

# FINAL REPORT

---

ACCIDENT 2019/2199



Państwowa Komisja Badania Wypadków Lotniczych

UL. CHAŁUBIŃSKIEGO 4/6, 00-928 WARSZAWA | DUTY PHONE (+48) 500 233 233

# FINAL REPORT

## ACCIDENT

OCCURRENCE NO. – 2019/2199

AIRCRAFT – Aeroplane Yakovlev Yak-52, SP-YDD

DATE AND PLACE OF OCCURRENCE – 15 June 2019, Płock, Vistula River.



The Report is a document presenting the position of the State Commission on Aircraft Accidents Investigation concerning circumstances of the air occurrence, its causes and safety recommendations. The Report was drawn up on the basis of information available on the date of its completion.

The investigation may be reopened if new information becomes available or new investigation techniques are applied, which may affect the wording related to the causes, circumstances and safety recommendations contained in the Report.

Investigation into the air occurrence was carried out in accordance with the applicable international, European Union and domestic legal provisions for prevention purposes only. The investigation was carried out without application of the legal evidential procedure, applicable for proceedings of other authorities required to take action in connection with an air occurrence.

The Commission does not apportion blame or liability.

In accordance with Article 5 paragraph 6 of the Regulation (EU) No 996/2010 of the European Parliament and of the Council on the investigation and prevention of accidents and incidents in civil aviation [...] and Article 134 of the Act – Aviation Law, the wording used in this Report may not be considered as an indication of the guilty or responsible for the occurrence. For the above reasons, any use of this Report for any purpose other than air accidents and incidents prevention may lead to wrong conclusions and interpretations

This Report was drawn up in the Polish language. Other language versions may be drawn up for information purposes only.

**WARSAW 2023**

## Table of contents

---

Abbreviations.....	3
Synopsis.....	6
1. FACTUAL INFORMATION .....	7
1.1. History of the flight.....	7
1.2. Injuries to persons .....	8
1.3. Damage to aircraft .....	9
1.4. Other damage.....	9
1.5. Personnel information (crew data).....	9
1.6. Aircraft information .....	10
1.7. Meteorological information.....	11
1.8. Aids to navigation .....	12
1.9. Communications.....	12
1.10. Occurrence site information.....	12
1.11. Flight recorders.....	13
1.12. Wreckage and impact information .....	13
1.13. Medical and pathological information .....	14
1.14. Fire .....	14
1.15. Survival aspects .....	14
1.16. Tests and research.....	15
1.17. Organizational and management information .....	15
1.18. Additional information .....	16
1.19. Useful or effective investigation techniques.....	16
2. ANALYSIS .....	18
2.1. Level of training .....	18
2.2. Spin on the YAK-52 .....	18
2.3. Start of the air show .....	19
2.4. Spin .....	19
2.5. The pilot's well-being .....	21
2.6. Rescue operation.....	21
3. CONCLUSIONS .....	22
3.1. Commission findings.....	22
3.2. Causes of the accident .....	23
3.3. Contributing factors.....	23
4. SAFETY RECOMMENDATIONS.....	23
5. ANNEXES .....	23

## Abbreviations

<b><u>ABBREVIATION</u></b>	<b><u>FULL WORDING [ORIG. + ENG.]</u></b>
<b>DOSAAF</b>	Добровольное общество содействия армии, авиации и флоту Volunteer Society of Cooperation with Army, Aviation and Fleet [USSR]
<b>AGL</b>	Above Ground Level
<b>EASA</b>	European Aviation Safety Agency
<b>GAMET</b>	General Aviation METeorological Information
<b>ICAO</b>	International Civil Aviation Organization
<b>JRG</b>	Rescue and Firefighting Unit
<b>KMP</b>	City Police Headquarters
<b>KP PSP</b>	District Headquarters of the State Fire Service
<b>LAPL</b>	Light Aircraft Pilot License
<b>LMT</b>	Local Mean Time
<b>LPR</b>	Medical Air Rescue
<b>MTOM</b>	Maximum Take Off Mass
<b>NLGS</b>	Нормы Летной Годности Самолётов Aeroplane Airworthiness Standards
<b>OC</b>	Civil liability (insurance)
<b>OSP</b>	Volunteer Fire Service
<b>PAŻP</b>	Polish Air Navigation Services Agency
<b>PKBWL</b>	State Commission on Aircraft Accidents Investigation [Poland]

<b>PPL(A)</b>	Private Pilot License (Aeroplanes)
<b>PSP</b>	State Fire Service
<b>SEP(L)</b>	Single Engine Piston (Land)
<b>SGRW-N</b>	Water and Diving Rescue Specialised Group
<b>SPL</b>	Sailplane Pilot License
<b>ULC</b>	Civil Aviation Authority [Poland]
<b>UTC</b>	Universal Time Coordinated
<b>WOPR</b>	Volunteer Water Rescue Service
<b>VFR</b>	Visual Flight Rules
<b>VMC</b>	Visual Meteorological Conditions
<b>VML</b>	Correction for defective distant, intermediate and near vision
<b>USSR</b>	Union of Soviet Socialist Republics [USSR]

Occurrence reference number:	<b>2019/2199</b>			
Type of occurrence:	ACCIDENT			
Date of occurrence:	15 June 2019			
Place of occurrence:	Płock, Vistula River			
Type and model of aircraft:	Aeroplane Yakovlev Yak-52			
A/C registration marks:	SP-YDD			
A/C user/operator:	Private individual			
Pilot-in-Command:	PPL(A)			
Number of victims/injuries:	Fatal	Serious	Minor	None
	1	-	-	-
Domestic and international authorities informed about the occurrence:	ULC, EASA, ICAO, BFU, CIAS			
Investigator-in-Charge:	Jacek Bogatko			
Investigating Authority:	State Commission on Aircraft Accidents Investigation (PKBWL)			
Accredited Representatives and their advisers:	ACCREP BFU			
Investigation team:	A. Pussak, T. Makowski, P. Pacak, P. Richter, Jacek Bogatko			
Document containing results:	FINAL REPORT			
Safety recommendations:	None proposed			
Addressees of the safety recommendations:	Not applicable			
Investigation completion date	27 October 2023			

## Synopsis

---

On 15 June 2019 at about 10:55 hrs LMT (all times in this Report are provided in LMT; LMT = UTC + 2 hours.) the pilot and, at the same time, the owner of the Yak-52 aeroplane with registration marks SP-YDD, a citizen of the Federal Republic of Germany, took off for an air show during the VII Płock Aviation Picnic "Płock-2019". The air show took place over the Vistula River opposite the Płock Old Town. After gaining altitude, the pilot initiated a deliberate spin, from which he did not recover and, after making 12 turns, hit the water surface. As a result of the collision, the pilot died on the spot and the aeroplane was destroyed.

