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FINAL REPORT
ON THE ACCIDENT INVESTIGATION OF AIRCRAFT
PIPISTREL PANTHERA
S5-MTR

10 September 2019
AT PORTOROŽ AIRPORT - LJPZ

Republic of Slovenia

»2019«

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INTRODUCTION

Final report on aircraft accident investigation contains facts, analyses, causes and safety recommendations of Committee for investigation of aircraft accident, taking into account the circumstances in which the accident took place.

This investigation has been conducted in accordance with Annex 13 to the ICAO Convention on International Civil Aviation, EU Regulation No 996/2010, Aviation Act (Official Gazette of the Republic of Slovenia No 81/10 and official consolidated text 46/16) and Regulation on investigation of aviation accidents, serious incidents and incidents (Official Gazette of the Republic of Slovenia No 72/03 and 110/05).

The sole objective of the investigation is the prevention of future accidents and incidents. It is not the purpose of the final report to apportion blame or liability. Using this report in any other intent may lead to wrong interpretation.

The final report should undoubtedly contribute to flight safety.

This document is the translation of the Slovenian version of the Final Report.
Although efforts have been made to translate it as accurately as possible,
discrepancies may occur.
In this case, the Slovenian is the authentic, official version.

COMPOSITION OF THE INVESTIGATION COMMISSION

The Head of Safety Investigation Agency of Slovenia on the basis of Regulations of the European Parliament No.1095/2010 and 996/2010 and of the Council on civil aviation accident and incident investigation and prevention and Decree on Investigation of Air Accidents, Serious Incidents and Incidents on 10 October 2019, appointed an Accident Investigation Commission to investigate the circumstances in which the accident occurred, to identify the causes of the accident and to prepare safety recommendations for preventing such accidents in the future.

Composition of the commission:

1. Toni STOJČEVSKI, - Investigator in Charge, Head of SIA, and
2. Urban ODLAZEK - Member of the Commission, ATPL pilot

I. SUMMARY

1. Date and time of the accident: 9 October 2019 at 9:47 UTC

2. Aircraft: Panthera Pipistrel, serial no. PX1520002, Registration mark S5-MTR

3. Manufacturer: SVP AVIO Ltd., Slovenia

4. Designer: Pipistrel Vertical Solutions Ltd., Slovenia

5. Location: Runway of the Portorož Airport (LJPZ), N452824 E0133654, Republic of Slovenia

6. Type of Flight: Private VFR flight in VMC conditions

7. Owner / user: SVP AVIO Ltd., Slovenia

8. Consequences: Damage to the propeller and lower fuselage. Engine inspection required.

7.1 Injury to persons:

Injuries	***Crew***	***Passengers***	***Other***
Fatal	**-**	**-**	**-**
Serious	**-**	**-**	**-**
Minor / None	**0/1**	**0/2**	

7.2. Damage to the aircraft: Damage to the lower fuselage and propeller

7.3 Damage to Equipment: Nil

1. This report uses the Coordinated Universal Time (UTC). On the day of the accident two hours (UTC + 2) must be added for local time.
2. The aircraft involved in the event falls under the category of Amateur Built Aircraft (according to Regulation (EU) No. 2018/1139) for which a national "Permit to Fly" is issued in order to comply with the airworthiness requirements (and not the Airworthiness Review Certificate).

II. GENERAL

On 10 September 2019, the pilot conducted a pre-flight inspection of the aircraft and contacted the ATC at the Portorož Airport (LJPZ) for the purpose of conducting a private panoramic flight within the airport zone. After obtaining permission from the Controller, the pilot, at 9:28 along with two friends, took off from runway 33 and flew to PE2 reporting point north of the airport. About 14 minutes after takeoff, the pilot decided to return and called for landing instructions. The controller issued landing clearance for runway 33 and issued wind data. At 9:47 the aircraft landed without landing gear, was sliding on the asphalt base of the runway in the trajectory approximately 300 m after the first contact with the lower fuselage until it came to rest near TWY B junction. Pilot secured the aircraft and evacuated himself and the passengers.

Immediately after the event, the ATC triggered an alarm and issued a NOTAM for the closure of the landing runway. Portorož Airport Services immediately informed the aviation investigation body of the Ministry of Infrastructure and the Police, documented adequately the position of the aircraft and its trajectory, inspected the runway and collected the relevant documentation of the crew and aircraft.

After prior coordination with the investigating authority, the aircraft was removed from the runway. Afterwards the NOTAM was withdrawn by the ATC and the runway was reopened for use.

