MINISTRY OF INFRASTRUCTURE

AIR, MARITIME AND
RAILWAY ACCIDENT INVESTIGATION UNIT

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No.: 37200-7/2014/51
Date: 10. 4. 2018

FINAL REPORT

ON THE INVESTIGATION OF AN AIR ACCIDENT INVOLVING THE ROBIN DR 400/180 AIRCRAFT WITH REGISTRATION NUMBER S5-DKL 14 SEPTEMBER 2014 AT THE DIVAČA - LJDI AIRPORT

The Republic of Slovenia

2014

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INTRODUCTION

The Final Report on the Investigation of an Air Accident contains facts, an analysis, causes, and safety recommendations of the Air Accident Investigation Commission taking into account the circumstances in which the accident occurred.

Pursuant to point 3.1 of Chapter 13 of the Chicago Convention on International Civil Aviation (10th edition), Article 1 of Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, paragraph four of Article 137 of the Aviation Act (Official Gazette of the Republic of Slovenia [Uradni list RS], No 81/2010 – official consolidated text UPB-4), Article 2 of the Decree on the Investigation of Aircraft Accidents, Serious Incidents and Incidents (Official Gazette of the Republic of Slovenia [Uradni list RS], Nos 72/03 and 110/05), the purpose of the Final Report on the Investigation of an Air Accident is not to determine blame or liability.

The Final Report on the Investigation must, without doubt, benefit flight safety.

It is imperative that the Final Report on the Investigation be used to prevent air accidents or incidents. Use of the Final Report on the Investigation of an Air Accident for any other purposes may lead to false interpretation.

In case of any divergence of interpretation of the final aircraft accident investigation report, the Slovenian version shall prevail.

MEMBERS OF THE AIR ACCIDENT INVESTIGATION COMMISSION

Pursuant to paragraph four of Article 5 of Regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, paragraph three of Article 138 of the Aviation Act – officially consolidated text (ZLet–UPB4, Official Gazette of the Republic of Slovenia [Uradni list RS], No 81/10) and Article 7 of the Decree on the Investigation of Aircraft Accidents, Serious Incidents and Incidents (Official Gazette of the Republic of Slovenia [Uradni list RS], Nos 72/03 and 110/05), by way of Decision No. 37200-7/2014/20-00121171, the Head of the Air, Maritime and Railway Accident and Incident Investigation Unit appointed on 17 September 2014 an air accident investigation commission to investigate the circumstances in which the accident occurred, discover the causes for the air accident, and draft safety recommendations to prevent such air accidents from happening in the future.

Members of the Commission:

1. Toni STOJČEVSKI, Ministry of Infrastructure, Air, Maritime and Railway Accident and Incident Investigation Unit, Investigator-In-Charge,
2. Aljaž MEZEG, aircraft captain, ATPL pilot, external expert,
3. Matjaž GRUBER, aircraft mechanic, external expert.

SUMMARY

1. Accident date and time: 14 September 2014 at 12:55 LT[1]

2. Aircraft: Robin DR 400/180 four-seat powered aircraft

3. Registration no./serial no.: S5-DKL/1889

4. Place of accident: Divača Airport 45° 41' 00" N; 14° 00' 10" E – the Republic of Slovenia

5. Flight type: Commercial panoramic flight (according to VFR)

6. Owner: KLUB KRAŠKI LETALSKI CENTER DIVAČA – KLC DIVAČA (Divača Karst Aviation Club)

7. User/operator on the day of the incident: KLC DIVAČA

8. Consequences: /

8.1 Injuries to persons:

injuries	***crew***	***passengers***	***others***
fatal	**1**	**2**	**–**
serious	**–**	**1**	**–**
minor/uninjured	**–**	**–**	

8.2 Aircraft damage: destroyed

8.3 Equipment damage: destroyed

[1] *This Report uses local time = LT*

1 STATEMENT OF FACTS

1.1 Flight information

According to a prior arrangement made with a representative of the aviation club, the pilot arrived to the airport with the intention of carrying out a panoramic flight, which had been previously arranged between a representative of the aviation club and a group of friends who wished to take the flight. In the morning, the pilot submitted a flight plan, which was accepted and confirmed by the competent office of the Slovenian Air Navigation Services (hereinafter: KZPS). According to the flight plan (VFR points PN1, PE2, and PE1), the pilot and three passengers were to fly to the Adriatic coasts, Portorož Airport, and then return to the airport of origin, Divača Airport. The remaining friends from the group and a representative of the aviation club observed flight preparations and the departure of the aircraft.

After receiving confirmation from the head of flying, the aircraft took off at 12:54 p.m. in direction 29 from the runway. After take-off, the aircraft turned west and then, in a left roll, collided with the terrain that was 420 m away from threshold 11 of a grass runway. Upon collision with the terrain, the aircraft caught fire. Upon the crash, the pilot and two passengers died at the scene of the accident and one passenger sustained serious bodily injuries.

Upon the arrival of the Investigator-In-Charge, the scene of the incident was properly secured. On the day of the accident, an inspection of the scene was carried out together with representatives of the Koper Police Directorate. Later in the investigation, the debris from the aircraft was taken, with the logistical assistance of the Ministry of Defence, to the secure facilities of an investigation authority at the Maribor Airport.

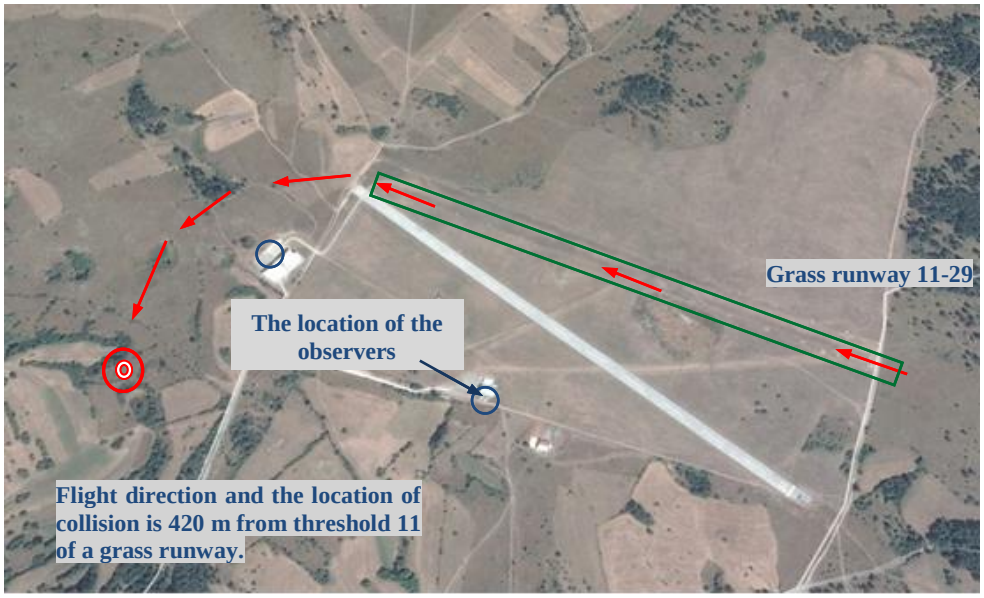


Figure 1 1: Divača Airport – take-off route and the site of the collision

1.2 Information on the injuries of the persons involved in the incident

Injuries	*crew*	*passengers*	*others*
fatal	**1**	**2**	/
serious	/	**1**	/
minor/uninjured	/	/	

1.3 Information on aircraft damage

Upon collision with the terrain, the structure of which was essentially wooden, the aircraft caught fire and was completely destroyed in the fire. At the scene of the accident, mainly the metal components of the aircraft's landing gear, the engine with the drive shaft and the propeller, the cabin structure, parts of the burnt electrical installation equipment, and metal parts of the command controls were visually recognisable.

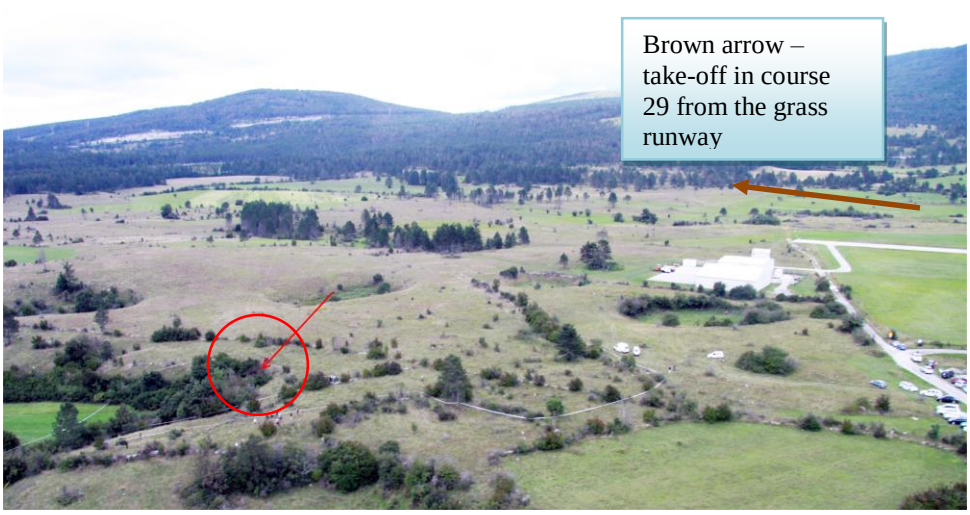


Figure 1 2: The red arrow indicates the location of the accident

Figure 1 3: The location of the wreckage of the left wing at the scene of the accident

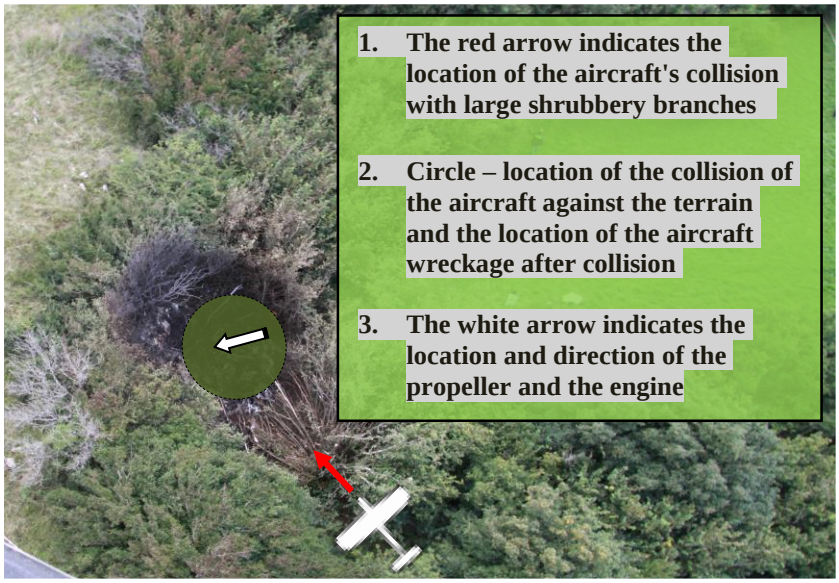


Figure 1 4: A helicopter image of the scene of the accident – crash direction

1.4 Information on other damage

After the collision of the aircraft, a fire burnt the grass surface and low and medium-height shrubbery in a radius of approximately 5 m from the aircraft. At the scene of the accident, a dead owl was found outside of the radius of dust and ashes. There was no other damage.

1.5 Crew information

1.5.1 Pilot

A man, 37 years old on the day of the accident, held:

- a glider pilot licence – GPL, no SLO/001214, issued by the CAA on 8 November 2012, valid until 8 November 2014;

- an ultra light pilot licence – ULN powered aircraft no. SLO/00538, issued by the CAA on 3 December 2012, valid until 3 December 2016;

- a private pilot licence – PPL (A) no. SI.FCL.P.A.000186, issued by the CAA on 20 May 2013;
  - class rating SEP (LAND): valid from 30 April 2013 to 30 April 2015 (the last extension of the SEP (LAND) rating was on 30 April 2013 (examiner No. SI.1).

The pilot proved his health condition by way of a medical certificate for aircraft crew (Medical Certificate Class 2) – valid until 7 January 2016 (at SI-AME No. 27).

