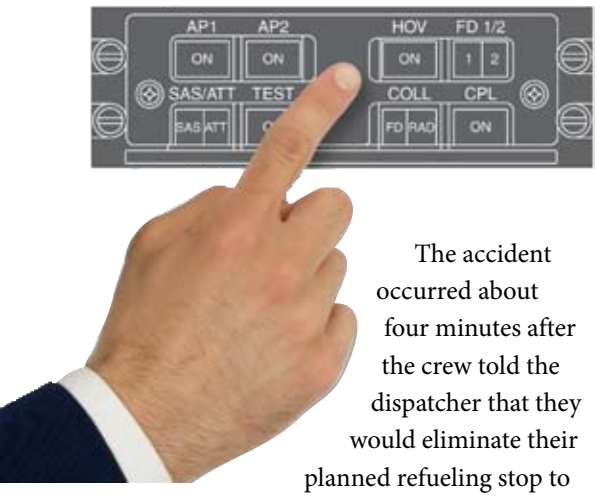
Accident investigators used a full-motion S-76A simulator to identify four likely scenarios that might have contributed to the inadvertent

descent into the Gulf of Mexico. Each assumed that the pilots were using the DDAFCS:

- The right-seat pilot (captain) "maintained control but did not select altitude-hold mode";
- The left-seat pilot (copilot) "coupled the flight director but did not select altitude-hold mode";
- The left-seat pilot "selected the altitude-hold mode but did not couple the flight director"; and,
- The left-seat pilot "selected the altitude-preselect mode but did not couple the flight director."

"It is clear … that the flight crew should have been actively monitoring cockpit instrumentation showing the helicopter's altitude, especially because of the lack of outside visual references," the report said. "The flight crew would have been presented with salient cues to detect the helicopter's descent and proximity to the water."

The report said that both pilots had adequate experience not only in the accident helicopter but also with the S-76A EFIS-DDAFCS configuration and with night operations. Both also had received adequate CFIT training.



The accident occurred about four minutes after the crew told the dispatcher that they would eliminate their planned refueling stop to proceed directly to the drilling ship — a decision that would have required them to coordinate a course change, receive updated ship coordinates from the dispatcher and reprogram the helicopter GPS, the report said.

"It is also possible that the flight crew initiated a change in control from one pilot to the other or a change in flight control method from automatic (coupling of the autopilot and flight director) to manual flight or vice versa," the report said. "Such changes require effective crew coordination, including continuous cross-checking and monitoring of instruments to ensure that the intended system inputs have correctly been made."

Crew coordination may have required more effort than usual because the accident flight was the first flight in which the captain and copilot had worked together, the report said.

"New crew pairings have been associated with increased errors and less effective communication patterns than crew pairings with crewmembers who have previously flown together," the report said. "During critical phases of flight, a lack of familiarity can affect a flight crew's ability to coordinate effectively. However, because of the poor quality of the CVR recording, it was not possible for the [NTSB] to determine whether crew coordination was a factor in this accident."

The report said that the crew might have intended to couple the autopilots and flight director to automatically maintain heading and altitude while they completed tasks involving the destination change.

"However, the pilots could have incorrectly programmed the flight director mode selector and either not have detected this situation or have misinterpreted it, given the available system feedback," the report said. "It is also possible that the pilots were in the process of reprogramming the flight director mode selector."

The report said that the pilots might have chosen to maintain the appropriate flight path manually, without using the coupling feature. If they had begun a gradual descent, the autopilots' ATT mode, which provides stability during manual flight, would have maintained the flight trajectory with "minimal, if any, physical cues," the report said.

"Significant deviations in altitude or flight path, if controlled by automation, may develop without detection by the flight crew, especially when the flight crew is focused on other tasks," the report said. "The only reliable way for pilots to detect such deviations is through continuous monitoring of cockpit instrumentation. Although the opportunity for successful monitoring would be increased with two flight crewmembers rather than an individual pilot, research indicated that an overreliance on automation and a failure to monitor were unaffected by the presence of a second pilot in the cockpit."

