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In case of inconsistency original version in Slovak language is applicable.

MINISTRY
OF TRANSPORT
AND CONSTRUCTION
OF THE SLOVAK REPUBLIC

AVIATION AND MARITIME INVESTIGATION AUTHORITY
Námestie slobody 6, P.O.BOX 100
810 05 Bratislava

FINAL REPORT

on the safety investigation of the air accident

of aircraft type **Z-37A-C3**

with registration mark **OM-DCC**

Reg. No: SKA2017008

The original of the Final Report was issued in the Slovak language.
In case of inconsistency original version in Slovak language is applicable.

The investigation of occurrence has been conducted pursuant to Art. 18 of the Act No. 143/1998 on Civil Aviation (Civil Aviation Act) and on Amendment of Certain Acts and in accordance with the Regulation (EU) No. 996/2010 of the European Parliament and of the Council on investigation and prevention of civil aviation accidents and incidents, governing the investigation of civil aviation accidents and incidents.

The final report is issued in accordance with the Regulation L 13 that is the application of the provisions of ANNEX 13 Aircraft Accident and Incident Investigation to the Convention on International Civil Aviation.

The exclusive aim of investigation is to establish causes of accident, incident and to prevent their occurrence, but not to refer to any fault or liability of persons.

This final report, its individual parts or other documents related to the investigation of occurrence in question have an informative character and can only be used as recommendation for the implementation of measures to prevent occurrence of other accidents and incidents with similar causes.

Abbreviations and acronyms used

ADF	Automatic Direction-Finding, equipment
ata	Atmosphere (unit of atmospheric pressure)
BKN	Broken
°C	Degrees Celsius
CPL(A)	Commercial Pilot License (Aeroplane)
CTAF	Common Traffic Advisory Frequency
E	East or eastern longitude
FI(A)	Flight Instructor (Aeroplane)
Ft	Feet (dimensional unit)
g	Gravitational acceleration
hrs	Hours (unit of time)
FaRS	Fire and Rescue Services
hPa	Hectopascal (unit of pressure)
L	Left (RWY designation)
LZDB	ICAO abbreviation for Dubnica airport
LZHL	ICAO abbreviation for Holíč airport
LZPE	ICAO abbreviation for Prievidza airport
km	Kilometres (unit of length)
km.h^{-1}	Kilometres per hour (unit of speed)
kt	Knots (unit of speed -1.852 km h $^{-1}$)
kW	Kilowatts (unit of power)
m	Metres (unit of length)
m.s^{-1}	Metres per second (unit of speed)
MHz	Megahertz (unit of frequency)
MTOW	Maximum take-off weight
N	North or northern latitude
n	Aircraft load multiple
OVC	Overcast
QNH	Barometric setting on an aircraft´s altimeter to read altitude above mean sea level of an aircraft on the ground.
R	Right (RWY designation)
RWY	Runway (for both take-offs and landings)
s	Second (unit of time)
SAR	Search and Rescue

SC	Stratocumulus
SCT	Scattered
SEP(land)	Class rating for single-engine piston aeroplanes (land)
SERA	Commission Implementing Regulation (EU) No. 923/2012
SET	Class rating for single-engine turbo-prop aeroplanes
THR	Runway threshold
u	Wind gust speed
UTC	Co-ordinated Universal Time
VFR	Visual Flight Rules
VHF	Metre (very short) waves (30 to 300 MHz), on-board communication radio station
VMC	Visual Meteorological Conditions
Z	Designation of UTC time (in meteorological reports)
Φ	Angle of bank of aircraft in turn

A. INTRODUCTION

Operator/Owner:	AEROKLUB DUBNICA, s.r.o.
Operation type:	General aviation/sports and recreational flying
Type of aircraft:	Z-37A - C3
Registration mark:	OM-DCC

Take-off site:	LZDB
Flight phase:	Flight operations/demonstration above LZPE
Accident site:	LZPE
Accident date and time:	16 September 2017, 13:18

Note: All time data in this report is reported in UTC time.