1.5.2 Information on the pilot's medical certificate

MEDICAL CERTIFICATE TYPE:	• Medical Certificate Class 2
Restrictions:	• None
Valid until:	• 7 January 2016 (Class 2)

1.5.3 Information on the pilot's total logged flight time[2]

Pilot's total flight time until the date of the accident[3]: 156:45 hours

Total flight time in the aircraft type[4]: 47:57 hours

Of which, in the last 90 days: 1:52 hours

Of which, in the last 30 days: 01:30 hours

Of which, in the last 24 hours: 0 hours

1.6 Aircraft information

- Aircraft type: Robin DR400/180 four-seat powered aircraft
- Manufacturer: ROBIN AIRCRAFT, 21121 DAROIS, France
- Type: Robin DR400/180S
- Serial number: 1889
- Year of manufacture: 1989
- Country of registration: The Republic of Slovenia
- Licence number: 38/10 of 26 September 2013[5]
- Operator/owner: KLC Divača
- Date of entry in the Slovenian register: 15 February 2000[6]
- Reg. no.: S5-DKL
- Validity of the pilot's license: until 25 September 2014

[2] Records on the total flight time were obtained from the documentation obtained from KLC Divača Aviation Club, AK Portorož Aviation Club, and the CAA.
[3] Total flight time in the GPL, ULN, and PPL categories.
[4] After obtaining a PPL(A) licence, the pilot mostly performed flights for glider towing.
[5] The last Airworthiness Review Certificate – ARC, issued by an authorised maintenance and continued airworthiness management organisation, no SI.MG.021
[6] Prior to being entered into the Slovenian register, the aircraft had been entered into a register of German aviation authorities, reg. no. D-EKPT

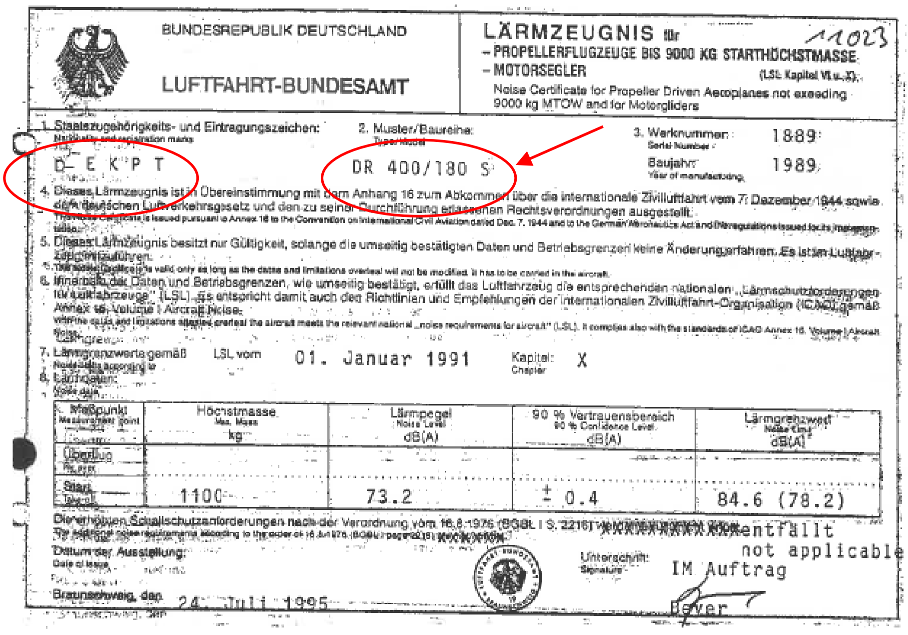
1.6.1 Engine information

- Manufacturer: Textron Lycoming
- Type: O-360-A3A,
- Power: 180 hp
- Serial number: L-31858-36A
- Date of last overhaul/ approved TBO: 12 October 2004 / 2000 hours or 12 years
- Total number of operating hours: 738
- Remaining TBO: 1217 hours

1.6.2 Propeller information:

- Manufacturer: Sensenich Wood Propeller
- Type: 76 EM 8S5-0-58
- Serial number: 26192 K
- Date of last overhaul: 25 July 2002
- Approved TBO: 2000 hours
- Total number of operating hours: 926

1.6.3 Information on the time of the purchase of the aircraft and the entry into the aircraft register in the Republic of Slovenia



BUNDESREPUBLIK DEUTSCHLAND

LUFTFAHRT-BUNDESAMT

LÄRMZEUGNIS für
– PROPELLERFLUGZEUGE BIS 9000 KG STARTHÖCHSTMASSE
– MOTORSEGLER
(LSL Kapitel VI u. X)
Noise Certificate for Propeller Driven Aeroplanes not exeeding 9000 kg MTOW and for Motorgliders

11023

1. Staatszugehörigkeits- und Eintragungszeichen: D-EKPT
2. Muster/Baureihe: DR 400/180 S
3. Werknummer: 1889
Baujahr: 1989

4. Dieses Lärmzeugnis ist in Übereinstimmung mit dem Anhang 16 zum Abkommen über die internationale Zivilluftfahrt vom 7. Dezember 1944 sowie dem deutschen Luftverkehrsgesetz und den zu seiner Durchführung erlassenen Rechtsverordnungen ausgestellt.
This Noise Certificate is issued pursuant to Annex 16 to the Convention on International Civil Aviation dated Dec. 7, 1944 and to the German Aeronautics Act and the regulations issued for its implementation.

5. Dieses Lärmzeugnis besitzt nur Gültigkeit, solange die umseitig bestätigten Daten und Betriebsgrenzen keine Änderung erfahren. Es ist im Luftfahrzeug mitzuführen.
This noise certificate is valid only as long as the dates and limitations overleaf will not be modified. It has to be carried in the aircraft.

6. Innerhalb der Daten und Betriebsgrenzen, wie umseitig bestätigt, erfüllt das Luftfahrzeug die entsprechenden nationalen „Lärmschutzforderungen für Luftfahrzeuge" (LSL). Es entspricht damit auch den Richtlinien und Empfehlungen der internationalen Zivilluftfahrt-Organisation (ICAO) gemäß Annex 16, Volume I Aircraft Noise.
With the data and limitations attested overleaf the aircraft meets the relevant national „noise requirements for aircraft" (LSL). It complies also with the standards of ICAO Annex 16, Volume I Aircraft Noise.

7. Lärmgrenzwerte gemäß LSL vom 01. Januar 1991 Kapitel: X

8. Lärmdaten:

Meßpunkt	Höchstmasse kg	Lärmpegel dB(A)	90 % Vertrauensbereich dB(A)	Lärmgrenzwert dB(A)
Überflug				
Start	1100	73.2	± 0.4	84.6 (78.2)

Die erhöhten Schallschutzanforderungen nach der Verordnung vom 16.8.1976 (BGBl. I S. 2216) XXXXXXXXXXXXentfällt not applicable

Datum der Ausstellung:

Braunschweig, den 24. Juli 1995

Unterschrift: IM Auftrag Beyer

Figure 1 5: Information on the type of the aircraft prior to the entry into the Slovenian register (Type "S")

Figure 1 6: Information on the type of the aircraft upon import and prior to the entry into the Slovenian register (Type "S")

1.6.4 Aircraft information taken from the Aircraft Register of the Republic of Slovenia

The review of the aircraft documentation acquired from the authorised maintenance organisation, CAMO – Continuing Airworthiness Management Organisation, and the documentation from the Civil Aviation Authority (CAA) showed that when managing the documentation at the maintenance organisation, the aircraft manufacturer designation was changed from "S" to "R." The last ARC[7] licence issued by the authorised organisation for managing continuing airworthiness was until 25 September 2014.

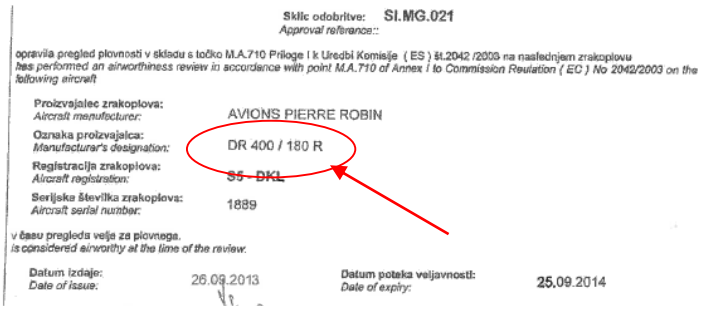
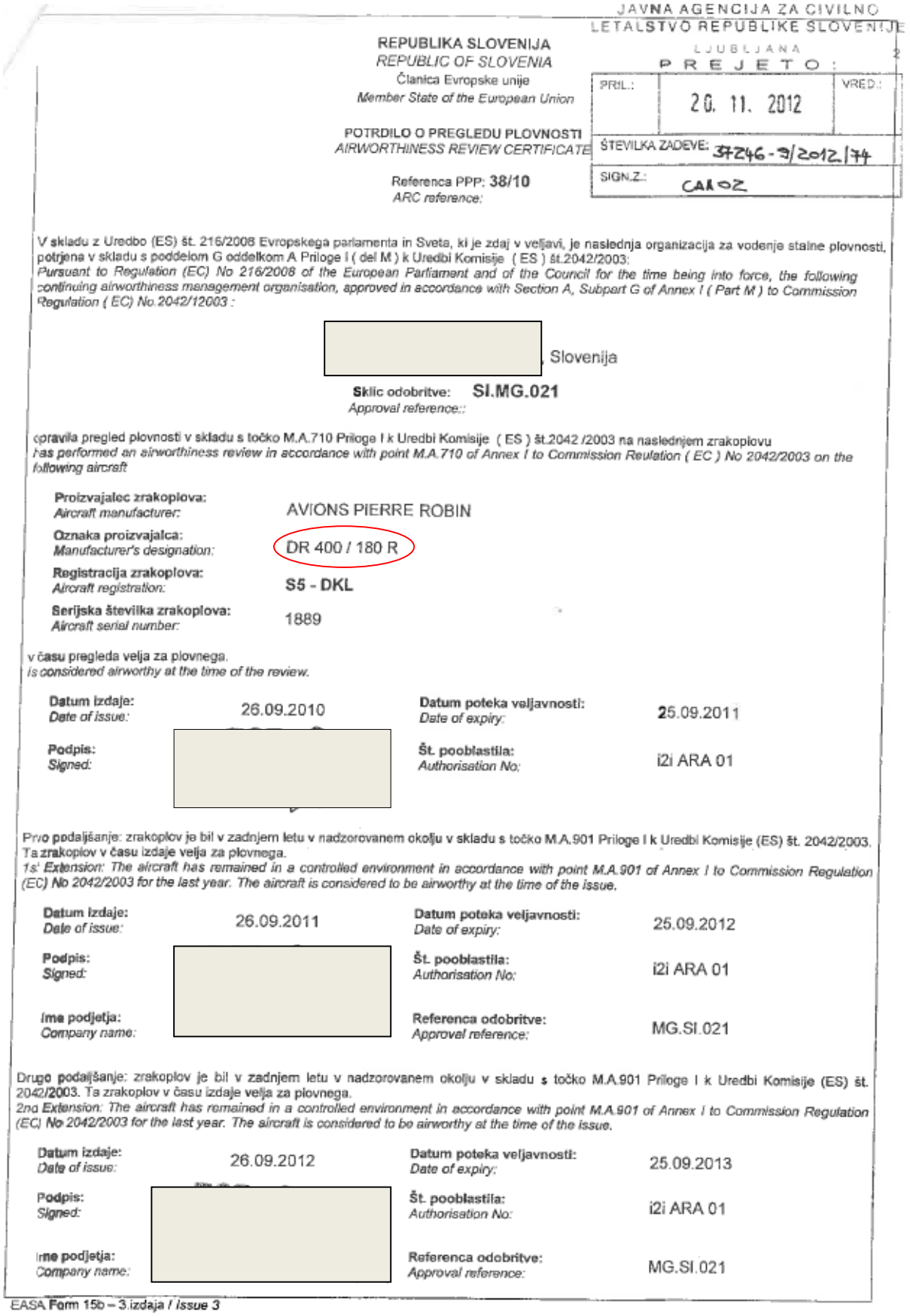


Figure 1 7: Partial information from the last issued Airworthiness Review Certificate – Type "R"

[7] *The Airworthiness Review Certificate is issued by an organisation for managing continuing airworthiness certified by the European Aviation Safety Agency (EASA) in accordance with Part-M, Subpart G of the requirements.*



JAVNA AGENCIJA ZA CIVILNO LETALSTVO REPUBLIKE SLOVENIJE
LJUBLJANA
PREJETO: 2
PRIL.: 20. 11. 2012 VRED.:
ŠTEVILKA ZADEVE: 3726-9/2012/74
SIGN.Z.: CAI 02

REPUBLIKA SLOVENIJA
REPUBLIC OF SLOVENIA
Članica Evropske unije
Member State of the European Union

POTRDILO O PREGLEDU PLOVNOSTI
AIRWORTHINESS REVIEW CERTIFICATE

Referenca PPP: **38/10**
ARC reference:

V skladu z Uredbo (ES) št. 216/2008 Evropskega parlamenta in Sveta, ki je zdaj v veljavi, je naslednja organizacija za vodenje stalne plovnosti, potrjena v skladu s poddelom G oddelkom A Priloge I (del M) k Uredbi Komisije (ES) št.2042/2003:
Pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council for the time being into force, the following continuing airworthiness management organisation, approved in accordance with Section A, Subpart G of Annex I (Part M) to Commission Regulation (EC) No.2042/12003 :

[redacted], Slovenija

Sklic odobritve: **SI.MG.021**
Approval reference::

opravila pregled plovnosti v skladu s točko M.A.710 Priloge I k Uredbi Komisije (ES) št.2042 /2003 na naslednjem zrakoplovu
has performed an airworthiness review in accordance with point M.A.710 of Annex I to Commission Reulation (EC) No 2042/2003 on the following aircraft

Proizvajalec zrakoplova: *Aircraft manufacturer:*	AVIONS PIERRE ROBIN
Oznaka proizvajalca: *Manufacturer's designation:*	DR 400 / 180 R
Registracija zrakoplova: *Aircraft registration:*	**S5 - DKL**
Serijska številka zrakoplova: *Aircraft serial number:*	1889

v času pregleda velja za plovnega.
is considered airworthy at the time of the review.

