AVIATION INVESTIGATION REPORT
A02O0301

HARD LANDING ACCIDENT

CANADIAN HELICOPTERS LIMITED
SIKORSKY S-76A (HELICOPTER) C-GIMM
LONDON, ONTARIO
17 SEPTEMBER 2002

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

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Summary

Two qualified pilots took off at approximately 1530 eastern daylight time (EDT) from London International Airport, Ontario, in a Sikorsky S-76A helicopter, registration C-GIMM, serial number 760044, operated by the Emergency Medical Services Division of Canadian Helicopters Limited. The flight was for crew training purposes, and they carried out some multi-engine exercises in the local area. They returned to the airport to carry out simulated one-engine-inoperative exercises involving take-offs and landings across the button of Runway 27.

During the second approach, nearing the flare, the pilot flying raised the collective in the normal manner for both engines operative, not realizing that an engine failure had been simulated on the number 2 engine. The rotor speed decayed, resulting in touchdown at a higher than normal rate of descent, notwithstanding an attempt by the pilot not flying to regain power from the simulated inoperative engine. The tail boom of the helicopter buckled, bringing the tail rotor drive shaft into contact with internal structure. The crew was unaware of the structural damage. They felt a buzz in the anti-torque pedals that might have indicated that a main rotor blade had hit the tail rotor. Consequently they terminated the flight and began to ground taxi back to the company ramp. While taxiing, the tail rotor failed when the drive shaft was cut through. The accident occurred at approximately 1630 EDT.

Ce rapport est également disponible en français.

1.0 Other Factual Information

1.1 History of the Flight

Both pilots arrived at the London base at 1000 eastern daylight time (EDT)[1] for a recurrent training flight in preparation for a pilot proficiency check (PPC) ride for one of the pilots. The pilot undergoing training occupied the right-hand seat which is the seat normally designated the pilot-in-command (PIC) seat.[2] A PIC was not designated for this flight; each pilot thought the other was PIC for the flight.

The crew briefed for a normal visual flight rules (VFR) training flight. It was to include simulated engine failures during vertical profile departures and approaches to a simulated ground level heliport. The number 1 engine would be the "good" engine and would be artificially topped prior to commencing one-engine-inoperative (OEI) exercises. Topping is a routine practice by the company to avoid exceeding limits and damaging the engine. It is done by reducing the number 2 engine to idle power, then raising the collective and retarding the number 1 engine lever until the engine does not exceed continuous limits on torque, temperature, or rpm at full-up collective. Typically, this results in the engine lever being behind the gate about 5% back of the full throttle, or "fly" position.

The flight was to begin with 1600 pounds of fuel, 400 pounds greater than the normal quantity for dispatch on emergency medical services (EMS) operations. This was normal company practice to minimize delay in the event of recall for an EMS response when using the on-line EMS helicopter for training. OEI training was to be left until the end of the flight when the helicopter was lighter, with less than 1000 pounds fuel remaining. The crew did not determine a specific gross weight limit for the existing meteorological conditions for vertical profile take-offs.

The flight was delayed when the helicopter was called out for EMS . It returned at 1405 and was refuelled to the briefed fuel state. Take-off weight was recorded as 9542 pounds. On the initial take-off, the crew got a false number 2 engine failure annunciation and tone that resulted in them rejecting the take-off. It was attributed to an intermittent N_1 (gas generator rpm) signal and was corrected by cleaning the electrical connector. The helicopter eventually took off for the training flight at about 1530.

The flight proceeded as briefed. Multi-engine exercises were carried out first. Prior to beginning OEI exercises, the number 1 engine was topped as briefed. OEI exercises were carried out as circuits to the button of Runway 27 approaching the button on a track of approximately 360 degrees magnetic and landing across it to simulate a helicopter landing pad.

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[1] All times are eastern daylight time (Coordinated Universal Time[UTC] minus four hours).

[2] The pilot undergoing training was the pilot flying (PF) at the time of the accident. The pilot not flying (PNF) in the left-hand seat was acting as training pilot. They will be referred to as the PF and PNF respectively throughout the report.

