DATA SUMMARY

LOCATION

Date and time	**Saturday, 18 June 2011; 17:15 local time**
Site	**Tabuyo del Monte (León, Spain)**

AIRCRAFT

Registration	**SP-SUI**
Type and model	**PZL W-3AS**
Operator	**LPU Heliseco sp. z o.o.**

Engines

Type and model	**PZL-10W**
Number	**2**

CREW

	Pilot in command	Copilot
Age	**52 years old**	**38 years old**
Licence	**ATPL(H)**	**CPL(H)**
Total flight hours	**7,075 h**	**859 h**
Flight hours on the type	**1,700 h**	**622 h**

INJURIES

	Fatal	Serious	Minor/None
Crew			**2**
Passengers			**9**
Third persons			

DAMAGE

Aircraft	**Destroyed**
Third parties	**Trees at the crash site**

FLIGHT DATA

Operation	**Aerial work – Commercial – Training**
Phase of flight	**Takeoff – Initial climb**

REPORT

Date of approval	**30th October 2013**

1. FACTUAL INFORMATION

1.1. History of the flight

Minutes before 15:00[1] on 18 June 2011, the crew of a PZL W-3AS aircraft, registration SP-SUI, commenced with the engine start procedure. Weather conditions were suitable for the flight. After two attempted stand-alone engine starts, first with the #2 engine and then with the #1, they had to resort to the external auxiliary power unit (APU) to start the #1 engine, followed by the #2.

The flight was scheduled to be a training flight for one of the firefighting brigades stationed at the Tabuyo del Monte base in León, located at an elevation of 986 m. They were going to fly to an area located some 10 km away from the base. The flight crew[2] assembled by the operator consisted of a captain, sitting in the no. «2» position in the cockpit, and another pilot seated in the no. «1» position who would be the pilot flying, and who would be supervised by the captain.

The brigade boarded the helicopter when instructed by the crew. After securing the tool they were carrying in the space allocated for that purpose, the brigade members took their seats and fastened their seatbelts.

The helicopter started its takeoff at 15:14:08 on a heading of 305°. The crew confirmed that the cockpit instruments were in the green normal operating region and after yawing slightly left and a short taxi run on the ground, they started climbing 10 seconds later and turned right. The ground below was at a 6% incline.

Twelve seconds later (15:14:30), with the aircraft at a radio-altitude of 45 m (147 ft), a difference in the torque readings for the two engines of 12% was recorded, after which the turbine gas exhaust temperature for the #1 engine (TOT_1), which at that instant was 614° C, and the #1 engine compressor RPMs (N1_1) started to decrease gradually while the #1 engine torque (TQ_1) rose rapidly.

Eleven seconds later (15:14:41) the pilot flying (in the «1» position) is heard on the cockpit voice recorder considering a return to base and reporting on the radio "we're going back", immediately followed by "yours" as he transferred control to the captain. Four seconds later (15:14:45) the difference in the torque readings between the two engines was 80%, N1_1 (RPMs) was at 77% and the temperature (TOT_1) had fallen to 490 °C.

[1] All times in this report are in UTC. To obtain local time, add two hours to UTC.
[2] The minimum crew required for a PZL W-3AS aircraft is one pilot seated in the LH seat in the cockpit (the «1» position). The «2» position is in the RH seat in the cockpit.

The helicopter maintained its altitude above the ground thanks to the downslope of the hill they were flying over. The crew continued to manage the emergency while they tried to clear a power line that cut across their path.

Another 11 seconds later (15:14:56), the captain is heard on the cockpit voice recorder saying "the other one, downward", to which the pilot in the «1» position asks, "number two?", with the captain replying "two, down a little".

At 15:15:15 the helicopter crashed as it made contact with the tops of some pine trees some 200 m away from the takeoff location.

The aircraft fell on its right side. Its main rotor blades broke and the tail cone separated from the central part of the frame, which had been pierced by a tree trunk (Figure 1).

The aircraft's occupants were uninjured or had light bruises.

Figure 2 shows the path taken by the aircraft as determined from global positioning system (GPS) data. The timestamps are those recorded by the GPS.

