Final Report

ACCIDENT 2020/1515

STATE COMMISSION ON AIRCRAFT ACCIDENTS INVESTIGATION

UL. CHAŁUBIŃSKIEGO 4/6, 00-928 WARSZAWA | EVENT NOTIFICATION +48 500 233 233

Final Report

ACCIDENT

OCCURRENCE No. – 2020/1515

AIRCRAFT – SOCATA MS 893 E-D, D-EGET

DATE AND PLACE OF OCCURRENCE – 28 June 2020, EPBC

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 2021

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Abbreviations and acronyms

A/C	Aircraft
AFIS	Aerodrome Flight Information Service
AKI	Anti-Knock Index
AMSL	Above Mean Sea level
ARC	Airworthiness Review Certificate
ARP	Aerodrome Reference Point
ATS	Air Traffic Services
ATZ	Aerodrome Traffic Zone
AW	Warsaw Aero Club
BEA	Bureau of Enquiry and Analysis for Civil Aviation Safety
BFU	German Federal Bureau of Aircraft Accident Investigation
CAO	Combined Airworthiness Organisation
CG	Center of Gravity
CofA	Certificate of Airworthiness
CofR	Certificate of Registration
CRS	Certificate of Release to Service
DOW	Dry Operating Weight
DS/RWY	Runway
EH	Engine Hours
FH	Flight Hours
HP	Horsepower
IIC	Investigator in Charge
LAPL	Light Aircraft Pilot Licence

LBA	Luftfahrt-Bundesamt[1]
LMT	Local Mean Time
LPR	Medical Air Rescue
M	Month
MAC	Mean Aerodynamic Chord
METAR	Meteorological Aerodrome Report
MTOM	Maximum Take-off Mass
PDC	Pre-departure Check
PPL(A)	Private Pilot Licence (aeroplanes)
RPM	Revolutions per minute
RWY	Runway
SEP(L)	Single Engine Piston (Land)
TBO	Time Between Overhaul
TOW	Take-off Weight
ULC	Civil Aviation Authority of the Republic of Poland
VFR	Visual Flight Rules
WBR	Weight and Balance Report
WGS 84	World Geodetic System 1984

[1] German Civil Aviation Authorities (equivalent to ULC in Poland).

General

Occurrence reference number	**2020/1515**			
Type of occurrence	ACCIDENT			
Date of occurrence	28 June 2020			
Place of occurrence	EPBC			
Type and model of aircraft	SOCATA MS 893 E-D			
Aircraft registration marks	D-EGET			
Aircraft/User Operator	Private user			
Pilot in Command	PPL(A)			
Number of victims/injuries	Fatal	Serious	Minor	None
	0	2	0	2
Domestic and international authorities informed about the occurrence	Polish CAA (UCL), EASA, BEA , BFU			
Investigator-in-Charge	Andrzej Bartosiewicz			
Investigating Authority	State Commission on Aircraft Accidents Investigation (PKBWL)			
Accredited Representatives and their advisers	Accredited Representative – BEA Technical advisor – SOCATA			
Document containing results	Final Report			
Safety recommendations	None			
Addressees of the recommendations	Not applicable			
Date of completion of the investigation				

Synopsis

On 28 June 2020 the aircraft SOCATA M.S. 893 E-D, registration D-EGET, took-off from Warszawa-Babice (EPBC) at 12:25 LMT[2] to perform an en-route recreational flight to Giże (EPGE) landing site. Four persons were on board – pilot in command (PPL(A)) and three passengers. During take-off run and climb the engine power was not sufficient to continue the flight safely. The pilot decided for emergency landing out of the airfield. Landing took place in nearby forest. During the landing the aircraft hit trees and sustained substantial damage (fire did not occur). As a result of the occurrence the pilot and the passenger behind him did not suffer serious injuries and were able to leave the cockpit unaided. Two passengers on the right side suffered serious injuries. The female from the front seat was transported to the hospital by LPR helicopter.

The investigation into the occurrence was conducted by the PKWBL Investigation Team in the following composition:

Andrzej Bartosiewicz	Investigator-in-Charge;
Krzysztof Miłkowski	Team member;
Krzysztof Błasiak	Team member.

PKBWL has determined the following cause of the accident:

Failure to abort the take-off despite the symptoms of insufficient engine power.

Contributing factors:

1) Refuelling of the aircraft with automotive gasoline Pb95 with too low anti-knock index (AKI), not permitted for use.
2) Improper connection of the electrical wire connector of upper spark-plug on the cylinder no. 4, what caused the lack of spark and reduced the engine RPM.
3) The take-off mass close to the MTOM, what caused reduction of the climb rate.
4) High ambient temperature, what caused decrease in the engine power and reduction of lift force.
5) Little flight time of the PIC over 90 days prior to the accident.
6) No place for emergency landing in close vicinity of EPBC aerodrome.

PKWBL has not proposed any safety recommendations.

[2] All Times in Final Report are in LMT, unless otherwise indicated. On the day of occurrence LMT=UTC+2h.

1. FACTUAL INFORMATION

1.1. History of the flight

On 28 June 2020, around midday, the aircraft SOCATA M.S. 893 E-D, registration D-EGET, was planned to make en-route (recreational) flight from Warszawa-Babice (EPBC) to Giże (EPGE) landing site and come back to EPBC in the evening.

Around 11:00 hrs the co-owner of the aircraft – licenced PPL(A) pilot – together with her accompanying person, came to the EPBC airfield and carried out the pre-flight inspection and refuelled the aircraft.

When the second co-owner came – also PPL(A) licenced pilot – with his accompanying person, it was decided by drawing lots, that the PIC would be the male during the flight to EPGE and the female in the return flight.

As per pilot's statement, he performed one more pre-flight inspection and then, the aircraft was pushed out from hangar to the apron.

The aircraft was refuelled with 140 l of automotive gasoline Pb95, however, such a fuel does not meet the requirements of aircraft and engine manufacturers. Aviation gasoline AVGAS 100LL was available on EPBC airfield on the day of the occurrence.

On the day of occurrence, the glider training flights were taking place on EPBC airfield, being supervised from the launch point. The flight coordinator (KL) was appointed by Aeroklub Warszawski (AW). Due to the low intensity of flights, the KL was working alone, without support of another person.

The seats in the cabin were occupied in the following order: left seat – pilot in command, behind – his wife, right seat – a female pilot (as a passenger), behind her – her husband.

While seated, the pilot started the engine and established communication with Babice Radio on frequency 122,305 MHz, reporting readiness to taxi to the runway in use.

After getting the clearance from KL to cross the grass runway and taxi to the threshold of RWY 28L, the pilot did it and then – after getting next clearance – reported readiness for take-off. Due to high ambient temperature (28o C in shadow), the pilot lined up the RWY in a position allowing use its maximum length.

The pilot switched on the fuel pump, set the flaps for take-off and set the engine power (RPM) at maximum. At 12:22 hrs the pilot received clearance and started the take-off run. In his opinion, the take-off run and initial climb were normal.

According to the flight coordinator, who was monitoring the take-off until half the length of the runway, nothing non-normal occurred.

However, recordings of CCTV cameras on the airfield show irregularities from the beginning of the take-off. While airborne, the aircraft entered a mush and the further

portion of the climb was very slow (see Fig. 14). The camera's recording shows also that the climb was with a very large angle of attack.

Beyond the airfield boundary, over a forest, the aircraft was only a few meters above the trees. Only then, as per pilot's declaration, he noticed the drop in the engine power.

Since the continuation of the flight was impossible and return to the airfield involved the risk of a stall in turn, the pilot decided to perform an emergency landing at the forest clearing, which ended in failure and finally the aircraft crashed into trees.

Fig. 1. SOCATA M.S. 893 E-D D-EGET at the crash scene[3]

As a result of the collision of the left wing with a tree, the tree was uprooted, and the aircraft turned about 90º left horizontally, getting in contact with another tree and then collided with the ground. There was no fire. Traces on trees prove that the engine was running and the propeller rotated till the contact with the ground.

The largest damage occurred on the right side of the cockpit – the passengers on the right suffered serious injuries. The female seated on the right by the pilot was jammed in the seat and due to injuries, she was unable to leave the wreck unaided. The pilot and the passenger on the left did not suffer injuries and were able to leave the cabin unaided.

The rescue operation was triggered by random witnesses walking through the forest, via emergency phone 112. The Medical Air Rescue from EPBC was assigned to the action.

[3] Unless in Final Report otherwise mentioned – [source: PKBWL].

The first aid to the injured female was done by the Medical Air Rescue crew and then she was transported to the hospital by helicopter. The male seated on the right side was also taken to the hospital for medical treatment.