B. INFORMATIVE SUMMARY

Crews of aircraft type Z-37, registration mark OM-DCC and OM-CJA ("Dusty Team - 2x Z37"), took off at 12:55 from LZDB for a group flight under VFR conditions without a flight plan. There were two other persons on board of OM-DCC in the cabin.

The planned task involved approaching LZPE with subsequent flight operations/demonstration above LZPE´s RWY 04/22.

After the two aircraft diverged perpendicularly to the axis of RWY 04/22, OM-DCC fell in a right climbing turn, hitting the ground with its right wing in a right-hand rotation.

The pilot of OM-DCC suffered fatal injuries and the persons in the cabin were injured in the accident.

The aircraft was destroyed.

A committee was set up to investigate the causes of the accident in question:

Ing. Igor Benek	– Chairman of the Safety Investigation Committee
Ing. Ján Chudý	– Member of the Safety Investigation Committee

The Report to be issued by:

Aviation and Maritime Investigation Authority
of the Ministry of Transport and Construction of the Slovak Republic

C. MAIN PART OF THE REPORT

1. FACTUAL INFORMATION

1.1 History of the flight

In their preparations for the critical flight the pilots of OM-DCC and OM-CJA focused on flight operations/demonstration at LZPE which was supposed to involve a low pass - with their smoke-emitting equipment switched on - above LZPE´s RWY04, with a subsequent climb to a working turn which was to be followed by another low pass - with the smoke-emitting equipment switched on - in the direction of LZPE´s RWY22. The low pass was supposed to be followed by a mild climbing turn by 270° perpendicularly to the axis of RWY 04/22 and with the first divergence of the group. After the divergence the pilots were supposed to fly on approaching tracks with another subsequent climbing divergence. Then OM-DCC was supposed to continue for landing and OM-CJA was supposed to continue providing individual flight operations/demonstration.

The other persons present on board of OM-DCC reported not having been present during the pilots´ preparations for the group flight and not having been informed by the OM-DCC´s pilot-in-command about the planned activities to be performed at LZPE, i.e. flight operations/demonstration.

As the leader of the group, at 12:55 the pilot of OM-DCC took off from LZDB for line flying together with the pilot of OM-CJA under VFR conditions without a flight plan.

The planned task involved approaching LZPE with subsequent flight operations/demonstration above LZPE´s RWY 04/22. The group leader made the first radio contact with LZPE´s CTAF operator on 122.600 MHz from the area above Valaská Belá and the second contact from the area above Nitrianske Rudno. During the second radio contact the group leader was informed by the LZPE´s CTAF operator about weather conditions at LZPE and about the airport´s QNH - 1012 hPa.

After the group approached the position "before the last turn" of the left operational circuit of RWY 04, the group leader reported initiation of the flight operations/demonstration. With a left descending turn the two aircraft reached the "final" position for RWY 04 and continued with a low pass above RWY 04 with their smoke-emitting equipment turned on. At the end of RWY 04 the group started climbing and turning left, then they continued with another low pass in the direction of LZPE´s RWY 22 with their smoke-emitting equipment turned on. The low pass was followed by a mild climbing turn by 270° perpendicularly to the axis of RWY 04/22.

After the two aircrafts diverged perpendicularly to the axis of RWY 04/22, the OM-CJA pilot continued flying, taking a left climbing turn with a 15° bank against the wind, and the leader of the pair, the OM-DCC pilot, continued with a right climbing turn with a tail wind, with an increasing bank of over 60° and with an obvious stall which turned into a fall with the right wing pointing to the ground and with a subsequent impact on the ground in a right-hand rotation.

At first, OM-DCC hit the ground with the leading edge of the right wingtip, then with a wheel of the right main gear which broke off as a result, and then the right gear leg tore off towards the front. Then the left main gear, the rotating propeller and the left wingtip touched the ground.

After rotating, the aircraft stayed on the ground in the 092° direction and the speed indicator indicated 60 $km.h^{-1}$.

Persons in the cabin of the OM-DCC aircraft were injured in the accident. The pilot suffered fatal injuries in the accident.