Figure 1. Aircraft wreckage

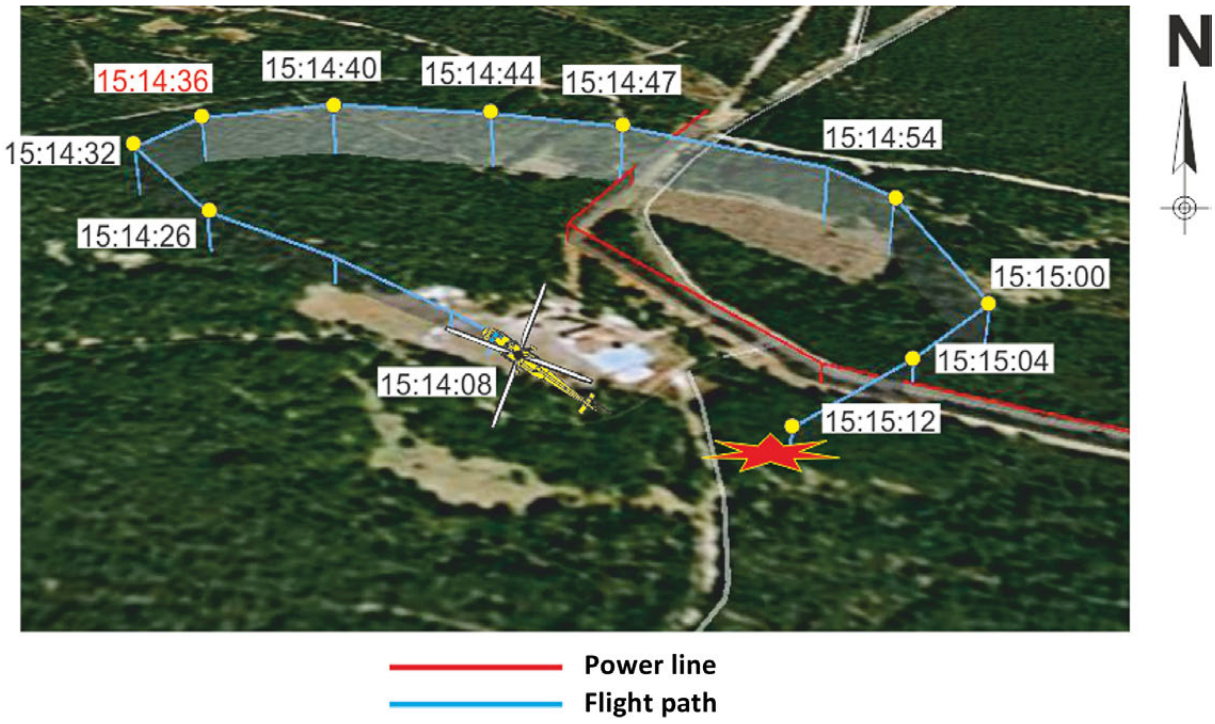

Figure 2. Path taken by the aircraft

1.2. Personnel information

Both pilots had valid licenses and medical certificates, which were in compliance with the Joint Aviation Requirements for Flight Crew Licensing (JAR-FCL) approved by the Joint Aviation Authorities (JAA). They had also taken part in the refresher training required for the aircraft type.

The pilot in «1» position used to fly for Spanish operator of aerial works Hispánica de Aviación, S.A., alternating with other flights for Polish operator LPU Heliseco Sp. Z.o.o. He had recently started flying as captain in flights for this operator. This experience lasted for some three hours.

The pilot in the «2» position was of a different nationality than the pilot supervising him and had considerable flying experience. As experienced pilot he had the status of base chief for his operator.

This distribution and function of each of the pilots in the cockpit was due to the fact the pilot in position «1» was at the beginning of his training period as captain for the Polish operator.

Both pilots flew basically the same aircraft type and model and during this flight the communications between them took place in Spanish.

1.2.1. *Pilot in the «1» position*

Age:	38
Nationality:	Spanish
Flight license:	CPL(H)[3] • Initial issue date: 14/06/2005 • Expiration date: 24/07/2014
Class 1 medical certificate:	• Date renewed: 7/04/2011 • Expiration date: 21/04/12
Valid ratings and expiration dates:	• W-3 Sokol: 28/02/2012 • Agricultural (firefighting only): 31/05/2012

Training: CRM[4] aptitude check by refresher training on 7/02/2011

Training courses received from operator Heliseco Sp. Z.o.o. covering: organization and regulations of the aerial operations; introduction to regulations Part M and Part 145 of airworthiness and maintenance; minimum equipment list and technical logbook onboard helicopters.

1.2.2. *Pilot in the «2» position*

Age:	52
Nationality:	Polish
Flight license:	ATPL(H)[5] • Initial issue date: 3/04/2006 • Expiration date: 23/03/2016
Class 1 medical certificate:	• Date renewed: 10/01/2011 • Expiration date: 10/01/2012
Valid ratings and expiration dates:	• TR W-3 Sokol: 20/11/2011 • TR Mi2: 4/02/2012 • AGRO (Agricultural spraying), 4/02/2013 • FFF (firefighting), 20/11/2011

Training: MCC – Multi Crew Cooperation/Coordination, valid until 28/02/2012

Spanish competence certificate and specific vocabulary.

[3] CPL(H): Commercial Pilot License (Helicopter).
[4] CRM: Crew Resource Management.
[5] ATPL(H): Airline Transport Pilot License (Helicopter).

1.3. Aircraft information

The PZL W-3AS aircraft, manufactured by PZL-Świdnik, is equipped with two PZL-Rzeszów PZL-10W engines. The aircraft's weight at the start of the operation was 5,929 kg. Its maximum takeoff weight (MTOW) was 6,400 kg.