1.2. Injuries to persons

Injuries	Crew	Passengers	Others	TOTAL
Fatal	0	0	0	0
Serious	0	2	0	2
Minor	0	0	0	0
None	1	1	N/A	2

1.3. Damage to aircraft

As a result of collision with trees and then with the ground, the aircraft was destroyed. The PKWBL Investigation Team determined the following damage:

a) The fuselage was broken at the place of pilot's seats. The canopy was destroyed. The right side of the cabin was pressed inwards, the nose and the right landing gear were broken (Fig. 2);

Fig. 2. SOCATA M.S. 893 E-D D-EGET aircraft, damage to the cabin: A – view from left, B – view from right

b) Left and right wing preserved their geometry and connection with the fuselage, the leading edges and lights were damaged, the fuel tanks preserved their integrity. Flaps were found set at "take-off" position. The control systems of flaps and ailerons preserved their kinematic continuity (Fig. 3);

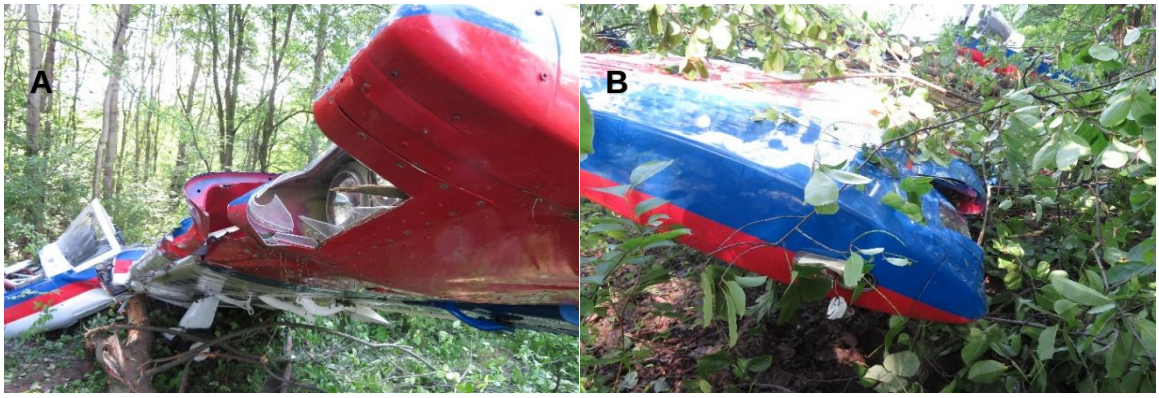


Fig. 3. SOCATA M.S. 893 E-D D-EGET aircraft, wing damage: A – left wing, B – right wing

c) The rear part of fuselage and the empennage were slightly damaged with scratches and dents. The kinematics continuity of the elevator's control was affected broken in the area of the fuselage' break. In front of the break area the cable drive and both yokes volantes were moving without jams, behind the break – the elevator and cable connected to it drive were moving freely in a full range. The rudder preserved its integrity and was following reacting on pedals movements. (Fig. 4);

Fig. 4. SOCATA M.S. 893 E-D D-EGET after the crash: A – tail with German registration marks, no visible damage, B – empennage with visible dents

d) The cockpit was deformed due to in result of fuselage break, the seats preserved their fixing to the floor, the rear part of canopy was destroyed (Fig. 5);

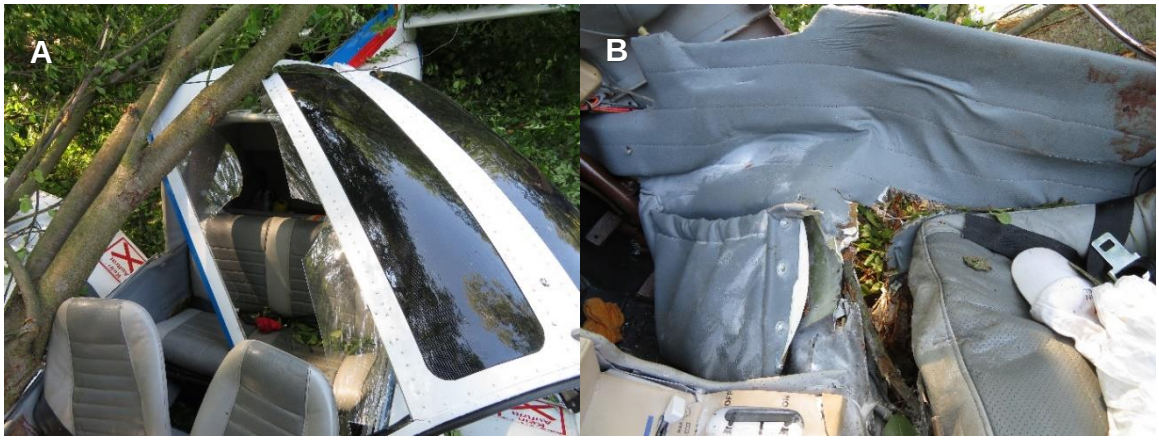


Fig. 5. SOCATA M.S. 893 E-D D-EGET cockpit after the crash: A – damage to the canopy, B – broken fuselage in the area of front seat

e) The instrument panel did not sustain visible damages, the central mid panel with switches for flaps and heating was affected;

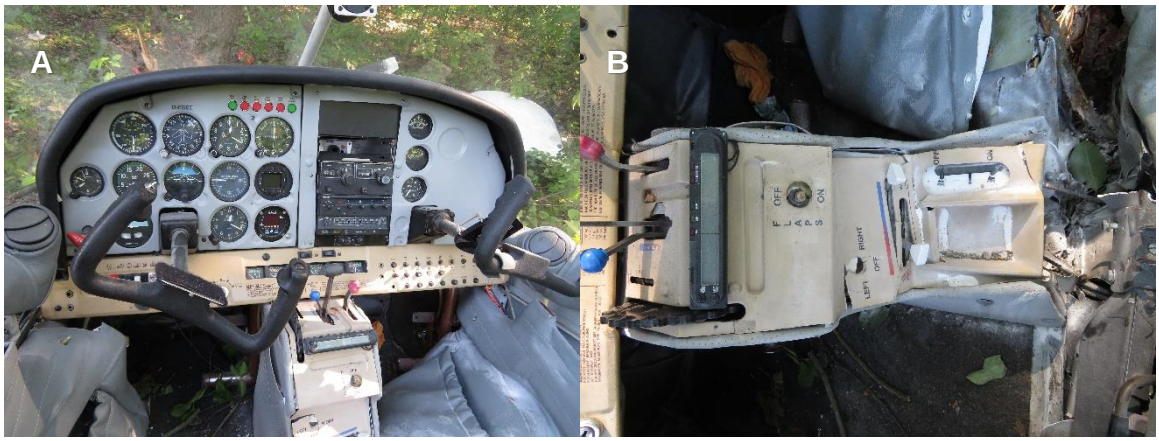


Fig. 6. SOCATA M.S. 893 E-D D-EGET cockpit after crash: A – instrument panel, B – central panel

f) The engine was without visible external damages, no leakages nor signs of overheating, no disconnected wiring harness, propeller fixed firmly – blades bent due to collision.

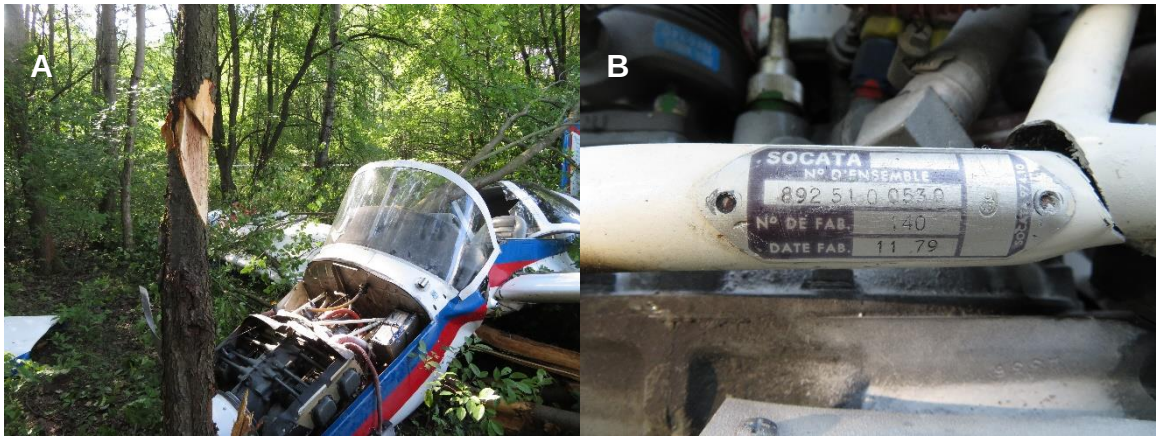


Fig. 7. SOCATA M.S. 893 E-D D-EGET engine compartment: A – general view (visible damage to the tree made by rotating propeller, B – broken engine mount

1.4. Other damage

Some trees were damaged on the site of emergency landing (Fig. 1).

1.5. Personnel information (crew data)

Pilot in Command

Pilot – male, aged 65. PPL(A) – issued 29 May 2009, no expiration date, SEP(L) rating, valid until 30 June 2021. Medical certificate – class II with VNL limitation (valid only with near vision correction), valid until 26 May 2020, LAPL valid until 21 May 2021.

