PRACE INSTYTUTU LOTNICTWA
218, s. 5-10, Warszawa 2011

IMPLEMENTATION OF FLIGHT TESTS IN ORDER TO DEVELOP NEW FLIGHT TECHNIQUES FOR TAKEOFFS AND LANDINGS IN A LIMITED SPACE FOR HELICOPTER W-3A SOKOL

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Summary

Gradually increasing group of users the W-3A helicopter and a rapid increase in the use of helicopters in urban areas with limited space for takeoffs and landings requires from helicopter manufacturers to develop new piloting techniques which ensure the complete safety of flight.

Confirmation of the feasibility of new techniques for takeoffs and landings in the limited space on the helicopter W-3A was carried out during the flight tests which are made by PZL Flight Test Division in the framework of a research project conducted by the Institute of Aviation

During the trial carried out:

- *Assess the size range of a vortex ring and the maneuverability of a helicopter in this state*
- *Minimize the danger area of H-V*
- *Determine the possibility OEI flight*
- *Determine the minimum space for takeoffs and landings, depending on the weight of the helicopter and height of surrounding obstacles*

This presentation shows how flight tests were conducted since the preparation of a helicopter to trials, through their implementation, and ending on the development of procedures for takeoffs and landings to the Flight Manual and their verification by representatives of the EASA.

INTRODUCTION

Gradually increasing user group of W-3A helicopters, and a sharp increase in the use of helicopters in urban areas and in areas with limited space requires from manufacturers to develop new flight techniques for helicopters with ensuring complete safety of flight during takeoff and landing.

W-3A is a twin-engine helicopter, which has the ability to take off and landing in category A, it means that after the failure of one of the engines is ensured continuation of the climbing with OEI (one engine inoperative) flight or landing is possible. Flight technique in the category A helicopter W-3A Sokół did not provide so far the possibility of taking off and landing helicopter where the airfield has a small size (confined heliport) or space is limited by obstacles (restricted helipad).

Knowing the aerodynamic performance and capabilities of W-3A, Flight Test Division performed tests, which aimed to develop such a takeoff and landing techniques that would allow the conduct of air operations from smaller airfields, as well as those which are surrounded by obstacles (eg buildings, trees), and all this with the provision of flight safety and in accordance with the regulations FAR 29 and CS 29.

Tests were conducted in the framework of a research project conducted by the Institute of Aviation. This paper presents the way in which flight tests conducted since the helicopter prepare for trials, through their implementation, and ending on the development of procedures for takeoffs and landings to the Flight Manual and their verification by representatives of EASA.

1. PREPARING THE HELICOPTER

Before performing the test W-3A helicopter was equipped with elected in accordance with Test Program set of sensors to enable with the measuring equipment ACRA KAM 500 registration important parameters for the test. The GPS system was built with the antenna on a sampling frequency of 5Hz to the precise trajectory and recording the position of the helicopter over the ground. To determine the zero velocity relative to ambient air, the helicopter was equipped with a special indicator before the helicopter windshield.

Figure 1. Measuring equipment ACRA KAM-500

Figure 2. A special indicator mounted in front of the windshield used to maintain near-zero velocity relative to the ambient air

2. THE STUDY VORTEX RING

New techniques for takeoffs and landings based on the low speed flight and descending close to vertical so in conditions conducive to vortex ring formation. So important was to learn the range of a vortex ring and the possibility of controlling Sokol helicopter in the state. Attempts to study the phenomenon of ring spinning were carried out at a safe height H = 1000m with the weight of the helicopter G = 5800kg at speed 30, 20kts and hovering for ever increasing rate of descent. Based on tests carried out found that the speed of 15 to 20kts and descending about -6m/s are only increased levels of vibration on the helicopter without deterioration maneuverability, while for the velocity close to zero (10 to -5 km/h) and descending from w =- 4m/s vortex ring phenomenon was observed but it was easy to leave it through the increasing speed of the helicopter.