The first circuit was a normal vertical profile departure without an engine failure. After the PF indicated that he was at the landing decision point, the PNF simulated an engine failure by retarding the number 2 engine lever to flight idle, a normal procedure for such training exercises. The PF responded correctly and carried out a safe OEI landing. On the ground, the PNF debriefed the PF on the importance of watching engine torque during the approach, then instructed the PF to take off to do the exercise again.

On the second take-off, the PNF announced a number 2 engine failure at the critical decision point, when the helicopter was committed to continuing the take-off, and simulated it in the same manner as before. After the correct initial response by the PF, the PNF brought the number 2 engine to normal flight power to assure clearance from trees that were ahead on the flight path and to expedite the climb to circuit height. When established downwind, the PNF returned the number 2 engine lever to flight idle, pointed out the torque to the PF and reiterated the importance of monitoring torque. The PF checked the torque and believed incorrectly that both engines were at 70%.

The torque indicator in the S-76A displays the torque of both engines on a single gauge with a separate needle for each engine. In fact, the number 1 engine torque was at 70% and the number 2 engine torque was at zero. This put the needles at the 1 o'clock and 7 o'clock positions, aligned with each other and offering no angular displacement to attract the pilot's attention. As a result, the PF did not notice that the number 2 engine torque was zero, and he continued the circuit, expecting that an engine failure would be simulated at or near the landing decision point as per the previous approach. When it wasn't announced, he initiated the flare and raised the collective at approximately 35 feet above ground, the normal technique for a two-engine landing. The rotor rpm decayed, resulting in a high rate of descent. The PNF recognized that the "good" (number 1) engine power was insufficient for the recovery and advanced the number 2 engine lever. The number 2 engine did not respond quickly enough to avoid a hard landing.

1.2 Damage to Aircraft

The tail boom of the helicopter buckled on impact and brought the tail rotor drive shaft into contact with a flange where the tail boom mates to the fuselage. The flange cut into the drive shaft, eventually severing it during ground taxi back to the company ramp. The helicopter was shut down at that time.

1.3 Personnel Information

	Captain (PNF)	First Officer (PF)
Pilot Licence	ATPL Helicopter	ATPL Helicopter
Medical Expiry Date	1 Nov 2002	1 Sep 2003
Total Flying Hours	9000	3000
Hours on Type	3000	1700
Hours Last 90 Days	4.3	100
Hours on Type Last 90 Days	4.3	100
Hours on Duty Prior to Occurrence	6.5	6.5
Hours Off Duty Prior to Work Period	12	16

The PF came to Canadian Helicopters Limited (CHL) with previous experience as a co-pilot of S-76 helicopters and checked out as co-pilot in October 2001. He upgraded to captain in December 2001, and became a training pilot in March 2002. His PPC was valid until October 2002. He was on vacation the week of the occurrence but came to work to carry out recurrent training that was required prior to the PPC ride that was scheduled in Ottawa the following week. The previous day, he had come in to fly with a different training pilot who was on EMS standby. Three EMS call-outs resulted in there being insufficient time to brief and fly the trip. The training pilot was not available the next day, requiring the PF to find someone else to fly with him or further delay the training, possibly compromising the PPC ride.

The PNF was a designated company training pilot. He had recently assumed the position of Senior EMS pilot with responsibility for standards and training for the entire EMS Division. He ceased holding normal rotation for EMS standby at that time. There was no record of the number of take-offs, circuits, and landings the PNF performed during the previous 90 days. He was not scheduled to fly on the day of the occurrence but, when the PF called him the previous afternoon, he agreed to fly the proposed training flight.

1.4 Aircraft Information

Manufacturer	Sikorsky
Type and Model	S-76A
Year of Manufacture	1980
Serial Number	760044
Certificate of Airworthiness	Issued 14 September 1999
Total Airframe Time	16 860 hrs
Engine Type (number of)	Rolls-Royce (Allison) 250-C30S (2)
Propeller/Rotor Type (number of)	four-bladed main rotor (1)
Maximum Allowable Take-off Weight	4763 kg / 10 500 lb
Recommended Fuel Type(s)	JP-4/JP-5/JP-8/Jet A/Jet A1/Jet B
Fuel Type Used	Jet A1

According to records, the helicopter was maintained in accordance with current regulations. There were no outstanding maintenance issues or indication of any pre-existing mechanical failure or other condition that would have contributed to this accident. It was equipped with an emergency locator transmitter (ELT). The ELT did not activate indicating that local forces at the ELT were below its activation threshold.