**The occurrence was investigated by a PKBWL investigation team in the following composition:**

Andrzej Pussak	- investigator-in-charge until 6 October 2020;
Tomasz Makowski	- team member / investigator-in-charge from 17 November 2020;
Piotr Borowik	- team member / investigator-in-charge from 5 July 2022;
Jacek Bogatko	- team member / investigator-in-charge from 24 April 2023;
Patrycja Pacak	- team member;
Piotr Richter	- team member until 6 October 2020;

---

**In the course of the investigation, the PKBWL investigation team established the following cause of the accident:**

- a) Insufficient current training in aerobatic flights;**
- b) lack of adequate pilot rest before commencing flight duties;**
- c) high ambient temperature;**
- d) loss of situational awareness, probably due to body weakness.**

Contributing factors:

None established.

## **1. FACTUAL INFORMATION**

### **1.1. History of the flight**

On 14 June 2019, the EASTSIDE YAKS TEAM of the Federal Republic of Germany took off for a flight to an air show in Płock with intended en-route stopovers at Bautzen aerodrome [EDAB] (two crews, including the pilot of the Yak-52 SP-YDD aeroplane departing from Köthen aerodrome [EDCK]) and next at Leszno aerodrome [EPLS], where the third crew was to join in. The three crews landed at Leszno at about 13:30 hrs. After refuelling, the team, now in a three-aeroplane formation, took off for Płock at about 14:30 hrs. The team landed at Płock [EPPL] at about 15:35 hrs. Having handled all formalities, members of the three crews headed to Petropol Hotel where, after checking in to single rooms, they had supper at 19:00 hrs and then went to inspect the air show site along the Vistula River from the ground. The crews returned to their hotel rooms before 22:00 hrs, arranging breakfast together at 07:00 hrs the next day.

At breakfast on 15 June 2019, the pilot of the SP-YDD aeroplane complained to his colleagues that he could not fall asleep until about 01:00 hrs even though air conditioning in his room had been on. He switched off air conditioning and opened the window, but could not fall asleep anyway. After breakfast, the crews went to the aerodrome. The air show schedule of the pilot of the SP-YDD aeroplane included a solo aerobatic show followed by a group show in a three-Yak formation (two Yak-52s and one Yak-50). The pilot of the SP-YDD aeroplane was the group leader.

At 10:00 hrs, the pilot added 20 litres of fuel and smoke paraffin. Having been cleared by the flight coordinator of EPLL, the pilot took off for his show in the designated zone over the Vistula River. After take-off, the pilot climbed and next made a left turn approximately to the wind direction blowing from the 70-80<sup>0</sup> direction at a speed of ca. 5 m/s), and headed for the air show site (Fig. 1).



Fig. 1. Air show site [source: Google Earth, PKBWL]

Having stabilised the heading along the Vistula River (upstream) and establishing communications with the air show coordinator, the pilot switched on the smoke generator and entered into a right spin. After one and a half turns of the spin, he unsuccessfully attempted to recover the aeroplane from spin. After 12 ¼ turns, at ca. 120 m above the water surface the spin was stopped. A moment later, the aeroplane commenced a left turn and collided with the water surface near the left bank of the river. The collision occurred at 10:55 hrs, 31 s from the aeroplane's entry into a spin.

As a result of the collision, the pilot died on the spot.

The services securing the air show commenced a rescue operation immediately after the collision.

The organisers of the air show intended to continue the show after the accident but the President of the Polish Civil Aviation Authority exercised his powers and ordered to terminate the event.

## 1.2. Injuries to persons

Injuries	Crew	Passengers	Others	TOTAL
Fatal	1	-	-	1
Serious	-	-	-	-
Minor	-	-	-	-
None	-	-	-	-

### 1.3. Damage to aircraft

As a result of the collision with the water surface and following the recovery operation, the aeroplane was completely destroyed. It was established during the post-accident inspection of the wreckage that the integrity of the airframe control system had been maintained and the engine had been running without interruption until the collision with the water surface.

### 1.4. Other damage

Contamination of the Vistula River with petroleum products, i.e. the fuel from the destroyed fuel system (ca. 30-40 l), engine oil (ca. 2-3 l) and residuals of the smoke paraffin.

### 1.5. Personnel information (crew data)

**Pilot:** male, aged 58, a citizen of the Federal Republic of Germany, holder of:

- a valid PPL(A) with a SEP(L) rating, aerobatics, English language command - level 4 - valid;
- a valid Class 1/2 and LAPL aeromedical certificate, with VML restriction;
- General Radiotelephone Operator's Certificate;
- Sailplane Pilot Licence (SPL);
- Private Pilot Licence issued by the Russian Aviation Lovers Federation.

The pilot held the following aeroplane ratings:

- Cessna 152;
- Cessna 172;
- Zlin Z-142;
- Yak 52;
- An-2.

Since 2008, the pilot carried out aerobatic flights with Yak-52s. He took part in regional aerobatic competitions, winning top prizes, as well as in air shows across Germany. The pilot's flight time on aeroplanes was – 814 hours and 28 minutes in 2,296 flights, including 218 hours and 16 minutes in 696 flights on the Yak-52. The data does not include the flight from Germany to Płock or the accident flight.

A summary of flights conducted by the pilot on the Yak-52 in 2019.