3. MINIMIZING THE H-V ZONES

Another point is necessary to develop new techniques was to minimize the H-V area after failure of one of the engines. The test was carried out for different weights helicopter for selected points from the previous zone of HV including hover. Based on the results of the tests found that it is possible to a safe landing after engine failure at any hovering height of helicopter with a weight G = 5800kg, even after taking 1-second pilot response delay.

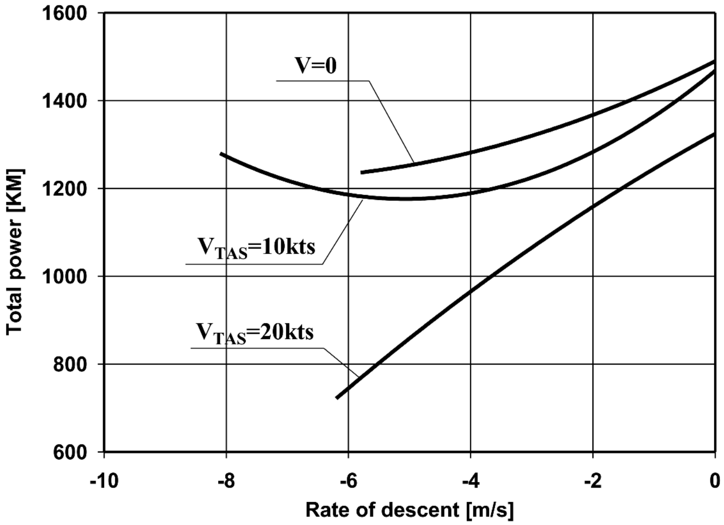

Figure 3. Require power

4. PERFORMANCE WITH OEI

Also carried out an attempt to determine OEI performances with speed at which the helicopter reaches a positive rate of climb (+0.5 m/s), it is approximately VTAS = 20kts. And for the best climb speed = 60kts VTAS, the OEI climb with extraordinary power and weight of 5800kg is w = 4.5 m/s.

Due to the limitations of the speed indicator in the very low speeds, as a safe speed during take-off (VTOSS) adopted VTOSS = 30kts for which rate of climb was 2.5 m/s.

5. DETERMINATION OF THE MINIMUM SPACE FOR TAKEOFFS AND LANDINGS

The purpose for which it sought in these tests was to develop such technology take-off and landings, which will minimize the space needed to start using the full capabilities of W-3A Sokol. The study was carried out so that the techniques developed takeoffs and landings ensure flight safety at any point on the trajectory of the flight and were in line at the same time the requirements of the aviation regulations. The first stage of testing was to check the possibility of rejected take-off and continued take-off at a safe height (H = 1000m). Profile startup look like that of a fixed hovering (based on the fixed rate before the pilot's window) the pilot began the climbing with a slight movement to the rear. In a fixed climbing co pilot flight caused engine failure by moving power lever in the ground position. Pilot after seeing the failure tried to keep the rotor speed NR = 95%, while acceleration began. During these tests initially estimated the loss of height after engine failure. The loss of height depends on the state in which the failure occurs, if a failure occurs during back flight, loss is almost twice higher than during acceleration helicopter.

This is due to the time required to change the angle of inclination of the helicopter to fly forward. The next stage of trials already close the ground was to test emergency procedures at take-off. Faults were simulated on a normal pre-launch trajectory during vertical ascent and the climb with vertical displacement to the rear as well as during acceleration just behind the TDP point.

Figures 4 and 5 shows examples of trajectories of flight after an engine failure during rejected take-off and continued take-off.

