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Set-up for Disaster

The helicopter was heavily laden with a sling-loaded concrete bucket, the crew had had a tiring duty day, spectators remained at the delivery site despite warnings to leave and an engine failed.

by
John A. Pope
Aviation Consultant

In a mountainous region approximately 2.5 miles east of Sisimiut/Holsteinsborg, Greenland, a Sikorsky S-61N, crashed and was destroyed while engaged in a cargo-sling operation. Of the three-man crew, the pilot in command (PIC) was fatally injured and the copilot (CP) received severe injuries; the sling operator (SO) escaped injury.

The accident occurred on September 1, 1987, and Denmark's Aircraft Accident Investigation Board (AAIB) published its findings in July 1991. The accident scenario is provoking not only as it pertains to the events surrounding the accident but also from what can be learned by exploring the facts for accident prevention purposes.

History of the Flight Reveals The Seeds of Disaster

The helicopter had been chartered by a local ski club for transporting liquid concrete for construction of the foundation for a ski lift.

The day's work began at 1301 hours local. Two passenger flights were made from Sondre Stromfiord (BGSF) to Sisimiut/Holsteinsborg (BGHB) heliport that ended at BGHB at 1423 hours.

At 1436 hours, the helicopter departed BGHB on its first cargo-sling operation. The sling cargo weighed approximately 4,400 pounds and consisted of a metal bucket filled with liquid concrete. The total takeoff weight of the S-61N was estimated at 19,535 pounds; normal takeoff weight limit is 20,000 pounds.

To prevent accidental opening of the cargo hook, the cargo-sling master switch was placed in the "Sling" position during all of the sling flights, as recommended by the flight manual.

Between 1436 hours and 1943 hours, 22 sorties were carried out with 11- to 16-minute stops for refueling, and apparently all flights were uneventful. However, on the last of these flights, the crew dropped a cardboard note at the construction site requesting ground personnel to keep unauthorized spectators clear of the area below the helicopter during delivery of the concrete. A number of persons had been observing operations from positions beneath the path of the aircraft. The crew indicated that flights would be terminated if there was no compliance with the request. This information also was radioed from the heliport to the ground personnel at the construction site. Radio communication was not available directly between the helicopter crew and the ground personnel at the construction site.

The Sikorsky S-61N helicopter came to rest in rugged terrain after an engine failed during a sling-load delivery of concrete to a remote construction site.

When the helicopter took off at 1955 hours, a portable, two-way radio was brought along to be given to the workers at the ski lift to allow direct communication between them and the helicopter crew as a precautionary safety measure.

The cockpit voice recorder (CVR) revealed what happened next:

- About 30 minutes before the end of the tape, the SO said, "One gets tired of that kind of work." As the CP laughed at that remark, the PIC said, "Yes, and now it's real routine."

- About 12 minutes later, the CP said, "One can feel it in the legs. One is not used to work with the feet." The PIC replied, "But it's very difficult to relax. One is tightening up too much in the legs. It's not necessary."

- On the last flight, the concrete at BGHB was not ready for pickup, so the helicopter crew landed the aircraft and waited approximately five minutes with the two engines operating. Then they took off and hovered to pick up concrete cargo. The CVR transcript indicated the crew noted that the bucket was filled to the edge and the cargo load was rather heavy due to excess water in the mix.

- The transcript also indicated that the PIC was annoyed to find that people were still standing in the delivery area when the helicopter arrived.

As the helicopter approached the ski lift area, controls were transferred from the CP to the PIC as they had been on all of the previous flights. On the final approach for delivery of the concrete cargo, the CP increased the rpm and the SO started a countdown of the distance to the point of delivery. When the helicopter reached a distance of 65 feet (20 meters), the PIC suddenly shouted, "Engine failure!"

… the PIC was annoyed to find that people were still standing in the delivery area … .

Witnesses observed smoke coming from one of the engines as the helicopter initiated a change in heading and altitude. At that point, the flight was only a few yards from the delivery point and the metal bucket was about three feet (one meter) above the point of delivery.