Date	Flight time	Number of flights
06.04.2019	0h 15'	1
16.04.2019	0h 16'	3
20.04.2019	0h 17'	2
25.04.2019	1h 35'	4
25.05.2019	1h 05'	6
<b>Total:</b>	<b>3h 28'</b>	<b>16</b>

Earlier, throughout 2018, the pilot conducted 58 flights amounting to a total of 8 hours and 43 min flight time.

The last flights in 2018 were conducted by the pilot on 2 September 2018 (3 flights totalling 45 minutes).

Since 25 August 2012, the pilot had been flying only Yak-52s.

### 1.6. Aircraft information

**Aeroplane:** Flight tested in 1976, two-seater, metal low-wing cantilever monoplane. Semimonocoque fuselage, trapezoidal monospar wings with stressed skin, fitted with metal crocodile flaps. Enclosed cabin with tandem seat configuration, dual flight controls, flight instruments and engine controls. Allowable in-flight g-loads +7/-5. Semi-retractable tricycle landing gear with nose wheel (it is not retracted completely into the airframe). The fuel system permits a 2-minute inverted flight. This type of aeroplane was operated mainly in the USSR. Following the fall of the USSR, many Yak-52s were exported to the USA, United Kingdom, New Zealand, Australia and other countries.

The Yak-52 SP-YDD, serial no. 844815, was manufactured in 1984. It was registered and operated with the following identification marks, respectively:

- 135 (DOSAAF, former USSR);
- LY-ALO (Lithuania, had an accident in the UK in 1994);
- G-CBRH (between 06.09.2002 and 25.02.2009, in the UK);
- LY-BOS (2009, after sold to Germany);
- RA-3626K (2010-2012, in Germany);
- SP-YDD (from August 2012, in Germany).

As an aircraft without an EASA type certificate, the Yak-52 was registered in Poland in the Special Category, S2 subcategory.

The aeroplane was managed by its owner since August 2012.

Year of manufacture	Manufacturer	Serial no.	ID markings	No. of registry	Date of entry
1984	Aerostar Bacau, Romania	844815	SP-YDD	4643	30.08.2012

Permit to conduct flights in Category SPECIFIC, Subcategory S2

no. PLS-15/12, issued by ULC on 29.08.2012.....valid until 15.04.2020

Certificate of Registration no. 4643 issued by ULC.....30.08.2012

Airframe flight time since new (until 25.05.2019):.....1972 hours 40 min

Airframe flight time since registered as SP-YDD (as above):.....159 hours 19 min

Aviation OC insurance expiry date:.....10.06.2019

**Engine:** M-14P (AI-14 development with turbocharger), 9-cylinder, 4-stroke, radial engine with twin ignition system, air cooled, adapted to inverted flights. Take-off power: 360 HP. Fuel: AVGAS 100LL. Oil: Aero Shell W100, 10 W40. The engine (the first production batch) was installed on the aeroplane in 2010.

Year of manufacture	Manufacturer	Serial number
n/a	Ivchenko/Vedeneyev M-14P	KJa441003

Propeller: two-blade, wooden, variable pitch; installed on the aeroplane in 2010.

Year of manufacture	Type	hub serial no.	blades serial no.	
n/a	W-530TA-D35	200362	62087259	62087266

The aeroplane documentation included correct records of:

- airworthiness of the aeroplane;
- airworthiness of the engine and propeller;
- implementation of bulletins;
- execution of mandatory maintenance and servicing;
- replacements and repairs carried out;
- ULC certificates.

Fuel and oil prior to the flight\*):

Fuel:.....120 l  
Oil:.....~12 l

Aeroplane load and mass data\*):

Empty mass\*).....1035 kg  
Fuel mass (full)..... 90 kg  
Oil mass.....~10 kg  
Smoke paraffin mass (~8 l)..... ~10 kg  
Pilot mass (with parachute)..... ~85 kg  
Take-off mass\*).....~1230 kg  
Maximum Take-off Mass MTOM (as per catalogue data)..... 1315 kg

\*) In the absence of accurate data on the SP-YDD aeroplane, serial no. 844815, the catalogue maximum values for the Yak-52 have been assumed.

The aeroplane's take-off mass and the location of the centre of gravity (near frontal) were within the prescribed limits.

## 1.7. Meteorological information

The flight was conducted in VMC, daylight, good meteorological conditions, and the ambient temperature reached 30°C.

Below is GAMET for the Płock area at the time of the accident:

<p>VIII'</p> <p>313 FAPL24 OKEC 150300</p> <p>EPHW GAMET VALID 150400/151000 EPWA- EPHW WARSAW FIR/A4 BLW FL100</p> <p>SECN I</p> <p>HAZARDOUS WX NIL</p> <p>SECN II</p> <p>PSYS: 06 H 1021 HPA OVER N LITHUANIA MOV N SLW NC L 1008 HPA OVER GERMANY MOV NNE NC WITH WARM FRONT OVER NW POLAND MOV NNE NC CONVERGENCE LINES OVER E GERMANY MOV NNE NC</p> <p>SFC WIND: 04/10 100/10KT W OF E021 04/10 060/05KT E OF E021</p> <p>WIND/T: 04/10</p> <p>1000FT AMSL 100/15KT W OF E021 04/07 P522 07/10 P525 060/10KT E OF E021 04/07 P522 07/10 P525</p> <p>2000FT AMSL 120/18KT W OF E021 P523 100/08KT E OF E021 P523</p> <p>3300FT AMSL 140/15KT W OF E021 P519 120/07KT LCA VRB/05KT E OF E021 P519</p> <p>5000FT AMSL 170/07KT LCA VRB/05KT P516 10000FT AMSL 200/07KT LCA VRB/05KT P508</p> <p>CLD: 04/08 NO CLD BLW 10000FT AMSL 08/10 LCA FEW/SCT CU 4000-6000/7000-8000FT AMSL</p> <p>FZLVL: 04/10 ABV 10000FT AMSL</p> <p>CHECK AIRMET AND SIGMET INFORMATION</p>	<p>314 FAPL23 OKEC 150300</p> <p>EPHW GAMET VALID 150400/151000 EPWA- EPHW WARSAW FIR/A3 BLW FL100</p> <p>SECN I</p> <p>SFC VIS: 04/05 LCA 1000-5000M BR N OF N53 SIG CLD: 04/05 LCA BKN 500-1000/1500FT AMSL N OF N53 SIGMET APPLICABLE: AT TIME OF ISSUE NIL</p> <p>SECN II</p> <p>PSYS: 06 H 1021 HPA OVER N LITHUANIA MOV N SLW NC L 1008 HPA OVER GERMANY MOV NNE NC WITH WARM FRONT OVER NW POLAND MOV NNE NC CONVERGENCE LINES OVER E GERMANY MOV NNE NC</p> <p>SFC WIND: 04/10 070/07KT</p> <p>WIND/T: 04/10</p> <p>1000FT AMSL 080/08KT 04/07 P519 07/10 P523 2000FT AMSL 080/10KT P520 3300FT AMSL 080/08KT LCA VRB/05KT P518 5000FT AMSL VRB/05KT P515 10000FT AMSL 270/18KT P507</p> <p>CLD: 04/10 NO CLD BLW 10000FT AMSL</p> <p>FZLVL: 04/10 ABV 10000FT AMSL</p> <p>CHECK AIRMET AND SIGMET INFORMATION</p>
--	--