The aircraft had a valid airworthiness certificate issued by the Polish authority and had been maintained in accordance with the approved maintenance program.

According to the aircraft logbook, it had a total of 3,076 flight hours. The engines had been installed in April 2011. They, along with the airframe, underwent 300-hr inspections on 6 June 2011. They had been flown a total of three hours between then and the date of the accident.

The aircraft manual specifies that the minimum flight crew is one crewmember seated in the LH seat, and two crewmembers for instrument flight (IFR).

1.3.1. *Brief description of the aircraft's controls and devices*

ALAE-2

This unit electronically controls the fuel flow to the engine. It automatically keeps it from functioning above its limits and stabilizes its operation. It relies on information from various parameters, primarily N1, TQ, TOT and maximum turbine RPMs (N2), which it processes before sending the fuel supply signals to the corresponding engine.

ALRT-2B

A hydromechanical limiter that regulates the speed of the power turbine. It is located next to the engine and it takes over the functions of the ALAE-2 if it fails.

The operation of ALAE-2 and ALRT-2B is mutually exclusive, meaning they can provide the same functions but not at the same time. If the pilot selects MANUAL on the engine power control lever, then ALRT-2B takes over and the automatic engine fuel control system (ALAE-2) can only be reengaged once the helicopter is on the ground.

ALRP-5

This unit controls the direct supply of fuel to the engine based on the signals it receives from ALAE-2. Inside this unit is WLP-3-5, an electrical actuator that governs the fuel valve.

Both ALRT-2B and ALRP-5 feature a mechanical device whose position mirrors the type of control, manual or automatic, selected via the engine power control lever in the cockpit and that can only be reset to automatic mode by a technician with the helicopter on the ground.

Engine power control lever

There are two levers, one for each engine, located in the top control panel in the cockpit, that are used to select or control the thrust required at any given moment. The positions of the levers are as follows (see Figure 3):

- "SHUT-OFF": to stop the engine (fuel cutoff).
- "GROUND IDLE": idle position.
- "START": start position.
- "GOV FLIGHT": automatic control during flight.
- "MANUAL": switch to hydromechanical control.

1.3.2. *Aircraft emergency procedures*

Section 3 of the Aircraft Flight Manual includes various emergency procedures, including one for a malfunctioning engine fuel control system. This procedure lists the steps to take when the difference in torque readings between the two engines is above 5% during normal flight. Appendix 1 to this report contains a copy of this procedure.