The aircraft was destroyed.

Time period: day
Flight rules: VFR

1.2 Injuries to persons

Injury	Crew	Passengers	Other persons
Fatal	1	-	-
Serious	-	1	-
Minor	-	1	-
None	-	-	

1.3 Damage to the aircraft

The aircraft was destroyed when it hit the RWY.

1.4 Other damage

No circumstances have been reported to the Aviation and Maritime Investigation Authority which might lead to any other claims for compensation for damage against a third party.

1.5 Personnel information

Pilot:

Citizen of SR, aged 31, holder of CPL(A) issued on 8 July 2015 by the Transport Authority of the Slovak Republic.

Medical certificate class 1 with marked validity until 11 March 2018.

Valid restricted ´radio telephonist of aeronautical mobile service II´ license.

He underwent both theoretical and practical training for the aircraft type at AEROSLOVAKIA a.s. between 24 July 2010 – 2 August 2010.

He performed another "Dusty Team" flight demonstration in the type Z-37A, OM-CJA, at LZHL and its duration was 10 minutes.

His pilot logbook did not contain any information about undergoing a training session for group flights. Before the critical flight he performed most flights in the type Pilatus PC 6 SET for parachute dropping.

Qualifications:

FI(A)	with marked validity until 28 February 2019
Pilatus PC6 SET	with marked validity until 31 March 2019
SEP(land)	with marked validity until 30 June 2019

Total flight hours:	801 hrs 57 min
Total flight hours as PIC:	687 hrs 77 min
In the last 90 days:	89 hrs 49 min
In the last 30 days:	34 hrs 58 min
Total flight hours in the aircraft type Z-37:	73 hrs 57 min
In the last 90 days:	**1 hr 39 min**
In the last 30 days:	0 hrs 39 min

1.6 Aircraft information

Type:	Z-37A-C3
Registration mark:	OM – DCC
Serial number:	2309
Manufacturer:	LET n.p. Kunovice, CR

Airworthiness Verification Certificate No. 0218-S / 05, valid until 22 April 2018.

Mandatory insurance: Association of Underwriters – Lloyd´s No. B0713AVNBG1700460-911-00, valid until 21 December 2017.

Aircraft Radio Station License No. 1410791098, valid until 31 December 2023.

Certificate of Maintenance and Release to Service No. DCC-019/2016 SK.MF.012, valid until 27 July 2018.

Total flight hours as of 16 September 2017: 1656 hrs 49 min / 3035 flights.

Engine

Type:	M462RF
Manufacturer:	AVIA n.p. Prague 9, Letňany, CR
Serial number:	641249
Total flight hours:	1483 hrs 48 min

Propeller

Type:	V520
Manufacturer:	AVIA Prague, CR
Serial number:	74231120
Total flight hours:	1174 hrs 21 min

With the pilot and the two other persons in seats 1 and 3 in the cabin the take-off weight amounted to 1,409 kg, which is less than its MTOW of 1,725 kg.

1.7 Meteorological information

SYNOP reports of the Prievidza meteorological station

PRIEVIDZA 161300Z 330° 10kt 10 km BKN 4200 ft SC 17°C 12°C QNH 1012
PRIEVIDZA 161400Z 330° 10kt 10 km BKN 4300 ft SC 17°C 12°C QNH 1012
PRIEVIDZA 161500Z 330° 8kt 10 km SCT 4000 ft SC OVC 4900 ft SC 17°C 12°C QNH 1012

1.8 Aids to navigation

N/A.

1.9 Communications

During their flight activities the aircraft crews were in contact with LZPE´s CTAF operator on 122.600 MHz.

1.10 Aerodrome information

LZPE is a public international aerodrome with irregular traffic. It is located 2.5 km away in direction 245° from the Prievidza railway station.

The grass RWY 22R (04L) has a size of 950 x 85 m; RWY 22L (04R) has a size of 950 x 30 m. The RWY´s altitude above sea level is 853 ft / 260 m.