1.5 Meteorological Information

The weather at London Airport at 1600, 30 minutes prior to occurrence, was reported as follows: wind 340°T at 5 knots, visibility 15 statute miles, sky clear, temperature 26°C. At 1700, 30 minutes after the occurrence, the weather was reported as follows: wind 110°T at 2 knots, visibility 15 statute miles, a few clouds at 22 000 feet, temperature 26°C.

1.6 Flight Recorders

C-GIMM was equipped with a cockpit voice recorder (CVR) as an EMS contractual requirement. The CVR was not operating at the time of the accident because the "G" switch had tripped at some previous but undetermined time. It was observed to have been inoperative the day prior to the accident, but no journey log entry was made to that effect and no rectification was recorded. A rotorcraft flight manual supplement contained a procedure that called for checking the serviceability of the CVR prior to each flight. The crew of the helicopter was unaware of this requirement and did not check the CVR prior to the flight. The helicopter was not equipped with a flight data recorder (FDR), nor was there a requirement.

1.7 Organizational and Management Information

Canadian Helicopters Limited has its head office in Les Cèdres, Quebec. Its commercial operations are under a single operating certificate. The company has separate organizational lines for operations, flight crew, and safety. EMS operations are controlled by an Executive Vice President (VP) of Operations located in Edmonton, a VP/General Manager in Toronto, a Director of Operations in Toronto, and a Base Manager at each EMS location. Flight crew standards, training, and discipline are administered through a chief pilot in Les Cèdres, a senior EMS pilot at London, and check pilots and training pilots at individual bases. A VP System Safety in Vancouver is responsible for the company safety program.

CHL operates a fleet of over 150 helicopters from 40 locations in Canada in a variety of commercial air operations and flight training units nationwide. EMS operations are carried out under Part VII , section 703, of CARs. Ontario EMS operations expanded from six helicopters at three locations in 1999 to the present eleven helicopters at seven bases. Toronto, Thunder Bay and Sudbury are main EMS bases with two helicopters each; London, Ottawa, Kenora, and Moosonee have one helicopter each; and there was one maintenance spare.

The company concept of operations is for each base to operate substantially independently. Training and check flights are done at the pilot's local base by training and check pilots from that base. The on-line helicopter is typically used for training. Ideally, training pilots are rotated through regular shifts thereby accommodating the necessary response posture for EMS operations while using the on-line helicopter for training. EMS call-outs pre-empt training and check rides.

Since expanding, the company has experienced greater turnover of personnel and problems recruiting and retaining training and check pilots. The problem of availability of check pilots was exacerbated by delays and difficulty in getting them qualified and by a "work-to-rule" campaign by Transport Canada inspectors. This necessitated rotating pilots, including training and check pilots, from base to base, and it was not always practicable to pair pilots with a training pilot to permit training during normal shifts. It became common to do training on pilots' days off, overtime, or vacation.

A lack of consistency in training and of basic knowledge of IFR and EMS procedures was noted during recent Transport Canada check rides. This is partly attributed to the individual nature of the training program and the lack of a structure to ensure that all the prerequisites are met before a check ride. The Company has recently appointed a chief EMS pilot to address training and standardization issues.

A review of recent occurrences involving the company's S-76 helicopters in EMS operations in Ontario yielded one occurrence of interest, a near collision between two S-76 helicopters in which issues of procedures, training, and standardization were identified. During a night approach to a roof-top pad, neither pilot had a clear view of the landing area and neither realized that another helicopter was on the pad. The approaching helicopter was in the flare when it overshot after hearing an instruction to overshoot transmitted blind by the pilot in the helicopter on the pad. The parked helicopter was moved two-to-three feet by downwash from the overflying helicopter.