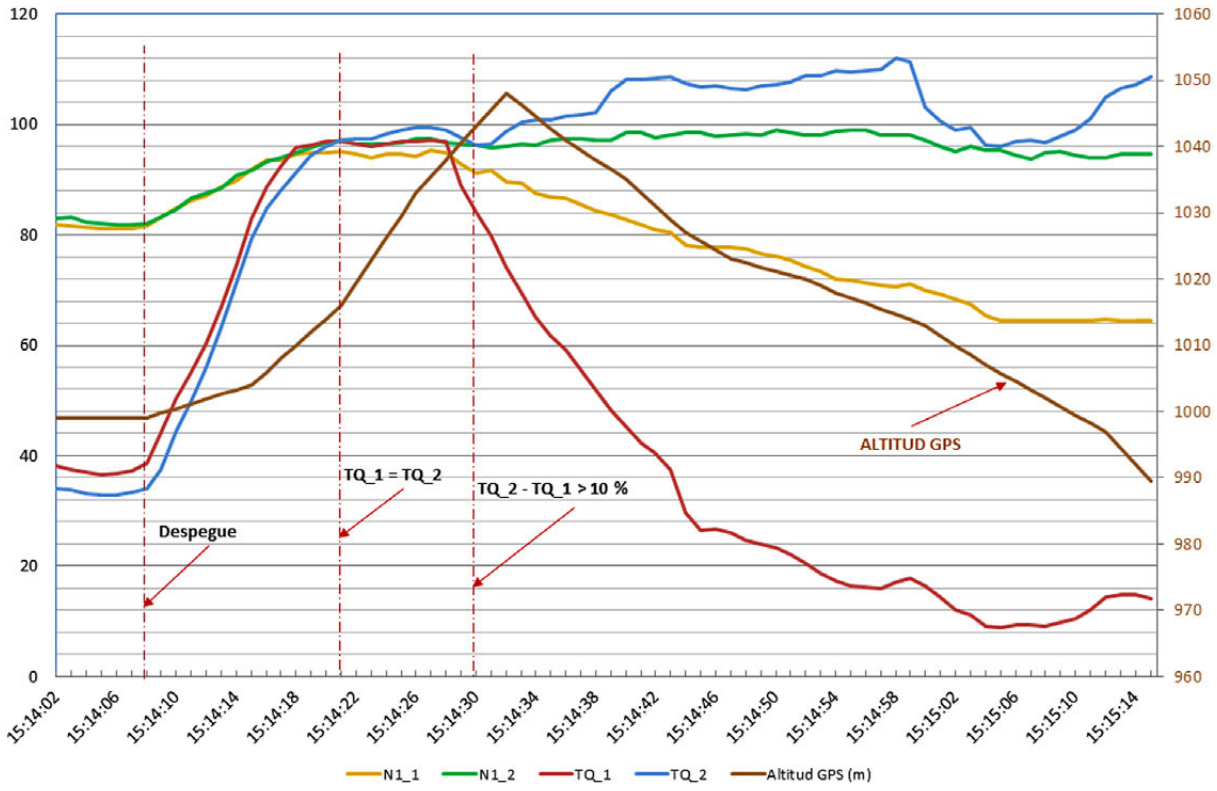

Figure 3. Flight data recorder parameters

1.4. Flight recorders

The aircraft was outfitted with flight data and cockpit voice recorders. Figure 3 shows the values for torque (TQ_1 and TQ_2 in percent) and compressor RPMs (N1_1 and N1_2 in percent) for both engines, along with GPS altitude[6]. The values for main rotor RPMs could not be validated.

The cockpit voice recorder taped the conversation referenced in Section 1.1. No exchanges were recorded between the flight crew and the firefighting brigade being transported onboard.

1.5. Survival aspects

Both the flight crew and the members of the firefighting brigade had their seat belts fastened throughout the entire flight; however the helmets were only being worn by the latter ones. After the aircraft crashed to the ground, everyone onboard was restrained by the harnesses and only some occupants received minor bruises.

The evacuation was orderly despite the initial confusion. The position of the helicopter, which was resting on its right side, meant that only the left door was accessible, though it had to be opened by one of the pilots from the outside after efforts to open it from the inside were unsuccessful.

The airframe withstood the impact with no deformation of the interior.

1.6. Tests and research

1.6.1. *Inspection of the aircraft*

1.6.1.1. Findings of the onsite inspection

The inspection of the wreckage revealed that:

- There were small tree branches in the ventilation system ducts for the engine and accessories, as well as firefighting powder residue, which had been sprayed by the responders who reported to aid the aircraft's occupants.
- The hydromechanical turbine RPM limiter (ALRT-2B) and the fuel control pump (ALRP-5) on the #1 (left) engine showed that the engine power control lever was placed in manual control during the flight. This indication could not be checked in the right engine, which could not be accessed during the onsite inspection.
- The right engine power control lever was jammed at about the 60% position. The lever for the left engine was in the SHUT-OFF (fuel cutoff) position. See Figure 4.

[6] The GPS altitude shown is approximate, since the vertical accuracy of the system is limited.