Datum izdaje: *Date of issue:*	26.09.2010	**Datum poteka veljavnosti:** *Date of expiry:*	25.09.2011
Podpis: *Signed:*	[redacted]	**Št. pooblastila:** *Authorisation No:*	i2i ARA 01

Prvo podaljšanje: zrakoplov je bil v zadnjem letu v nadzorovanem okolju v skladu s točko M.A.901 Priloge I k Uredbi Komisije (ES) št. 2042/2003. Ta zrakoplov v času izdaje velja za plovnega.
1st Extension: The aircraft has remained in a controlled environment in accordance with point M.A.901 of Annex I to Commission Regulation (EC) No 2042/2003 for the last year. The aircraft is considered to be airworthy at the time of the issue.

Datum izdaje: *Date of issue:*	26.09.2011	**Datum poteka veljavnosti:** *Date of expiry:*	25.09.2012
Podpis: *Signed:*	[redacted]	**Št. pooblastila:** *Authorisation No:*	i2i ARA 01
Ime podjetja: *Company name:*		**Referenca odobritve:** *Approval reference:*	MG.SI.021

Drugo podaljšanje: zrakoplov je bil v zadnjem letu v nadzorovanem okolju v skladu s točko M.A.901 Priloge I k Uredbi Komisije (ES) št. 2042/2003. Ta zrakoplov v času izdaje velja za plovnega.
2nd Extension: The aircraft has remained in a controlled environment in accordance with point M.A.901 of Annex I to Commission Regulation (EC) No 2042/2003 for the last year. The aircraft is considered to be airworthy at the time of the issue.

Datum izdaje: *Date of issue:*	26.09.2012	**Datum poteka veljavnosti:** *Date of expiry:*	25.09.2013
Podpis: *Signed:*	[redacted]	**Št. pooblastila:** *Authorisation No:*	i2i ARA 01
Ime podjetja: *Company name:*		**Referenca odobritve:** *Approval reference:*	MG.SI.021

EASA **Form** 15b – 3.izdaja / *Issue 3*

Figure 1 8: Airworthiness Review Certificate

1.6.5 EASA TYPE CERTIFICATE

EASA
TYPE-CERTIFICATE
DATA SHEET

EASA.A.367

DR300 and DR400 series

Manufacturer:
Robin Aviation
1 route de Troyes
21121 DAROIS
FRANCE

SECTION V: DR 400/180 S

V.I. General

1.	a) Type:	DR 400/180S
	b) Variant:	Not applicable
2.	Airworthiness Category:	Normal and Utility Category
3.	Type Certificate Holder:	C.E.A.P.R. 1 route de Troyes 21121 DAROIS FRANCE
4.	Manufacturer:	Robin Aviation 1 route de Troyes 21121 DAROIS FRANCE.
5.	(Reserved)	
6.	DGAC Type Certification date:	February 11, 1985
7.	EASA Type Certification Date:	Transferred by Commission Regulation (EC) No. 1702/2003
8.	The EASA type Certificates replaces DGAC-France Type Certificate no. 45	

V.II. Certification Basis

1.	Reference Date for determining the applicable requirements:	31 January 1985
2.	(Reserved)	
3.	(Reserved)	
4.	Certification Basis:	France AIR2052
5.	Airworthiness Requirements:	France AIR2052 amendment June 6th, 1966 FAR part 23 as amended by amendment 7
6.	Requirements elected to comply:	None
7.	EASA Special Conditions:	Canopy emergency release system
8.	EASA Exemptions:	None
9.	EASA Equivalent Safety Findings:	None
10.	EASA Environmental Standards:	ICAO Annex 16, Vol.1. Chap 6.

V.III. Technical Characteristics and Operational Limitations

1.	(Reserved)	
2.	Description:	Single-engine, four-seat, low-wing airplane, wood construction, fixed tricycle landing gear.
3.	Equipment:	The basic required equipment as prescribed in the applicable airworthiness regulations (see Certification Basis) must be installed in the aircraft for certification. Stall warning system "Safe Flight" n°164 or APR 79.88.00 or approved equivalent must be installed.
4.	Dimensions:	Span .....8.72 m (28.61 ft) Height .....2.23 m (7.32 ft) Length.....6.96 m (22.83 ft) - Round spinner .....7.10 m (23.29 ft) - Sharp spinner Wing Area .....14.2 m² (152.85 foot²)

5. Engines: Lycoming O-360-A3A

The EASA type certification standard includes that of FAA TC E-286, based on individual EU member state acceptance or certification of this standard prior to 28 September 2003. Other standards confirming to TC/TCDS standards certificated by individual EU member state prior to 28 September 2003 are also acceptable.

5.1 Engine Limits: Maximum continuous power: 2600 rpm
Remark: Maximum continuous power limited by noise regulation.

6. Propellers:

Manufacturer	Model	∅	Number of blades	Minimum static RPM at sea level
Sensenich	76 EM8S5-0-64	1.93 m (1)	2	2250 (2)

Remarks:
(1) No acceptable diameter reduction for repair.
(2) Do not continuous operate between 2150 rpm and 2350 rpm.

The EASA type certification standard includes that of FAA TC P4EA, based on individual EU member state acceptance or certification of this standard prior to 28 September 2003. Other standards confirming to TC/TCDS standards certificated by individual EU member state prior to 28 September 2003 are also acceptable.

7. Fluids:
7.1 Fuel: 100/100LL octane minimum aviation grade gasoline. Refer to latest revision of Service Instruction Lycoming No. 1070.

7.2 Engine Oil: Refer to latest revision of Service Instruction Lycoming No. 1014.

Air temperature	Ashless dispersant (AD) grades	Mineral grades
All temperature	SAE15W50 or SAE20W50	------
Above 80°F (+25°C)	SAE60	SAE60
Above 60°F (+15°C)	SAE40 or SAE50	SAE50
30°F to 90°F (O°C à +30°C)	SAE40	SAE40
0°F to 70°F (-15°C à +20°C)	SAE30, SAE40 or SAE20W40	SAE30
0°F to 90°F (-15°C à +30°C)	SAE20W50 or SAE15W50	SAE20W50
Below 10°F (-10°C)	SAE30 or SAE20W30	SAE20

8. Fluid capacities:

8.1 Fuel:

Main tank (liters)		RH tank (liters)		LH tank (liters)		Auxiliary tank (optional) (liters)	
Capacity	Usable	Capacity	Usable	Capacity	Usable	Capacity	Usable
110	100/109 (1)	40	40	40	40	50	50

(1) New standard called "Standard 92" from serial number 2210, unusable quantity of fuel reduced from 10 liters to 1 liter, (refer to note 2).

8.2 Oil: Oil sump capacity ..... 8 U.S. quarts (7.57 liters)
Usable ..... 6 U.S. quarts (5.68 liters)

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9. Air speeds:

V_{NE}	308 km/h (166 knots IAS)
V_{NO}	260 km/h (140 knots IAS)
V_C	260 km/h (140 knots IAS)
V_A	215 km/h (116 knots IAS)
V_{FE}	170 km/h (92 knots IAS)

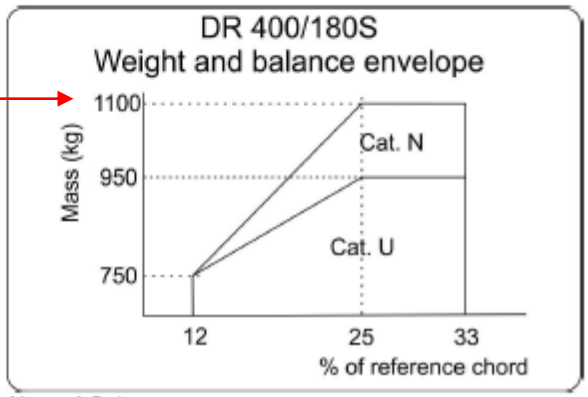
10. Maximum Operating Altitude: Refer to approved aircraft flight manual.

11. Operational Capability: Refer to approved aircraft flight manual.

12. Maximum Masses:

"N" Category		"U" Category
Take-off	Landing	
1100 kg (2425 lb)	1045 kg (2304 lb)	950 kg (2094 lb)

13. Centre of Gravity Range:



The MTOM – maximum take-off mass – for the DR 400/180 S aircraft type is 1100 kg.

Compared to the DR 400/180 R aircraft type, the MTOM is 1000 kg.

Normal Category
Forward limit (12 % ref.): .. 0.205 m aft of datum at 750 kg
Intermediate limit (25 % ref.):0.428 m aft of datum at 1100 kg
Aft limit (33 % ref.): ..... 0.564 m aft of datum at 1100 kg
Utility Category
Forward limit (12 % ref.): .. 0.205 m aft of datum at 750 kg
Intermediate limit (25 % ref.):0.428 m aft of datum at 950 kg
Aft limit (33 % ref.): ..... 0.564 m aft of datum at 950 kg

14. Datum: Wing leading edge of the rectangular part of the wings. Cord length at reference section: 1.71 m (5.61 ft)

15. Load factor at maximum weight:

Normal Category:	Flaps up n	+ 3.8
	Flaps up n	- 1.9
	Flaps down n	+ 2
	Flaps down n	0
Utility Category:	Flaps up n	+ 4.4
	Flaps up n	- 2.2
	Flaps down n	+ 2
	Flaps down n	0

16. Leveling Means: Horizontal reference upper fuselage spar

17. Minimum Flight Crew: 1 (pilot) at 0.41±0.05m aft of datum

18. Maximum Passenger Seating Capacity: 1 at 0.41±0.05m aft of datum and 2 at 1.19m aft of datum.

19. Baggage / Cargo Compartment — Maximum baggage compartment: 60 kg (132 lb) at 1.90m aft of datum)

20. Wheels and Tires:

Main gear track .....2.58 m (8.46 ft)
Wheel tire size .....380 x 150
Front gear angular movement ..... left: 27°
..... right: 27°
Tire pressure ..... refer to following table
Oleo strut pressure ..... refer to following table

Front gear		Main gear	
Tire	Oleo strut	Tire	Oleo strut
1.8 bar	5 bar	2 bar	6 bar

21. Control surface movements

Elevator: up ..... 9°30' ± 30'
down ..... 12° ± 30'

Ailerons: Relative to the trailing edge of the wings

up	neutral	down
15°± 1°	2° ± 1°	10°± 1°

Elevator tab: Elevator up: .....25°30' ± 1°.....6° ± 1°
Elevator down: 10°30' ± 1° 16°30' ± 1°

Flaps: 1st notch: .....15° ± 5°
2nd notch: .....60° $^{+0°}_{-5°}$

Rudder: .....25° $^{+3°}_{-0°}$ (1)

(1) For planes fitted with brakes controlled with rudder pedals:
16° (-0°, +2°) before operating drum brakes
20° (-0°, +3°) before operating disk brakes

22. (Reserved)

V.IV. Operating and Service Instructions

Airplane Flight Manual ..... Refer to the latest amendment of Service Letter no. 6
Airplane Maintenance Manual ..... Refer to the latest amendment of Service Letter no. 6
Airplane Maintenance Schedule ..... Refer to the latest amendment of Service Letter no. 6

V.V. Note:

1. This plane is identical to DR 400/180 except:
   - maximum continuous power rpm
   - Sensenich 76 EM8S5-0-64 propeller only
2. "Standard 92" model

The following speed limits are stated in the Flight Operation Manual for a Robin 400 aircraft:

- max. speed (never exceed): 166 KTS (308 km/h),
- max. cruising speed: 140 KTS (260 km/h),
- max. manoeuvring speed: 116 KTS (215 km/h),
- minimum (stalling) speed: **51 KTS (95 km/h).**

Compared to the "R" class aircraft, the MTOM in the "N" class is 1000 kg.

1.6.6 Other aircraft information

The owner, who was also the user of the aircraft, used to use the aircraft for educational purposes at a flying school that had been registered within the KLC Divača Aviation Club a few years prior to the accident for the purpose of training students to acquire a PPL licence. The flying school's licence expired on 14 December 2012, so the aircraft could not be used for practical training after this date. It was discovered on the basis of the documentation from the KLC Aviation Club that the aircraft was mainly used to tow gliders and maintain qualifications in the category of pilots with a PPL (A) licence.