Both pilots in the overflying helicopter had heard parts of earlier transmissions from a helicopter on the pad, but they assumed that it was operating elsewhere and did not realize that it was on their intended landing pad. Neither pilot communicated to the other his inability to see the pad. The company did not report the occurrence to the TSB. The company carried out an internal hearing that identified numerous problems with procedures, training, and standardization. The basic standard of establishing and maintaining visual contact with the landing site was not observed; deficiencies in the SOPs were identified; inappropriate assumptions were made as to the relevance of radio communications; the company "sterile cockpit" policy may have stifled inter-pilot communication. The hearing also recommended that crew resource management skills be stressed in training programs.

1.8 Operations Manuals and Regulations

The company FOM applies to the operation of all company aircraft. It contains duties and responsibilities of personnel, guidance as to conduct of operational and training flights, and standard operating procedures (SOPs) for the operation of different helicopter types.

The FOM requires the PIC to be designated before flight; it does not specify a method of recording the designation. CARs indicate that it is the responsibility of the PIC to make entries in the aircraft journey log. The PNF made the requisite entries on the day of the accident. The PNF also identified himself as PIC in a company occurrence report.

The FOM allows training pilots to practise emergencies for their own requirements from either seat. The PF was a training pilot, and he occupied the right-hand seat which is normally occupied by the PIC.

The FOM requires a pilot to log a minimum of three take-offs, circuits, and landings within the previous 90 days to act as PIC on a commercial flight. On a training flight when a training pilot is practising emergencies, the FOM requires that the other pilot be a captain on type. The FOM does not state a currency requirement associated with being a captain for a training flight.

The Sikorsky *Rotorcraft Flight Manual*[3] (RFM) for the S-76A helicopter does not contain procedures or limits for vertical profile take-offs and approaches to heliports. Okanagan Helicopters, a predecessor company to CHL, developed the procedures and weight limitations that are published in the FOM as a SOP. The maximum gross weight for vertical take-offs varies with field elevation, ambient temperature, and headwind speed. For the conditions of the day—temperature 26°C and field elevation 902 feet—the maximum take-off weight was 8820 pounds with zero headwind and 8990 pounds with a 5-knot headwind. This performance is based on the torque specification for an engine that is not artificially topped. The weight at the time of the accident was 8842 pounds.

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[3] Sikorsky publication SA 4047-76-1, FAA-approved Rotorcraft Flight Manual, Model S-76A Helicopter

The topping procedure is not documented in the Sikorsky aircraft flight manual or in company SOPs nor is it otherwise approved by the manufacturer. The OEI procedures and limitations charts are based on normal engine operation which, according to certification data[4], would provide a two-and-a-half minute OEI limit of 111% torque or 826°C turbine inlet temperature (T5) and a 16-second transient limit up to 155% torque. These limits are not achievable when the engine is topped. Investigation indicated that the practice of topping is used by other operators, not only for the Sikorsky S-76A helicopter, but also for other twin-engine types.

The SOP part of the FOM provides guidance for the use of checklists during both normal and emergency operation of the helicopter. The normal procedures section requires checklists to be followed using the challenge/response method. The emergency procedures section, after initial memory response items, requires the PNF to carry out checklist items and call out both the challenge and response to keep the PF informed without distracting him. There are no specific SOPs for procedures such as circuits that are particular to the training environment. The SOPs do not provide specific methods of simulating and communicating in-flight emergencies during training. Material on training procedures existed in other forms in the company but was not specifically used for this flight.

The part of the FOM dealing with air ambulance operation requires checklists to be used in accordance with SOPs. However, the part of the FOM dealing with training does not discuss the use of checklists. Specifically, the FOM does not provide for abbreviating or otherwise deviating from normal operating SOPs. However, company pilots generally considered that it was impractical to do all the normal challenge and response checks during recurrent training. In the circuit, the landing check would be abbreviated, omitting items that were considered unnecessary. For instance, since the landing gear is not raised after take-off in a circuit and doesn't need to be checked before landing, the landing gear check is omitted. The accepted practice was for the PNF to do the check silently and say it was complete.

The SOPs require a landing briefing as part of both IFR and VFR procedures. In practice, VFR training was viewed as being for hands-on techniques and did not require adherence to all of the cockpit procedures, briefings, etc. that are associated with commercial flights and would be practised during IFR training.