## 1.8. Aids to navigation

n/a

## 1.9. Communications

The aeroplane was equipped with a Landysh-S radio and SPU-9 intercom. The pilot maintained communications with other pilots of the team and the show coordinator on EPPL. No objections were raised regarding the quality of radio communication. On listening to the recorded radio correspondence (with the participation of PAŽP representatives), it was found that while performing the spin, the pilot pressed the send button twice (a characteristic "click" noise) without making any contact.

## 1.10. Occurrence site information

The accident occurred in the south-east part of Płock over the Vistula River (Fig. 1). The show zone was marked by a barge anchored on the Vistula and a line of anchored buoys. The alignment of the barge showed the wind direction on that day (bow upwind). The aeroplane collided with the water surface ca. 10-12 m off the left bank of the river (coordinates 52°32'13.96"N 019°40'44.47"E), at a peninsula separating the main stream of the river from the port and river shipyard dock (Fig. 2).

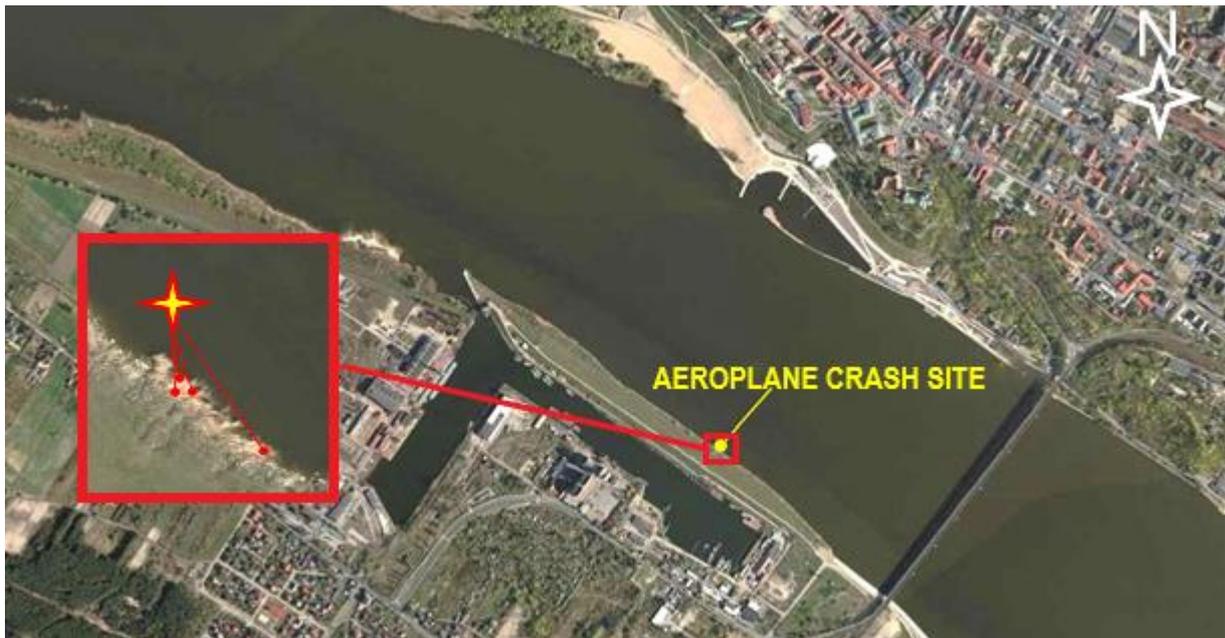


Fig. 2. The aeroplane crash site and approximate dispersion of the wreckage (red frame) [source: PKBWL]

### 1.11. Flight recorders

The aeroplane was not equipped with any devices recording flight parameters.

### 1.12. Wreckage and impact information

The aeroplane collided with the water surface at an angle of about 25°. The left wing was first to hit water, followed by the engine and right wing (Fig. 3).



Fig. 3. The moment when the aeroplane collided with water [source: Internet]

After impact, the aeroplane turned over and rested on the river bottom at a depth of ca. 7 m in the inverted position (cockpit down). On impact, fragments of different sizes detached from the aeroplane and were thrown onto the river bank (Fig. 2).

No part of the aeroplane was found to have detached from it prior to the impact.

Recovered from the wreckage was its documentation, including an abridged aircraft flight manual (*YAK-52 Operating Handbook*) and a GoPro camera which had been

mounted on the windshield. The cameras mounted on the left horizontal stabiliser and the left wing tip were not found.

### 1.13. Medical and pathological information

The pilot died of extensive multiple-organ injuries to the chest, abdominal cavity, head trauma and multiple fractures caused by a sudden contact with the aeroplane's structure. It was established that the pilot had not drowned.

#### **The pilot's life could not be saved.**

The pilot was not under the influence of alcohol, psychotropic or psychoactive substances.

On the day of the accident, at breakfast, the pilot complained to his colleagues that he could not fall sleep until 01:00 hrs and that he had woken up early in the morning.

During refuelling the aeroplane, the driver of the tanker truck saw that the Yak-52 pilot looked weakened. The driver had an impression that the pilot's hands were shaking and he was irritated.