TAWS Not Installed

Investigators did not determine whether the pilots were using an automated system to control altitude and flight path. Nevertheless, the report noted that, because of the possibility for errors in monitoring automated systems, other technologies, such as the terrain awareness and warning system (TAWS), have been developed to provide warnings of potential collisions with terrain. Helicopters are not required to be equipped with TAWS, and at the time of the accident, TAWS was not installed in any of the S-76A helicopters operated by Era Aviation.

U.S. National Transportation Safety Board and iStockphoto Inc.

The report said that if the accident helicopter had been equipped with TAWS, aural and visual warnings "should have provided the flight crew with ample time to recognize that the helicopter was descending toward the water, initiate the necessary corrective actions and recover from the descent."

As a result of the investigation, NTSB issued the following safety recommendations on March 24, 2006, to FAA:

- "Require all existing and new U.S.-registered turbine-powered rotorcraft certificated for six or more passenger seats to be equipped with [TAWS];
- "Ensure that all operators of helicopters equipped with either the SPZ-7000 or SPZ-7600 [DDAFCS] provide training that includes information on flight director and coupling status annunciations; the command cue presentations when only the pitch or the roll mode is engaged; and, if applicable, the differences between the SPZ-7000 and the SPZ-7600;
- "Ensure that the infrastructure for the [ADS–B] Program in the Gulf of Mexico is operational by fiscal year 2010 [beginning Oct. 1, 2009]";
- "Until the infrastructure for the [ADS–B] program in the Gulf of Mexico is fully operational, require principal operations inspectors of Gulf of Mexico aircraft operators to inform the operators about the benefits of commercial flight-tracking systems and encourage the operators to acquire such systems"; and,
- "Require all operators of aircraft equipped with a [CVR] to test the functionality of the CVR before the first flight of each day as part of an approved aircraft checklist and perform a periodic maintenance check of the CVR as part of an approved maintenance check of the aircraft."

As of early June 2006, FAA had not filed official responses to the recommendations.

On March 7, 2006, as a result of this investigation and the investigation of an August 2005 accident in which an S-76C struck the Baltic Sea after takeoff from Tallinn, Estonia, NTSB issued two other safety recommendations to FAA[3]:

- "Require all rotorcraft operating under [FARs Parts 91 and 135] with a transport category certification to be equipped with a [CVR] and [an FDR]. For those transport category rotorcraft manufactured before Oct. 11, 1991, require a CVR and an FDR or an onboard cockpit image recorder with the capability of recording cockpit audio, crew communications and aircraft parametric data."

  [In response, FAA said that it would "review and identify changes in [FDR] technology … to ensure that current technology used in airplanes is appropriate to helicopter operations" and then consider changes in its regulations. FAA also will "consider applications of new technology for [CVR] and FDR systems for rotorcraft specifically."]
- "Do not permit exemptions or exceptions to the flight recorder regulations that allow transport category rotorcraft to operate without flight recorders and withdraw the current exemptions and exceptions that allow transport category rotorcraft to operate without flight recorders."

  [In response, FAA said that it would review existing exemptions, "re-evaluate the analysis upon which the exemptions were originally granted" and require a complete revalidation when requests are submitted to continue the exemptions, which usually are issued for two-year periods. Because regulations allow an exception to the FDR requirement for some aircraft manufactured before Aug. 18, 1987, FAA said that it "will not be able to justify the installation of an FDR in these types of aircraft due to a combination of technical and economic considerations."] ●

Notes

1. U.S. National Transportation Safety Board (NTSB). *Controlled Flight Into Terrain, Era Aviation, Sikorsky S-76A++, N579EH, Gulf of Mexico, About 70 Nautical Miles South-Southeast of Scholes International Airport, Galveston, Texas, March 23, 2004.* Aircraft Accident Report NTSB/AAR-06/02. March 7, 2006.
2. After the accident, Sikorsky began to install flight data recorders in all new commercial aircraft, including the S-76.
3. The accident in Estonia was the first involving a large helicopter equipped with a flight data recorder (FDR). The NTSB report described the FDR data collected during that accident investigation as "extremely valuable."