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MINISTRY OF TRANSPORT, CONSTRUCTION
AND REGIONAL DEVELOPMENT
OF THE SLOVAK REPUBLIC



AVIATION AND MARITIME INVESTIGATION AUTHORITY
Námestie slobody 6, P.O.BOX 100
810 05 Bratislava 15

FINAL REPORT

on investigation of serious incident
Flying sport vehicle – Prototype AeroMobil 3.0.1
Identification number OM-M929

Reg. No.: SKS2015001

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.

A. INTRODUCTION

Operator / Owner:	AeroMobil s.r.o.
Type of operation:	general aviation / test flight
Type of aircraft:	flying sport vehicle – Prototype AeroMobil 3.0.1 (hereinafter “AeroMobil“)



Identification number:	OM-M929
Take-off site:	airport Nitra / airport LZNI
Flight phase:	aerodrome circling
Place of accident:	aircraft LZNI
Date and time of accident:	08.05.2015, 19:06

Note: All time data in this report are stated in CEST.

B. INFORMATIVE SUMMARY

On 08.05.2015, at 19:06, AeroMobil crashed from altitude of 313 m above ground level during a test flight. The pilot activated the rescue parachute system and AeroMobil fell to the ground near the grass runway (hereinafter "RWY") of the airport LZNI. After the fall the pilot left AeroMobil uninjured, nevertheless he was transported by an ambulance to the hospital in Nitra for observation.

The AeroMobil operator reported the incident to the Aviation and Maritime Investigation Authority and called all rescue services and the police.

The following commission was appointed for investigation of the incident:

Ing. Igor BENEK – chairman of the investigation commission
Ing. Dominik JANČIK – member of the investigation commission

The report is issued by:

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

C. MAIN PART OF REPORT

1. FACTUAL INFORMATION
2. ANALYSES
3. CONCLUSIONS
4. SAFETY RECOMMENDATIONS

1. FACTUAL INFORMATION

1.1 History of the flight

On 08.05.2015 the pilot conducted test flights with AeroMobil according to the schedule. Before the incident the pilot made 3 short flights to check the propeller blade angle for power cruise.

Before the critical flight the pilot taxied with AeroMobil to RWY15 and at 19:01:05 he conducted the ground run and takeoff with climb to an altitude of about 90 m. After the lift-off the pilot retracted the flaps from position 15° to position 0° and left the air incidence angle in take-off configuration, because the measurement required it. After the take-off he did a short climbing right turn of 220° to an altitude of about 200 m. Then he did a short direct climbing movement and climbing left turn of 180° to an altitude of about 250 m, followed by a short direct movement and climbing left turn of 180° to an altitude of about 327 m. This configuration was maintained until the start of left wing stall, with left flight path turn of 90° from the start of the take-off (v 284 s - 19:05:48).