Flight experience:
Total – 450 FH, on M.S 893 E-D D-EGET 140 FH (as per pilot's statement).
Date of revalidation of SEP(L) – 30 June 2019.
Over last 90 days prior to the occurrence on M.S. 893 E-D – 3:10 FH.
Over last 30 days prior to the occurrence on M.S. 893 E-D – 0:26 FH.

1.6. Aircraft information

1.6.1. General information

Design

SOCATA MS 893 E-D Rallye 180GT Gaillard is a single-engine, 4-seat, low-wing all metal construction monoplane aircraft. Duralumin frame, stringers and ribs are tack-welded to the skins. Single-spar wings with dihedral of 7,25O equipped with interconnected full-span automatic leading edge slats and electrically-driven Fowler flaps. Fixed tricycle landing gear, with free-castering nose wheel, oil-gas welded gear struts. One-piece canopy slided rearwards. Type certificate EASA.A.369

Basic data:

- type (class) – powered aircraft (A);
- subcategory – very light aircraft (A4);

- design – cantilever slow-moving, low-wing all metal semi-monocoque construction;
- designation and number of seats – trainer, 1+3;
- registration marks – D-EGET;
- manufacturer – Morane-Saulnier (later called SOCATA);
- manufacturer's designation – MS 893 E-D;
- serial no. – 13300;
- owner of the aircraft – two co-owners (natural persons);
- user – private;
- number and type of engine installed – 1 x Lycoming O-360-A3A (4-cylinder, carburettor, 180 HP);
- number and type of propeller installed – 1 x Sensenich 76EM8-0-56 (fixed pitch);
- landing gear undercarriage – tricycle, non-retractable, with nose wheel.

Certificate of Registration (CofR) – valid on the day of occurrence:

- no. in register number – L 11415 (German register of civil aircraft);
- date of entry – 10 June 2016 r;
- **the aircraft was not reported for permanent residence in Poland.**

Certificate of Airworthiness (CofA) – valid on the day of occurrence:

- date of issue – 6 May 1980;
- limitations – no limitations.

Airworthiness Review Certificate (ARC) – valid on the day of occurrence:

- date of issue – 21 May 2020;
- date of expiry – 7 July 2021.

Confirmation of Release to Service (CRS):

- date of issue – 21 May 2020.

Noise Certificate (NC) – **not valid on the day of occurrence**:

- date of issue – 6 November 2001;
- date of expiry – 31 December 2009;
- max. permitted constant RPM of propeller 2575 (on territory of Germany).

Insurance (CofI) – valid on the day of occurrence:

- date of issue – 2 June 2020;
- date of expiry – 1 June 2021;
- policy holder – Aeroklub Warszawski.

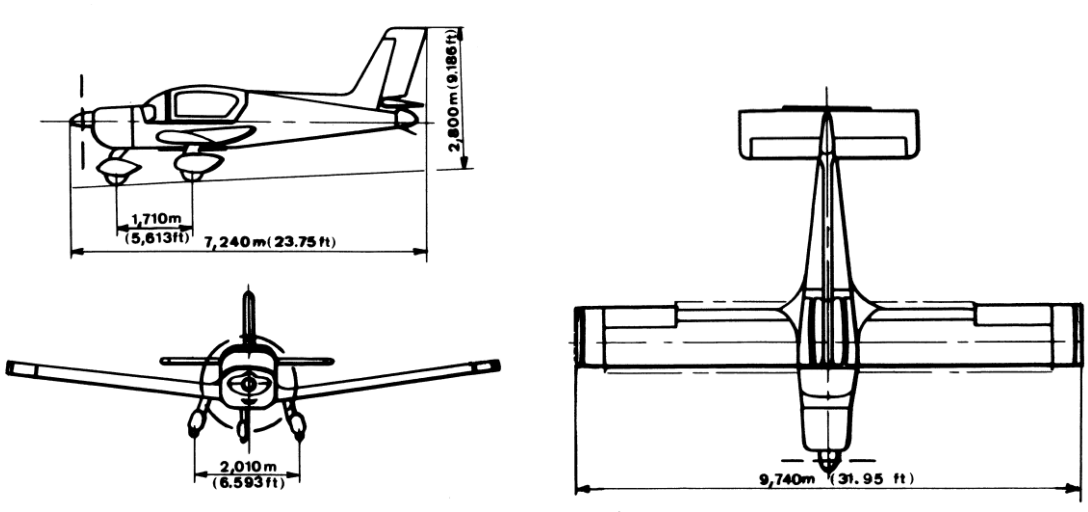


Fig. 8. SOCATA M.S. 893 E-D aircraft– 3-view drawing

1.6.2. Life-limit data

<u>Airframe – SOCATA M.S. 893 E-D</u>	
Serial no.	13300
Date of manufacture	April 1980
Airframe total since new	6 897:34 FH[4]
Number of take-offs	37 605
Since last check (annual/100 FH)	4:23 FH
Last maintenance	21.05.2020
– after total time	6893:11 FH
– effected by	licenced aircraft mechanic
<u>Engine – Lycoming 0-360-A3A</u>	
Date of manufacture	1999[5]
Serial no.	L-28826-36A
Date of installation on the airframe	01.06.2000
Engine total since new	1492:23 EH[6]
Engine total since last overhaul	does not concern

[4] HH:MM (hours: minutes).
[5] Year of first installation on the airframe as per data established during the last annual check (no other data to confirm the date of engine manufacture).
[6] Based on the data established during annual check dated 21 May 2020.

Remained to overhaul	507:37 EH / (-) 108 M[7]
Date of last check (annual/100 FH)	21.05.2020
– at total time	1488:00 EH[8]
– carried by	licenced aircraft mechanic
Since the last check (annual/100 FH)	4:23 EH

Propeller – Sensenich 76EM8-0-56

Date of manufacture	July 1999
Serial no.	27288-K
Date of first assembly on the engine	5.08.1996
Propeller total since new	1574:23 H[9]
Propeller total since last overhaul	not applicable
Remained to next overhaul	425:37[10] PH / (-) 166 M[11]
Date of last check (annual/100 FH)	21.05.2020
– at total time	1565:37 H
– carried by	licenced aircraft mechanic
Since the last check (annual/100 FH)	4:23 EH

1.6.3. Maintenance

Maintenance of the aircraft was effected by Part-66 licenced aircraft mechanic. Since 2017 he was effecting annual checks and issuing the CRS.

The last ARC dated 21 May 2020 was issued by certified airworthiness organisation Part-CAO, registered in Germany.

The maintenance records were found non complete several mistakes and unauthorized corrections were revealed. Some records are contradictory and some parameters are unreliable, e.g.:

- on 12 June 2015 the total time of the propeller , recorded during annual check at certified Part-145 organisation/Germany, was 2072 H (life-limit for the propeller is 2000 H), however on 26 June 2018 during annual check effected by licenced aircraft mechanic, the value entered for the same propeller was 1407 H;

[7] Engine life-limit recommended by manufacturer expired in June 2011. Since that time the engine was operated per its mechanical condition..
[8] Based on the data established during annual check dated 21 May 2020.
[9] Based on the data established during annual check dated 21 May 2020.
[10] Based on the data established during annual check dated 21 May 2020, according to other documents from 2015, the propeller life-limit expired 72 hours prior to the check.
[11] Life-limit recommended by propeller manufacturer expired in August 2006, since that time the propeller was operated "on-condition".

- the discrepancies have been revealed with regard to total airframe time of the propeller installation, what caused mistakes in determination of TBO. According to the available records, in 2003 the propeller was installed at the total airframe time 5000 H, however, in the period 2004-2015 this value is 4455 H, and in 2016, it was changed again on 5343 H;
- the engine parameters and propeller review during annual checks 2017, 2018 (no records from 2016 & 2019) are an evident copy of the document of 2015, with some data hidden and changed e.g. the date of inspection or owner name, with exactly the same parameters .

The parameters from annual check of 2020 were recorded on a different template and are different if compared to those from the past. As per this document the maximum RPM value during ground check was 2550.

While interviewing the owner and another witness it has been established that in the past the aircraft crew performed a precautionary landing due to insufficient spark-plugs tightening, following the maintenance effected by the mechanic involved in annual check in 2020 and earlier.

1.6.4. Mass and balance

The Weight and Balance Report (WBR) – valid on the date of occurrence:

- issue date – 18 June 2017;
- MTOM: 1050 kg;
- DOW: 646 kg;
- CG: 10,1 % MAC.

Center of gravity (CG) – limits:

- datum: front side of engine firewall;
- front limit of CG: 0,780 m after datum, for the mass up to 685 kg;
- mid limit of CG: 0,969 m after datum, for the mass up to 1050 kg;
- rear limit of CG: do 1,047 m after datum.

Fuel:

- automotive gasoline Pb95: 140 l;
- density in temp. 15^{o}C: 720÷775 kg/m^{3};
- mass: 100,8 kg (for density 720 kg/m3);
- distance from the firewall: (+)[12] 1,067 m.

Olej:

- distance from the firewall: - 0,493 m;
- amount 7,5 l

[12] (+) to the rear, (-) forward from datum.