The analysis of the aircraft documentation from 2001 to 2005, the period in which airworthiness was extended by the then competent aviation authority of the Ministry of Transport (Civil Aviation Directorate), showed that the purpose of the use of the aircraft, which was entered in the Certificate of Airworthiness, was "sports, education, towing, transport of passengers and things." The purpose entered in the Certificate of Airworthiness did not constitute a licence for carrying out commercial flying or aerial work. For these activities, operators had to acquire a special licence[8] (Aerial Work Licence) at the time in order to be able to carry out aviation operations, such as recording, taking photographs, and panoramic flights.

1.6.7 Information on the review of the documentation on the aircraft maintenance and airworthiness

International and national aviation regulations for such aircraft stipulate that the aircraft owner and user must ensure that the documentation on the technical maintenance and airworthiness of the aircraft be kept. It was discovered on the basis of the Journey Log Book and the Technical Log Book that this documentation was regularly kept, but with certain shortcomings that were subject to additional cross-examinations within the investigation. The owner performed periodical inspections in accordance with the instructions of the manufacturer regularly, which is confirmed by the records found in the documentation of the Civil Aviation Agency concerning expert inspections by the supervisory authority and, later, by the authorised organisation for managing continuing airworthiness, which managed the procedures for

[8] *Paragraph two of Article 77 of the Aviation Act (Official Gazette of the Republic of Slovenia [Uradni list RS], No 81/2010 – official consolidated text UPB-4) also references the application (mutatis mutandis) of the provisions of Article 76 of the said Act and CAA regulations.*

extending the Airworthiness Review Certificate procedures from 2011 to 2014. The validity of the last licence issued by an authorised organisation for managing constant airworthiness was from 26 September 2013 to 25 September 2014 (Figure no. 5).

1.6.8 General information arising from the review of the aircraft's technical documents

During the investigation, additional cross-examination was required in order to determine any deviations that may have affected safety, and relating to this, also any technical deficiencies that could have affected the use of the aircraft prior to the incident or the time limit of the use of the aircraft during the validity of the Certificate of Airworthiness. After the additional inspection of the technical documents of the aircraft was completed, the Commission found that certain administrative errors occurred when these documents were managed, which, however, did not affect airworthiness nor any limitation of the use of the aircraft at the time of the incident.

The Commission performed an additional review of the following documentation:

- Folder 1 – Archives of technical documents from 18 June 2003 to 4 July 2008
- Folder 2 – Archives of technical documents from 26 May 2009 to 26 August 2014
- Technical Log Book No 1, date of first entry: 27 June 2003
- Engine Log Book (*no entry*), date of first entry: 12 October 2004
- Propeller Log Book, date of first entry: 26 February 2000
- Journey Log Book No 9, date of first entry: 28 September 2009,
  date of last entry: 2 September 2010
- Journey Log Book No 15, date of first entry: 26 April 2014,
  date of last entry: 14 September 2014

1.6.8.1 Information from the propeller documentation

- The Propeller Log Book does not contain data on the last installation of a propeller manufactured by Sensenich Wood Propeller onto the Lycoming O-360-A3A engine, serial number: L-31858-36A.

- Irregularity with regard to keeping records on the total number of propeller operating hours following overhaul was discovered. 1831 hours were entered instead of the actual time, which was 294 hours following overhaul. The error occurred when data was entered into the technical documents related to the performed inspection at the maintenance organisation "A/H" (JAR-145, SVN.CAA-06) of 31 May 2004.

1.6.8.2 Aircraft Journey Log Book No 9

On 17 October 2009, a note was made in the Log Book stating that *"the flap lever fails to lock in the second level position".* There was either no answer to the note or there was no traceability that would prove that the note was discussed and any deficiency eliminated.

On 9 December 2009, the following note was entered: "*starter and the gears of the flywheel were changed by [name]*". It is not evident from the documentation which authorised person performed the change and where it was performed. This page in the Journey Log Book is crossed out without any special clarification.

On 2 July 2010, the following note was added: *"the tape on the contact with the fuselage detached, top right wing."* There was no answer to the note. No finding can be found in the documentation with regard to the note.

1.6.8.3 Aircraft Journey Log Book No 15

The crew insufficiently entered data. In certain cases, there is no information on who flew and where they flew. On 23 July 2014, the name of the pilot and the flight duration were not entered. After the calculation of the data carried over onto the next page of the Log Book, the performed flight time was 1 hour and 3 minutes.

1.6.8.4 Aircraft Technical Log Book

Minor administrative errors were found in the Technical Log Book with regard to the recording of data into the prescribed CRS[9] forms, such as the incorrect number of flight time hours and the incorrect number of hours for the components (engine, propeller), and errors related to dates (date of performed inspection).

1.6.8.5 Engine Log Book

The information on the engine TBO after the date of the last overhaul on 12 October 2004, amounting to 12 years, was not entered.

1.6.8.6 Archives of technical documents of 18 June 2003 to 4 July 2008

After an inspection of the aircraft for the purpose of the extension of airworthiness, the air control authority at the time, the Civil Aviation Authority of the Republic of Slovenia, submitted a request on 2 June 2003 in the minutes of the inspection: *"Send magnetos to the 500-hour (illegible) for the tests (SLICK 4270, 4373)."* Furthermore, a request was issued on this day to file Form 1 for the magneto inspection into the technical documentation. Form 1 for

[9] *CRS (Certificate Release to Service)*

magnetos was not found in the documentation, but an overhauled engine with Slick magnetos (left magneto P/N 66GC25SFNN, S/N 04041357; right magneto P/N 66GP-OSANN, S/N 04040409) covered in Form 1 of the overhauled engine was installed in the aircraft on 12 October 2004. The period of airworthiness of the aircraft from 2 June 2004 (when the request of the control authority *"Send magnetos to the 500-hour ..."* was submitted) to 12 October 2004, when the engine was installed, was not clearly defined. It was discovered that the control authority did not provide a deadline for the fulfilment of its request.

1.6.8.7 Archives of technical documents of 26 May 2009 to 26 August 2014

1. When the total flight time of the aircraft reached 4710:01 hours on 7 August 2010, a 50-hour inspection was performed. Upon review of the enclosed list of parts with a limited lifespan, it was discovered that, at the time of the inspection, 500-hour inspections for magnetos, the starter, and the alternator, a 3-year inspection, a 6-year inspection, and the inspection of the flexible hose of the engine were 10 hours overdue. There is no supporting documentation proving that these works have been performed despite the expired status. CRS's were enclosed with the Aircraft Journey Log Book, Technical Log Book, Engine Log Book, and Propeller Log Book only for the performed 50-hour inspection.

2. When the total flight time of the aircraft reached 4711:25 hours on 22 September 2010, a 50/100/200-hour/1/2/3-year inspection was performed (CRS). After a work order of 20 September 2010, the requested parts also included a 500-hour inspection of magnetos, a 500-hour inspection of the alternator, and a 6-year inspection; however, these were not entered into the CRS (as significant works, these should be stated in the CRS).

3. The technical documents also include a report that states that a 50/100/200-hour/1/3/6-year inspection and a 500-hour control of the magnetos and the alternator as well as additional required works were performed. According to this report, this inspection was performed 1 hour and 24 minutes after the performed 50-hour inspection of 7 August 2010. Upon the review of the Aircraft Journey Log No 9, it was discovered that between flight time 4710:01 (7 August 2010 when the 50-hour inspection was performed) and 4717:16 (the last entry in the Aircraft Log Book of 2 September 2010) there was no entry of any such performed major inspection – 50/100/200-hour/1/3/6-year inspection and a 500-hour inspection of the magnetos and the alternator. The Aircraft Log Book, the Engine Log Book, and the Propeller Log Book do not contain any information on any performed major inspection.

4. An additional cross-examination of the technical documents showed that there were administrative errors or deviations that could have affected the traceability of the performed regular and special inspections of the aircraft in accordance with the regulations in the field of airworthiness and with the aircraft maintenance programme and in the field of the CAMO organisation – managing continuing airworthiness. Due to the discovered deviations and errors in the technical documents, a special inspection of the available parts of the aircraft wreck was performed, namely the magnetos, the structure of the pilot's seat, the connections of the flap remains, the flap system, the flaps themselves, and the gear wheel of the flywheel were once again inspected. The report by the authorised organisation according to PART 145 concerning the additional inspection of parts of the aircraft was provided in Appendix 2 of the Final Report.

1.6.9 Mass and centre of gravity

It is evident from the aircraft's type certificate and the manufacturer's operational manual that the maximum take-off weight (MTOW) is 1100 kg, which should not exceed this value in conditions without any loads. It is evident from the report of the confirmed maintenance organisation on the weighting of the aircraft (the last measurement was performed on 12 March 2014) that the mass of the empty aircraft was 659 kg. The sum of the quantity of fuel, the mass of the crew, and the mass of the empty aircraft should not exceed the MTOW – 1100 kg. The Commission finds that the MTOW value was on the limit of the permitted MTOW or on the limit of the aircraft's capability in the category "normal," prescribed by the aircraft manufacturer in the operational manual.

Signature

Wiegebericht

Luftfahrzeugart: LFZ

Kennzeichen: S5 DKL

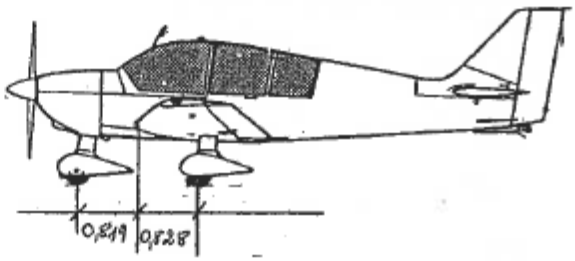
Baumuster: DR 400/180

Werk Nr. 1889

Bezugspunkt: FLUGZEUGNASE

Bezugsebene: LONGGROW

Angaben aufgrund: HM u. FLUGHANDB



Wiegezustand: Ausrüstungsverzeichnis vom: —

Triebwerksöl: Full

Treibstoff: Full

Sonstiges:

Wiegung:	Wiegepunkt	Abgelesenes Gewicht kg / lbs	Tara kg / lbs	Nettogewicht kg / lbs	Arm m / in	Moment mkg / in lb
	(RM) links	289,5	—	289,5	0,828	239,70
	(RM) rechts	285,5	—	285,5	0,828	236,39
	Bug/Heck (RM)	206,8	—	206,8	0,819	169,36
	Gesamtgewicht laut Wiegung:			781,80		
	Nichtausfliegbarer Treibstoff: 10 LITER					
	Triebwerksöl: Full					
	AusfliegbarerTreibstoff max 100 LITER			72,0	1,110	80,64
	WOG AH u. LH 80 LITER			57,6	1,621	93,43
	Leergewicht laut Wiegung vom: 09.09.08			652,20	0,20	133,36
Gewichtsberichtigung	**Gewichtsänderung lt. Bericht vom:**					
	Leergewicht lt.Gewichtsberichtigung vom:					

Luftfahrzeug Kategorie			
Verwendungsart			
Einsatzart			
Aktuelles Leergewicht	652,20 KG		
Zuladung	447,8		
Maximales Abflug-/Landegewicht	1100 / 1045 KG		

LOWG 09.09.08

Ort und Datum der Wiegung/ ~~Berichtigung~~

Signature

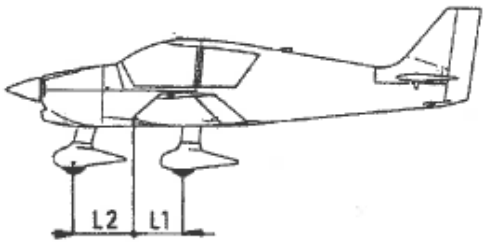
Figure 1 9: Measurement of aircraft weight of 9 September 2008

MAINTENANCE MANUAL **ROBIN DR400**

Aircraft type: DR400/180R	Registration: S5-DKL	Serial number: 1889

AIRCRAFT WEIGHING ON WHEELS

- Vertical moment datum: leading edge of the rectangular part of the wing
- Datum chord: 1.71 m
- Horizontal levelling: upper longeron (arm rests)



L1 = 0,828

L2 = 0,819

BASIC EMPTY WEIGHT					
	WEIGHT MEASURED in kg		TARE in kg		NET WEIGHT in kg
NOSE WHEEL	203	-	/	=	203
L/H MAIN WHEEL	230	-	/	=	230
R/H MAIN WHEEL	226	-	/	=	226
	TOTAL EMPTY WEIGHT =				659

EMPTY MOMENT = SUM OF MOMENTS ABOUT EACH WHEEL					
	NET WEIGHT in kg		MOMENT ARM in m		MOMENT in m.kg
R/H WHEEL	226	x	0.828	=	187,128
L/H WHEEL	230	x	0.828	=	190,440
UNUSABLE FUEL*	7,3	x	1.120	=	8,176
NOSE WHEEL	203	x	-0.819	=	188,370
	EMPTY MOMENT =				197,374

* Unusable fuel in main tank: 7.3 kg or 0.7 kg depending on model

12. 3. 2014

Signature

FIG. 3.1 - WEIGHING, BASIC EMPTY WEIGHT, EMPTY MOMENT

Figure 1 10: Last aircraft weight measurement was performed on 12 March 2014.