Fig. Spatial flight scheme

Závislost výšky AeroMobilu nad zemou od času počas letu

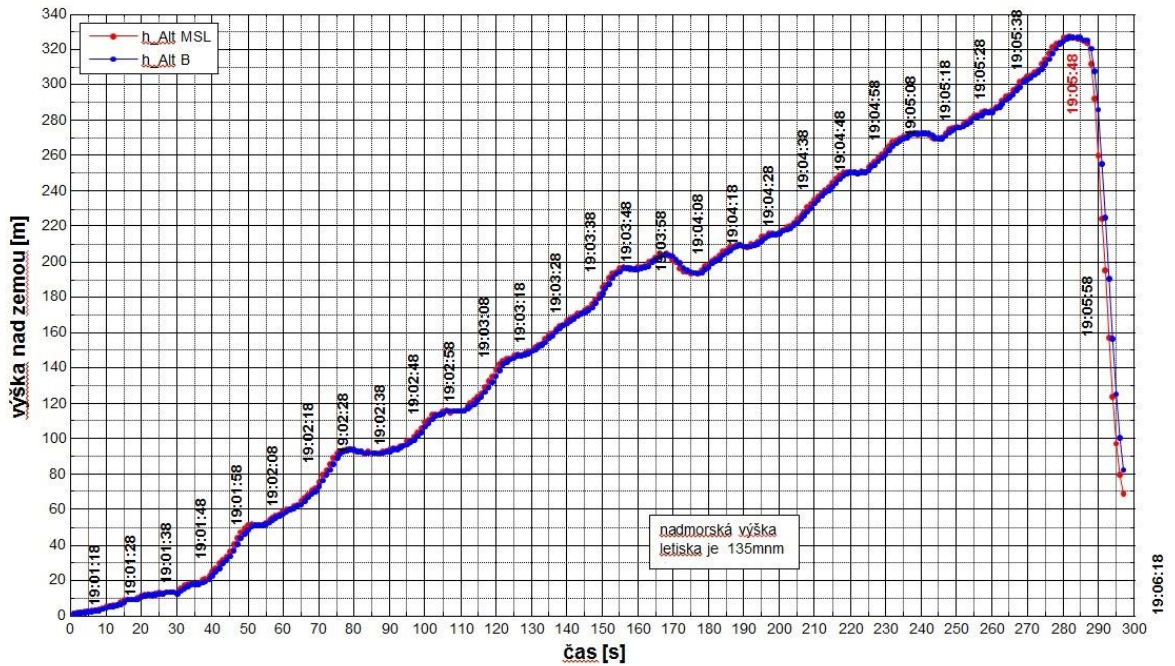


Fig. Dependence of altitude of AeroMobil above ground level on time during flight

Závislosť indikovanej rýchlosti AeroMobilu od času počas letu

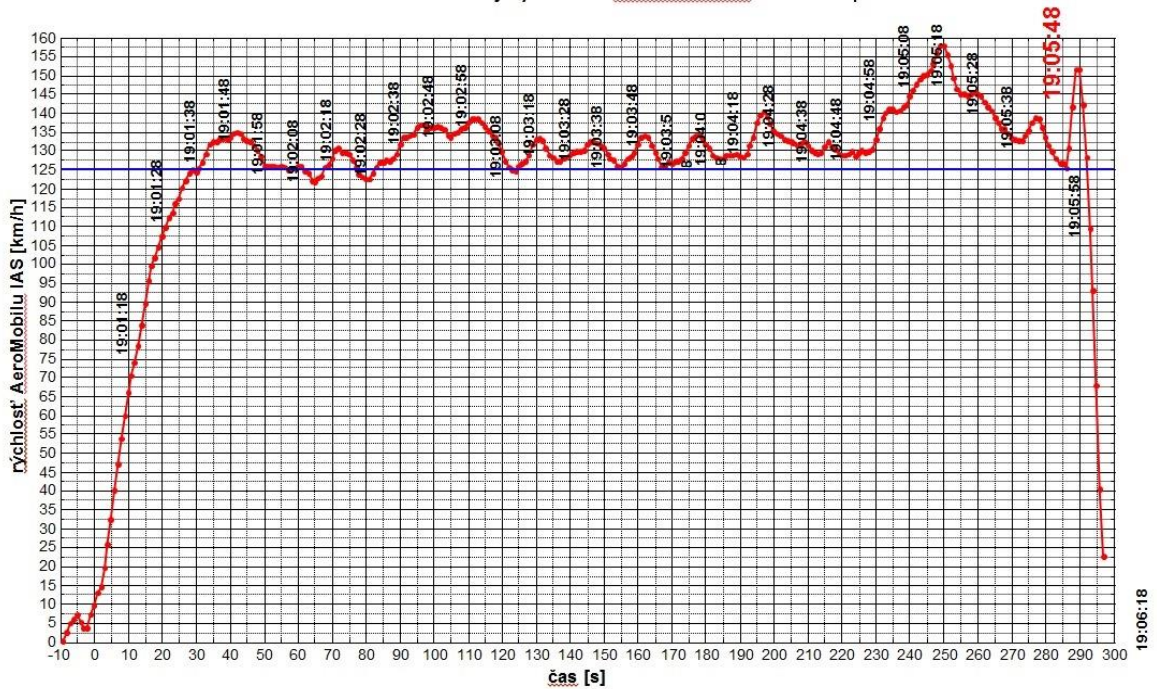


Fig. Dependence of indicated speed of AeroMobil on time during flight

During the stall the pilot switched the engine to run at idle thrust and activated the rescue parachute system (286 s). In an altitude of about 70 m he felt the full opening of the canopy, which caused a dramatic decrease of the vertical stall speed. AeroMobil fell to the ground (v 302 s - 19:06:18) about 80 m away of the west boundary of airport LZNI.