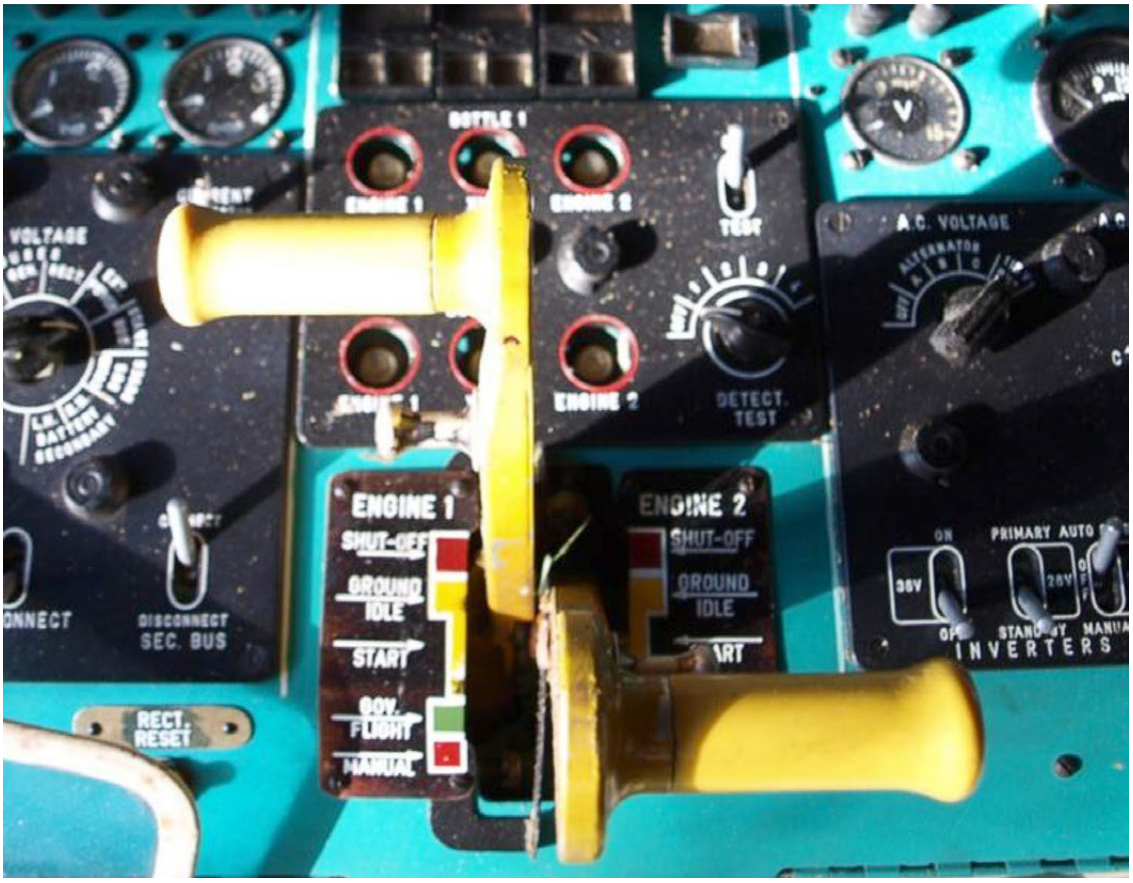

Figure 4. As-found positions of the engine power control levers

1.6.1.2. Workshop inspection

The aircraft was inspected on 28 June 2011 by a working group consisting of representatives from the aircraft, engine and fuel system manufacturers, the operator and this Commission.

The most important findings are listed below:

- The tests conducted on each engine's electronic fuel control unit (ALAE-2) showed that they were both within operating tolerances.
- A visual inspection of the filter on the #1 engine fuel supply control pump (ALRP-5) showed some impurities.
- The #2 (right) engine ran in automatic mode throughout the flight.
- There were no metal chips in the engine detectors.
- The right engine could not rotate freely due to the damage it had sustained as the aircraft struck the ground.
- The left engine rotated freely. The borescope inspection performed showed damage on the blades of the axial compressor stages that gradually decreased toward the

internal stages. Traces of firefighting powder was also found on some of the axial compressor stages.

The inspection concluded that the following additional tasks should be carried out:

- Inspection of pump ALRP-5 on the #1 and #2 engines.
- Inspection of the ALAE-2 control units on the #1 and #2 engines.
- Inspection of the ALRT-2B hydromechanical limiter the #1 and #2 engines.
- Borescope inspection of the #1 engine.

1.6.1.3. Borescope inspection of the aircraft's left engine

A second, more detailed borescope inspection was conducted in August 2011. The results helped to determine the extent of the internal damage in the left engine.

Of the axial compressor's six stages, the first exhibited significant damage to at least 60% of its moving blades, thus placing it outside its operating limits. The blades on the second and third stages showed progressively less damage, though they too were beyond operating limits. A thin layer of firefighting powder was found on these three stages.

The last three stages did not show any signs of powder residue. Some of the blades were visibly damaged but not seriously affected.

No damage was found in the centrifugal compressor, the combustion chamber, the compressor turbine or the high-pressure turbine.

No internal engine components were found to have detached and caused internal damage affecting the engine's operation.

1.6.2. *Status of the investigation*

So as to locate the source of the mismatch between the left and right engine torques, this Commission repeatedly requested the country of manufacture to inspect the components singled out after the first inspection, but the tests proposed were never arranged since no reply was received.

1.6.3. *Inspection of the access doors*

The operation of the passenger compartment's left door was checked once the aircraft was recovered. It was noted that after releasing the locking mechanism, the door was difficult to slide along the upper and lower tracks due to the misalignment caused

following the crash. Also, since the aircraft was inclined at a 115° angle from its longitudinal axis, its weight was being transferred to the upper track.

1.6.4. *Crew statements*

The two crewmembers stated that they had flown together two or three times and that they were familiar with the base of operations from previous fire seasons. The crew was seated in the cockpit in accordance with the policy of the operator that employed the pilot seated in the «1» position, where pilots being considered for promotion to captain are supervised by more experiences captains.

As regards the operation, they knew the surrounding landscape, which caused the takeoff to be slightly more vertical than normal. It was the first flight of the day.

During the emergency, the pilot in the "1" position stated having seen yellow lights on the instrument panel. The other pilot did not. They did not hear any aural warnings.

In response to the emergency, the pilot in the "1" position stated that the power control levers were placed in MANUAL, but that this action did not result in the mismatched engine torques equalizing. As for the main rotor RPMs, the captain recalled they were at 105% at the start of the emergency.

Their decision to return to base was hampered by the power lines they had to fly over.

In terms of the members of the firefighting brigade, there were no instructions given during the flight to the brigade leader regarding the emergency landing procedure.

1.6.5. *Fuel*

The helicopter had been refueled to maximum capacity the day before the flight. The fuel tank at the base had been refilled three days earlier. The analysis of the fuel samples taken from the supply tank, as well as from each engine's fuel pump, showed that the fuel complied with the manufacturer's specifications.