Pilot and passenger on front seats:

- pilot: 80 kg;
- passenger: 61 kg;
- distance from the firewall: + 0,947 m.

Passengers on rear seats:

- passenger on left seat: 70 kg;
- passenger on right seat: 79 kg;
- distance from the firewall: + 1,777 m
- max. permitted load on rear seats: 154 kg.

Luggage:

- distance from the firewall: + 2,447 m;
- luggage mass[13]: 5 kg.

Based on the above data:

- **TOW=1041,8 kg** (8,2 kg below MTOM);
- **CG=1,00 m** (4,7 cm before the rear limit position).

1.7. Meteorological information

On the day of the occurrence, one hour prior to the accident, the following METAR was released for EPWA airport located nearby:

METAR EPWA 281030Z 28006KT 230V320 9999 FEW030 28/20 Q1012 NOSIG=

- date: 28.06.2020.;
- hour: 10:30 UTC;
- wind direction: 280º;
- wind speed: 6 kt;
- visibility: 10 km and more;
- clouds: 1-2/8, cloud base at 3000 ft;
- temperature: 28ºC;
- dew point: 20ºC;
- pressure: QNH 1012 hPa;
- forecast TREND: no significant changes expected to the reported conditions within the next 2 hours.

High ambient temperature had significant impact on engine power and reduced airplane lift, other meteorological conditions had no impact on the accident.

1.8. Aids to navigation

Not applicable.

[13] Approximately.

1.9. Communications

The communication was in accordance with established procedure, on the frequency of BABICE RADIO 122.305 MHz. The correspondence was readable in both ways.

1.10. Aerodrome information

EPBC – Warszawa-Babice aerodrome, general information:

a) ARP – coordinates in accordance with WGS-84, position: 52°16'09"N 020°54'26"E;
b) Type of traffic permitted: VFR;
c) Aerodrome management: Centrum Usług Logistycznych "Lotnisko Warszawa-Babice";
d) Hours of service: MON-SUN, 05:00 do 21:00 (H24 for military, public order enforcement services and medical air rescue flights);
e) Air traffic services (ATS): H24 AFIS – BABICE INFORMATION 119.180 MHz;
f) Fuel/Oil types: Jet A-1, AVGAS 100LL;
g) Aerodrome firefighting category – OTHER (Aerodrome Rescue Service);
h) Meteorological information provided: Associated MET office Central Aeronautical Forecasting Office – Meteorological Watch Office.

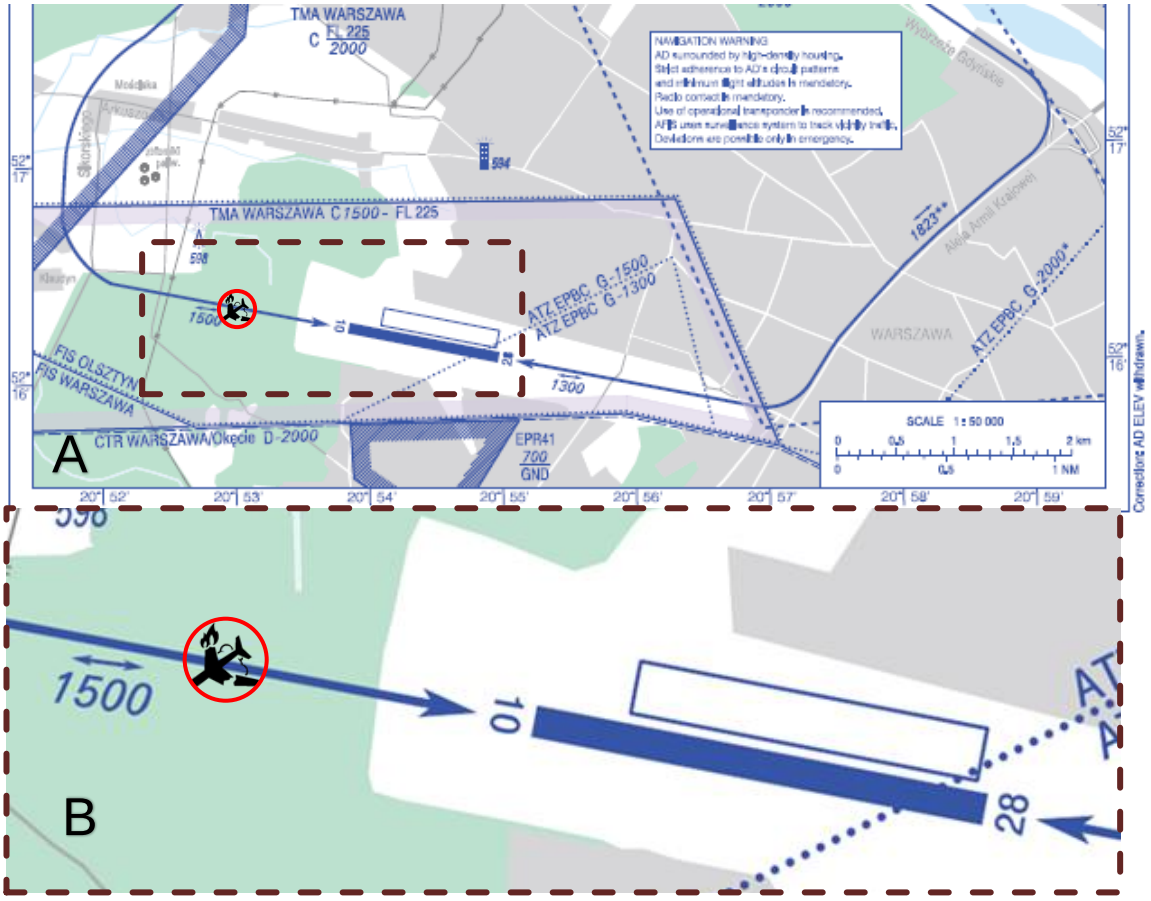
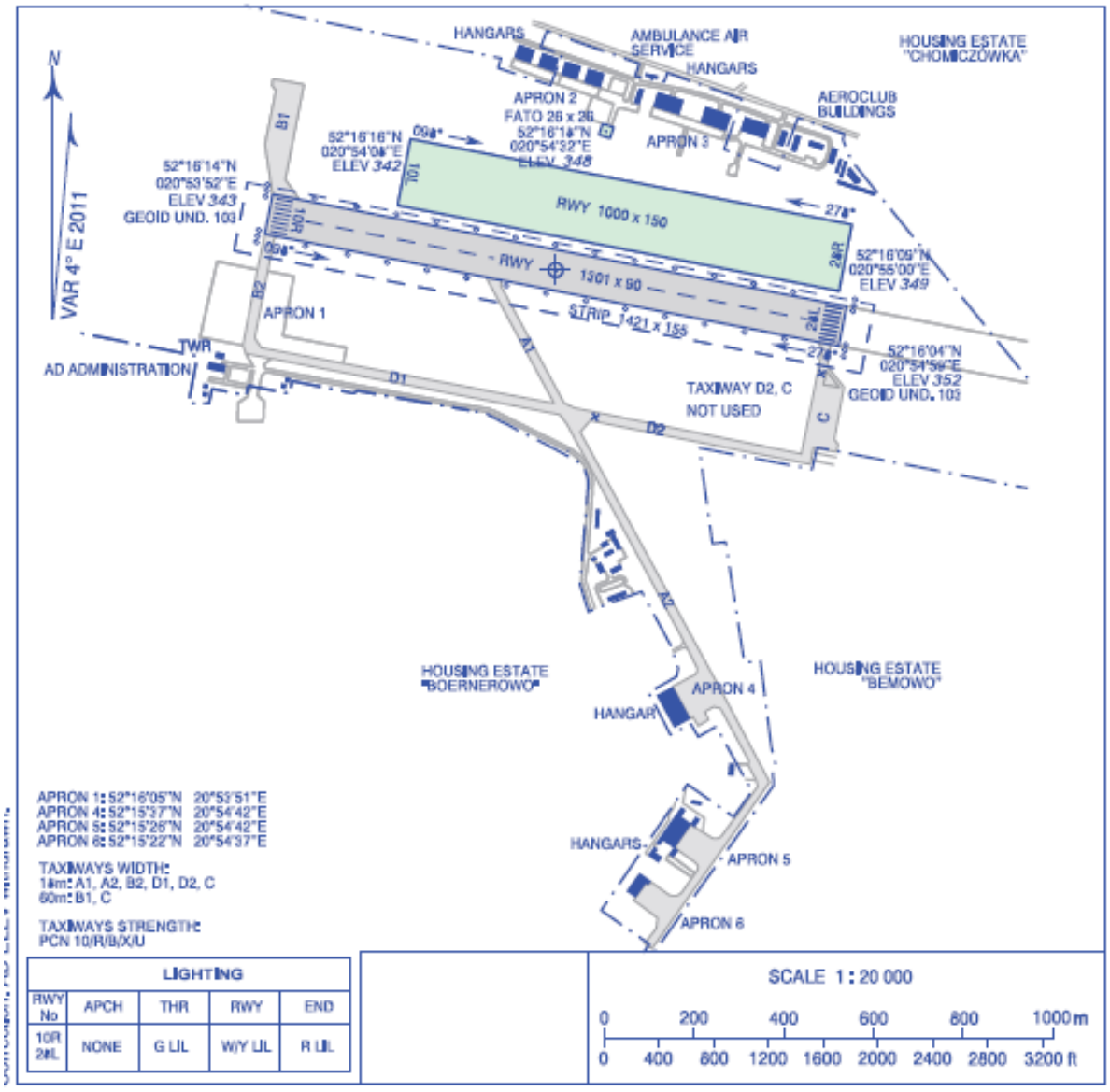


Fig. 9. EPBC – aerodrome visual operation chart with accident place shown: A – general view, B – enlarged view [source: AIP Poland]



RWY	TRUE (°)	MAG (°)	DIMENSIONS (m)	SURFACE	MTOW / STRENGTH	TORA (m)	LDA (m)
10R	102	098	1301 x 90	CONCRETE	PCN 10/R/B/X/U	1301	1301
28L	282	278				1301	1301
10L	102	098	1000 x 150	GRASS	-	1000	1000
28R	282	278				1000	1000

Fig. 10. EPBC – aerodrome chart [source: AIP Poland]

1.11. Flight recorders

The accident aircraft was not equipped with flight recorders. No flight recorder was required according to the applicable regulations.