After the fall the pilot disconnected the electric network, unfastened the belts and left the cockpit of AeroMobil without help.

Daytime: day

Flight rules: VFR

1.2 Injuries to persons

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

1.3 Damage to AeroMobil

During the stall of AeroMobil the pilot successfully activated the rescue parachute system. During its operation the pack assembly and the parachute chords became entangled in the rotating parts of AeroMobil.

After the fall to the ground AeroMobil was seriously damaged.

The inspection of AeroMobil detected the following scope of damage:

- Damage to front fuselage
- Damage to left wingtip
- Damage to elevator hinge (detachment of the hinge from the elevator); after fixing the joystick it was possible to drive the elevator by application of little force.
- Damage to right horizontal rudder caused by the rescue system chords (the upper part of horizontal rudder was cut through),
- Damage to the hinged part of fuselage and cockpit canopy
- Damage to deformatio part of fuselage consisting of side tunnels
- Damage to front landing gear axle
- Damage to canopy (rupture) and rupture of several parachute chords.





1.4 **Other damage**

No circumstances with potential claims for compensation of other damage toward a third party were notified to the Aviation and Maritime Investigation Authority.

1.5 **Personnel information**

Pilot

A national of the Slovak Republic, aged of 55 years

Holder of the private pilot licence issued by the Civil Aviation Authority of the Slovak Republic on 22.08.1997.

Qualifications

SEP(L) with marked validity until 31.10.2017,

Holder of the glider pilot licence issued by the Light Aircraft Association of the Slovak Republic on 25.09.2006, with marked validity until 31.12.2018.

Qualifications

GLD with marked validity until 31.12.2016,

Holder of the FSV pilot licence issued by the Light Aircraft Association of the Slovak Republic on 27.08.2014, with marked validity until 26.08.2016.

Qualifications

FSV wing pilot

Flying experience - AeroMobil

For the last 90 days: 5 hod 12 min 57 flights

For the last 30 days: 0 hod 17 min 7 flights

By the date of incident: 0 hod 11 min 4 flights

Medical certificate of the 2nd class with marked validity until 26.08.2016.

1.6 **AeroMobil information**

Type: AeroMobil
Identification No: OM-M929
Serial No: 3.0.1
Manufacturer: AeroMobil, s.r.o
Engine: ROTAX 912 ULS, not certified as aero engine

Operating hours of AeroMobil

Total operating hours since manufacture: 7 h 27 min 95 flights

On the date of incident: 0 h 11 min 4 flights

Certificate of airworthiness of FSV No. ZRS296, issued on 29.04.2015 by the Slovak Microlight Federation within the meaning of authorization No. P/SLP-009-10831 of 19.06.2013, issued by the Civil Aviation Authority of the Slovak Republic, with marked validity until 31.05.2015.

Certificate of third-party insurance No. 411019632, Allianz – Slovenská poisťovňa, a.s., valid from 06.10.2014 to 05.10.2015.

Data from the flight data recorder prove that the condition of AeroMobil during flight was not the cause of the incident.

Operating history of AeroMobil

The start of preparation of documentation was in December 2013, the implementation took place in 2014 and the first flight was conducted on 22.10.2014.

	Take-offs	Min
22.10.2014	3	15
23.10.2014	2	20
17.01.2015	8	30
18.01.2015	7	20
21.01.2015	5	10
22.01.2015	13	40
11.02.2015	15	30
15.02.2015	3	18
18.02.2015	1	15
19.02.2015	1	6
20.02.2015	3	18
21.02.2015	7	14
08.03.2015	9	24
16.03.2015	1	20
18.03.2015	4	48
19.03.2015	2	30

20.03.2015	1	12
23.03.2015	2	40
24.03.2015	1	20
06.05.2015	3	6
08.05.2015	3	6
08.05.2015	1	5

Calculation of weight of AeroMobil at the time of incident

		Weight [kg]
Empty weight (AeroMobil including engine working fluids, but without available fuel)		494.5 kg
Pilot		85.0 kg
Fuel weight (1 l = 0.72 kg)	13.8 L	10.0 kg
Capacity of fuel tanks	80.0 L	57.6 kg
Luggage		0.0 kg
TOTAL		589.5 kg

The maximum take-off weight of 600 kg (indicated in the Flight Manual and in the Record from measurement of weight and centre of gravity) was not exceeded during the critical test flight .