1.7 Meteorological data

Weather description on 14 September 2014

Weather conditions

The closest automatic weather station is located in the area of Škocjan, at an elevation of 420 m, and its distance from the airport is less than 5 km. Considering the weather conditions and the proximity of measuring devices, the information is representative of the general area surrounding the station. In the area of Divača, the cloud coverage was approximately 1/8 Cu (cumulus clouds) with a base at approximately 1500 m and cloudy, and there was from 6/8 to 8/8 of medium to high cloudiness. Horizontal visibility was beyond 20 km.

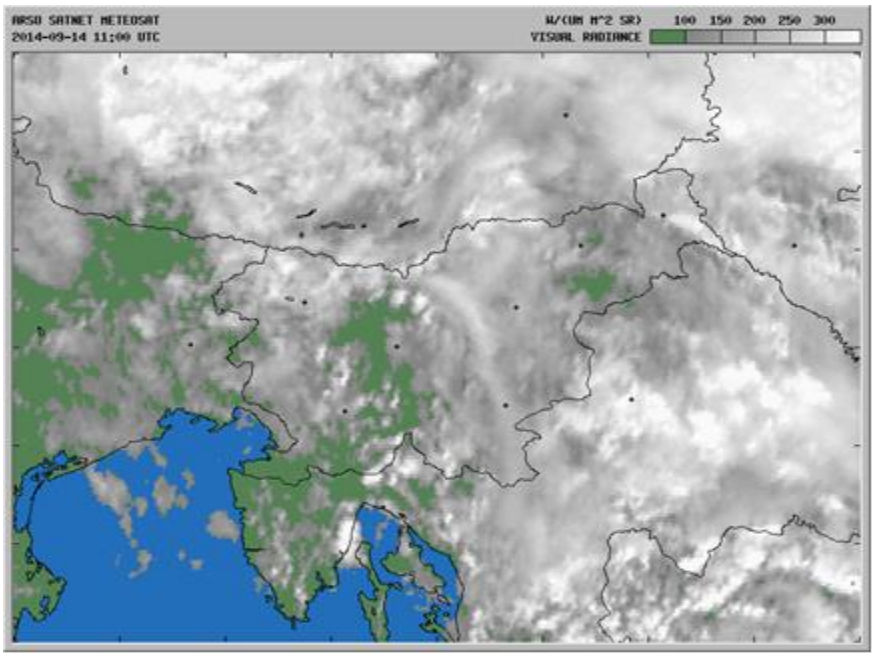


Figure 1 11: Satellite image at 1:00 p.m. LT.

Weather conditions and turbulence

During the day, there was weak wind with changeable direction and speeds of up to 2 KTS and gusts of up to 5 KTS, and in the late afternoon there was wind with gusts of up to 9 KTS. At higher altitudes, there was a north-eastern wind with speeds of up to 10 KTS.

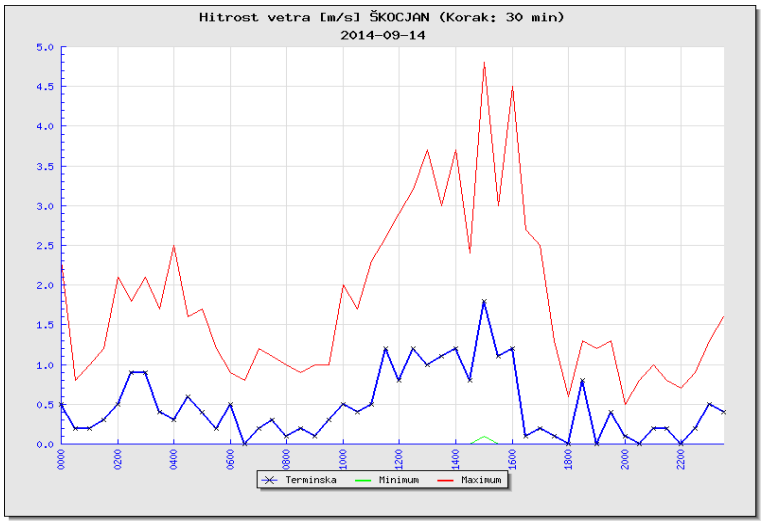


Figure 1 12: Wind speed at the Škocjan automatic weather station. The speed is in m/s, time is UTC+1

The wind direction was changeable, the prevailing wind directions on the ground could not be determined.

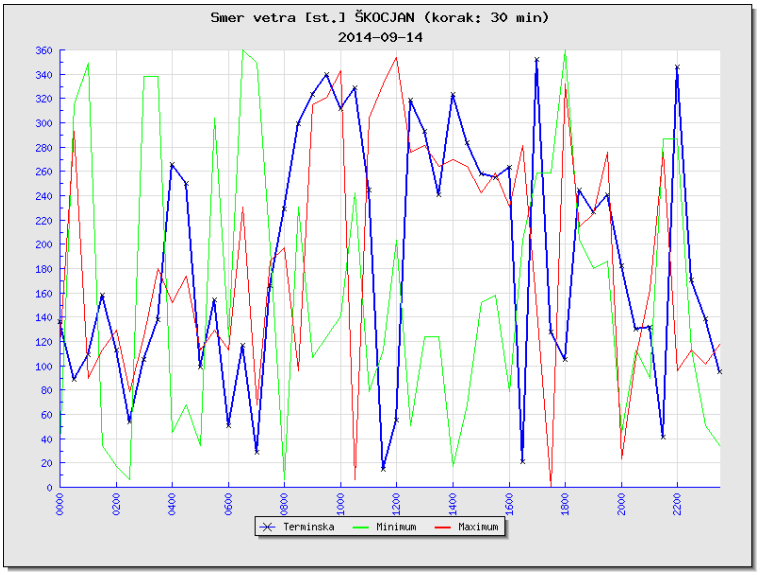


Figure 1 13: Wind direction at the Škocjan automatic station. The time is UTC+1

During the day on 14 September 2014, the following weather conditions were prevalent in the area of the Divača Airport:

- meteorological visibility was beyond 20 km,
- there were mostly medium and high clouds in the sky,
- there were no weather phenomena,
- the day-time air temperature was approximately 20°C,
- there were weak local winds with changeable directions,
- there was no turbulence at ground level.

1.8 Information on navigation equipment

Not comparable.

1.9 Information on the radio connection

The Divača Airport Manual provides that the frequency 123.50 MHz be used for radio communication. At the time the flight was performed, radio communication at this frequency was ensured. There were no other aircraft at the airport zone at the time. According to the obtained statements, the pilot performed a radio check after starting the engine. After the pilot's request for take-off in the direction 29 of the grass runway and after it was approved by the head of flying, there was no other voice communication.

1.10 Flight data recorder information

The regulations for this aircraft category do not require the use of flight data recorders.

1.11 Airport information

The Divača Airport is located 3.5 km east of the town of Divača. The operator of the airport, the "KLC Divača Aviation Club," held a licence issued by the Civil Aviation Agency of the Republic of Slovenia (hereinafter: CAA), which allowed it to operate both runways during daytime under visual meteorological conditions (VMC) and according to visual flight rules (VFR) For aircraft with a weight of up to 5700 kg of maximum take-off weight (MTOW).

Figure 1 14: Divača Airport – the grass runway is indicated by means of an arrow

In Appendix no. 1 of the Divača Airport Manual (reviewed version no. 5 of 15 August 2013, confirmed by the CAA), the operator determined the instructions for approach and departure procedures. Among other things, the instructions stated that *"the zone and the traffic pattern are north of the airport above the railway."* This means that the traffic pattern for take-off and landing is "right-hand" in the direction north or "left-hand" in the direction south.

DOLET IN ODLET NA LETALIŠČE

Vhodno-izhodna vrata je mesto Kozina (S2) na višini 4000 ft QNH za prihod letal iz južne smeri (Portorož in Ilirska Bistrica).
Vhodno-izhodna vrata je mesto Razdrto (N1) na višini 4000 ft QNH za prihod letal iz severne smeri (Ljubljana, Ajdovščina).
Cona in šolski krog sta severno (N) od letališča nad železniško progo.
Cona jadranja jadralnih letal je sever-severovzhodno (NNE) od letališča, pobočje in planota Vremščice.

PILOTAŽNE CONE

Cona št.1.: center je naselje Vremski britof premera 2 km. Višina letenja je 2000-4000 ft QFE oz. 3400-5400 QNH.
Cona št. 2.: center cone je naselje Povir severozahodno (NW) od Divače premera 2 km. Višina letenja je od 4500 QNH do 6000 QNH.
Cona čakanja:

- za prihode iz severa (N1) je med cestami Senožeče-Sežana in avtocesto. Oddaljena je približno 3 nm od točke N1. Višina cone je 3000 ft QNH.
- za prihode iz juga (S2) je iznad mesta Kačiče (križišče ceste Divača-Kozina in železniške proge). Višina cone je 3000 ft QNH.

PREPOVEDANE ZONE

Letenje nad Škocjanskimi jamami pod višino 3000 ft QNH je prepovedano. Izogibati se je potrebno letenju nad sosednimi vasmi.
Nad letališčem v višini 10.000 ft QNH se začne cona LJ-R6A in LJ-R6B.
Vzhodno od letališča se nahaja cona LJ-R5.

Figure 1 15: Information from the Airport Manual

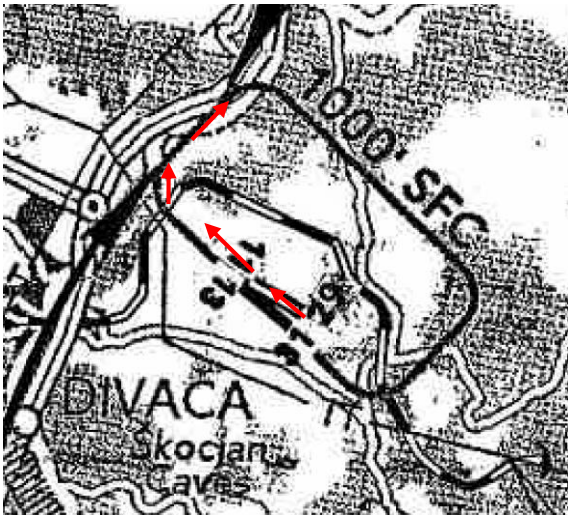


Figure 1 16: A sketch of the traffic patterns determined by the Airport Manual

1.12 Information from the scene of the accident

The Air, Maritime and Railway Accident and Incident Investigation Unit was notified of the accident within a few minutes of the incident. Prior to the arrival of the Investigator-In-Charge (hereinafter: the IIC), the police properly secured the scene of the accident. The IIC inspected the scene of the accident on the same day. The location of the incident was documented from the air with the help of a helicopter owned by the Air Support Unit. After the collision, the aircraft completely burned out at the scene. The bodies of three people were charred to a large extent, and taken to the Institute of Forensic Medicine in Ljubljana after being documented at the scene of the accident. Upon the arrival of emergency medical assistance, the passenger who survived the accident was taken to the hospital for treatment.

The aircraft wreck was concentrated in a radius of 4–5 m from the centre of the fire, which affected a small area of shrubbery with a diameter of 8–10 m. During the investigation, the grass runway and the terrain above which the aircraft flew before it crashed were fully examined.

1.13 Medical and pathological information

On the basis of a review of the pilot's medical records and performed interviews, it was discovered that there were no elements of illness or medical restrictions that could affect the accident. The pilot was in a suitable medical condition. The toxicology test results from the Institute of Forensic Medicine came out negative. According to the report by the Institute of Forensic Medicine, the direct cause of death was the termination of vital functions due to spinal cord injuries, where vital centres are located, within the multiple traumata sustained by the pilot in the accident.

1.14 Information on the fire

As the aircraft collided, a fire broke out, most likely caused by an explosion or a spark in the battery, the magnetos, or some other system in the aircraft, causing the ignition of the fuel in the tank, which was deformed as the aircraft collided with the terrain. The main tank located in the central part of the aircraft's fuselage contained at least 80 litres of 110 possible litres, which is the capacity of the main tank (information on fuel exploitation obtained from the KLC Divača Aviation Club). According to the acquired statements, there was no fuel in the wing tanks. The left wing of the aircraft first collided with large shrubbery branches and then the propeller collided with the rocky part of the terrain – a natural depression with a 7–10 m diameter and approximately 0.5 to 2 m lower than the elevation of the terrain in the radius of the point of collision.

Immediately after the aircraft crashed, representatives of the airline company from Divača Airport arrived at the scene of the accident, but were unable to extinguish the fire with a manual fire extinguisher. Upon the arrival of the Senožeče Volunteer Fire Brigade, the Sežana Fire and Rescue Service, the Povir Volunteer Fire Brigade, and the Divača Volunteer Fire Brigade, the fire was localised and extinguished. As the scene of the accident was inspected, only the metal components of the engine, propeller, the landing gear, the metal structure of the cabin, and certain metal components of the aircraft systems, installations, and equipment were recognisable.