The autopsy showed that the pilot's general health was good.

### 1.14. Fire

No fire occurred.

### 1.15. Survival aspects

The course of the occurrence did not give the pilot any chance to survive.



Fig. 4. The fall of the aeroplane [photo: Internet, unknown author]

The course of the accident put at risk a group of several people who were relaxing on the river bank. The aeroplane fell into water at a distance of ca. 12-14 m away from them (Fig. 4). Some wreckage which detached from the aeroplane during the collision with water fell on the river bank.

The pilot wore an SE-4/1-A rescue parachute, serial no. 53896, manufactured in May 2000. The parachute underwent mandatory inspections in 2002, 2003, 2004, 2005,

2006, 2007, 2010 and 2011. There are no entries in the parachute documentation regarding any inspections after 2011.

### **1.16. Tests and research**

Immediately after the accident, PKBWL members, together with the police and prosecutor, inspected the accident site, the body of the pilot and the wreckage of the aeroplane; the inspection was continued the next day in a hangar of the Mazovian Region Aero Club in Płock. Photographs of the accident site and wreckage were taken. The aeroplane records as well as the pilot's documents and his flight time on the aeroplane type were analysed. The course of the spin was analysed.

### **1.17. Organizational and management information**

On 15 and 16 June 2019, the Mazovian Region Aero Club undertook the task of organising the Płock Aviation Picnic after a 6-year break.

The invited guests included Germany's aerobatic team EAST SIDE YAKS – a winged history from the east, flying the legendary Russian aerobatic aeroplanes Yak-50 and Yak-52.

On the air show organiser's request, the ULC President permitted reducing the flight height for a selected group of pilots (including the pilot of the Yak-52 SP-YDD) to 10 m during the show. The display zone was delineated in consultation with the Polish Air Navigation Services Agency, and its horizontal and vertical boundaries as well as the air traffic rules applicable therein were published in a Supplement to AIP VFR Poland.

**The air show plan issued by the organiser and held by the flights coordinator and the air show director did not contain any details regarding the sequence of flying figures to be performed.** As regards the Yak-52 SP-YDD, the information includes only the time of the display (10:50 hrs - 11:00 hrs) and some aeroplane characteristics (engine, wingspan, aeroplane mass, airspeed, range), without even the pilot's surname or the surnames of other pilots in the formation.

Due to the nature of the event, i.e. the VII Płock Aviation Picnic, the occurrence site had been secured by all law enforcement and rescue services, i.e. the Police (on land and water), Fire Service (professional and volunteer; on land and water), Ambulance Service, a team of the Medical Air Rescue with a helicopter, and Volunteer Water Rescue Service.

On the right bank of the river, the air show had been secured by SGRW-N "Płock 5" with a crew of four and diving equipment (a FASTER rescue boat fitted with hydraulic equipment for technical rescue, pneumatic equipment, fire pump for delivering extinguishing agent, medical rescue equipment etc.) and a GBA 361-21 as firefighting support on the right bank of the river.

The left bank of the river was secured by a GRAND rescue raft manned by a crew of three.



Fig. 5. The rescue operation and recovery of the wreckage [photo: Internet, unknown author and KMP Płock]

After the occurrence, the personnel on water commenced their actions immediately (Fig. 5).

The air show organiser reported the accident to the State Commission on Aircraft Accidents Investigation (PKBWL).

Due to the Yak-52 SP-YDD accident, the President of the Polish Civil Aviation Authority issued Airworthiness Directive SP-0003-2019-A of 3 December 2019 regarding Special category aeroplanes Yak-50 and Yak-52.

### 1.18. Additional information

In accordance with Article 16(4) of Regulation (EU) 996/2010 of the European Parliament and of the Council of 20 October 2010, the air show organiser was advised of the possibility to get acquainted with the contents of the draft final report. Representatives of the organiser submitted their comments to the document and signed the relevant protocol of reviewing the draft final report. The Commission took into account some of those comments and introduced corresponding changes in the report.

Before publicising its Report, PKBWL informs family members of the accident victims and associations representing them about the findings that will be communicated to the public.

The Aircraft Flight Manual held by the pilot (a copy of the abridged Aircraft Flight Manual titled *YAK-52 Operating Handbook*) did not contain any data on performing aerobatic figures or the related limitations or advice and warnings in this respect.

As can be inferred from the documents kept on board, the aeroplane was not insured during the accident flight (the insurance expired on 10 June 2019).

### 1.19. Useful or effective investigation techniques

Standard investigation techniques were applied.

During the accident flight, the aeroplane was fitted with three GoPro video cameras. The owner had used cameras for documenting the flights performed for his own purposes. The camera mounted on the windshield was recovered after the occurrence. Based on the recording from that camera (Fig. 6) the control of the aeroplane was analysed from the moment of entry into a spin until the collision with the water surface.