1.7 Meteorological situation

On 08.05.2015 a high-pressure area remained over our territory.

Near the city of Nitra the total cloud amount did not change and remained at a level of 4/8, with dominance of Stratocumulus clouds with lower base altitude of 2000 m. In addition to these clouds, middle-level clouds of Altopcumulus lenticularis type and high-level clouds of Cirrus type occurred to a smaller extent. The air pressure slightly dropped (by 2 hPa over 4 hours).

Around 19:00 the airport LZNI had partly cloudy weather without precipitation. The air temperature was 22 °C and relative humidity was 40 %. Horizontal visibility was 35 km. At an altitude of 300 m above ground level the south-east to east wind with speed of 8 to 10 m/s was blowing. Towards lower altitudes, the wind speed gradually decreased and the wind direction remained unchanged (east wind). In an altitude of 10 m above ground level the gentle east wind with speed of 4 m/s was blowing and wind gusts achieved the maximum speed of 6 m/s. The wind direction was stable, without distinct fluctuations.

1.8 Aids to navigation

AeroMobil was equipped by navigation system Garmin G3X. The AeroMobil operator in cooperation with the investigation commission evaluated the flight data recorded during the critical flight.

1.9 Communications

AeroMobil was provided with radio communication equipment enabling the two-way communication with all air and rescue service stations at every moment of the flight.

1.10 Aerodrome information

The airport LZNI is a public international airport with altitude of 135 m (443 ft) and RWY 15/33 of 1080 m x 100 m. At the time of the incident the airport was suitable for the critical flight.

1.11 Flight recorders

During test flights AeroMobil was equipped by two cameras scanning the tail and the interior of AeroMobil.

1.12 Wreckage and impact information

The place of incident is determined by the geographic coordinates:

N 48°16'49,81''

E 18°07'40,82''



1.13 Medical and pathological information

N/A.

1.14 Fire

No fire broke out.

1.15 Survival aspects

Search and rescue using SAR devices were not required.

1.16 Tests and research

AeroMobil was analysed using 3D non-viscous panel method in accordance with reference literature. The main purpose of the analysis was to determine the position of aerodynamic centre of AeroMobil. The analysis of the calculation was determined for conditions 0 m ISA and speed of 130 km/h. The determined aerodynamic centre of AeroMobil was situated very near its centre of gravity. For zero deviation of the horizontal rudder the positive pitch moment was calculated for the whole scope of pitch angles. During the analysis a stabilised horizontal flight could be achieved only with horizontal rudder in down position. These results correspond to data from available flight video records.

AeroMobil was subject to the analysis of calculation of lift distribution on the wing using the nonlinear lifting line theory.

1.17 Organizational and management information

The test flight was conducted in accordance with requirements of the Slovak Microlight Federation and methodology for determination of the position of the aerodynamic centre of AeroMobil with fixed control on the basis of flight measurements.

The purpose of the test flight was to verify the behaviour of AeroMobil at a constant wing chord pitch of 16° against the level of the fuselage during the whole flight. The elevator deflection and the pitch trim at different flight speeds were examined as well.

1.18 Additional information

The activated rescue parachute system fulfilled its function, although during its operation the canopy and the parachute chords became entangled with propeller blades, which caused AeroMobil to fall to the ground in unplanned position.

The analysis of flight test records shows that with increasing speed of AeroMobil moving on the ground the static pressure (taken from the cockpit for barometers) in the cockpit dropped with parallel increase of the altitude indicated by the altimeter. At the altitude of airport LZNI of 135 m above sea level and achievement of the ground speed of 67.4 km/h, the altitude increased by 3.962 m. It means that if the altimeter indicated 125 km/h the difference in indicated altitude was 5 m and the difference in static pressure was 60 Pa. The actual speed was 119.81 km/h and the speed difference was 5.19 km/h. Consequently, the altimeter reading was higher than the actual speed.

1.19 Useful or effective investigation techniques

Standard investigation techniques were used.

2. ANALYSIS

2.1. Activity of pilot

At the time between 250 s and 286 s, the pilot continuously decreased the flight speed from 158 km/h to 125 km/h, with a slight increase at 277 s to 138 km/h. The (left) bank angle diminished from 30° to 15° . The pitch angle remained constant, i.e. $+4$ to $+5^\circ$ (above the horizon).