The aircraft was properly secured by the airport staff and with dedicated equipment towed to a hangar at the Portorož Airport. Police sealed the cabin of the airplane until the arrival of the investigators. The following day, coordinated with Police representatives, Investigation Commission continued its investigation at the Portorož airport. At that time the representatives of the aircraft designer and the pilot involved in the incident were also present.

After reviewing the documentation obtained by the Portorož Airport stuff, the Investigation Commission on 11 September 2019 conducted a survey of the damaged aircraft, interviewed the pilot and witnesses and checked the functionality of the landing gear system (performed retraction and extension function test). Representatives of Pipistrel Vertical Solutions Ltd., who provided both technical support and explanations of the operation of the systems, were present.

III. FINDINGS:

1. An external inspection of the closed and sealed cabin of the airplane revealed that the landing gear selector switch was in the UP position. The position of the landing gear was up and the indication lights showing UP were also confirmed after the cockpit door was opened and main power switch turned on. The following is a test of the landing gear system according to normal procedure, as well as the emergency landing gear extension in accordance with the instructions in the airplane Pilot Operating Handbook. Following items were reviewed:
    - Operation of the landing gear electrical system,
    - Landing Gear Selector Switch operation,
    - Operation of indication lights
    - Operation and use of the mechanical landing gear lowering system according to emergency procedures.

    In all of the performed procedures, no errors or deviations in the operation of the landing gear system were identified. The time interval from the start of the landing gear extension initiation to the full down and locked position and vice versa did not exceed 20 seconds. No deviations were found during the procedures for checking the operation of the indication lights - signaling. In the simulated landing phase, the light signaling responded correctly.

2. When reviewing the airplane Pilot Operating Handbook, it was found that the airplane designer had specified proper checklists. Section 4 of the Handbook states in Section 4.9 (under item 4, 5 and 6) the procedures for managing the configuration of the aircraft before landing.

4.9 BEFORE LANDING

1	Approach Speed (80-85 KIAS)	ESTABLISH
2	Propeller Lever	Full Forward
3	Mixture	RICH
4	Flaps	SET for Landing
5	Landing Gear	DOWN & CHECK
6	Landing Light	ON
7	Trim	As Required
8	Autopilot	CHECK Disengaged
9	Fuel Pump - BOOST	ON

Image 1: Section 4 - Normal procedures

3. When examining and analyzing switch positions and indication signaling for landing gear in the design phase, the design organization of the first of three existing Panthera aircraft (reg. S5-MTP) determined that the position of the switch, which is manufactured in the form of a wheel shaped lever in the lower part of the instrument panel as shown in Image 2 is not safe. The pilot explained that, for the aircraft involved in the accident, the designer planed the switch location in the upper part of the instrument panel because of the possibility of accidental activation of the switch with the right leg of the left seated pilot (Image 3) if switch was positioned in the lower part of the instrument panel. The Commission noticed that the Landing gear selector switch on the instrument panel of the aircraft involved in the accident is identical to the Flap selector switch located at the same height and in the immediate vicinity - approximately 10 cm from the Landing gear selector switch. Switches are in close proximity and are designed to control the configuration of the aircraft, which represents the risk of confusion and possibility of misunderstanding their actual function. UP and DOWN positions of the Landing gear

selector switch mounted on the airplane involved in the accident, are far more difficult to detect than the positions of the Landing gear selections of the switch position installed in the first Panthera aircraft (Image 2) where the lever is wheel shaped.