1.7. Organizational and management information on the operator

LPU Heliseco sp. z o.o. is certified by Poland's civil aviation authority as an aerial work operator and a Part-145 maintenance center. As a maintenance organization, it has several facilities in Spain, including one located in the Tiétar Aerodrome (Toledo).

At the time of the accident, the aircraft was being operated under a wet lease[7] agreement between LPU Heliseco sp. z o.o as the lessor, and the Spanish company

Hispánica de Aviación, S.A., also an aerial operator, as the lessee. The lease contract was entered into with the approval of Spain's Aviation Safety Agency (AESA) under the stipulations that allow for foreign crews and aircraft to be contracted during annual forest firefighting and fire prevention campaigns. The authorization granted imposed a series of requirements on both the lessor and lessee concerning inspections and the conduct of the activity.

The two air operators mentioned are different companies that are based at the same aerodrome and that basically operate the aircraft of the same type and model. At the same time both operators have signed contracts to collaborate in performing aerial works.

As for the flight crew, the operator LPU Heliseco sp. z o.o. assigned to the operation two pilots who were licensed in accordance with the Joint Aviation Requirements Flight Crew Licensing (JAR-FCL) requirements and that enabled them to pilot the PZL W-3AS aircraft. The captain on the flight, seated in the «2» position in the cockpit, was Polish and flew regularly for this operator. The second pilot, seated in the «1» position in the cockpit, was Spanish and flew regularly for Hispánica de Aviación. Both crewmembers had received refresher training and cockpit resource management training from their respective usual operators.

LPU Heliseco sp. z o.o. has an Operations Manual (OM) that is approved by Poland's civil aviation authority. It was originally written in Polish, though a certified translation of some of its contents to English exists. The contents of said OM include the following information, found in Section A, Part 5, regarding the qualifications of the members of the flight crew:

- The "pilot under instruction" is the flight crewmember who is undergoing training or, in agricultural flights, the crewmember who is performing the practical tasks in the training manual. In the first case said member shall be accompanied by an instructor and in the second case by the chief of the agricultural base or by an instructor.
- Procedure for validating the qualifications obtained at another air operator by pilots performing flight duty for the operator. In this case the pilot's experience shall be verified and training shall be conducted as specified by Heliseco under the supervision of an instructor assigned by management.

2. ANALYSIS

2.1. Analysis of the flight crew's actions

Immediately after takeoff the crew confirmed that the parameters were in the green band and started to climb in a manner suitable to their operational setting. The torque

[7] A wet lease agreement is one in which air operators lease both aircraft and crews to or from other operators.

on both engines rose to 97%, a value that remained stable for about 10 seconds. Then, suddenly, before reaching the highest point on their flight path, as shown in Figure 2, the TQ_1 torque value started to fall gradually, reaching a difference of 10% with respect to the #2 engine torque value (TQ_2).

This situation requires executing an emergency procedure that is included in Section 3 of the Aircraft Flight Manual titled "Engine Fuel Control System Malfunction" (see Appendix 1), which specifies the following actions:

- Set both engine power levers to MANUAL.
- If a torque split above 10% persists during prolonged flight eliminate it by retarding the power lever of the engine with the higher torque.
- Before landing move the previously retarded power lever to the full forward position.
- If engine parameters exceed takeoff limits and cannot be controlled manually, shut down affected engine.

Figure 5 shows the communications that took place in the cockpit and the flight data recorded.

Once the torque TQ_1 dropped to point A, the crew recognized the emergency, though no dialogue took place between the crewmembers. The pilot flying stated seeing yellow warning lights on the instrument panel, possibly involving GOV MAX.