In the left steady turn at altitude of about 327 m with forward speed of about 125 km/h and with left bank of 15° the pilot slowly pulled the stick back, which caused the increase of the pitch angle of AeroMobil against the horizon by 5° and the increase of air incidence angle.

After 0.7 s the pilot reacted by slightly pushing the stick, which caused a loss of lift on the left wingtip, massive stream withdrawal, significant tilt of the left wing down and lowering of the front fuselage of AeroMobil below the horizon.

In the angular motion the rate of roll increased from $0^\circ/\text{s}$ to about $70^\circ/\text{s}$ within one second, i.e. the roll acceleration was $70^\circ/\text{s}$ until (at 284 s (19:05:48) the left wing stall.

The following stall entry in a low altitude above ground level did not allow the standard stall recovery of AeroMobil by the pilot.

2.2 Conclusions from the operation of the rescue parachute system

The rescue parachute system intervened properly as indicated by the manufacturer. The rocket gradually pulled the canopy out of the pack and the chords from the bag, but it lacked energy required for vigorous pulling of the pack off the canopy at a higher speed.

Consequently, the canopy and the parachute chords came into contact with rotating parts of AeroMobil (wrong direction of the rescue parachute).

It caused the rupture of several parachute chords, damage to the parachute canopy and higher descent speed of AeroMobil suspended on the parachute (based on data from the board variometer more than 10 m/s). In altitude of about 70 m the pilot felt the full opening of the canopy, which caused a dramatic decrease of the vertical stall speed.

2.3 Conclusions from flight test reports

During the test flight the speed indicator showed more than the actual flight speed, due to the tapping of static pressure from the cockpit of AeroMobil.

Similar dependence was observed on the speed indicator for all test ground rolls and flights. The speed indicator always showed a higher speed than the actual speed, which probably influenced the flight of AeroMobil at low/stall speeds.

2.4 Meteorological situation

The test flight was conducted at wind speed of 8 to 10 m/s and south-east to east wind direction, which – at the extraordinarily large surface of fuselage, imprecision of the speed indicator and flight near the stall speed – may have put AeroMobil into uncontrollable left wing stall.

3. CONCLUSIONS / CAUSE OF INCIDENT

3.1 Findings

- The pilot valid qualifications for this flight.
- AeroMobil had valid documentation and did not show any faults before the incident.
- AeroMobil fulfilled the conditions of airworthiness before the critical flight.
- Unsuitable direction of ejection of the rescue parachute.

3.2 Causes of incident

- Incorrect reading of the speed indicator due to the tapping of the static pressure from the cockpit of AeroMobil during flight;
- Configuration of AeroMobil with the centre of gravity in the back was more sensitive to stall characteristics, due to the test flight;
- For a yaw angle flight a small stabilizing banking moment was calculated for all air incidence angles;
- Relatively small wing twist increased the sensitivity to stream withdrawal in the area of ailerons;
- Atmospheric conditions in altitude of 300 m above ground level during a flight at nearly stall speed and with incorrect speed indicator reading caused the entry of AeroMobil into uncontrollable left wing stall.

4. SAFETY RECOMMENDATIONS

On the basis of investigation of the incident

Aircraft type **Prototype AeroMobil 3.0.1**
Identification No. **OM-M929**
Date of incident **08.05.2015**

We recommend the operator of AeroMobil s.r.o.:

- To apply for registration of prototype AeroMobil with the Transport Authority of SR because the authorized organization SFUL executes supervision over construction, and verification of airworthiness of individually home-built FSV with highest permissible take-off weight, which does not exceed 600 kg. If the prototype vehicle was filled with 80 l of fuel and occupied by another crew member, it would immediately exceed the maximum take-off weight,
- To conduct test flights under weather conditions CAVOK,
- To change the method of static pressure reading in order to increase the precision of the speed indicator during flight;
- To change the pitch of the rescue parachute system to prevent the canopy and chords from getting caught into the rotating parts of the engine after ejection of the parachute;
- To increase the engine output of prototype AeroMobil due to the insufficient output;
- To ensure the deactivation of magnetos at the moment of pushing on the button to eject the rescue parachute system.

Bratislava, 18.02.2016