Image 2: Position of the LDG selector switch on Panthera registered S5-MTP

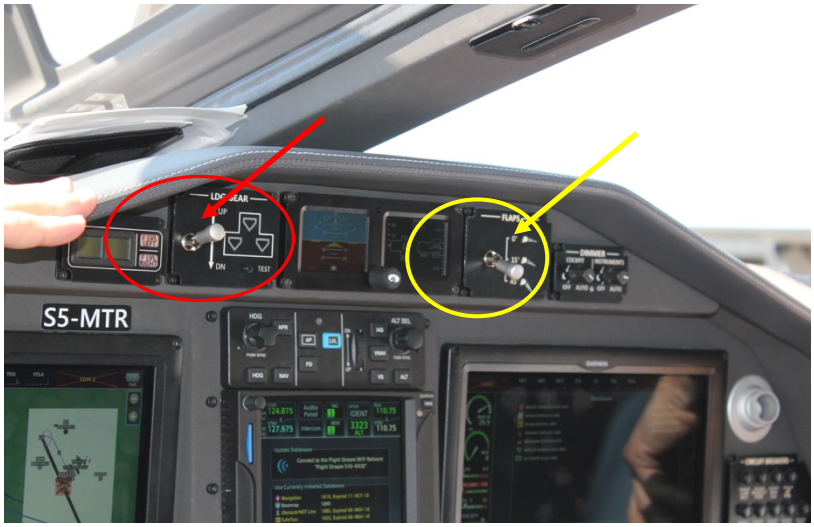

Image 3: Position of the LDG selector switch (red circle) on the accident aircraft Panthera registered S5-MTR

4. Upon inspection of the airplane and the landing gear, it was found that the indication of the extended landing gear (three green indication lights) during switch UP position is only possible when the emergency landing gear extension procedure is performed (without moving the landing gear selector switch for normal lowering of the landing gear) and the landing gear

comes into the final extended position (Image 4). Position of switches and the cabin state showed, that pilot did not perform emergency gear extension.

Image 4: LDG selector switch position and light signaling after landing gear emergency extension

In section 3.8.6 of the Pilot Operating Handbook, the designer stated the procedures for managing the landing configuration in an emergency - lowering the landing gear mechanically.

Landing Gear Manual Extension

1	Circuit Breaker	OFF
2	Manual Gear Extension Handle	ACTIVATE: TURN until 3 LIGHTS GREEN
3	Gear Indication Lights	CHECK 3 GREEN

Image 5: Emergency landing gear extension

5. After analyzing the information obtained from the pilot, it was concluded that the pilot was in a possession of a valid Private pilot license issued by the Austrian Civil Aviation Authority. The pilot's total flight time is over 300 hours on engine powered aircraft. In 2016, the pilot obtained the rating for single-engine piston aircraft and later completed training for multi-engine piston aircraft. The privileges from the license were exercised by the pilot with a valid Class 2 and LAPL medical certificate, issued on the basis of the examination carried out on 20 December

2018 by an authorized Slovenian medical institution SI-AME No.4. The medical certificate was valid until 4 January 2020.

6. In the final landing phase, the pilot checked the landing gear position indication and saw that all three indication lights were green. At that time the pilot was convinced that the landing gear was in the extended position. Inspection of the instrument panel showed that when the landing gear is in the retracted position, the landing gear indication lights are unlit (white color).

During the course of the investigation, taking into account the findings of the landing gear analysis (point 1 of the report) and the statement of the pilot, the commission considered an option that the pilot might have a color blindness (for green). The pilot stated that he saw three green lights, which would not be logical for a given selector switch position.

Taking into account the position of the sun (such as the sun rays and the sun reflection) in the landing phase, the Commission estimated that there was a possibility of white color of the landing gear indication lights (light indicators coated with plasticized white) being interpreted as green by people with color blindness. Regarding this issue, the comission, in preparation of the draft report, proposed an additional vision test for the pilot involved in the event, eliminating any doubt about color blindness.

In the follow-up of the investigation, the pilot responded to the draft report and provided photographs taken during the flight by a passenger sitting in the passenger seat at the rear of the airplane during the event. The analysis of the photography shows that during the flight, the landing gear indication lights **were green** when the Landing gear selector switch was in the UP position (Image 6).

This indication of the Landing gear indication lights is identical to that of the emergency landing gear extension (without moving the Landing gear selector switch to DOWN position) as described in point 4 of this report (Image 4).

Image 6: Photography taken by the rear passenger a few minutes before the accident

The following statement addressing this issue was made by the airplane designer:

"*During the course of the investigation, Pipistrel* (Vertical Solutions d.o.o. – remark of the investigator) *received information from the investigators that the landing gear position indicator was showing landing gear extended while the landing gear selector switch was in the up position. Pipistrel attempted to induce the same condition as reported by investigators on the PX1520002 S5-MTR aircraft itself, as well as through laboratory tests. The state when the landing gear indicator would show the extended condition with the selector switch in the UP position could not be established with any combination of the switches position, sensors and motor drives in the landing gear extension-retraction system. The mechanism of the landing gear on the PX1520002 S5-MTR aircraft, including its movement and indication, continued to*

function properly and reproducibly even immediately after the accident landing of the aircraft. The combination of influencing factors that would cause the situation reported, remains unconfirmed.