2.0 Analysis

Weather and mechanical failure were not issues in this occurrence. The analysis will focus on the crew communication and coordination that led to the PF incorrectly using a both-engines-operative approach and landing technique when one engine was simulated inoperative. In addition, the investigation considered the effect of topping an engine during simulated OEI training, the level of risk associated with routine training operations by the company[5], and company organizational issues.

2.1 Crew Communication and Coordination

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4 FAA Type Certificate Data Sheet No. H1NE. Section I

5 "Company" in the context of this report means the EMS division. The investigation did not examine practices of other divisions of Canadian Helicopters.

The safety significant event just prior to the accident was the PF raising the collective at approximately 35 feet during the landing flare. This action resulted in a decrease in rotor RPM and a loss of lift which led to the excessive sink rate and hard landing that damaged the helicopter. The PF's actions represented a misapplication of a good rule[6] in that he applied a technique for a multi-engine landing in a situation in which one engine was simulated inoperative. The error resulted from a breakdown in crew coordination during which the two pilots formed differing mental models of the situation.

When the PNF reduced power to simulate failure of the number 2 engine at the critical decision point after take-off, he intended the exercise to include an OEI circuit and landing. After the PF had correctly carried out the initial response to the simulated engine failure, the PNF reintroduced number 2 engine power as a temporary expedient to facilitate the climb to circuit height. There was no intent to terminate the OEI exercise. The PNF did not announce the reintroduction of power or otherwise indicate that the OEI exercise was complete. When he later moved the engine lever to flight idle, it was to restore the helicopter to the simulated OEI condition and continue the pre-existing OEI exercise, not to introduce a new failure. Accordingly, and consistent with not having announced the restoration of power, he did not announce this reduction of power.

When the PF saw the PNF advance the number 2 engine lever during the climb-out, he assumed that the OEI exercise had been terminated. The PF did not notice that the PNF restored the simulated OEI condition by returning the number 2 engine lever to the flight idle condition when established downwind, nor did he expect it since he understood that the briefed intention was to carry out a simulated engine failure at the landing decision point as on the previous approach.

The PNF assumed that the PF understood that the circuit would be conducted OEI and, therefore, no communication was necessary. The PF anticipated an engine failure exercise closer to the landing decision point, as had been done on the previous approach, consistent with the intention to do the exercise again. As he did not see the PNF retard the engine lever on the downwind leg, the PF assumed they were still in a two-engine condition when they entered the landing flare.

The cues that would normally indicate a failed engine to the PF were either not present or not compelling. In a real situation, loss of engine power would be announced by an aural tone and a warning light, followed by annunciations of associated system failures that would persist as long as the engine remained inoperative. In this instance, these warnings were not present because the simulated inoperative engine was operating at flight idle. Additionally, torque indications for the two engines are provided by a single gauge with a separate needle for each engine. An angular difference between the needles would be readily visible, drawing the pilot's

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[6] The failure mode was identified in accordance with the TSB Integrated Process for Investigating Human Factors. The following sources provide explanations of failure modes that may contribute to aviation accidents:

Norman, D.A. (1981). "Categorization of action slips"in *Psychological Review*, 88 (1), 1-15.;

Nagel, D.C. (1988). "Human error in aviation operations" in E.L. Weiner and D.C. Nagel (Eds.), *Human factors in aviation* (pp. 263-303). San Diego, CA: Academic Press; and

Reason, J. (1990). *Human error*. New York: Cambridge University Press.

attention to a discrepancy in torque between the two engines. When torque was discussed by the two pilots in the downwind, the readings were 70% and 0%, putting the needles at the 1 o'clock and 7 o'clock positions, aligned with each other offering no angular displacement to attract the PF's attention.

In the absence of such cues, verbal communication between the crew was critical to ensuring both crew members were aware of the aircraft state at any given time. In this instance, the PNF did not aurally announce actions he was initiating to simulate emergencies, nor did he provide adequate critical information that would normally flow from the PNF to assist the PF in managing critical parameters. Contrary to SOP, the PF did not carry out normal pre-landing briefings, which would have indicated to the PNF the difference in understanding. As well, he did not otherwise assert a crew concept in the conduct of the flight, possibly viewing the purpose of the flight as being his own hands-on training and recognizing the role of the PNF as the training pilot.