1.11 Flight recorders and other recording devices

The aircraft was not equipped with any flight recorder to record flight parameters.

1.12 Wreckage and impact information

The aircraft fell on the grass RWY 22L, 132 m away from its THR. The coordinates of the final position of the aircraft were N48°46´05.0´´ and E018°35´24.4´´.

The aircraft was found in the middle of RWY 22L with its longitudinal axis in the 092° direction, without the top part of the cockpit which had been removed by FaRS members who provided first aid to the pilot.

Accident site




The torn-off wheel of the right main gear was found 5.56 m from the left central wing; the torn-off oil cooler was found 1.3 m from the left wing slot. The left panel with light control switches (landing, taxiing headlight) and control switches of the smoke-emitting equipment was found 0.8 m from the left central wing. The light control switches were "OFF" and the smoke-emitting equipment control switch was "ON". The broken right panel with switches was found 1.5 m from the propeller head. Individual switches were in the following positions: battery – ON, generator – ON, fuel pump – OFF, signalling system – ON, engine equipment – ON, fan – ON, gyros – OFF, overhead light – OFF, Pitot – OFF, landing and position lights – OFF, VHF1 – OFF, VHF2 – ON, ADF – OFF. The broken right splashboard was found 3.5 m from the propeller head; the broken aerial of the aircraft radio station was found 3.8 m from the propeller head.

The right main gear was torn off towards the front; the leading edge of the right wing was distorted; the right wing was broken at the point of the right slot; the right wingtip was broken; the right winglet was damaged at the root; the top and the bottom part of the instrument panel was distorted; the firewall was distorted towards the cockpit; the fuselage was broken behind the cabin; the right stabilizer was broken 0.2 m from the keel area; the right part of the elevator was broken; the left main gear was broken off and pressed into the central wing; the left flap drive cable was torn off; the left wing was broken off at the rear wing hinge; the left flap on the central wing was distorted; the left winglet was damaged at the root; the Pitot tube was pressed into the left wing and ran through the lower and upper covering of the wing; the left wing was broken at the point of the left slot; the engine bed was ripped off; engine cowlings were distorted and the propeller blades were bent.

Cockpit

Cockpit switches needed for performing the flight were "ON". The main switch was ON. The ignition switch was in the position 1+2 ON. The fuel cock was in the "Auxiliary tank" position. The throttle was in the central position; the propeller control was in the central position. The flap control was in the 5° position. The oil cooler valve was "Closed" and the engine cooling valve was "Open". The elevator trim tab was in the central position. Analogue instruments on the instrument panel were not damaged and their readings were

readable. The airspeed indicator showed 60 km.h^{-1}. The gyro horizon was uncaged. The needle of the radio compass was pointing to 050°. The propeller revolutions indicator was indicating 0 rev./min. The charging pressure indicator was indicating 0.96 ata. The flight gyroscope indicator was caged and the needle was pointing to 230°. The variometer was indicating 0 vertical speed. The four-point pressure indicator in the engine (fuel, oil) and oil temperature indicator was indicating 0. The aircraft clock was showing 14:50. The aircraft radio station switch was switched to "II". The frequency of 123.500 MHz was set on the VHF I radio station and the frequency of 122.625 MHz was set on the VHF II radio station. The only damaged instrument was the altimeter. Its cover glass was broken; the regulator for setting the altimeter scale was missing and it was pressed behind the instrument panel. The pressure scale was set at 981 hPa; the big needle was missing and the small one was indicating a figure between 8 and 9 on the kilometre scale.

Power plant

After the falling the engine was connected to the propeller. The engine was fixed in the engine bed. All control elements were connected to operating elements.

1.13 Medical and pathological information

Pilot:
From the point of view of forensic medicine it was a case of violent death. All identified injuries were in a causal connection to the accident and they occurred when the aircraft hit the ground.

At the time of the accident the pilot was not under the influence of alcohol, prescription medication, narcotic substances or drugs which could have decreased the pilot´s attention during the flight.