1.15 Information on the possibilities of survival

When the aircraft went down, but prior to colliding with the terrain, a deformation of the structure of the cabin occurred, most likely due to the initial collision of the aircraft with large shrubbery branches. Due to the reaction to the collision of the fuselage and the left wing, the passenger who sat in the back right seat was thrown out of the aircraft cabin a few metres away from the point of collision and away from the crash direction before the aircraft and its engine and propeller crashed against the terrain and caught fire. After the crash, the passenger who sustained minor physical injuries crawled a few metres away from the crash site and then fell unconscious approximately 10 metres away from the fire, where he was subsequently administered emergency medical treatment. There was no possibility of survival for the pilot and the remaining two passengers in this accident.

1.16 Course of the investigation

On the day of the incident, the IIC and representatives of the Koper Police Directorate examined the scene of the accident. The investigation at the scene continued the next day when information was being acquired. In the continuation of the investigation, parts of the aircraft wreckage were transported to the secure facilities of the investigation authority at Edvard Rusjan Airport in Maribor, where additional analyses were performed.

An analysis of the data obtained from the police, the owner, and the user of the aircraft was performed by KZPS d. o. o. and the Civil Aviation Agency of the Republic of Slovenia (CAA) which provided the documentation on the aircraft and documentation on the pilot. In the enquiry and analysis procedure of the investigation, documentation was obtained from the authorised aircraft maintenance organisations according to PART 145 and the Continuing Airworthiness Management Organisation (CAMO). In cooperation with the investigation authority of the country of the aircraft manufacturer, additional data on the aircraft was obtained and additional

sound and video recording analyses were carried out – this was the French aviation investigation authority BEA[10] (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation – Aéroport du Bourget). Multiple analyses on the basis of the obtained statements and performed interviews and multiple mathematical calculations and video recording analyses were carried out. Cross-examination of the documentation and the parts of the aircraft wreckage were carried out.

1.17 Owner/operator information

The aircraft was owned by the KLC Divača Aviation Club. In the club, the aircraft was used for the purpose of maintaining pilots' flight qualifications and towing gliders. In the past, the aircraft was also used for the practical training of pilots for obtaining a private pilot licence (PPL (A)); however, the validity of the licence of the flying school, which was registered within the KLC Aviation Club for training private pilots (private pilot licence – PPL (A)), expired on 14 December 2012. After this date, the KLC Aviation Club no longer held such a licence for training. During the validity of the PPL (A) licence, the flying school did not carry out such training in practice.

Furthermore, the KLC Aviation Club also held a licence for operating a flying school for training glider pilots (glider pilot licence – GPL), which expired on 14 December 2013. After this date, the KLC Aviation Club did not hold any licences issued by the Civil Aviation Agency for training or performing aviation operations stated in accordance with the Aviation Act (Official Gazette of the Republic of Slovenia [Uradni list RS], No. 81/10 – official consolidated text, and 46/16) or in accordance with Part-SPO, Commission Regulation (EU) No 965/2012 on the basis of which an Operational and Technical Requirement[11] (OTR) was issued later.

According to the Divača Airport Manual, KLC is an operational user of the airport and is included in the organisational structure of persons in charge at the Airport (Chapter 2 – Airport Administrative and Operational procedures – Reviewed version no. 5 of 15 August 2013). The Airport Manual does not specifically state the elements of the traffic pattern for flying powered aircraft and gliders that were available to the club at the time of the incident. The section of the Airport Manual dealing with internal procedures states that the rules according to aviation

[10] *https://www.bea.aero/*

[11] *Operational and Technical Requirement issued by the Civil Aviation Agency of the Republic of Slovenia on 7 April 2014 pursuant to ARO.OPS.300 Subsection OPS Section ARO of Appendix II of Commission Regulation (EU) No 965/2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008.*

regulations apply for aviation operations performed by gliders and powered aircraft (Airport Manual, Section No. 17).

1.18 Other information

As part of the aviation operations of the aviation club, the pilot mostly flew for the needs of flying with gliders, namely to tow gliders, for which he was qualified. As a pilot for towing gliders at his home airport, he was trusted by the leading members of the aviation club; according to their testimonies, he was well acquainted with this type of flight, namely he knew how to use the aircraft, he knew the airport and emergency procedures. It was not evident from the documentation of the aviation club whether he had performed panoramic flights or introductory flights in the past; it was also not evident that he was flying alone with three passengers on board. Furthermore, the individual authorisations of the members related to the performance of aviation operations could not be determined on the basis of the aviation club documentation.

1.19 Investigation techniques

Standard investigation techniques were applied. The authorised aircraft maintenance organisation carried out an additional analysis of the documentation of the routine and special technical inspections of the aircraft. The cross-examination of data from the aircraft documentation kept at the headquarters of the KLC Aviation Club, by authorised aircraft maintenance organisations, and the CAA was performed. In the enquiry and data gathering procedure, the Commission was assisted by the police. The French investigation authority BEA was also included in a part of the investigation, and representatives of the authorised maintenance organisations were included later as well.

2 ANALYSIS

2.1 General

An analysis of engine operation and an analysis of audio and video recordings made by the person who recorded the departure of the aircraft were carried out. An additional analysis including the cross-examination of the maintenance and technical documentation of the aircraft, a flight analysis, an analysis of the regulations concerning the performance of aviation operations, an analysis of the aircraft exploitation, and an additional analysis in the field of the

control of aviation operations and the meeting of the criteria for their implementation were carried out[12].

No evidence was discovered in the investigation of any malfunctions regarding the functioning of the aircraft, the engine, the propeller, and the equipment. According to the instructions of the manufacturer and according to the Maintenance Programme for S5-DKL, first edition of 25 May 2010, the aircraft was regularly maintained by an authorised aircraft maintenance organisation. Particular deviations with regard to keeping technical documents were deemed as administrative errors that did not affect the limited use and the airworthiness of the aircraft. Insufficient traceability of the performed inspection was found in the aircraft maintenance documentation, specifically in the section referring to the 500-hour inspection of the magnetos, which was later clarified to the authorised maintenance organisation that supposedly performed this inspection.

2.2 Analysis of regulations and events prior to the performance of the flight and flight preparation

On the basis of the acquired statements from a group of people, namely the men who wished to give their friend a flight in a powered aircraft as a gift, it was discovered that the communication regarding the enquiry and the offer of a panoramic flight took place over a mobile phone, through a conversation between a representative of the KLC Aviation Club and one of the men in the group. The initial plan of the group was to fly around Mt Triglav, but after consulting with a representative of the KLC Aviation Club, this plan was changed due to poor weather, so that the group of men decided, upon consulting with the representative of the KLC Aviation Club, to offer their friend a flight in a four-seat powered aircraft from Divača Airport to the Adriatic coast and back.

It was discovered during the course of the investigation that the KLC Aviation Club offered its service, namely providing flights, on its website, on which a price was specified prior to the incident for flights on Robin aircraft, namely for training, education, informative flights, panoramic flights, recording, etc. A contact phone number was listed for such flight services and information on the offerings, and the e-mail address of the KLC Divača Aviation Club was also listed.

[12] *Licences for special purposes – air transport and other aviation operations (Aviation Act, Official Gazette of the Republic of Slovenia [Uradni list RS], No. 81/10 – official consolidated text, and 46/16; below, the requirements referred to in Regulation (EU) No 965/2012 can also be found).*

At the time of the incident, it was discovered that the competent CAA publicly posted on its website a list of the holders of licences for carrying out aviation operations related to passenger and goods transport and a list[13] of the holders of licences for carrying out aviation operations, pursuant to the Aviation Act (Official Gazette of the Republic of Slovenia [Uradni list RS], No. 81/10 – official consolidated text), such as:

- Panoramic flights,
- aerial works (A8) in accordance with national legislation,
- sky diving flights (A9) in accordance with national legislation, etc.

It was discovered that, in the period prior to the incident, the KLC Aviation Club did not hold a valid licence, nor did it meet the conditions for performing the stated aviation operations. Furthermore, the CAA did not manage any procedures for verifying whether the conditions for performing such an aviation operation have been met; such a procedure should have been initiated upon request or on the basis of an application previously submitted by the KLC Aviation Club.

It is evident from the inspection of the documentation of the KLC Aviation Club that it was not clearly defined in the internal organisation structure which of the members of persons in charge may organise flights and other operations at Divača Airport. It was discovered that, at the time when it was being verified whether the conditions for the work of the flying school were fulfilled, the KLC flying school had a list of experts and people in charge who were appointed and also confirmed by the CAA in the procedure for verifying the fulfilment of conditions. The list and responsibility of these persons were valid at a time when the Club held a valid licence for work in a flying school and a licence for performing aviation operations, namely in the field of training. The document that showed the competence of each member of the club or a clearly defined procedure within the KLC Aviation Club for performing aviation operations was not obtained by the Commission during the course of the investigation.

It was discovered that the KLC Aviation Club, as the operator, was not allowed to offer aviation operations, regarding which the provisions of Article 76 of the Aviation Act (Zlet) apply *mutatis mutandis*, even if such an operation is not performed for payment. In order to perform these operations, the operator should have previously acquired a special licence issued by the

[13] *http://www.caa.si/index.php?id=418&L=aygoapryypmwd#c583 – List of holders of the licence for performing aviation operations*

competent CAA. The fulfilment of the conditions for performing the stated operations is also assessed in accordance with the conditions of general aviation regulations.

2.3 The analysis of the regulation on implementing introductory flights

In the initial investigation stage, the following was discovered on the basis of performed interviews:

- In the period prior to the incident, the Civil Aviation Agency was in the process of drafting the so-called Operational and Technical Requirement (OTR) related to the implementation of the Commission Regulation (EU) No 245/2014 of 13 March 2014 amending Commission Regulation (EU) No 1178/2011 of 3 November 2011 laying down technical requirements and administrative procedures related to civil aviation aircrew with regard to the performance of introductory flights.
- During the investigation procedure, the Commission assessed that the interpretation of particular persons by the representatives of aviation sports organisations – aviation clubs – was incorrect or insufficient with regard to the anticipated implementation of the Commission Regulation (EU) No. 245/2014. According to the testimony of a KLC Aviation Club representative, the opinion was given that the offered service of performing panoramic flights was not in fact panoramic flights, but informative or introductory flights, for which no prior authorisation is required from the CAA. In some cases, the interpretation of the representatives of other aviation clubs was expressed as follows:

  "Introductory or informative flights will be an opportunity for minor aviation organisations, such as aviation clubs, to carry out certain aerial works, such as panoramic flights or flying in the airport zone, without the need to meet special conditions for obtaining a licence for aerial works, such as the current requirements for performing panoramic flights."
- On 7 November 2014 (a month and a half after the incident), the CAA published in the Official Gazette of the Republic of Slovenia an Operational and Technical Requirement for performing introductory flights under the Part-NCO conditions.[14]

[14] Part-NCO are non-commercial aviation operations performed in aircraft that are not complex motor-powered aircraft, pursuant to Appendix VII of the Commission Regulation (EU) No 965/2012, which was issued by way of the Commission Regulation (EU) No 800/2013.

The Commission finds that the CAA failed to carry out any activities by means of which certain new developments or amendments of regulations would be promoted in order to ensure their correct and timely understanding and adjustment to them by aviation organisations.

It is evident from the stated OTR that: (1) introductory flights can be carried out by legal entities governed by private law and established pursuant to the Societies Act (Official Gazette of the Republic of Slovenia [Uradni list RS], No 64/11 – officially consolidated text) and by authorised training organisations (ATO) established pursuant to Commission Regulation (EU) No 1178/2011.

(2) introductory flights are carried out under the conditions:
a. of the Part-NCO;
b. stating that a flight begins and ends at the same airport for powered aircraft, helicopters, and gliders;
c. stating that hot-air balloon flights are limited to a duration of 30 minutes from take-off to landing;
d. stating that flights are carried out during the day under VFR conditions;
e. stating that flights are controlled by an appointed person who is responsible for their safety (hereinafter: person in charge).

Based on the above, the Commission came to the conclusion that, at the time of the incident, there were no KLC representatives at the airport who were, based on the above point e.), qualified to appoint a person in charge – a person responsible for the control of the performance of introductory flights. Furthermore, the Commission finds that the pilot, who was involved in the air accident (if we compare the requirements[15] referred to in the OTR and the requirements/criteria that were valid at the time of the incident for pilots who were able to carry out panoramic flights), was not sufficiently experienced for performing the flight under the conditions and in the circumstances in question.