Contributing to the low level of communication were the following:

1. A flat 'trans-cockpit authority gradient'[7]. Both pilots thought the other was PIC. The PNF recognized the competence of the PF who was also a designated company training pilot. The flight at hand was a fairly routine, repetitive, and well-understood task, resulting in minimal briefing and monitoring activity. Additionally, the PNF was not flying regularly since assuming duties as chief EMS pilot. The fact that this was the PNF's first flight in 28 days and only his third in 90 days may have further flattened the authority gradient and contributed to the low level of verbal communication.

2. The lack of SOPs for the simulation of in-flight emergencies. SOPs represent an administrative defence that serve to create common expectations among crew members. In this occurrence, there were no company SOPs outlining the method of simulating and communicating in-flight emergencies during training. Other material regarding training procedures was available in print and on the company web site but was not used. SOPs could have served to increase the level of cockpit communication (e.g., through the requirement for standard briefings) or could have created a common expectation in the absence of verbal communication (e.g., by requiring a standard method of announcing simulated in-flight emergencies).

3. The lack of SOP for checks and briefings when performing circuits during training. SOPs call for challenge-and-response checks and pre-landing briefings, but pilots accepted that normal procedures did not apply in the circuit due to its short duration. Had there been a pre-landing briefing, it likely would have alerted the PNF that the PF was unaware of the simulated engine failure.

4. The company general SOP for two-pilot, multi-engine operations states that checklist items executed in flight should involve only the PNF unless the PF is an integral part of an item in order not to distract the PF from the primary mission of flying the aircraft. The S-76 helicopter normal procedures SOP states, in bold-face, that the use of the challenge/response method is mandatory in both IFR and VFR operations. The emergency procedures call for the PNF to use the checklist, calling out both the challenge and response to keep the PF informed without distracting him.

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[7] The term 'trans-cockpit authority gradient' is the relative authority and responsibility between crew members. A flat gradient implies a diffusion of authority and responsibility.

2.2 Engine Topping

The topping procedure results in the topped engine operating to limits below the normal engine specifications unless the crew advances the engine lever to its normal operating position. Gross weight at the limit published in company SOPs for vertical profile take-offs and approaches to heliports will result in less than expected helicopter performance because of the reduced performance capability of the topped engine. During the OEI climb that immediately preceded the accident, the helicopter was essentially at the published weight limit for the ambient conditions for both engines operating normally, and the reduced power available from the topped engine was insufficient for the helicopter to climb and clear obstacles after the simulated engine failure at the critical decision point. This and expediency were the reasons that the PNF brought the simulated inoperative engine back on-line.

During the approach, had the "good" engine not been topped, it would have produced more power, mitigating the consequences of the improper approach technique. In particular, the increased power would have reduced the severity of the landing and increased the time available for the simulated inoperative engine to respond to the demand for power when the PNF advanced the engine lever.

The topping procedure is seen as having training value by exposing pilots to rotor rpm decay without exceeding engine limits. This allows the pilot to experience the effect of limited power available in OEI operation and to learn to lower the collective to regain rotor rpm rather than continue to pull when the engine limit is reached. When this training is conducted in altitude-critical situations such as at the critical decision point and landing decision point, training pilot reaction and engine response times are too slow to ensure recovery in the event of improper technique by the PF. Without any other defence to mitigate the effects of the decreased power available, operating with a topped engine poses a risk of accident with potential for serious damage to the helicopter and injury to the crew.

2.3 Risk Management Issues

In addition to the penalties associated with engine topping, a number of routine practices, observed during this occurrence, served to increase the level of risk to which the flight was exposed in conducting simulated emergency procedures training:

1. Additional fuel load is typically carried on training flights to facilitate recall and dispatch for a medevac flight without a refuelling delay, thereby reducing performance margins of the helicopter.

2. OEI exercises are carried out perpendicular to the button of the runway to simulate a pad. This pattern virtually eliminates the possibility of conducting a run-on landing in the event of difficulty in the vertical landing and increases the risk of mishap during training operations.