No acute or chronic disease changes were identified during external or internal examinations or during additional laboratory expert examinations of biological materials collected during the autopsy which could have adversely affected the attention and actions of the pilot at the time of the accident or which could have had a causal connection to the pilot´s death.

Other persons on board:

- the woman sitting in the rear passenger seat suffered serious injuries during the accident,
- the man sitting in the front passenger seat suffered minor injuries to several parts of his body during the accident.

1.14 Fire

None.

1.15 Survival aspects

It was not necessary to perform any investigation or rescue by SAR equipment.

1.16 Tests and research

N/A.

1.17 Organizational and management information

On 16 September 2017 at LZPE:

- standard operations of Aeroclub Prievidza were scheduled which started only at around 11:00 due to bad weather;

- an exhibition of plastic models named "PLASTIC MODEL HORNA NITRA - PMHN2017“ was held in the hangar of Aeroclub Prievidza;

- during the Aeroclub operations the arrival of the "DUSTY TEAM" was scheduled to perform flight operations/demonstration above LZPE´s RWY 04/22 for participants of PMHN2017. After the end of the "DUSTY TEAM's" flight operations, the aircrafts were supposed to land at LZPE and park on a stand for a static demonstration.

The company operating the aircraft in question has a list of individual permissions for performing special business operations No. SK/SPO/001, issued by the Transport Authority of SR on 21 April 2017 based on a declaration by the operator according to Commission Regulation (EU) No. 965/2012. In the part "Types of special operations" the list contains approved types of special operations, including "flights for special purposes, such as flight demonstrations and competition flights". Individual parts of the Operations Manual of the company do not contain any standard operating procedures for performing such flights or requirements for the crew and the presence of passengers during such flights.

1.18 Additional information

Z-37A-C3 is a self-supporting low-wing aircraft with all-metal wings, and a fuselage welded from steel tubes coated with tesil fabric with polyurethane. The undercarriage is of a tail-wheel type with a broad gauge and very high main gear legs. The wing has three parts. The rectangular central wing is a double-beam wing connected to the fuselage with six hinges. Trapezoid exterior wings are hung on the central wing; they are equipped with firm slots on the leading edges of outward parts. The wing is equipped with very efficient double-slotted flaps. The maximum angle of the flap for landing is 50°.

The power plant is composed of an air-cooled nine-cylinder radial (compressor) Walter M-462RF engine with a power output of 235 kW, and an Avia V-520 propeller.

In the C3 modification the maximum number of seats is 4: one in the front for the pilot and three in the back for passengers.

The above-stated type of aircraft is certified in the class of use for aerial work and, according to operational restrictions stated in the Flight Manual, it may be used to perform the following activities:
- patrol, surveillance and search flights;
- aerial photography;
- flight training;
- leaflet distribution;
- aerial advertising;
- glider towing.

Flights with paying passengers on board are prohibited.

From the point of view of controllability and stress, the aircraft is classified as "NORMAL" and it was equipped with smoke-emitting equipment.
The maximum positive load which the structure has been designed for and which it should bear without permanent deformation is +3.8 g for the C3 modification.
The maximum negative load which the structure has been designed for is -1.4 g for the C3 modification.
Maximum load values must not be exceeded during intentional turns.

Before the take-off the aircraft was filled with working fluids:
100 litres of fuel and 12 litres of engine oil.

1.19 Useful or effective investigation techniques

Common investigation methods were applied.

2. ANALYSIS

Pre-flight preparations

Before the start of the flight the pilots in command became familiar with all information necessary for performing the intended flight as stated in SERA 2010 "Responsibility". Since it was a group flight, group flights may be performed after prior agreement has been made between the pilots in command of the aircraft forming the group, and group flights in a controlled airspace must be performed in accordance with conditions determined by a relevant authority.

The pilot in command of OM-DCC was appointed the leader of the group. The group leader and pilots in command of individual aircraft are responsible for keeping distance between the aircraft in the group during the flight; this applies also to transitional periods when the aircraft are manoeuvring to achieve their own space in the group as well as to form and dissolve the group.