2.4 Spectral analysis of the audio from the video recording

During the investigation procedure, the investigation authority – with the help of and in cooperation with the representatives of the French investigation authority BEA – obtained information on the performed analysis of the audio from the video recording[16] that was made during take-off preparation by one of the friends in the group of friends who observed the departure of the aircraft. The video recording was provided to experts for analysing voice recordings; their goal was to use a spectral analysis to determine any deviations in the

[15] At least 200 hours of total flying time, of which at least 100 hours as the PIC and 20 hours of overflights as the PIC;
[16] The translation of the report on the inspection of video data is enclosed in Appendix No 1 to this Report.

functioning of the engine and any audio irregularities that could indicate a suspected factor affecting the accident.

The analysis showed that the engine frequency of rotation at the time of the incident was 2450 revolutions per minute, which is in line with the statements given by the persons with sufficient experience on this aircraft – "during take-off, the aircraft never exceeded 2450 revolutions per minute." This value was in accordance with general practice and does not deviate from the values in comparable aircraft types. Furthermore, the analysis showed that there were no irregularities regarding engine function between TO and collision with the terrain that would indicate a direct cause of the accident.

2.5 Video analysis

On the basis of the video recording made on the mobile device of one of the witnesses, the Commission analysed the flight, and the analysis mainly showed the position of the aircraft at a particular point during the flight and the course of events from take-off to the point when the crash began. Technical details of the audio-video recording:

- File size: 348MB
- Length of the recording: 4 minutes 31 seconds
- Image captured every 26 s with a 1280x720 resolution
- Audio recording is mono

The analysis of the recording focuses on the following elements:

The recording shows:	The recording shows:
1. Engine ignition 2. Check list 3. Taxiing to the runway threshold 11–29 4. TOR 5. TO 6. CLB 7. Acceleration 8. Turning into the crosswind position 9. Increasing the bank angle **10. Critical point – point when aircraft began losing altitude, stall**	1. Aircraft collision 2. Events after collision

Findings arising from the video recording

1. The engine ignition was without any peculiarities. The pilot and the passengers were properly fastened in.
2. The flaps were set to level 1 – take-off position.

Figure 1 17: Aircraft flap setting

3. The taxiing was without any peculiarities. After the aircraft was aligned with the runway, it is assumed on the basis of the audio recording that the pilot performed a stationary engine magneto check and completed the checklist before take-off.

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4. Take-off run – on the basis of a video montage, this can be shown graphically for take-off:

Figure 1 18: Aircraft take-off run

The figure shows the take-off run of the aircraft: the distance from the beginning of the run until the moment of take-off is indicated with a red arrow.

The green circle indicates a mild headwind and the suitable runway selection. On the basis of this data, the calculation of take-off performance was carried out below.

5. TO video montage

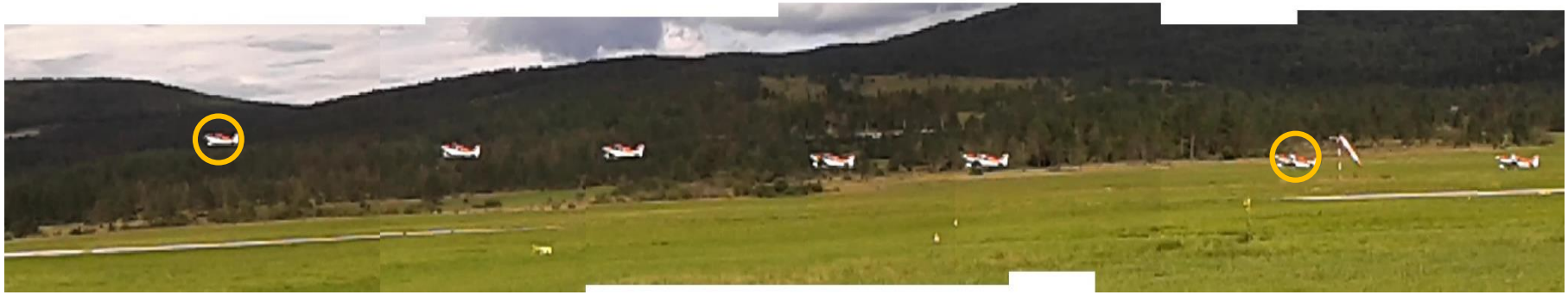

Figure 1 19: Aircraft climb

The figure shows the aircraft climb in the direction of the runway prior to the first turn. The TO took place without any noticeable issues or deviations from standard practices.

Video montage of the events following the TO

6. Acceleration
7. Turning into the crosswind position
8. Beginning of the increase of the bank angle
9. Beginning of stall conditions

Figure 1 20: Display of events following the TO

The acceleration begins as the aircraft turns into the crosswind run (blue). In this phase, the aircraft is not gaining altitude; at first, the bank is only slight. The aircraft bank then increased (purple) and, as a result, approached the point of stalling. The last marker (brown) indicates the position, in which the aircraft continued to increase the bank and begins to lose altitude due to stall.

Bank	Load	Speed increase factor when increasing the bank
30°	1.15	1.07
45°	1.41	1.19
60°	2	1.41
75.5°	4	2

The table shows the speed increase factor when increasing the bank.

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2.5.1 Analysis of aircraft capability during increased bank

On the basis of the video recording and the table above, the calculation of the required aircraft speeds necessary for maintaining flight conditions before the stall is carried out. Table of key aircraft speeds (source: Pilot Operating Handbook – POH):

Speed description	Speed (KTS)
Best Rate of Climb Speed	79
Best Angle of Climb Speed	63
Vs	**50**
Vsf	**44**

- minimum (stalling) speed: 51 KTS (95 km/h).

While flying with extended flaps and increasing the bank, the pilot must suitably adjust aircraft speed:

Bank	Speed increase factor when increasing the bank	Minimum permitted aircraft speed – KTS
0°	1	**44**
30°	1.07	47
45°	1.19	52
60°	1.41	62
75.5°	2	88

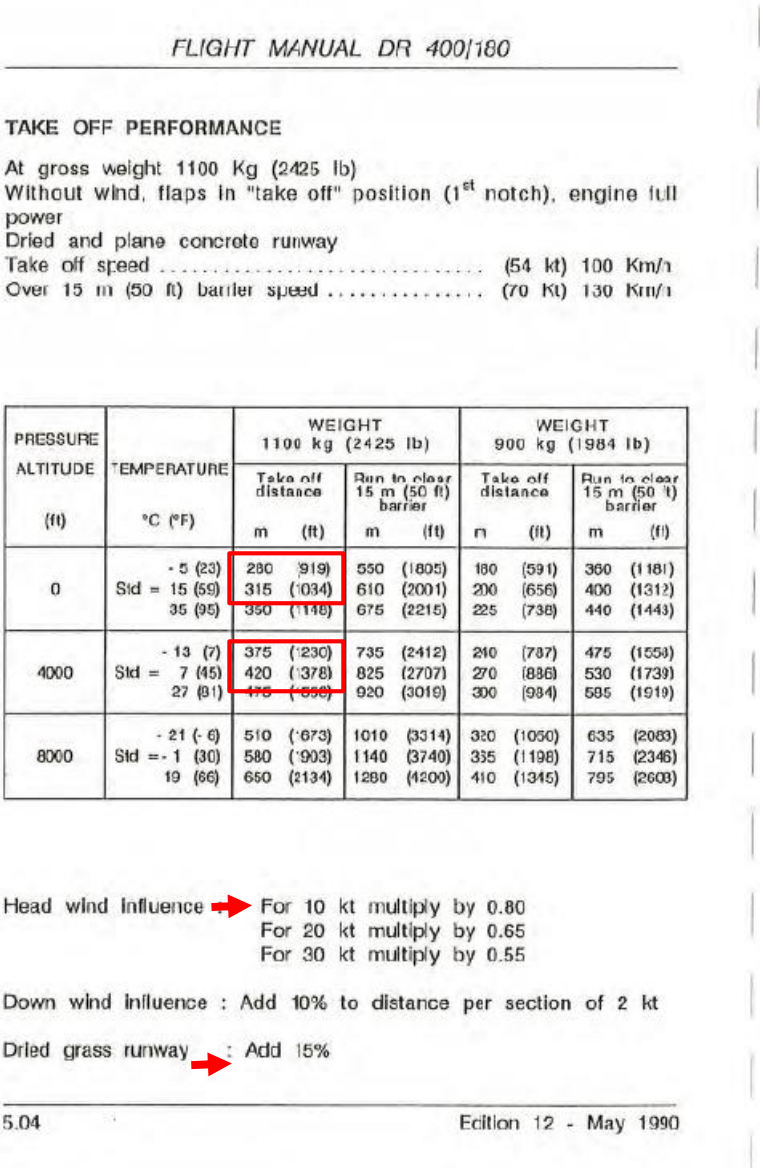
During the acceleration phase and while increasing the bank, the pilot must suitably adjust the aircraft speed depending on the speed:

Bank	Speed increase factor when increasing the bank	Minimum permitted aircraft speed
0°	1	**50**
30°	1.07	54
45°	1.19	60
60°	1.41	71
75.5°	2	100

On the basis of these tables, we see that a correction of the speed in the acceleration phase is necessary by at least 6 kts. In the video analysis in point 8 (purple), clean aircraft configuration (without flaps) is presumed, so we focus on the table below. We conclude on the basis of the video that the aircraft reached a bank exceeding 45 degrees, which matches the speed correction of at least an additional 10 kts. Therefore, the aircraft should have increased its speed from the acceleration phase until the increased bank by at least 16 kts in order to maintain a sufficient airspeed ensuring horizontal flight. The total high weight of the aircraft was an additional risk for the pilot due to the changed aircraft characteristics and reduced aircraft.

2.6 Analysis of aircraft capabilities during take-off

When analysing take-off distance, let us first look at the Flight Manual:



FLIGHT MANUAL DR 400/180

TAKE OFF PERFORMANCE

At gross weight 1100 Kg (2425 lb)
Without wind, flaps in "take off" position (1st notch), engine full power
Dried and plane concrete runway
Take off speed ..... (54 kt) 100 Km/h
Over 15 m (50 ft) barrier speed ..... (70 Kt) 130 Km/h

PRESSURE ALTITUDE (ft)	TEMPERATURE °C (°F)	WEIGHT 1100 kg (2425 lb) Take off distance m	(ft)	Run to clear 15 m (50 ft) barrier m	(ft)	WEIGHT 900 kg (1984 lb) Take off distance m	(ft)	Run to clear 15 m (50 ft) barrier m	(ft)
0	- 5 (23)	280	(919)	550	(1805)	180	(591)	360	(1181)
	Std = 15 (59)	315	(1034)	610	(2001)	200	(656)	400	(1312)
	35 (95)	350	(1148)	675	(2215)	225	(738)	440	(1443)
4000	- 13 (7)	375	(1230)	735	(2412)	240	(787)	475	(1558)
	Std = 7 (45)	420	(1378)	825	(2707)	270	(886)	530	(1739)
	27 (81)	475	(1558)	920	(3018)	300	(984)	585	(1919)
8000	- 21 (- 6)	510	(1673)	1010	(3314)	320	(1050)	635	(2083)
	Std = - 1 (30)	580	(1903)	1140	(3740)	335	(1198)	715	(2346)
	19 (66)	650	(2134)	1280	(4200)	410	(1345)	795	(2608)

Head wind influence → For 10 kt multiply by 0.80
For 20 kt multiply by 0.65
For 30 kt multiply by 0.55

Down wind influence : Add 10% to distance per section of 2 kt

Dried grass runway → : Add 15%

5.04 Edition 12 - May 1990

Calculation of the aircraft's take-off distance:

TOW (take-off weight) =1100 kg.
Flaps set to level 1.
Airport elevation = 1420 ft; temperature 20°C (ISA +8°C) – *possible interpolation.*
Headwind 5 kts.
Grass runway
After interpolation, TOD (take-off distance) is obtained from the table: 369 m.
Correction for the grass surface: 424 m; in the event of headwind, TOD is reduced to a maximum of: 381 m.