3. Simulated engine failures are introduced at the landing decision point, the most critical point of the approach, where the aircraft is committed to landing. As a result, there is no time for either pilot to correct an error, no time for the training pilot to coach the PF, and no opportunity for the crew to carry out a coordinated decision making process.

Training operations entail a number of unwritten procedures, that are at variance with or not approved by the company's FOM and SOPs. As a result, there are risks associated with training procedures that are not adequately recognized and controlled by company management. These serve to increase the risk of mishap during training operations:

1. The company practice of carrying out vertical profile procedure training without calculating a weight limit in accordance with SOPs results in a risk of training operations being carried out at gross weights in excess of limits while operating with engine power below normal specifications. As a result, recovery from an actual engine failure may not be possible.

2. The briefings and checks called for in SOPs are routinely omitted during VFR training missions on the grounds that they are applicable only to IFR training. The omission of a landing briefing during the accident circuit eliminated the opportunity to correct a misunderstanding prior to a critical phase of flight. This practice reduces the training value and increases the risk of mishap during training.

3. The challenge/response method of carrying out checklist procedures called for in SOPs is not practised on training flights. This increases the risk of the crew omitting routine but essential actions.

4. When practising emergency procedures, the PNF carries out procedures silently rather than keeping the PF informed, as called for in the SOP. This obviates crew co-operation and co-ordination in critical situations.

5. There are no SOPs for checks and briefings when performing circuits during training. As a result non-standard procedures are adopted that deviate from normal flight operations.

6. There are no SOPs for the simulation of in-flight emergencies, resulting in inconsistent use of informal or unwritten procedures that differ amongst training pilots, weakening the standardization value of training and increasing the risk of misunderstanding.

7. There is no procedure or requirement to formally designate a PIC for training flights. This created confusion and undermined crew coordination in this occurrence. This increases the risk of improper or poorly coordinated procedures during recurrent training operations.

The FOM addresses the designation of PIC and pilot qualifications and currency without indicating how this is to be accomplished or documented, leaving much to individual interpretation. The FOM requires a minimum of three take-offs, circuits, and landings to qualify as PIC on a commercial flight. The FOM has no specific currency requirement for the PIC on non-commercial flights. The PNF had flown only two flights, both EMS flights, in the previous 90 days. There was no record of the number of take-offs and landings performed.

Training is carried out on an ad hoc basis so as not to interfere with EMS operations. Frequently and unpredictably, training is delayed or cancelled when the helicopter is recalled or is otherwise not available. Pilots are required to train during vacation and off-duty time. Training is subject to the availability of training pilots, who may be on vacation or off-duty. The lack of a training schedule and dedicated training resources imposed stress on pilots due to their inability to get training accomplished in a timely manner and the possibility of their qualifications lapsing.

Company training and standardization have been challenged by the expanded EMS operation. Inadequacies of crew procedures, coordination, and standardization were noted and were recognized by the company in another recent incident that had accident potential. Similar deficiencies were evident in this occurrence, involving the chief EMS pilot, whose responsibility was training and standardization, and a training pilot whose role was to implement it.

The CVR was inoperative. One pilot had checked the CVR a day earlier and found it unserviceable but did not record the deficiency in the aircraft log book. The unserviceability was not recorded on subsequent flights. Neither pilot checked it this flight or was aware of the requirement to do so. The requirement to check it is in a RFM supplement but not in SOPs. That neither the chief EMS pilot nor a training pilot was aware of the requirement is an indication of weakness in standardization and training within the company's EMS division.