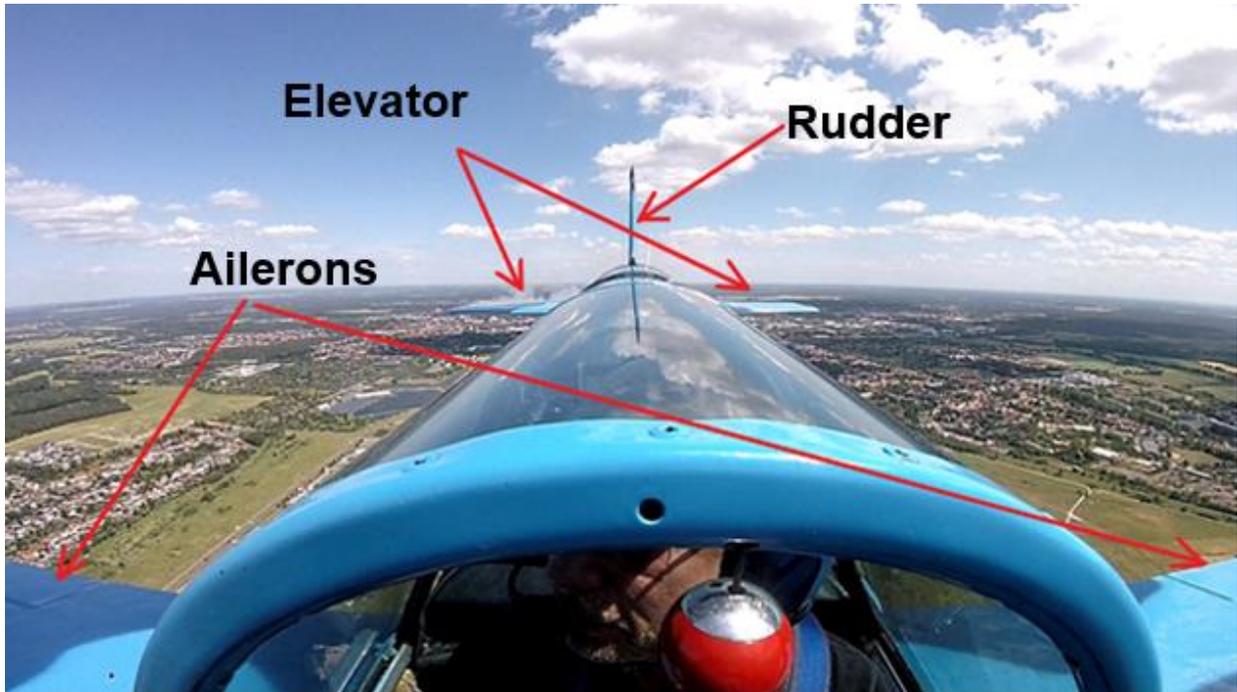


Fig. 6. The image from the camera on the windshield – the aeroplane control surfaces clearly visible  
[source: the owner of the aeroplane – a frame from the video recording]

The analysis of the GoPro video recording allowed the following findings:

- the pilot started the show at ca. 1200 m AGL;
- after entering the zone, he reduced the engine speed, deflected the elevator up and the rudder to the right, entering a spin;
- after a moment, he deflected the control stick to the left;
- on completing 1.5 turns of the spin, the pilot deflected the rudder to the left, the elevator down, and the aileron to neutral;
- on completing another 1.5 turns of the spin, the pilot again deflected the ailerons to the left, and after a moment deflected the elevator up;
- until right autorotation was stopped, the pilot aligned the ailerons to neutral once for two seconds, deflected the elevator down twice for one second, and deflected the rudder several times;
- on completing 12¼ turns, at a height of ca. 120 m, the aeroplane started entering left spin. The elevator was deflected up and the control stick to the left;
- a moment before the collision with the water surface, the pilot moved the control stick to the right.

The PKBWL investigation team got acquainted available publications and papers on performing spins on the Yak-52.

## **2. ANALYSIS**

### **2.1. Level of training**

Considering the pilot's performance during regional competitions in the Sportsman category across Germany in 2009-2019, his qualifications, skills and experience in aerobatic flights must be assessed as high.

However, the entries in his flight logbook show that between 2018 and 2019 he flew sporadically. The pilot's flight time in 2018 was about 9 hours in 58 flights, whereas in 2019 it was about 5 hours in 19 flights, including the flight from Köthen (Germany) to Płock. The above shows that he performed few aerobatic flights in that period.

**The pilot had not been in current training due to the low flight intensity.**

### **2.2. Spin on the YAK-52**

Since the Yak-52 is a heavy aeroplane, the moments of inertia during a spin are high; it has a heavy engine installed in the nose section, and there are a heavy radio and other equipment behind the rear seat. When recovering from a spin (particularly a flat one), the aforementioned features make the control surfaces unable to generate aerodynamic forces necessary to rapidly counteract the forces of inertia, thus leading to a delay in stopping the autorotation.

A spin performed in the direction in which the propeller rotates is steeper, whereas a spin performed in the opposite direction is flatter. This phenomenon is due to the gyroscopic moment generated by the propeller. This was the case in the situation concerned. The propeller on an M-14P engine, with which the aeroplane was equipped, rotates to the left, and the pilot was performing a right spin. The YAK-52 Pilot Handbook (published by DOSAAF, USSR, in 1987) says that in a left spin, the aeroplane's pitch can be 50-70°, whereas in a right spin 30-40°. The aeroplane loses ca. 100m of altitude per one turn of the spin, and the flatter the spin, the smaller the altitude loss. In a flat spin, the aeroplane's pitch is 20-30°.

As the Yak-52 is equipped with a slotted aileron, air continues to flow around the ailerons when the air streams on the wing are interrupted (e.g. in autorotation), which makes them still effective. Moving the control stick in the direction in which the aeroplane rotates makes the spin steeper, and the rotation is faster and it can be stopped faster. Moving the control stick in the opposite direction will make the spin flatter, the rotation will be slower and will be stopped with a greater delay. In a developed spin, depending on the location of the centre of gravity, the delay can be between 1.5 to 3.5 turns.

According to the Yak-52 pilot handbook and accounts of pilots who perform aerobatics on this aeroplane type, recovery from a spin should be done as follows:

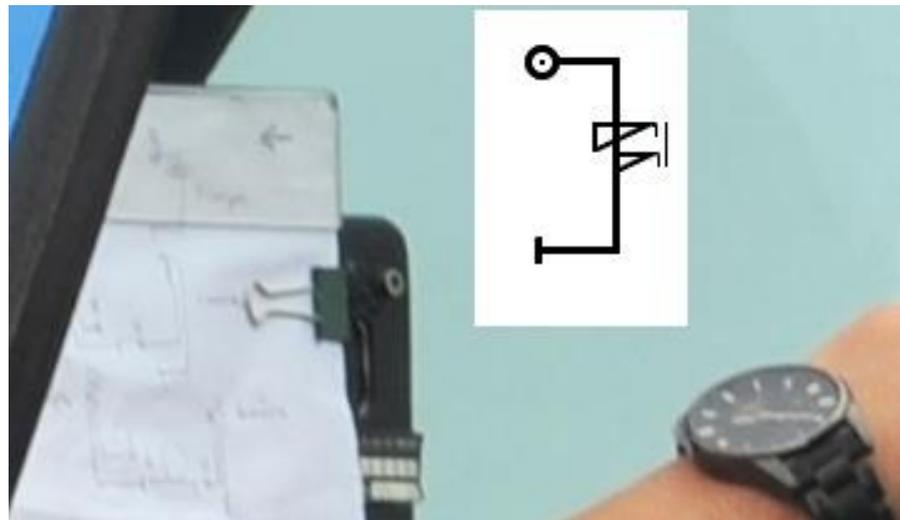
- deflect the rudder counter-rotation-wise;

- move the control stick forward between the neutral and full forward position;
- after the rotation stops, move the controls to neutral;
- on reaching the airspeed of 200 km/h, pull the aeroplane out to a straight level flight while opening the throttle. Before the aeroplane gets into a level flight, the throttle should be fully open.