The calculated data is compared with the video recording analysis and the calculation carried out in Google Earth:

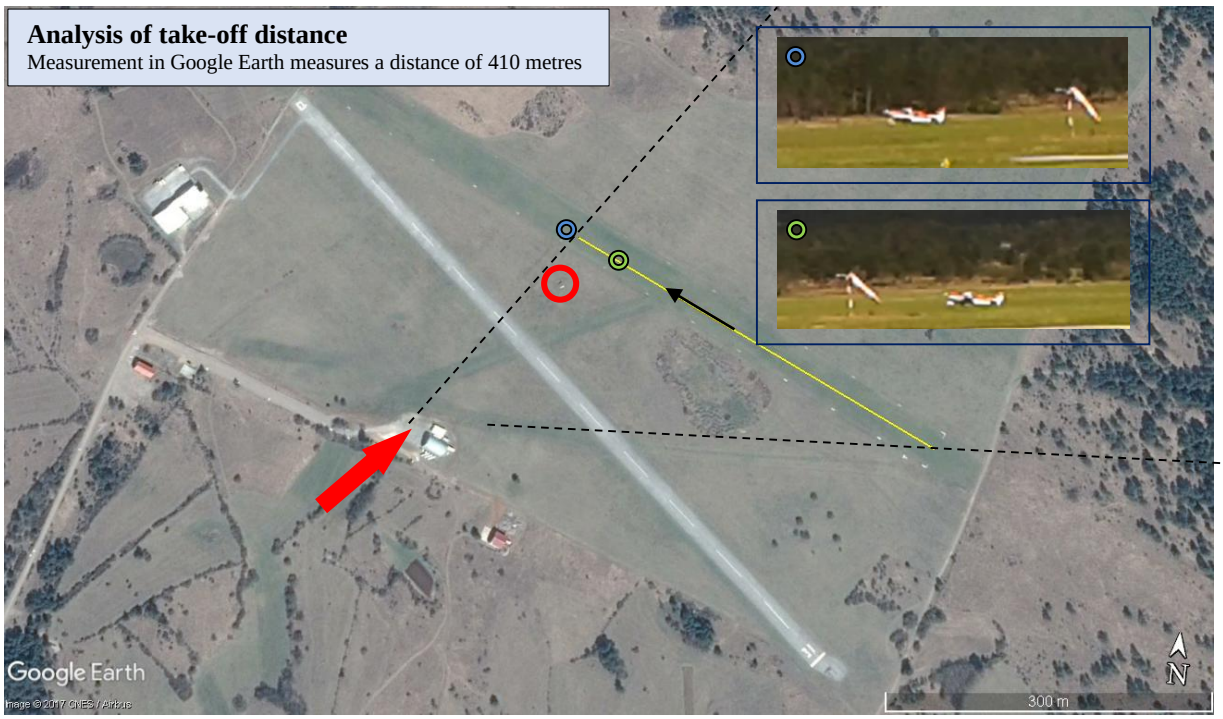


Figure 1 21: Graphic display of the calculation of the aircraft's take-off distance

The red arrow indicates the location of the observer – recorder. The red circle indicates a windsock, which is clearly seen in the recording. The black dashed lines indicate the visible line from the beginning of the take-off run until take-off. The green and blue circles indicate the position of the aircraft in the take-off phase from the location of the observer.

The measured distance in the Google Earth software is 410 metres. We may conclude from the above calculation of the take-off distance (381 m) and the distance measured through video analysis (410 m) that the aircraft and the pilot did not deviate from the anticipated flight parameters in the take-off run phase with the purpose of take-off.

Furthermore, the recording also shows that the aircraft, during the part of the flight shown in the phases following take-off (points 6–9), gradually increased its bank with slight brief corrections; the bank reached an angle of somewhere between 45° and 60° prior to the crash.

The reason for this constant bank following take-off cannot be confirmed with certainty in the incident analysis. The Commission concludes that it was probably the pilot's intention to carry out a low pass[17] after take-off above the group of friends observing the aircraft's departure.

[17] *In practice, this is a low-altitude flight with the aircraft in landing configuration with the purpose of allowing the people on the ground to visually inspect whether the landing gear is in the proper extended and locked landing position.*

2.7 Analysis of performing the airfield traffic pattern

In general, the airfield traffic pattern is a structure that is not strictly defined. It should be used during every departure and approach to the airport. It should assist pilots in keeping the learned take-off and landing methods, regardless of the different features of airports. At the same time, it allows other participants in air traffic and on the ground to be aware of the position of other aircraft in the area of the airfield traffic pattern.

The traffic pattern serves as an operational procedure for aircraft taking off and landing at the airport. The standard traffic pattern is a left-hand traffic pattern, with consecutive turns changing the direction of the flight by 90 degrees in relation to the runway. The height of the flight pattern is 1000 ft above ground level. After take-off, the aircraft takes off along the axis of the runway with the purpose of gaining altitude. At an altitude of 300–500 ft, the aircraft initiates a left turn into the "crosswind"[18] position while continuing to ascend up to an altitude of 1000 ft above ground level. At a sufficient distance from the airport, the aircraft continues its left turn into the downwind leg, while maintaining the altitude of 1000 ft above ground level. The basic purpose of carrying out the traffic pattern is safety.

In the event of engine failure, the traffic pattern structure allows the return to the runway or, depending on the case and emergency procedures, landing in the direction of take-off.

The performance of the traffic pattern allows aircraft to safely gain altitude prior to departing the airport. Usually, aircraft enter the traffic pattern in the position with the wind under a 45-degree angle. The departure from the traffic pattern depends on sufficient altitude – usually at the end of the crosswind leg.

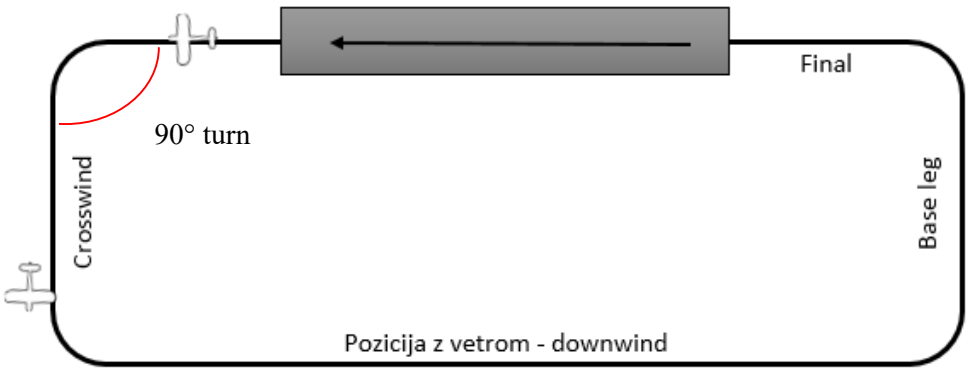


Figure 1 22: Standard traffic pattern for take-off and landing in VMC conditions

[18] *A flight phase or maintaining a controlled direction in the traffic pattern, the path of which after TO depends on the wind component*

The analysis of the instructions in the DKL Divača Airport Manual showed that these instructions are inadequate or insufficiently clear with regard to instructions regulating the area of aircraft approaches and departures and flying in the airfield traffic pattern. The instruction in the Airport Manual "the zone and traffic pattern are north of the airport above the railway" was not carried out in practice as a rule that had to be observed by all pilots and the head of flying.

The Commission finds that the instructions in the Airport Manual cannot only be administrative in nature. The existing Airport Manual, specifically the instructions for take-off and landing and flying in the traffic pattern, can be interpreted in a number of ways, which creates an inadmissible tolerance and free choice by pilots and people in charge (head of flying), who are responsible for flight safety and managing and controlling aircraft in the airport zone.

3 CONCLUSIONS

3.1 Findings

The general finding is that the aircraft was used for an unauthorised air operation – panoramic flights, defined as aerial work – without a licence and without internal operational procedures for implementing such aviation services. Other findings are as follows:

- the pilot held a valid private pilot licence,
- the medical condition of the pilot did not affect the accident,
- there was no evidence of any malfunctions regarding the functioning of the aircraft, the engine, the propeller, or the control system,
- the weather conditions on the day of the incident did not affect the accident,
- the owner or user of the aircraft did not have a licence to carry out aviation operations, such aviation operations should not have been performed without the authorisation of the competent agency, the CAA,
- the operator of the airport does not have more detailed instructions for managing aircraft in the airport's traffic patterns, the non-observance of existing and the lack of clearer instructions is the result of an insufficient inspection and control by the authority for aviation control – the CAA,
- At the time of the incident, the owner of the aircraft did not have any established procedures, by means of which he would ensure the competency of persons within the KLC Aviation Club for the implementation of aviation operations,
- the pilot did not have sufficient experience using this type of aircraft, the pilot's lack of experience affected the accident,
- the pilot's non-observance of the manufacturer's instructions regarding the aircraft's capabilities, i.e. minimum speed, affected the accident,

- piloting technique error – the uncoordinated operation of the aircraft along its longitudinal and transverse axes under minimum speed conditions, increased bank, and maximum take-off weight affected the accident.

3.2 Findings on possible risk

On the basis of the analysis of the incident, the Commission finds that, when flights are performed for the purpose of the transport of people, such as panoramic flights or informative flights, the passenger seated next to the pilot, who is operating the aircraft through dual control, and especially if this is the passenger's first flight and they have no experience with motor-powered aircraft, may, due to fear or accidentally, when energetically or suddenly moving their hands, grab hold of or use their legs to shift the control yoke at the aircraft's critical speed. Such risk is possible and particularly dangerous if the pilot fails to inform the passenger during the pre-flight preparation of the instructions for a safe flight – special passenger instructions.

3.3 Accident causes

Direct cause:

- Collision of the aircraft with the terrain as a result of losing control due to a stall directly after take-off.

Indirect cause:

- attempt to fly with a maximum load, beyond the capabilities of the aircraft,
- the arbitrariness of an individual – members of the KLC Aviation Club, as a result of insufficient instructions, internal control, and situational awareness.

4 SAFETY RECOMMENDATIONS

1. The Civil Aviation Agency should apply emergency control procedures to determine facts and assess the need to provide a list of contact persons and persons in charge at aviation clubs in Slovenia.

2. The Civil Aviation Agency should perform inspection control over entities and individuals that promote the provision of aviation services for payment, even though they are not listed as holders of licences for the performance of aviation operations and do not hold suitable valid licences issued in accordance with national and common aviation regulations and adopted international aviation standards.

3. The Civil Aviation Agency should prescribe systemic requirements, by means of which it would require that the operators of public airports in the Republic of Slovenia include mandatory content in airport manuals, in which, among other things, the instructions for the arrival and departure of aircraft and the instructions for flying in the airport traffic pattern for individual aircraft categories should be clearly defined.

Toni STOJČEVSKI

Head Investigator

Appendix 1

Report on the inspection of video recording data – BEA

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Technical document

Video data examination report

Document ID:	**BEA_s5-l140914_tec01**
Date of occurrence:	14/09/2014
Place of occurrence:	AD Divaca (Slovenia)
Aircraft type:	AVIONS ROBIN - DR400 - 180R
Registration number:	**S5-DKL**

Equipment examined:

A ground observer video named *« 20140914_124233.mp4»,* with duration of 4 min 31 s, was analyzed.

Work performed:

A spectrum analysis of the audio soundtrack from the video was performed to determine the engine speed and identify any acoustic anomalies.

Results:

The spectrum view in the appendix shows several acoustic signatures typical of the engine spectrum:

- The harmonic family associated with propeller blade rotation (BR - Blade Rate);
- The harmonic family associated with cylinders movement (CR - Cylinder Rate).

The monitoring of the engine frequencies evolution and the interpretation of the results during the whole flight is limited because of Doppler Effect, which affects the measured values of engine frequencies during the aircraft movement.
However, the frequency measurement at the CPA, when the relative speed is zero, indicates that the engine speed was **2450 rpm.**

The aircraft was equipped with a fixed pitch two-bladed propeller and a four cylinder piston engine (Lycoming O-360-A). Various publications indicate a nominal engine speed at take off between 2200 and 2700 rpm.

Those acoustic signatures at take-off were consistent with the spectrum usually observed on that family of aircraft. The spectral lines associated with those acoustic signatures did not show any anomalies and were continuous until the collision with the ground.

The propulsion system condition appeared to be nominal from the beginning until the end of the flight.

Glossary

BR — Blade Rate: Propeller blade rotation frequency (proportional to the number of blades and to the Cylinder Rate)

CPA — Closest Point of Approach: Point (or instant) of closest approach between a mobile and a reference point (ground observer for example) or between two mobiles. At that point, the relative speed of the mobile is zero..

CR — Cylinder Rate: Number of explosions by cylinder per minute.

Doppler — Variation of the frequency perceived by an observer when the source of the frequency is moving. The variation depends on the relative speed between the emitter (mobile) and the receiver (observer). The received frequency is higher (compared to the emitted frequency) during the approach, identical at the closest point of approach (CPA), and lower when the mobile move away.

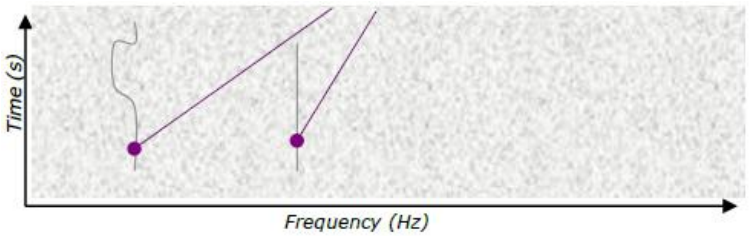
Osnovna — Rotation frequency of a rotating element (1st spectral line of a harmonic family).Nanaša se na harmonično razvrstitev (red n).

H_n — Refer to the harmonic ranking (rank n)

Harmonična skupina — All the multiple frequency of the fundamental

Lofargram (Lofar) — Spectrum view (LOFAR) : graph with frequency in X-axis and time in Y-axis

Signal frequency components



Rpm — Revolution per minute

Appendix: Spectrum view (Lofargram) – Last minute of the video (audio soundtrack)