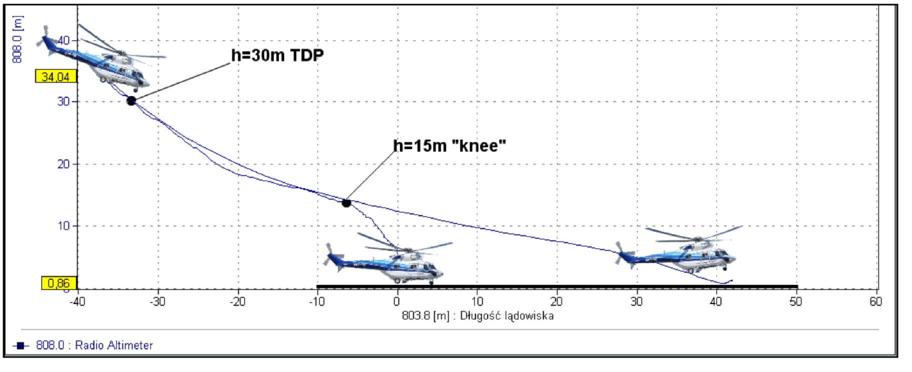

Figure 4. Rejected take off trajectory, engine failure at the height of the TDP point

After many starts with an imitation of an engine failure with different helicopter weights and on the assumption that the landing site is surrounded by obstacles to 15m, a vertical take-off technique was developed by the following procedure:

1) hovering 1-2m,
2) vertical climb for h = 15m with ROC 1-2m/s,
3) the "knee" or start reversing the ascent up to the TDP,
4) after reaching TDP helicopter acceleration to VIAS = 70kts using take-off power fuselage inclination about 10 deg,
5) steady climbing with maximum continuous power and airspeed V_Y = 70kts.

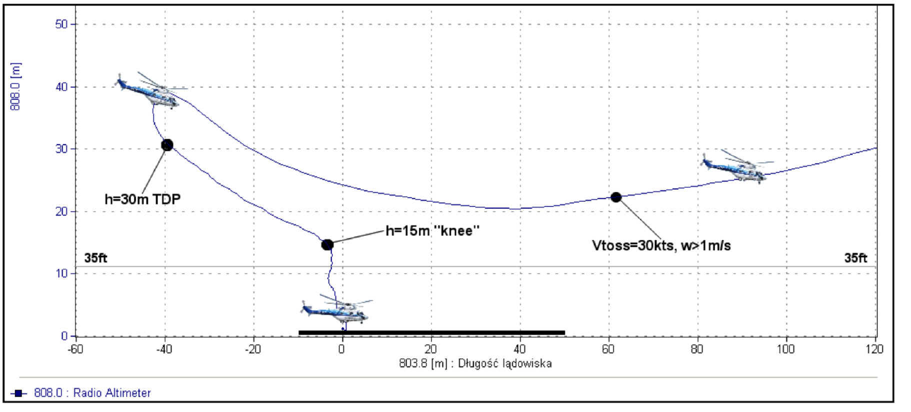

Figure 5. Continued take off, engine failure just behind the TDP point

By analyzing the records of the trials also identified the minimum landing sizes needed to perform such operations.

The last step was to develop techniques for landing. Similarly as for the predicted trajectory starts at a normal landing, initiated one of the engine failure before and after the point LDP. If the failure occurred before the LDP point, pilot interrupting the landing and began climbing with 2.5 OEI power (balked landing). If the failure occurred for the LDP pilot continued the landing single-engine (continued landing).