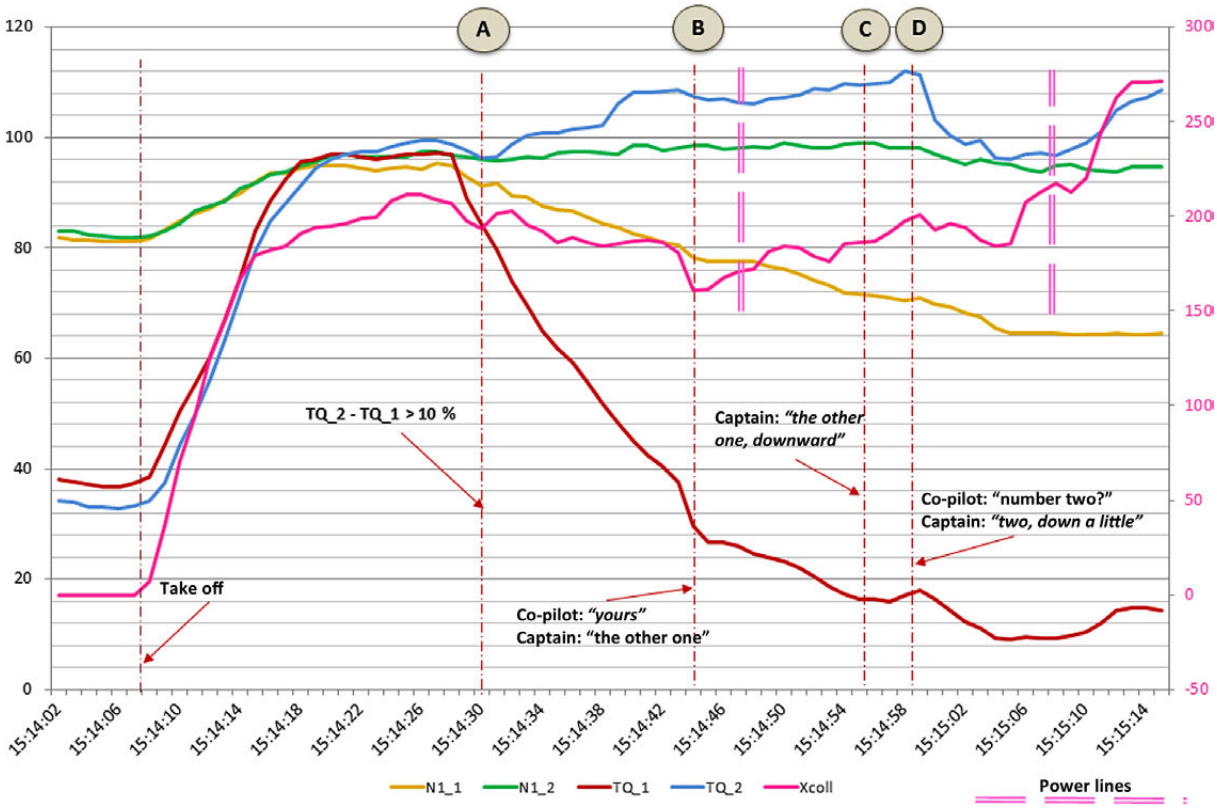

Figure 5. Significant flight events

The torque on the #2 engine (TQ_2) increased gradually and automatically to a value of 109%, point B, in keeping with the design characteristics of its control system. The pilot in the «1» position transferred control to the captain. The N1 value continued to fall on the #1 engine.

Eleven seconds elapsed between points B and C, during which the captain made two inaccurate remarks that are not specifically acknowledged by the copilot. The torque value for the #2 engine (TQ_2) was consistent with the GOV FLIGHT mode of operation and with the slightly increased output commanded by the captain through the collective control during that time as he attempted to ensure obstacle clearance above the terrain.

At point D the CVR recording seems to indicate that the captain was instructing the copilot to work the #2 engine controls, which is what he could have been referring to since just before reaching point C. This assumption stems from the fact that the copilot was operating the thrust lever for the #1 engine, which was found in the MANUAL position during the inspection of this engine's ALRT-2B limiter.

Upon identifying and realizing that the captain's instruction was to reduce the thrust on the #2 engine ("two, down a little") and executing it, TQ_2 dropped, though the torque immediately rose in response to the captain's operation of the collective control as he attempted to keep clear of the power lines and the wooded area where they would soon be landing.

The subsequent inspection of the ALRT-2B limiter revealed that the position of the #2 engine power control lever was corrected without having gone through the MANUAL position. The #1 engine is also thought not to have stopped, rather its thrust was reduced, since the lowest recorded N1_1 value was 64%[8].

The crew's reaction to the emergency and its handling of the situation was very likely conditioned by the low margin of clearance above the ground, which could have justified the absence of communications with the fire brigade leader so that the firemen could have assumed the proper protective position.

In general there was a lack of communication between the two crewmembers with imprecise phraseology and no clear method for handling the emergency. In short, there was a lack of proper resource management.

2.2. Operational and organizational aspects of the operator

LPU Heliseco sp. z o.o. is certified by Poland's civil aviation authority as an aerial work operator and a Part-145 maintenance center.

This company was engaged in an aerial work operation at the Tabuyo del Monte (León) firefighting base under a "wet lease in" contract with the Spanish operator

[8] The Aircraft Flight Manual indicates that below 58% N1, the engine is in an ENGINE OUT condition.

Hispánica de Aviación, S.A. Said contract was approved by Spain's Aviation Safety Agency.

The two companies mentioned above are both aerial work operators and Part-145 maintenance centers, with their corresponding certificates approved by the civil aviation authorities in their countries, Poland and Spain, meaning that each has its own organizational manuals and procedures.

As regards the flight crew, both members had the individual legal qualifications required by the regulations in their countries of origin. Both also complied with the Joint Aviation Requirements for Flight Crew Licensing (JAR-FCL).