The sling cargo was not released.

The helicopter descended and collided with the surrounding terrain several times before it came to rest at a cliff formation. Two of the main rotor blades had cut through the upper front section of the cockpit and the fiberglass engine intake ice deflectors. The radome and 20 inches (50 centimeters) of the top skin behind the cockpit were cut off.

During the final ground impact, the PIC hit his head

against the rear part of a metal holder for a portable strobe light that was mounted on the bulkhead behind his seat. His skull was fractured, resulting in a fatal injury.

The CP, who had grabbed an overhead handle with his left hand during the violent final maneuvers, received serious injuries when four fingers and half the thumb on his left hand were cut off by the rotor blades; amputation above the wrist was later required.

Neither pilot was wearing protective headwear.

Cause Factors Point to Room for Improvements

The AAIB report stated the cause factor was that the "automatic shutdown of engine number two due to a failure of the number two engine input freewheel unit [IFWU] was not followed by an instantaneous release of the external load." The IFWU is a clutch mechanism that allows the main rotor blades to disengage, or freewheel, during autorotation or for the main rotor blade to be driven by the operating engine if one of the two engines fails.

Contributing factors included:

- Sikorsky Aircraft, apparently following notification about a large number of IFWU failures (slippage or clunking), issued Customer Service Notice Number 6135-6A on September 2, 1986, recommending that the two existing roller retainer springs be exchanged by two stiffer retainer springs. This change of roller retainer springs caused more than normal wear to the IFWUs.

- The sling flights were initiated to a delivery area where obstacles and terrain conditions made a recovery impossible with the sling load attached. Consequently, the sling load should have been released immediately.

- Insufficient supervision from ground personnel contributed to the presence of unauthorized people in an area beneath the helicopter, thus injecting a serious consideration into the PIC's decision whether to release the sling load when the engine failure occurred. (An engine failure means an occurrence in which a loss or interruption of power is experienced or the engine stops, according to the definition of the International Civil Aviation Organization — ICAO).

… planned emergency actions were based on the immediate release of the sling load.

Analysis Illustrates How Trouble Developed

The AAIB stated that four areas required special attention for preflight planning of sling load operations: 1. instruction of ground personnel; 2. extension of pick-up and delivery areas; 3. reconnaissance of the area in order to familiarize the flight crew with the best approach and climbout paths, emergency landing areas and sling-load release areas; and 4. restrictions to enter the vicinity of the sling-load pickup and delivery area.

As to the first item, the crew did inform ground personnel when they dropped the cardboard note directing them to remove all spectators from the delivery area and, if this were not done, flights would be aborted. Radio communication was not available directly between the helicopter crew and the ground personnel at the construction site. In spite of the fact that spectators were still in the area during the accident flight, the PIC obviously decided to proceed, possibly because it was the last scheduled flight for the day.

As to items two and four, the delivery area was not marked or protected in any way to indicate to unauthorized persons that there was a "no personnel allowed" buffer zone for a radius of 115 feet (35 meters) around the delivery point. Briefings and other efforts did not keep spectators outside the required perimeter.

As to item three, planned emergency actions were based on the immediate release of the sling load. In the event that a sling load was not released, prior reconnaissance indicated a climbout could not be accomplished. Company and operational requirements in such an emergency condition dictate immediate release, and the AAIB considered that the reconnaissance of the pick-up and delivery areas must have been satisfactory.

The AAIB stated that the PIC should have aborted the mission to stress the point of his prior warning about unauthorized spectators in the delivery area. The sudden emergency at a point which required immediate release of the sling load could probably not be dealt with as quickly as was necessary to utilize the surrounding area for safe recovery/landing actions.

When the automatic shutdown of engine number two took place, triggered by the number two IFWU malfunction — a situation recognized by the PIC as an engine failure — the external load should have been released immediately, according to the AAIB, because the unsuit-

able and rocky terrain made a recovery with the load engaged impossible.