CCTV cameras located at EPBC tower recorded the take-off of the airplane.

The take-off sequence has been presented by time-lapse record (combined picture), see (Fig. 14).

1.12. Wreckage and impact information

The accident site and the wreckage of aircraft are shown in Figs. 1-7.

The wreck preserved its integrity. No elements were identified to be separated in flight. The wreckage of the plane were located on the area of several square meters.

The first contact with trees took place a few metres above the ground, on the west side of the forest clearing, in the distance of about. 500 m west beyond the fence of the aerodrome, on the extension of the runway centre line. The plane cut and broke several tree branches (Fig. 11). Next, after about 30 m in the air, the left wing (at the landing light) hit another tree and uprooted it, the aircraft turned left horizontally about 90º, and fell down to the ground from several meters. During the fall, the tree roots, located on the ground below the fuselage, caused the fuselage to break in the area of pilots seats.

Fig. 11. Crash scene of SOCATA M.S. 893 E-D D-EGET: A – broken tree branches on the west side of forest clearing (direction opposite to the flight direction), B – overturned tree and the wreck (blue arrow shows the flight direction)

1.13. Medical and pathological information

No physiological factors or incapacity were found to affect the performance of the pilot.

1.14. Fire

Fire did not occur. The accident site was secured by the State Fire Service.

1.15. Survival aspects

The fuselage broke as a result of the collision with the ground and the right side of the cabin was deformed after collision with the tree (Fig. 2).

The passengers on the right side s suffered injuries and needed medical treatment.

Pilot-in-Command and passengers had their seatbelts fastened, what prevented them from more serious injuries.

1.16. Tests and research

1.16.1. Fuel

The fuel samples were secured from the wreck For further investigation. Due to the pilot's statement that the aircraft was refuelled i with automotive gasoline Pb95, the laboratory tests were abandoned .

1.16.2. Engine

On 30 June 2020, the wreck examination was made again, with special attention to the condition of the engine.

Exterior view of the engine – no visible damage, no overheating symptoms or leakages, the shaft was rotating without jams.

The oil, fuel and air filters and carburettor were examined – no visible particles.

All levers and cables of the engine controls were examined – all were moving in their full range and without jams.

The condition of oil and fuel hoses were examined – no loosened elements or leakages.

The electrical wiring harness, and connectors were examined – no findings.

An inspection of spark-plugs and their torque moments was made. The connector of ignition harness of upper spark-plug of cylinder no. 4 was improperly tightened and more contaminated than the others. Fig. 12 below shows the upper spark-plug from cylinder no. 4 and, for comparison, from cylinder no. 3.

Fig. 12. Spark-plugs: A – cylinder no. 4; B – cylinder no. 3

During the examination it was also found that the starter was coupled with the engine. The starter was taken for further examination Abrasions were on the starter housing, probably resulting from long-time rubbing against the bottom engine cowling. No internal damage to the starter were found.

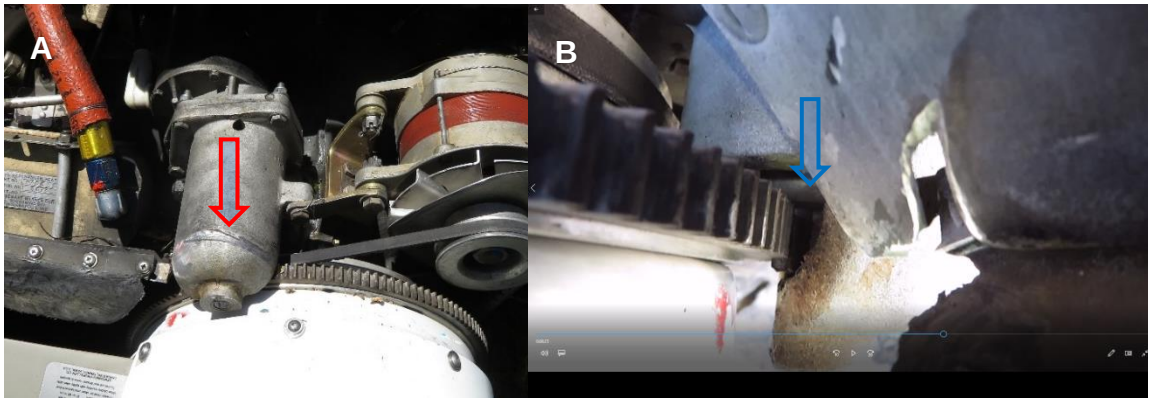


Fig. 13. Starter: A – general view (the red arrow shows the gouge); B – coupled tooth gears of an engine and starter (the blue arrow)

1.17. Organizational and management information

1.17.1. Organization of flights on the day of occurrence

On 28 June 2020, during the take-off of the accident aircraft, powered and gliding activities were conducted on EPBC. RWY 28L was dedicated for airplane and helicopter training, non-scheduled and familiarization flights, and RWY 28R for glider activity. Because of gliders, the launch point was established on the airfield.

The flights were coordinated from the launch point and the flight coordinator was appointed by Aeroklub Warszawski.

1.17.2. CAA (ULC) auditing

On 13 August 2020, upon request of PKBWL, a meeting was held with ULC to discuss the safety issues related to coordination of combined flights on EPBC and to initiate appropriate corrective actions.

During the meeting, ULC presented a report on the audit which was carried out a month earlier on EPBC aerodrome and in some of its users.

During the audit conducted in the period 7-8 July 2020, 23 findings were noted with regard to the aerodrome infrastructure and other 3 with regard to AFIS service.

The findings related to the lack of common procedures for search and rescue and obsolete Contingency Plan corresponded to the risks found by PKBWL during investigation of the accident.

In response to the findings EPBC management provided to ULC the corrective plan. ULC planned the complex audit after implementation of the corrective plan.

1.17.3. The corrective plan and findings

During the consultation on the draft final report, on 23 September 2021, PKBWL asked ULC to send information on the progress in the implementation of the corrective plan and the close of findings by the EPBC management.

On October 8, 2021, ULC presented information that all findings in the area of the AFIS service had been closed – the corrective plan had been implemented.

The Air Navigation Department of the CAA carried out two audits: from September 25 to November 19, 2020 – the comprehensive inspection (no. LOŻ-1.535.3.2020) and on September 9-10, 2021 – the planned inspection (no. LOŻ-1.543.21.2021).

The Contingency Plan is at the stage of final arrangements with the Operational Department of the State Fire Service of the City Headquarters in Warsaw. After its approval, joint exercises are planned in the field of cooperation between services concerning airport rescue. This matter will be monitored by the Airports Department of the CAA.

After all findings have been closed, an unscheduled inspection will be performed.

1.18. Additional information

1.18.1. Flight coordinator – regulation

The Regulation of the Minister of Transport and Construction, dated 4 October 2017, defines the powers and responsibilities of flight coordinator. According to this Regulation:

§ 5. Flight coordinator is entitled to:

1) provide information and directions to aircraft crews and monitor their traffic;

2) issue warnings and recommendations to aircraft crews in cases related to safety;

3) appoint additional persons to perform supporting functions during flights and define the scopes of their activities and responsibilities.

1.18.2. Consultation of the Draft Final Report

Before publication of the Final Report, SCAAI solicited comments from the persons and authorities concerned, including EASA.

The Draft Final Report was consulted with pilot-in-command of the accident aircraft. Except minor corrections no substantial concerns were raised with regard to circumstances and causes of the accident.

The Draft Final Report was sent also to: the airport operator, AW and ULC – no comments.

Translated draft of the Final Report was circulated for consultation to:

- BEA representing the State of manufacturer and designer of the accident aircraft,
- BFU representing the State of registration, and;
- EASA.

None of the above made any significant comments to the Draft Final Report.