The company diffuses safety, operations, training, and standardization responsibilities through different organizational lines. Organizationally, this pushes decision making and conflict resolution up to the level of the company president, appropriate for corporate policy issues but too high a level for day-to-day operating issues. As a result, company staff cope with day-to-day issues by adopting work-arounds and using unwritten or informal procedures such as those cited above. The resolution of the immediate problem is effective because of the competence and knowledge of individual personnel, but the underlying issues remain. Over a period of time, these work-arounds become norms and may be passed on to new personnel who do not have as much knowledge and experience. Because of the absence of a direct impact on their specific responsibility, management does not discern a problem or hazard. The company's good operational safety record is viewed by company management as validation of the approach. There is no indication that the company had a risk or safety management process to define the risk associated with these norms, to put in place appropriate mitigating measures or defences, and to ensure explicit senior management recognition and acceptance of residual risk. Thus the risk associated with these norms is tacitly, perhaps unknowingly, accepted by the company. Deficiencies in procedures, training, and standardization in the company's EMS division pose a latent risk of accidents and incidents.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. During a circuit with one engine simulated inoperative, a breakdown in crew coordination resulted in the two pilots forming differing mental pictures of the situation.

2. The absence of a compelling cue that one engine was inoperative, the absence of a before-landing briefing, and the low level of communication between pilots resulted in the PF flying the approach as if both engines were operating.

3. The PF raised the collective at approximately 35 feet during the landing flare, a technique appropriate to a multi-engine landing although one engine was simulated inoperative. As a result, a high rate of descent developed that the crew could not arrest before the hard landing.

4. The operative engine was not operated in accordance with approved procedures resulting in less than rated power being available in the landing flare and contributing to the development of an excessive rate of descent.

3.2 Findings as to Risk

1. The company's EMS division routinely engaged in several operational practices that serve to reduce the margins of safety and increase the risk of accident during training operations, including topping the operative engine, carriage of additional fuel, carrying out approaches perpendicular to the runway, and deliberately simulating engine failures in situations that preclude effective coaching, crew co-ordination, or correction of error.

2. Training operations entail numerous informal and unwritten procedures and deviations from the company FOM and SOPs. As a result, recurrent training operations employ unapproved and non-standardized procedures, creating risks that are not adequately recognized and controlled by company management. This is exacerbated by the effect of company expansion, the lack of standardization in company procedures, the diffuse lines of responsibility for operations, pilot training, standards, and safety within the company organizational structure and the ad hoc nature of training arrangements.

3.3 Other Findings

1. Reliance on the training pilot to bring the simulated inoperative engine back on line to recover from

a poorly executed simulated OEI landing procedure does not provide an effective defence against a landing accident. The combined time for human reaction and engine response is too slow to correct a decay in rotor rpm and reduce the ensuing high sink rate before a hard landing results.

2. The CVR was not operating at the time of the accident because the "G" switch had tripped at some previous but undetermined time. Checking the serviceability of the CVR was routinely omitted from normal preflight checks. The pilots involved in the occurrence did not make a practice of checking the CVR and did not know of the requirement to check it.

3. The company FOM does not contain currency requirements for a PIC on a training flight, and there was no record kept of the number of take-offs, circuits, and landings by the PNF to establish his currency as a PIC for EMS operations.

4.0 Safety Action

The operator has taken the following actions that address safety issues identified in this investigation:

1. Canadian Helicopters has contracted with Flight Safety International to do Sikorsky S-76A recurrent training on a flight simulator at West Palm Beach. The company no longer carries out emergency training on their aircraft. The practice of “engine topping” has been discontinued.

2. The principles of CRM, including crew co-ordination and communication, is inherent in the simulator training.

3. Standardization is improved by a central (Flight Safety International) training organization and by eliminating any base-specific elements from the simulator training.

4. The number of company check pilots is reduced to four and check rides are carried out in the simulator , resulting in more consistent flight test standards.

5. A new Simulator Training section has been added to the Company Operations Manual incorporating training standards that are applicable to all bases.

6. The S-76 normal procedures SOP, Emergency Checklist, and Cockpit Checklist have been rewritten. Items from the RFM that were previously excluded are now included.

7. CRM training has been increased to become a bi-annual company requirement and to include material specific to the company's EMS operations.

8. Increased emphasis is placed on the role of Flight Standards pilots at each of the company's operating bases. Frequency of flight standards and training pilots meetings is increased to every six months (previously annual).

9. Increased emphasis is placed on recurrent ground training, including IFR and SOP seminars and training in new avionics. Standardization is achieved by either a dedicated instructor or a third-party consultant who travels to each operating base.

10. New criteria have been adopted for upgrading pilots to captain status.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 01 June 2004.

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