### 2.3. Start of the air show

The pilot commenced his display at ca. 1200 m (AGL). A photo of the pilot in the cockpit taken before the flight shows the aerobatic sequence which he probably intended to perform during the show (Fig. 7).

Fig. 7. A photo of a fragment of the sequence affixed in the cockpit on the day of the air show [source:]



Although the close-up image of the sequence is fuzzy, the outline and direction of exiting the figure seem to suggest  $1\frac{1}{2}$  or  $2\frac{1}{2}$  turns of a spin. The video recording of the windshield camera shows the pilot making an unsuccessful attempt to recover from the spin after completing  $1\frac{1}{2}$  turns. The pilot should have set the decision height at which to abandon the aeroplane (by making an emergency parachute jump) in case of an unsuccessful recovery from a spin.

According to manuals and handbooks on recovering the Yak-52 from a spin define such a decision height to be 1000 m.

**Considering the aeroplane's flight characteristics and the current training of the pilot, the aerobatic sequence was started at a too low height.**

### 2.4. Spin

Having entered the air show zone, the pilot deflected the elevator up and the rudder to the right, entering a right spin. After a moment, he deflected the control stick to the left (counter-autorotation-wise) to make the spin flat (Fig. 8).



Fig. 8. Incipient spin [source: the owner of the aeroplane]

After completing  $1\frac{1}{2}$  turns, the pilot attempted to recover from the spin. He deflected the rudder counter-rotation-wise, deflected the elevator down (the control stick full forward), and set the ailerons in neutral (Fig. 9-1).

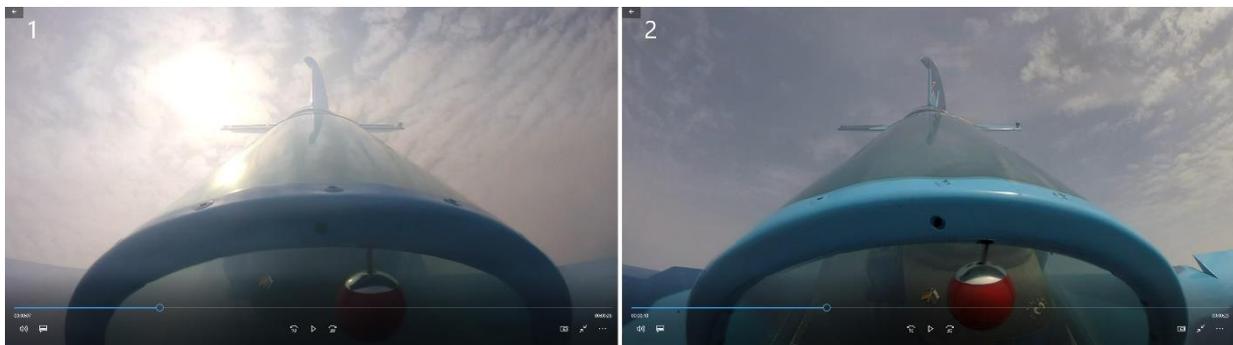


Fig. 9. Recovery from the spin [source: the owner of the aeroplane]

After completing  $1\frac{1}{2}$  turns in that configuration, the pilot again deflected the ailerons to the left (Fig. 9-2), making it more difficult to recover the aeroplane from the spin.

The video recordings from aerobatic flights on a Yak-52 uploaded by the pilot (YouTube) shows that when recovering from such a spin, the pilot had deflected the rudder counter-rotation-wise, and the control stick diagonally right and fully forward. This caused the aeroplane to do some  $1\frac{1}{4}$  turns more and stop the autorotation.

After completing three turns (since starting the attempt to recover from the spin), the pilot deflected the elevator up (pulled the control stick towards himself) and maintained the control stick deflection to the left. From that moment on, he took no action that could lead to recovering from the spin. He once aligned the ailerons to the neutral for two seconds, deflected the elevator down twice for one second, and made aimless/chaotic movements with the rudder.

**After  $12\frac{1}{4}$  turns, at a height of ca. 120 m, the aeroplane started entering a left spin** (Fig. 10-1). This is evidenced by the fact that the aeroplane did not accelerate after the autorotation stopped. The elevator was deflected up all the time, the control stick was deflected to the left, and a moment before the collision with the water surface, the pilot moved the control stick to the right to level the aeroplane, but the aeroplane did not respond (Fig. 10-2).

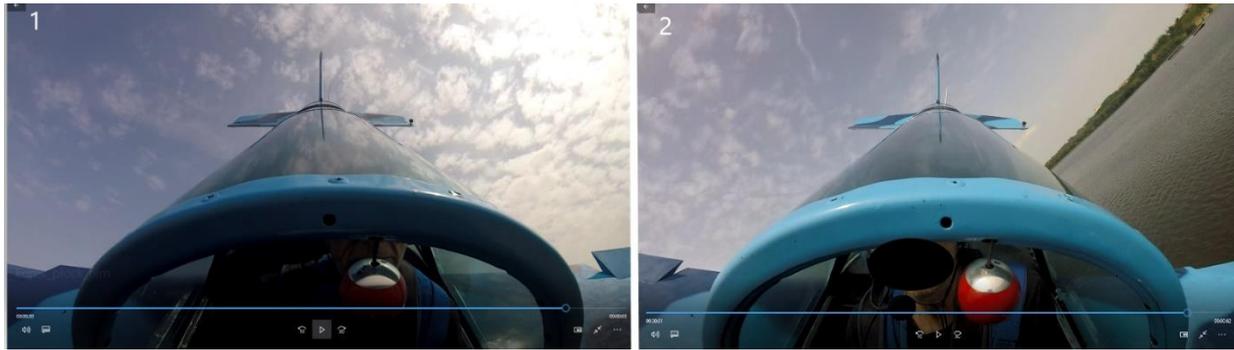


Fig. 10. 1- The moment when the right autorotation stopped. 2- The attempt to level the aeroplane.  
[source: the owner of the aeroplane]