Given that there are no technical requirements for non-certified aircraft types, agreed standards for how systems are displayed, including the retractable gear indications, are used by Pipistrel to provide an adequate level of safety. As a Panthera aircraft designer, Pipistrel uses best industry practices.

As the selector switch shapes are not prescribed, these are unambiguous, clearly visible placards in English language (LDG GEAR, UP, DOWN) for the retractable landing gear system, and the use of display colors in accordance as per certified aircraft (green, red, flashing). In addition to the visual indicators of the landing gear position, the Panthera aircraft has a distinctly elevated noise caused by the increase of the air resistance when the landing gear is extended. The airplane also slows down noticeably. All of these elements are addressed by Pipistrel's training programs precisely to ensure greater flight safety."

7. No deviations or shortcomings were identified in the part relating to the analysis of the incident response and aerodrome incident related procedures and the decisions taken in coordination with the competent ATC service unit. The response procedures and actions of the licensed airport staff and the ATC were in timely manner and correct.

8. In the process of analyzing aircraft documentation it was found that airplane designer Pipistrel Vertical Solutions d.o.o. issued Pilot Operating Handbook revision B00, dated 13 May 2019. In this revision designer provided appropriate checklists, which were suitable in shape and size and made ready for copying, cutting and plastification. Checklists for DESCENT / APPROACH and BEFORE LANDING are described on pages 4-31 and 4-32 of the Pilot Operating Handbook.

It was concluded that pilot did not use Pilot Operating Handbook checklists but other unknown origin checklist (probably early version during aircraft design), which did not include all items included in current revision of Pilot Operating Handbook (only DESCENT/APPROACH and BEFORE LANDING procedures where analyzed in details). Pilot's checklist was printed in small size (small fonts) which would be hardly readable by a pilot limited with VNL (defective near vision) or this would require too much of his attention during flight.

Unsuitable shape and size of checklists or missing items therein (according to POH), could have contributed to the accident.

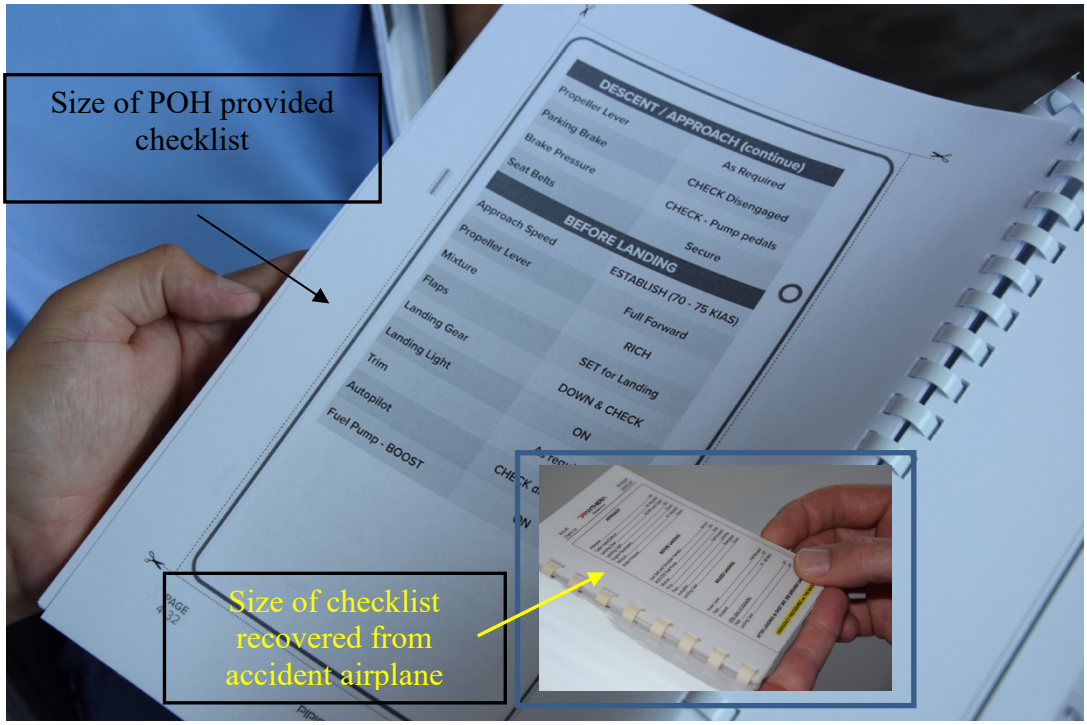

Image7. Checklist size comparison

IV. FACTS

1. Pilot holds a valid Private Pilot License and a valid Medical Class 2 Certificate;
2. The privileges of the license were exercised by the pilot with a valid Class 2 Medical Certificate;