1.19. Useful or effective investigation techniques

Standard investigation techniques were used.

2. ANALYSIS

2.1 Flight operations

2.1.1 Take-off

The Commissions analysed the CCTV recordings from the cameras located at the t EPBC tower. The camera no. 16 recorded the take-off of the accident plane.

Selected time-lapse shots have been combined into one picture as shown in Fig. 14. Since the plane itself is poorly visible, the particular phases of the take-off have been numbered and marked with red circles, in the following way:

1 – start of the take-off roll (11:25:05);
2 – lift-off (11:25:25);
3 – the highest point of initial climb (11:25:28);
4 – first mush of the aircraft (11:25:31);
5 – the highest point of further climb (11:25:37);
6 – second mush (11:25:39);
7÷10 – minimal climb on a high angle of attack (11:25:42÷11:25.45).

Fig. 14. Take-off of SOCATA M.S. 893 E-D, D-EGET, dated 28 June 2020

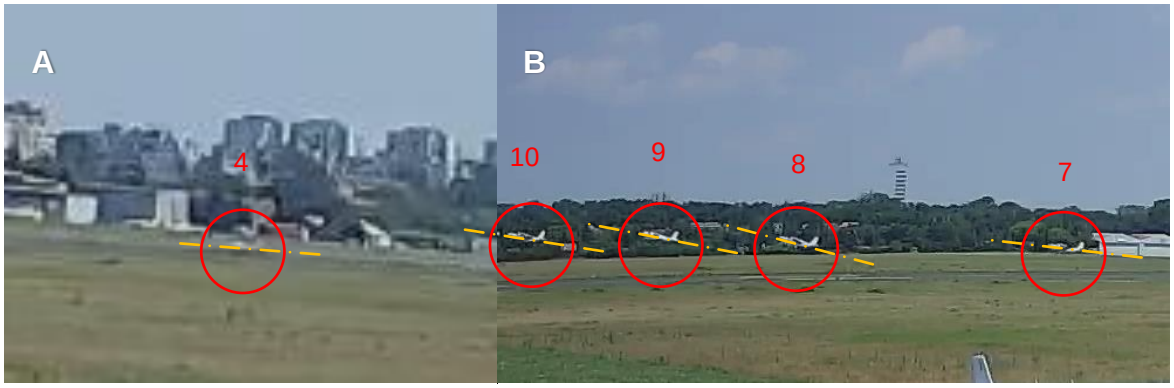


Fig. 15. Take-off of SOCATA MS 893 E-D D-EGET dated 28 June 2020 – close-up of selected shots from Fig. 14. (the orange line shows the longitudinal axis of the plane)

The pilot was increasing and decreasing the angle of attack, as shown on selected shots from Fig. 15 – B. It shows, that he was aware of problems with airplane performance, so decreasing angle of attack may be considered as a proper action to accelerate.

2.1.2 Flights coordination

During the combined operations on EPBC, the common practice was to appoint a flight coordinator from Aeroklub Warszawski, in most cases – licenced glider instructor.

Based on records analysis, correspondence and interviewing flight coordinators, it has been established that in fact the flight coordinator was coordinating and supervising only the glider operations , and – as far as other aircraft were concerned – his role was reduced to provide the information for take-offs and landings only. Coordination of flights in the manner described above is inconsistent with the applicable regulations.

> *§ 6. Flight coordinator is obliged to:*
>
> *1) prior to flight operations, parachute jumps or aviation sport events:*
>
> *a) agree with air traffic management unit the conditions for performing planned operations if required by regulations issued under art. 121 item 5 of the Act dated 3 July 2002 – Aviation Law,*
>
> *b) inspect the part of an aerodrome which is planned for use, regarding its readiness for operations ,*
>
> *c) familiarize with current and forecast meteorological conditions in the area of operations,*
>
> *d) designate a take-off area ,*
>
> *e) familiarize the personnel involved in operations with:*
>
> – *current and planned air traffic in the area of operations,*
> – *current and forecast meteorological conditions,*
> – *aerodrome infrastructure,*
> – *rules of conducting flight operations and rules of ground movement,*
> – *obstacles on aerodrome and its vicinity ;*
>
> *2) during flight operations, parachute jumps or aviation sport events:*
>
> *a) monitor the air traffic above the aerodrome and receive information about planned aircraft trajectories and current positions of aircraft,*
>
> *b) provide flight crews with information, warnings and advice necessary for conducting aviation operations ,*
>
> *c) monitor and coordinate the ground movement ,*

d) keep contact with air traffic management unit in respect to clearances and exchange of necessary information,

e) release the airspace which is not used,

f) supervise student flights y, properly respond to changes in meteorological conditions,

g) monitor condition of aerodrome infrastructure in the course of flight operations ,

h) supervise the observance of aviation regulations and safety rules by all participants and, if necessary, issue appropriate orders to ensure flight safety,

i) inform the management or their representative about aviation occurrences and violations of regulations, take action to provide assistance or initiate rescue action in case of an aviation occurrence or emergency, in accordance with the aerodrome emergency plan.;

The flight coordinator did not monitor the take-off of the accident airplane until the end despite the fact that this take-off was not normal.

The separate issue is the action y of flight coordinator in emergency situations. He should have warned the pilot that something is happening that may be a safety hazard but he failed to do that. Moreover, after receiving information that the plane had an emergency landing outside the aerodrome, he did not initiate the rescue operation and continued glider flights.

The rescue operation was initiated by the EPBC AFIS service, and only several minutes after the accident, the emergency services started their action and take-offs from the aerodrome were suspended.

The emergency action plan for EPBC dated 2015 was out of date and did not take into account REGULATION OF THE MINISTER OF INFRASTRUCTURE AND CONSTRUCTION dated 4 October 2017 on flight coordinator. According to the above plan, AFIS was responsible for initiating and conducting the rescue operation.

According to EPBC Operational Instruction issue I/2011, revision 5, dated 01.08.2017, the aerodrome management was obliged to appoint the flight coordinator according to guidelines of ULC President dated 01.06.2004. However, the above guidelines, expired on the day of entry into force the REGULATION OF THE MINISTER OF INFRASTRUCTURE AND CONSTRUCTION dated 4 October 2017.

2.2 Aircraft

2.2.1. Fuel octane numbers

Two basic standards for determining octane number are used around the world: Research Octane Number (RON) and Motor Octane Number (MON) - both based on the same measuring principle but with different test conditions. In both cases, the test is performed on single-cylinder engine with adjustable compression ratio. During the

test, the engine RPM is kept constant but the compression ratio is gradually being increased. In the RON test RPM is 600 but in the MON – 900. Therefore, the MON conditions better reflect a heavy duty engine, RON is better for medium to light duty engine.

For a typical fuel derived from refining crude oil, MON and RON differ slightly (by approx. 1-2 octanes), however, for individual hydrocarbons present in the mixture, the differences are up to over a dozen octanes, which means that it is possible to produce fuels with large differences between the octane numbers, depending on the method of measuring the octane number (RON or MON).

In Poland and in Europe, there is a standard for determining the octane number similar to RON, while in the USA, Canada, Australia and several other countries, the octane number is based on AKI standard (Anti-Knock Index) and calculated as the arithmetic mean of RON and MON - (RON + MON)/2.

2.2.2. Aircraft refuelling

The use of fuel in various Lycoming engine models was standardized by the manufacturer in the service manual. The document issued on April 4, 2020 (valid as of the date of the occurrence) is titled Service Instruction No. 1070AB.

According to the above document, for O-360-A engine model, in addition to several types of aviation fuels, it is also allowed to use automotive fuel with an octane number of 93 AKI according to ASTM D4814 standard or “super plus” according to EN228 standard.

The pilot used an outdated instruction from March 30, 2016 (Service Instruction No. 1070T), which allowed the use of 93 AKI automotive fuel according to ASTM D4814 or EN228 standard.

On the accident day, the plane was refuelled with Pb 95 automotive fuel, for which RON = 95, MON = 85, which means AKI = 90.

Both service manuals on the first page stated that failure to read the document in its entirety could lead to errors (Figure 16) and a warning that the use of any fuel mix with a lower octane rating than approved could result in detonation combustion and mechanical damage to the engine.