The findings reveal that there was an arrangement between the two aerial work operators that, perhaps due to their contractual situation, to their same location and to having a similar fleet, led the operator (Heliseco) to put together a flight crew in which each member was from a different operator. This resulted in a captain from the company operating the flight flying with a copilot from another operator (Hispánica de Aviación) and, despite of the standardization and training procedures to be used, the emergency management had an improper execution.

2.3. Possible mechanical failure

Given the lack of tests on the components proposed during the workshop inspection for the reasons stated in this report, it is impossible to know for certain what caused the difference in torque that existed between the two engines. As a result the circumstances that could have caused a failure in one of the systems in the #1 engine are unknown.

The information and tests conducted, however, indicate that:

- The fuel used to refill the aircraft was in compliance with the engine specifications.
- The hydromechanical RPM limiter (ALRT-2B) on the #1 engine turbine could have experienced a fault or been out of synchronization.
- The condition of the fuel filters in the systems supplying the #1 engine was not sufficient to produce the improper operation of the engine.
- The possibility exists that ALRP-5 improperly controlled the fuel flow.
- The power control lever could have been operated incorrectly during the flight, either in automatic or manual mode.

3. CONCLUSION

3.1. Findings

- The aircraft had a valid airworthiness certificate issued by the state of registration and was maintained in accordance with the approved maintenance plan.

- Both crewmembers had a valid license and type rating for the type of aircraft they were flying.
- The torque reading for the aircraft's #1 engine dropped.
- When the mismatch in the torque readings for the two engines occurred, the aircraft was at an altitude above the ground of approximately 45 m (147 ft).
- The power control lever for the #1 engine was put in the MANUAL position.
- The emergency procedure was not followed properly.
- Before crashing to the ground, neither engine was in the ENGINE OUT operating regime.
- The investigation's findings indicate that the most likely cause of the drop in torque in the #1 engine could have involved the turbine's hydromechanical governor (ALRT-2B) or the fuel flow supplied by (ALRP-5) on said engine.

3.2. Causes

The accident is deemed to have been caused by the improper execution by the crew of the emergency procedure included in the Aircraft Flight Manual for handling a torque split between the two engines.

APPENDIX 1

Emergency procedure for an engine fuel control system malfunction

MALFUNCTION PROCEDURES

ENGINE FUEL CONTROL SYSTEM MALFUNCTION

Indications:

Engine torque split above 5% in steady flight.

N_1 split.

Engine 1 or engine 2 **GOV. MAX** or **GOV. MIN** caution light comes on.

Procedure:

Verify engine instruments. If oil pressure and temperature are normal and there is no vibration signal, increase the collective while monitoring engine instruments for the following symptoms:

Symptoms - group I:

Engine torque split remains the same.

Torquemeter indications are stable.

TQ, N_1, and **TOT** response follows the collective input.

Procedure for symptoms - group I:

1. Adjust N_r = 104...100% with **NR TRIM** toggle switch located on the grip of collective control lever.

NOTE

*When operating at N_r below 105% select V_{NE} from the **AIRSPEED LIMITS (INDICATED AIRSPEED) N_r = 104 to 100%** placard.*

2. Continue flight.

NOTE

A momentary torque split or decrease may result from interference with strong magnetic fields and does not require any corrective action if engine power output remains unchanged.

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ENGINE FUEL CONTROL SYSTEM MALFUNCTION - *continued*

Symptoms – group II:

Torque split above 10%.

TQ, N_1, and **TOT** response does not follow the collective input.

Procedure for symptoms - group II:

1. Both engines power levers – Set to **MANUAL** (in case of power decay the demanded power output should be restored in 1...3 s).
2. If a torque split above 10% maintains during prolonged flight eliminate it by retarding the power lever of engine with a higher torque.
3. Before landing move the previously retarded power lever to extreme forward position.
4. If engine parameters exceed takeoff limits and cannot be controlled manually shut down affected engine.

WARNING

*Engine power decreasing in order to eliminate torque split shall be accomplished with only one engine power lever at a time while the other engine power lever is left in **MANUAL** position. Manipulating with both power levers at the same time may lead to loss of engine power.*

CAUTION

Limiters in the engine fuel control switched-over to hydromechanical backup mode enable engine operation beyond takeoff limits. Monitor engine parameters closely to prevent twin engine operation within OEI power range.

NOTE

1. *When the engine power lever is set to **MANUAL** the hydromechanical backup of engine fuel control maintains N_2/N_r within 102...104% at takeoff power.*
2. *When the engine power levers are set to **MANUAL** avoid exceeding N_r = 108% during helicopter maneuvers (in transients).*

Continued on next page

ENGINE FUEL CONTROL MALFUNCTION - *continued*

3. *If time and flight conditions permit, instead of simultaneous setting both levers, set only the affected engine power lever to* ***MANUAL*** *while the good engine will remain in normal mode of operation. In such a case minimize torque split by* N_r *change with* ***NR TRIM*** *toggle switch on the grip of collective control lever.*