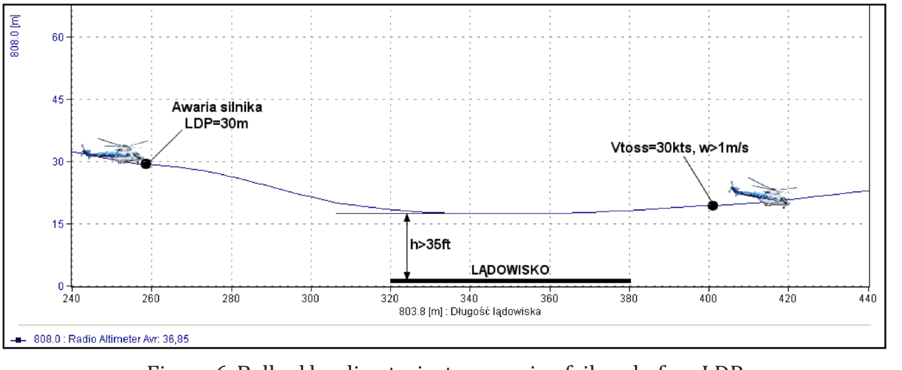

Figure 6. Balked landing trajectory, engine failure before LDP

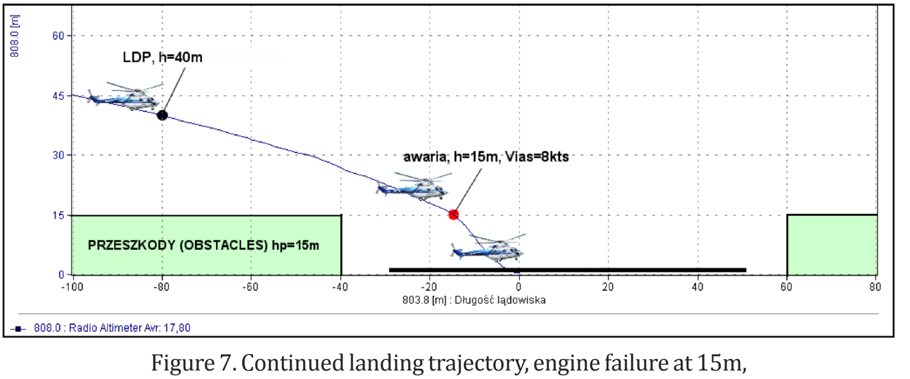

Figure 7. Continued landing trajectory, engine failure at 15m, airfield surrounded by 15m height obstacles

On the basis of completed balked and continued landings the piloting technique was developed according to the following procedure:
1) steady descending with airspeed V_{IAS} = 30kts and rate of descent 2-3m/s,
2) from 50-40m should start braking so that the beginning of the landing at a height h = 15m have about 15kts ground speed,
3) go the steep descent to touchdown.

The resulting new take-off and landing techniques have been verified in flight and accepted by representatives of EASA, confirming compliance with FAR29 and CS29 regulations.

Erwin Chołożyński

REALIZACJA PRÓB W LOCIE W CELU OPRACOWANIA NOWYCH TECHNIK STARTÓW I LĄDOWAŃ W OGRANICZONEJ PRZESTRZENI NA ŚMIGŁOWCU W-3A SOKÓŁ

Streszczenie

Sukcesywnie zwiększająca się grupa użytkowników śmigłowca W-3A oraz gwałtowny wzrost wykorzystania śmigłowców w aglomeracjach miejskich jak i w obszarach o ograniczonej przestrzeni do startów i lądowań wymaga od producentów śmigłowców wypracowania nowych technik z zapewnieniem pełnego bezpieczeństwa lotu.

Potwierdzenie możliwości wykonania nowych technik startów i lądowań w ograniczonej przestrzeni na śmigłowcu W-3A przeprowadzono podczas prób w locie, które wykonał Wydział Prób w Locie

PZL Świdnik w ramach projektu badawczego prowadzonego przez Instytut Lotnictwa.

Podczas prób należało:

- *Ocenić wielkość strefy występowania pierścienia wirowego oraz możliwości pilotażowe śmigłowca w tym stanie*
- *Zminimalizować strefy H-V*
- *Określić możliwość wznoszenia w locie jednosilnikowym*
- *Określić minimalną przestrzeń do startów i lądowań w zależności od ciężaru śmigłowca jak i wysokości otaczających przeszkód*

Niniejszy referat przedstawia sposób w jaki przeprowadzono próby w locie od momentu przygotowania śmigłowca do prób, poprzez ich realizację, a kończąc na wypracowaniu procedur startów i lądowań do Instrukcji Użytkowania w Locie i ich weryfikacji przez przedstawicieli EASA.