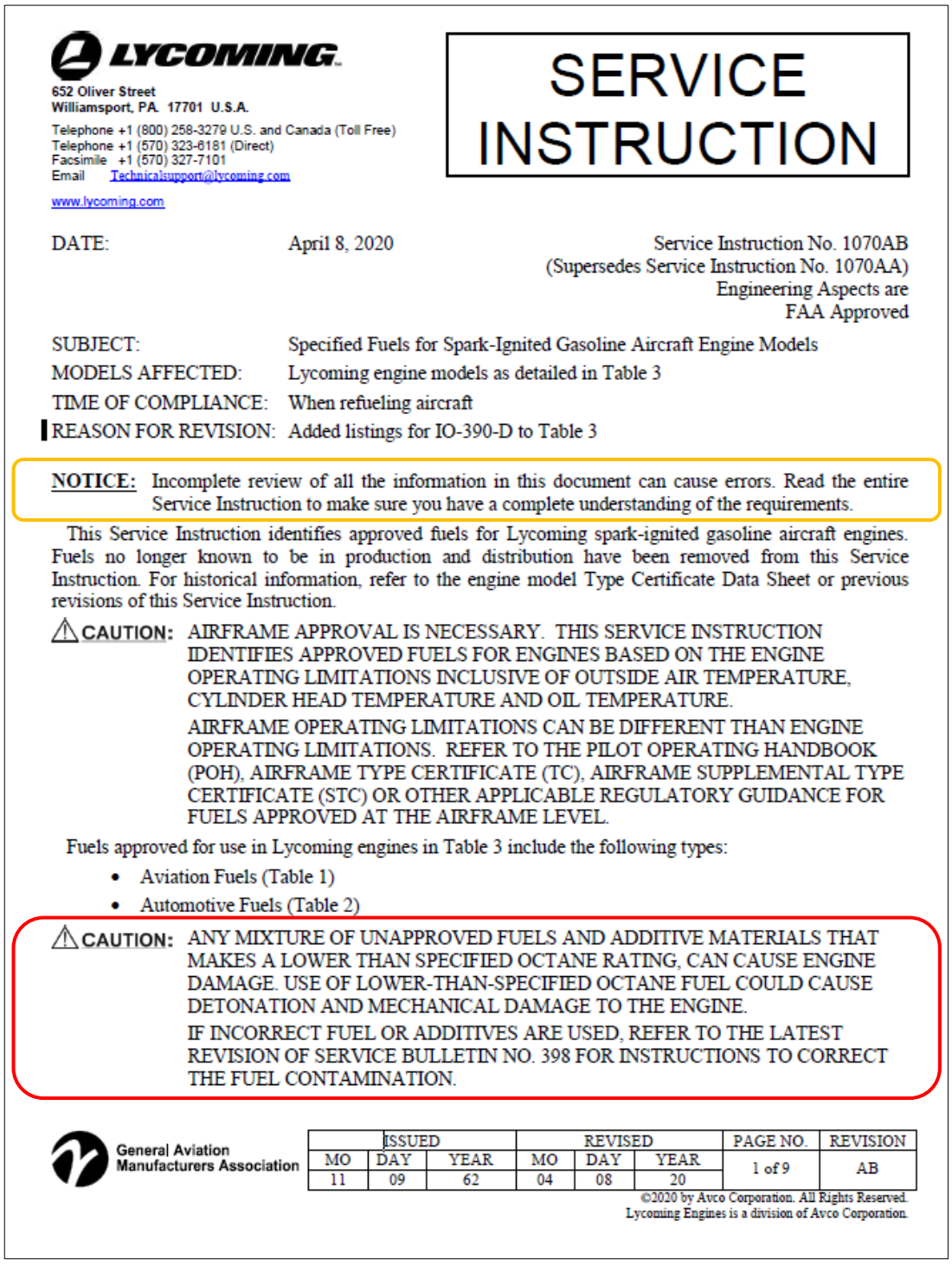
Each instruction also explains the differences between the MON, RON and AKI octane numbers (Fig. 17).

According to his statement, the pilot had a sufficient English language proficiency to understand the provisions of the above manual.

Most of the oil companies present on the Polish market offer automotive fuels that meet the requirements of Service Instruction No. 1070AB, e.g. Lotos Dynamic 98 (RON =

98, MON = 88), Orlen Verva 98 (RON = 98, MON = 88), but they are a few percent more expensive than Pb 95.

AVGAS 100LL aviation fuel was available at EPBC on the day of accident.



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SERVICE INSTRUCTION

DATE: April 8, 2020

Service Instruction No. 1070AB
(Supersedes Service Instruction No. 1070AA)
Engineering Aspects are
FAA Approved

SUBJECT: Specified Fuels for Spark-Ignited Gasoline Aircraft Engine Models
MODELS AFFECTED: Lycoming engine models as detailed in Table 3
TIME OF COMPLIANCE: When refueling aircraft
REASON FOR REVISION: Added listings for IO-390-D to Table 3

NOTICE: Incomplete review of all the information in this document can cause errors. Read the entire Service Instruction to make sure you have a complete understanding of the requirements.

This Service Instruction identifies approved fuels for Lycoming spark-ignited gasoline aircraft engines. Fuels no longer known to be in production and distribution have been removed from this Service Instruction. For historical information, refer to the engine model Type Certificate Data Sheet or previous revisions of this Service Instruction.

⚠ CAUTION: AIRFRAME APPROVAL IS NECESSARY. THIS SERVICE INSTRUCTION IDENTIFIES APPROVED FUELS FOR ENGINES BASED ON THE ENGINE OPERATING LIMITATIONS INCLUSIVE OF OUTSIDE AIR TEMPERATURE, CYLINDER HEAD TEMPERATURE AND OIL TEMPERATURE.

AIRFRAME OPERATING LIMITATIONS CAN BE DIFFERENT THAN ENGINE OPERATING LIMITATIONS. REFER TO THE PILOT OPERATING HANDBOOK (POH), AIRFRAME TYPE CERTIFICATE (TC), AIRFRAME SUPPLEMENTAL TYPE CERTIFICATE (STC) OR OTHER APPLICABLE REGULATORY GUIDANCE FOR FUELS APPROVED AT THE AIRFRAME LEVEL.

Fuels approved for use in Lycoming engines in Table 3 include the following types:

- Aviation Fuels (Table 1)
- Automotive Fuels (Table 2)

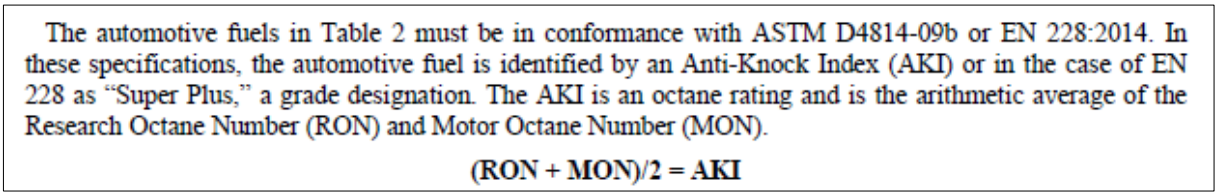
⚠ CAUTION: ANY MIXTURE OF UNAPPROVED FUELS AND ADDITIVE MATERIALS THAT MAKES A LOWER THAN SPECIFIED OCTANE RATING, CAN CAUSE ENGINE DAMAGE. USE OF LOWER-THAN-SPECIFIED OCTANE FUEL COULD CAUSE DETONATION AND MECHANICAL DAMAGE TO THE ENGINE.

IF INCORRECT FUEL OR ADDITIVES ARE USED, REFER TO THE LATEST REVISION OF SERVICE BULLETIN NO. 398 FOR INSTRUCTIONS TO CORRECT THE FUEL CONTAMINATION.

General Aviation Manufacturers Association

ISSUED			REVISED			PAGE NO.	REVISION
MO	DAY	YEAR	MO	DAY	YEAR		
11	09	62	04	08	20	1 of 9	AB

Fig. 16. Service Instruction No. 1070AB – the notice is marked with yellow, the caution with red [source: Lycoming]



The automotive fuels in Table 2 must be in conformance with ASTM D4814-09b or EN 228:2014. In these specifications, the automotive fuel is identified by an Anti-Knock Index (AKI) or in the case of EN 228 as "Super Plus," a grade designation. The AKI is an octane rating and is the arithmetic average of the Research Octane Number (RON) and Motor Octane Number (MON).

(RON + MON)/2 = AKI

Fig. 17. Service Instruction No. 1070AB – explanation of differences between RON & MON [source: Lycoming]

2.2.3. Powerplant

The engine and propeller were operated with the exceeded calendar life (see Section 1.6.2) however, within the hourly TBO. The engine was almost 9 years after the manufacturer original calendar life.

On 16 March 1999, the propeller manufacturer issued Service Bulletin No. R-17, increasing the TBO of all aluminium fixed pitch propellers from 1000 to 2000 hours.

The RPM ratio of the propeller to the engine is 1: 1.

Due to noise restrictions in Germany, the allowable continuous RPM of the propeller (and thus the engine) for the MS 893 E-D airplane were limited to 2575 RPM.

During the engine test on the ground performed on 21 May 2000, the maximum engine RPM was 2550.

The engine RPM data from previous years are unreliable as they are photocopies of the 2015 parameter sheet. All parameters are identical, including the ambient temperature and aerodrome elevation.

According to the operating instructions for the O-360-A series engines, their rated power is respectively: 180 HP at 2700 RPM, 135 HP at 2450 RPM, and 117 HP at 2350 RPM.

The engine power as a function of its RPM for the O-360 series B and D engines is shown below, in Fig. 18. The characteristic values of RPM for the A series engines were plotted on the graph and the curve for this series was drawn.

When determining the maximum engine power available during take-off, the drop in RPM caused by improper tightening the connector of one of the spark plugs and the power loss caused by using Pb 95 automotive gasoline instead of aviation fuel should be taken into account (a decrease in power of approx. 5 HP was assumed).