Company procedures called for the cargo-sling master switch to be placed in the Sling position which is intended to prevent accidental opening of the cargo hook. Consequently, the cargo could not be released by an automatic touchdown circuit when the metal bucket touched the ground. The only methods left to release the cargo were either by activating one of the cargo release thumb-operated switches located on the pilot's and copilot's cyclic stick grips or by depressing the cargo release pedal located on the pilot's side of the compartment. The AAIB was unable to determine whether sufficient time was available after the engine run-down took place for the crew to detect the problem and take proper action. Later tests in a simulator indicated it was possible to release the load in time but the AAIB did not consider those tests as representative of the actual flight.

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The fact that some people were still standing in the delivery area may have had an influence on the PIC's decision to not release the load at the most critical point and thereby create a hazardous situation for the people on the ground. However, by not releasing the load, the PIC created a serious situation for the crew.

At the time of the accident, the PIC and CP had been on duty for 12 hours and 15 minutes, of which five hours and 13 minutes were flight time. Before reporting for duty, each pilot had a rest period of 20 hours. The SO had been on duty for 17 hours and 15 minutes and had a rest period of 14 hours and 15 minutes before reporting for duty. The SO's flight time for the duty period was unknown.

The duration of the duty or flight time did not exceed any of the limitations mentioned by the operator for flights with the S-61N. However, the CVR remarks about being tired could indicate a more demanding mission than anticipated.

One of the methods used by the operator for limiting flight and duty time is a "system of points." This system credits a crew member with five points per hour between 0600 and 2200 hours local time, six points per hour between 2200 and 0600 hours and five points per landing. According to this system, no flight duty period must be planned in such a way that the active duty of a crew member exceeds 90 points. Contrary to this system, the hour-based duty time system has no adjustment factor for number of landings.

In spite of the fact that the flight and duty time for the crew on board the accident flight did not exceed the regulatory limitation, the AAIB stated that the nine landings, 24 pickups of sling cargo and 23 deliveries, which cannot be compared to a routine flight from A to B with routine landings, must have had some influence on the crew's fatigue threshold.

Both IFWUs were removed from the main gear box for visual as well as dimensional evaluation by the operator. IFWU number one showed normal wear. Examination revealed more than normal wear on the unit for the number two engine. Heavy indentation marks were found on the camshaft cam surfaces. The inner diameter of the gear housing was above limit. The outer roller diameter was below limit. Tests by Sikorsky corresponded with the results found by the operator.

The AAIB was of the opinion that the PIC might have survived the accident had he been wearing a protective helmet.

Crew Factors Considered

The AAIB covered the mechanical malfunction rather thoroughly and submitted to the manufacturer its conclusion that testing of the new type of roller retainer springs in the IFWU was not sufficient to disclose the significant increased camshaft wear pattern.

In reviewing the scenario of the flight, the decision-making processes of the PIC and crew call for further discussion.

The crew had been on duty for more than 12 hours, accomplished two passenger sorties and more than 22 sling operations, and during the flights, had made comments about being tired. The crew had informed ground personnel at the delivery site that it would abort further flights if spectators were not cleared from the delivery site.

When the helicopter arrived on the final flight, the PIC was annoyed to find that spectators were still a problem in spite of his warning. He decided to continue the flight, as the AAIB stated, probably because it was the last scheduled flight of the day. In a previous article concerning a Hughes 500C accident in Canada (May/June 1991 *Helicopter Safety*), the author referred to a 1980 Canadian study of helicopter pilot traits which contained this statement: "More specifically, they [helicop-

The pilot, who was not wearing protective headgear, was fatally injured when his head hit a metal holder for a portable strobe light which was situated on the bulkhead behind

ter pilots] can succumb to pressures of the situation or be coerced into a high-risk situation. In addition, helicopter pilots scored very high in their need for 'achievement.'" The study indicated that the "can-do" attitude is an inherent personality characteristic of the successful helicopter pilot.