The other persons present on board of OM-DCC were not present during the pilots´ preparations and were not informed by the OM-DCC´s pilot-in-command about the planned activities to be performed at LZPE.

Pilot activity

The pilot with persons on board made a turn with a high bank angle, exceeding the limits of the flight envelope, which led to a stall and a subsequent fall on the wing.

Turns with a high bank angle belong to Flight mode II with significant flight instability according to speed. It is dangerous to perform sharp or extreme turns at the limit of the performance capabilities of Z-37A-C3, particularly at a low height above the ground.

Z-37A-C3 aircraft

According to the Flight Manual, the aircraft's operations are restricted only to standard flight turns. Acrobatic turns are not allowed. Permitted flight load ranges from +3.8 g to -1.4 g. Controllability of Z-37A-C3 and control in extreme modes differs from other common aircraft, mainly due to slots on part of the wings. In certain modes the aircraft warning is insignificant. It is therefore equipped with stall speed warning. Winglets are usually effective also during a fall. The rudder is slightly less effective in certain modes. At full engine power, response moments are manageable also during a fall. The aircraft is sensitive to gusts and turbulence. When falling in a right turn with a bank of up to 45° in a horizontal flight with engine power, the aircraft´s stall warning is more significant; the aircraft levels out with the horizon and continues descending.

Table 1 below contains calculated stall speed values in a turn with different bank angles performed by Z-37A-C3 with a mass of 1,500 kg. These are only informative.

Bank / Speed	0°	15°	30°	35°	40°	45°	50°	60°	70°	75°
V_{fall} [km h^{-1}]	60.0	61.0	64.5	66.3	68.6	71.3	74.8	84.6	102.6	118.0

Table 1

Table 2 below contains calculated stall speed values in a turn with different bank angles performed by Z-37A-C3 with a mass of 1,500 kg and with gusts of u = 5 $m.s^{-1}$. These are only informative.

Bank / Speed	0°	15°	30°	35°	40°	45°	50°	60°	70°	75°
V_{fall} [km h^{-1}]	73.3	74.3	77.8	79.6	81.9	84.6	88.1	97.9	115.9	131.3

Table 2

With gradual increase of the bank of an aircraft flying at a constant speed, the aircraft gradually reaches such a bank angle which will result in it falling. The stall speed warning system starts signalling the approaching stall speed only a few degrees before reaching a critical bank angle.

Table 3 contains load values for a number of aircraft´s bank angles Φ. For the purposes of better illustration, the load values have been rounded off to whole numbers starting from a bank of Φ >70°.

Bank Φ	0°	15°	30°	45°	60°	70°	75°	78°	80°	82°
n	1	1.04	1.15	1.41	2	3	4	5	6	7

Table 3

3. CONCLUSIONS / Cause of the air accident

3.1 **Findings**

- the pilot had valid qualifications to perform the flight in question;
- the pilot´s logbook did not contain any information about undergoing a training session for group flights;
- the aircraft had valid documentation and did not demonstrate any malfunction before take-off or during the flight,
- the aircraft fulfilled airworthiness conditions before the critical flight according to the available documentation,
- the aircraft was not equipped with an onboard flight data recorder, so the flight analysis is based on witness testimony, the provided documentation and a video record of the flight operations/demonstration at LZPE;
- individual parts of the company's Operations Manual do not contain any standard operating procedures for performing such flights or requirements for the crew or the presence of passengers during such flights;
- there were other persons present on board of OM-DCC during the flight operations/demonstration who did not wear their seat belts during the flight.

3.2 **Cause of the air accident**

The cause of the accident was the performance of a sharp – extreme climbing right turn with persons on board, at a low height, at the limit of the performance capabilities of the aircraft type Z-37A-C3, with a subsequent stall at the top phase of the flight, causing the aircraft to fall on its right wing. Acrobatic turns are not permitted.

4. SAFETY RECOMMENDATIONS

The Final Report on investigation of the air accident does not contain any recommendations.

Bratislava, 19 February 2018