It should also be remembered that the maximum engine power is given for the standard temperature (15^{o}C) at sea level and will decrease with increasing in altitude and temperature.

At an altitude of 500 ft AMSL, the maximum power is 98.5% of the power available at sea level. Therefore, the EPBC elevation of 352 ft results in about 1,0% loss of power.

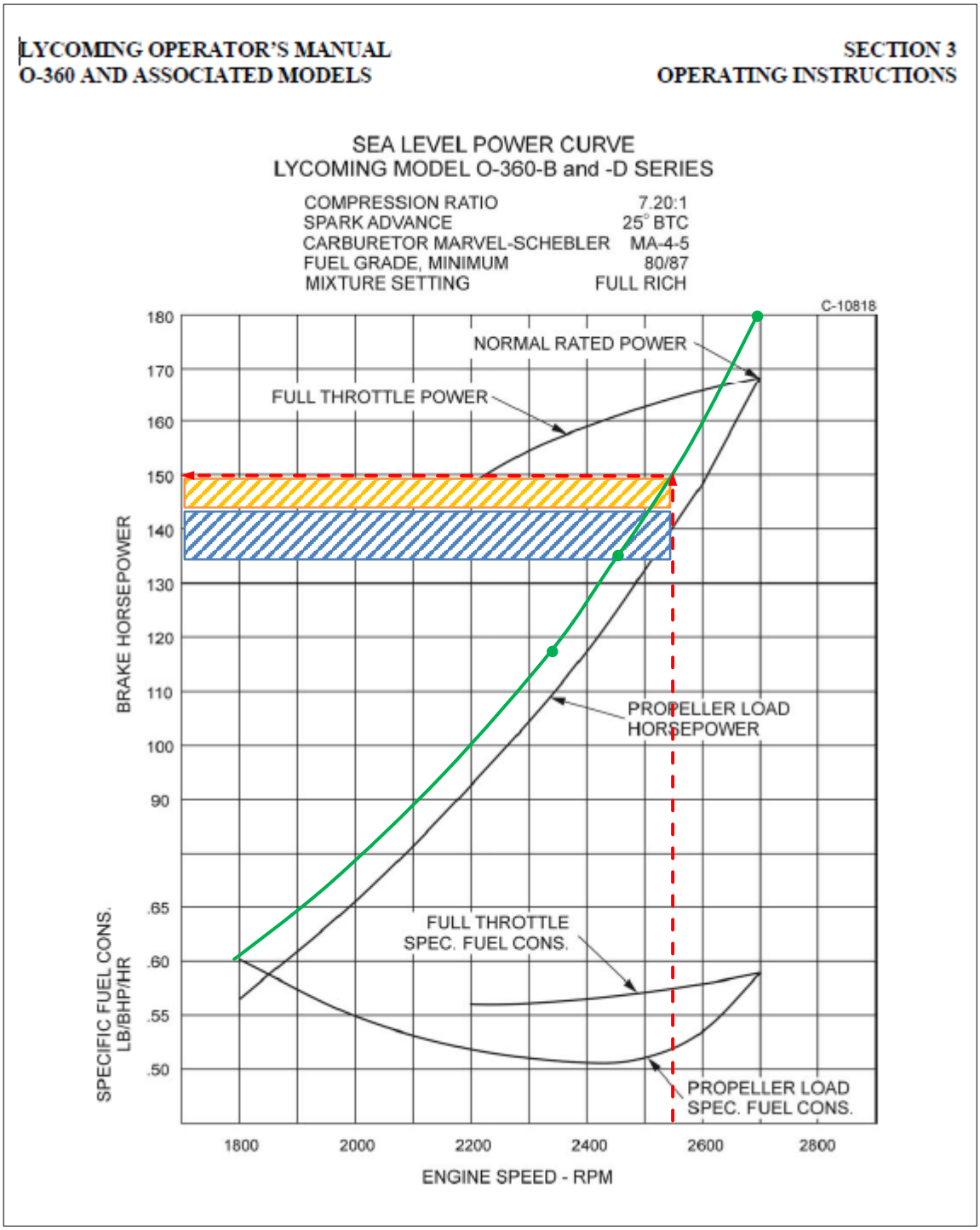


Fig. 18. The relations between engine's power and its RPM for O-360 series B & D [source: O, HO, IO, AIO, HIO, TIO-360 Series Operator's Manual] – the green colour for A series, red represents the power of O-360 series A for approx. 2550 RPM, orange is an area of estimated power drop because of improper fixing of spark-plug connector and using automotive gasoline, blue is a power correction due to elevation and outside temperature.

The power correction due to temperature is about 1% for each 10ºF. On the day of occurrence, the recorded temperature was 28ºC, i.e. 13oC (55,4ºF) higher than the standard one, what resulted in the drop of the engine power of 5,54%, i.e. about 9,97 HP.

With reference to the above calculations – the pilot had at his disposal only 135 HP (75% of maximum engine power), what – when combined with almost maximum permitted take-off weight (8,2 kg below MTOM) – reduced airspeed and climb rate during take-off.

3. CONCLUSIONS

3.1. Commission findings

1) The certificate of airworthiness for the aircraft was valid.
2) The aircraft was a private property and was used by its owners.
3) Maintenance of the aircraft was carried-out by licenced aircraft mechanic.
4) Several mistakes and unreliable data were found in the aircraft operational records.
5) The Noise Certificate for Propeller Driven Aeroplanes was not valid on the day of the accident.
6) The engine and propeller were operated based on prolonged TBO.
7) The engine was operated almost 9 years after TBO primarily established by the manufacturer.
8) The aircraft was refuelled with automotive gasoline with too low octane number which did not meet the requirement of the engine manufacturer.
9) The connector of one spark-plug was improperly tightened .
10) Mass and centre of gravity were within the permissible limits. The mass was close to MTOM, the CG was close to rear limit.
11) Due to high ambient temperature, maximum load, factors described in 8 & 9, the engine power was insufficient for a safe take-off.
12) The aircraft was destroyed as a result of the collision with trees and the ground.
13) As a result of the collision the fuselage was broken.
14) Fire did not occur.
15) The pilot had a valid licence and his qualifications met the requirements of the applicable regulations.
16) The pilot had a valid medical certificate.
17) The pilot was not under influence of alcohol and was rested.
18) The pilot's flight time (3:10 FH) over the last 90 days prior to the flight did not allow to keep his proficiency on a proper level.
19) The flight was planned as a recreational private event.

20) The pilot maintained routine communication with the flight coordinator.
21) The pilot continued the take-off despite the symptoms of insufficient engine power.
22) The pilot properly responded to airspeed drop by reducing the angle of attack.
23) After determining that the flight could not be continued, the pilot decided to perform an emergency landing outside the aerodrome.
24) The landing took place in the woods, a few hundred metres away from the aerodrome.
25) In the immediate vicinity of the EPBC landing area, on both directions of the runway, there is no place to perform safe emergency landing.
26) The flight coordinator did not initiate the search and rescue action and after the accident the flights on the aerodrome were suspended with delay.
27) Search and rescue action was initiated by a witness, who called emergency number 112.
28) According to the Emergency Action Plan for EPBC AFIS was responsible for initiation of rescue action, which was contrary to the applicable regulations.
29) Coordination of flights was done out of regulations, coordinator did not have access to Contingency Plan as well as was not familiarized with its procedures.
30) On the day of the accident the EPBC Operational Instruction had been out-of-date for several years.
31) The aircraft was not equipped with any flight recorder. No flight recorder was required by the applicable regulations.
32) As a result of the accident, two passengers sitting on the right side suffered injuries requiring medical treatment.
33) The female sitting in the front, next to the pilot, suffered the most severe injuries, what prevented her from leaving the wreck unaided.
34) The LPR crew provided first aid to the injured female, and then transported her to the hospital.
35) The pilot and the passenger sitting on the left side were not seriously injured.
36) The pilot and passengers seated on the back seats, left the wreck unaided.
37) Low airspeed and low height , partial shock absorption by one of the trees and fastening seat belts by all occupants, allowed them to survive the accident.
38) The aircraft was not reported for permanent residence in Poland, what resulted in lack of supervision both from ULC and LBA.

3.2. Cause of the accident

Failure to abort the take-off despite the symptoms of insufficient engine power.

3.3. Factors contributing to the occurrence

1) Refuelling the aircraft with automotive gasoline Pb95 with too low anti-knock index (AKI), not permitted for use.
2) Improper tightening of the ignition harness connector of upper spark-plug on the cylinder no. 4, what caused the lack of spark and reduced the engine RPM.
3) The take-off mass close to the MTOM, what caused reduction in the climb rate.
4) High ambient temperature, what caused decrease in engine power and reduction in the lift force.
5) Little flight time of the PIC over 90 days prior to the accident.
6) No place for emergency landing in close vicinity of EPBC aerodrome .

4. SAFETY RECOMMENDATIONS

PKBWL has not proposed any safety recommendations.

5. ANNEXES

None.

END

Investigator-in-Charge

signature on the original

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