## 2.5. The pilot's well-being

Taking into account:

- the statement by the tanker truck driver, who said that the Yak-52 pilot looked weakened, his hands were shaking and he was irritated;
- the statements of the pilot's colleagues from the team, who said that he had complained that he could not fall asleep until 01:00 hrs and had woken up early in the morning;
- the ambient temperature of 30°C, which could lead to fatigue due to dehydration or heat stroke.

**At the moment of the accident the pilot lost situational awareness, probably due to body weakness.**

This conclusion can be supported by the manner in which the pilot attempted to recover from the spin and by the fact that he did not make a rescue parachute jump.

## 2.6. Rescue operation

Due to the nature of the event, i.e. the VII Płock Air Picnic, the occurrence site had been secured by all law enforcement and rescue services. The first phase of the operation, which was aimed at locating the wreckage, the personnel of the State Fire Service was supported by WOPR Płock rescue team composed of 12 rescuers in 3 boats. The wreckage was found by divers of SGRW-N from JRG-1. The operation was conducted in very adverse conditions caused by the strong river current and zero visibility under water. The divers who reached the wreckage could not recover the body of the pilot from the cockpit because the aeroplane had overturned on impact and rested on the bottom with the landing gear upwards, and the cockpit was buried in the muddy bottom of the river.

The coordination centre sent heavy-duty technical rescue vehicles (SCRt) from JRG 1 and JRG 2 to the occurrence site from the Płock-Radziwie side. Also, the operations officer was sent to the site from on-call duty. The SGRW-N commanding officer decided to hook the rope of an SCRt vehicle's winch on the aeroplane to pull it to the shoreline.

Meanwhile, on order from the Płock City Fire Service Commander, a sonar from PSP Legionowo and a BOBCAT telescopic loader from OSP Gąbin were deployed. When the operations officer, Deputy Commander of JRG 2 in Płock, had arrived at the scene, the main operation was conducted from a rescue raft, and the supporting one, from the shore.

After the winch line had been hooked on the wreckage by the divers, the personnel started pulling it to the left bank of the river. When the aeroplane partially emerged, another rope was attached to it from a winch of an SRw water rescue vehicle. The ropes stabilised the wreckage (which was still partially submerged) in a position that allowed reaching the body of the pilot. Two rescuers, wearing safety vests and secured with ropes from the shore, started recovering the pilot's body from the cockpit with the use of a Holmatro hydraulic tool set. After partially releasing and cutting the safety belts and parachute harness (the parachute remained in the cockpit), they brought the pilot to the shore, where an LPR doctor pronounced him dead. A KP PSP Legionowo squad commenced a search for fragments of the crashed aeroplane on the river bottom with a sonar. No fragments of the aircraft were found.

Since the crashed aeroplane was leaking fuel and operating fluids, the scene was secured with sorption barriers to contain the leakage.

**The rescue operation was well organised and efficiently carried out.**

### 3. CONCLUSIONS

#### 3.1. Commission findings

- 1) The aeroplane was technically fit and properly prepared for the flight.
- 2) Since its registration in Poland under registration marks SP-YDD, the aeroplane had flown 159 hours 19 minutes (excluding the flight from the stopover to Płock and the accident flight).
- 3) During the accident flight, the aeroplane was not insured.
- 4) The aeroplane mass and balance were within the prescribed limits.
- 5) The aircraft flight manual recovered from the wreckage (*YAK-52 Operating Handbook*) did not contain any information on how to perform aerobatic figures.
- 6) The aeroplane was maintained and serviced as required for the category in which it had been registered.
- 7) The required aircraft records were kept correctly.
- 8) No defect/malfunction was identified that could have impact on the occurrence.
- 9) The pilot held the ratings required to perform the flight.
- 10) The pilot had experience in aerobatic flights.
- 11) The pilot held a valid aero-medical certificate.
- 12) The pilot had not been in current training.

- 13) The pilot performed a right spin with the control stick deflected to the left to make the spin flatter.
- 14) After completing 12¼ turns of a right spin, the aeroplane entered a left spin.
- 15) The aeroplane collided with the water surface when entering a left spin.
- 16) When performing flight duties, the pilot was not under the influence of alcohol or psychoactive substances.
- 17) At the moment of the accident the pilot lost situational awareness, probably due to body weakness.
- 18) The pilot died instantly due to extensive multiple-organ injuries.
- 19) The pilot wore properly fastened safety belts during the flight.
- 20) The pilot's rescue parachute was manufactured in 2000 and had not undergone any annual inspections since 2011.
- 21) The rescue operation was conducted in difficult conditions.
- 22) During the accident flight, the aeroplane was fitted with three GoPro video cameras. The camera mounted on the windshield was found and the recording recovered from it was used in the analysis of the course of the occurrence.
- 23) Ambient temperature on the day of the occurrence contributed to the occurrence.
- 24) The air show was organised and conducted in accordance with applicable aviation rules.
- 25) The air show plan issued by the organisers did not contain any details regarding the sequence of flying figures to be performed.

### **3.2. Causes of the accident**

- 1) Insufficient current training in aerobatic flights.**
- 2) Lack of adequate pilot rest before commencing flight duties.**
- 3) High ambient temperature.**
- 4) Loss of situational awareness, probably due to body weakness.**

### **3.3. Contributing factors**

None established.

## **4. SAFETY RECOMMENDATIONS**

The Commission did not formulate any safety recommendations after completing the investigation.

## **5. ANNEXES**

None.

**THE END**

*Investigator-in-Charge*

.....  
*(signature on original only)*