3. The pilot has sufficient experience and continually maintains aviation qualifications and licenses. During the last 12 months, he has not made any significant interruption in flying on the type of aircraft involved in the event;

4. A valid Permit to Fly has been issued for the aircraft by the Slovenian CAA;

5. The meteorological conditions were suitable for flying on the day of the event. The weather did not contribute to the event;

6. There was no evidence of malfunctioning of the aircraft, propulsion system, equipment and flight control system.

7. Following the event, inspection and analysis of the landing gear's performance revealed that the landing gear assembly and signaling functioned correctly and in accordance with the designers's instructions;

8. There was no evidence of any element that would have an impact on crew decisions at the time of the incident in the airport vicinity or in radio frequency communications with the ATC unit.

9. The pilot did not move the landing gear selector switch to "DOWN" position before landing. During the preparation phase for landing, he poorly performed the procedures specified by the designer in the checklist. The pilot also misjudged the position of the landing gear, which was actually in the retracted position;

10. Following the tests performed by the airplane designer, the causes for the pilot's assertion that the indication of "3 green" indication lights before landing indicated that the landing gear was in the extended position were not identified or confirmed. The landing gear selector switch selected to UP position always resulted in the landing gear retracted position.

Designer during internal technical investigation did not reveal a reson for false indication of retractable landing gear position. Designerv stated that one of possible reasons could be the interuption of data bus CAN, which could be a resault of data bus loss of conection (poor connection) or software error. Conclusion has been made that loss of CAN connection, does

not influence function of system configuration managment. As a precaution maesure, for possible loss of connection on CAN data bus, the airplane designer will issue a Technical bulletin for airplanes with serial numbers PX1520002, PX1520003 and PX1520005, including instructions for wiring system (indicating position of landing gear) modification, bypassing CAN data bus (direct connection to aircraft retractable landing gear indication).

11. The comment made by the pilot about the malfunctioning of the light signaling during the landing gear selection in approach is subject to further analysis under the responsibility of the aircraft designer and manufacturer. The aircraft designer has designated the position of the landing gear control lever, which is identical to and adjacent to the flap position control switch. Identical switches in the immediate vicinity on the instrument panel in the cockpit of the aircraft pose the risk that they may be mistaken during landing configuration checks. Given the relatively small distance between the UP and DOWN positions, the position of the Landing gear selector switch is very difficult to identify when viewed from the pilot's seat. Such an arrangement of the Landing gear selector switch and the Flap control switch on the instrument panel of the aircraft involved in the accident, poses a risk of switch confusion. The consequences of incorrect and untimely use of the Landing gear selector switch can be significantly more dangerous than the consequences of incorrect use of the flap switch.

12. Licensed Airport staff and ATC staff responded promptly and correctly to the accident and made decisions in accordance with their respective responsibilities.

V. CONCLUSIONS

Direct cause

Impact of the airplane with a runway during landing, without landing gear extended.

Indirect cause

Poor execution of procedures for lowering the landing gear according to the prescribed checklist during the preparation phase for landing. Insufficient check of the Landing gear position indication (also visual conformation Landing gear selector switch position selection prior to landing).

VI. SAFETY RECOMMENDATION

No. SI-SR001-2020:

Slovenian CAA should include a topic on the Correct use of checklists in general aviation in this year's safety promotion activities.

Issue of CAA Safety circular on Size and shape of checklists and their compliance with Aircraft Flight Manuals is recommended and shall be evaluated during safety promotion activities.

Fonts that are too small in self-made checklists can take too much pilot's attention (head down), contributes to negligence (jumping over checklist items and procedures) and diminishes overall situational awareness.

No. SI-SR002-2020:

The manufacturer and designer of the airplane should perform additional analyzes and comparisons of positions and shape of the Landing gear selector switch in comparison with airplanes of a similar category with retractable landing gear and ensure that the Panthera Landing gear selector switch is replaced with a lever of a suitable shape and size not equal to the Flap control switch. Switches should be shaped in accordance with the practices of designers for the manufacture of such class of aircraft, which according to the Commission, shows all the characteristics of a complex aircraft.

No. SI-SR003-2020:

The airplane designer should analyze the Landing gear warning system and, if possible, install an additional audio warning indication to reduce the risk of landing with landing gear retracted in the future.