The PIC on the accident flight was experienced. He was 55 years old, held a Danish Airline Transport Pilot license and had flown a total of 10,535 hours with 7,000 hours in type. In spite of that flying experience, he may have been possessed by those inherent helicopter pilot characteristics—achievement and can-do—that persuaded him to press on with the delivery of the sling load in spite of the spectators and the nature of the surrounding terrain. Undoubtedly, he could have accomplished the mission successfully if it had not been for the mechanical problem which caused him to call out, "Engine failure!"

The pressures of commercial helicopter activity may sometimes lead to a disregard for basic safety fundamentals … .

The AAIB points out that not releasing the external load immediately was a basic cause of the accident. Those familiar with the mechanics of sling-load operations can argue pro and con as to whether the procedure to prevent accidental opening of the cargo hook by placing the cargo-sling master switch in the Sling position is appropriate and whether there was sufficient time to release the load by alternate procedures. A point to keep in mind is that the PIC may have recognized that dropping the metal bucket full of concrete would have been hazardous to the unauthorized spectators who had exhibited a clear disregard for their own safety by refusing to vacate the area as instructed.

Apparently, the restricted perimeter of the delivery area was not clearly defined or marked, and that may have been the operator's responsibility. However, if a landing or operational area is not properly defined and marked, who makes the decision as to whether the mission can be accomplished safely? The pressures of commercial helicopter activity may sometimes lead to a disregard for basic safety fundamentals which may also fuel the "can-do" helicopter pilot syndrome. Could this operator's crews have declined to make the sling-load flights to the ski lift site until all the parameters were laid out?

What about fatigue and the accident crew's flight and duty day? Operators of aircraft worldwide have labored to develop guidelines for aircrew flight and duty times that cover all specific situations. Using hours to limit the duty day and the flying time within that duty day is the most common practice. Using points, as the operator of the accident aircraft does, is another practice and a criterion is set for so many points per day or night flying hour, points for landings and points for instrument flight or approaches.

It is most difficult to determine the flying situations that create high fatigue factors and how fatigue affects the

capability of the pilot. In examining the activities of the accident crew during their 12-hour duty day, going from A to B with a passenger load could be considered routine and relatively free of fatigue. But what about the 22 sorties delivering concrete? Considering the precision required to deliver the sling load in a demanding environment would suggest that the sorties did tax the crew's stamina and, very probably, their ability to react quickly in the event of an emergency. In addition to the PIC's regard for spectator safety, could an assumption be made that fatigue may have also impacted on his ability to act and think quickly? The AAIB indicated its concern when it stated "that the nine landings, 24 pickups of sling cargo and 23 deliveries, which cannot be compared with a routine flight from A to B with routine landings, must have had some influence on the crew's threshold of fatigue."

According to the operator's system, this crew had accomplished nine landings at five points per landing for 45 points. No allowance is made for hover and pickup. At five points per hour between 0600 and 2200 hours, the members of this crew accumulated 60 points for the 12-plus hours they were on duty. That totals 105 points yet, according to the system in use, "no flight duty must be planned in such a way that the active duty of a crew member exceeds 90 points." The AAIB did not state that the crew had exceeded the operator's limitation.

The last point to make is about protective headgear. The AAIB makes its point well. For flights that can be considered hazardous by any means, protective headgear should be worn by the crew. The PIC of the accident flight might have survived had he been so equipped. Certainly, the cost and any inconvenience of protective equipment is far outweighed by the additional safety afforded to crew members. ♦

About the Author

John A. Pope established John A. Pope & Associates, an aviation consulting firm located in Arlington, Va., U.S., after retiring in 1984 as vice president of the U.S. National Business Aircraft Association. He specializes in developing comprehensive operations manuals for corporate flight departments.

Pope, former Washington editor for "Aviation International News," is a frequent contributor to Flight Safety Foundation's publications.

He served as a command pilot in the U.S. Air Force and the Air National Guard. He retired as a colonel from the U.S. Air Force Reserve after 33 years of service.

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