



AIR ACCIDENTS  
INVESTIGATION INSTITUTE  
Beranových 130  
199 00 PRAGUE 9 – Letňany

---

CZ-21-0308

# FINAL REPORT

**on investigation of causes of an air accident  
of the North American T-28B Trojan aircraft, registration mark OE-ESA,  
near the village of Jickovice, District Písek  
on 20 June 2021**

PRAGUE  
June 2025

---

This investigation was carried out pursuant to Regulation (EU) of the European Parliament and of the Council No. 996/2010, Act No. 49/1997 Coll., on civil aviation, and Annex 13 to the Convention on International Civil Aviation. The sole objective of this report is the prevention of potential future accidents and incidents free of determining the guilt or responsibility. The final report, findings, and conclusions stated therein pertaining to aircraft accidents and incidents, or possible system deficiencies endangering operational safety shall be solely of informative nature and cannot be used in any other form than advisory material for bringing about steps that would prevent further aircraft accidents and incidents with similar causes. The author of the present Final Report states explicitly that the said Final Report cannot be used as grounds for holding anybody liable or responsible as regards the causes of the air accident or incident or for filing insurance claims.

## Table of Contents

Abbreviations used .....	4
Units used.....	5
A) Introduction .....	6
B) Synopsis.....	6
1 Factual information.....	7
1.1 History of the flight.....	7
1.1.1 Circumstances preceding the flight.....	7
1.1.2 Flight of the T-28B in a group behind the B-25J .....	7
1.1.3 Trajectory of the critical flight phase .....	10
1.1.4 Transport of cameras on board the T-28B.....	10
1.1.5 Memories of the photographer (includes an indicative translation of the direct speech).....	11
1.1.6 Photographer's statement on the method of transporting the camera on board .....	11
1.2 Injuries to persons .....	12
1.3 Damage to aircraft .....	12
1.4 Other damage.....	12
1.5 Personnel information.....	12
1.5.1 Pilot,.....	12
1.5.2 Photographer.....	13
1.6 Aircraft information.....	13
1.6.1 North American T-28B Trojan.....	13
1.7 Meteorological information.....	15
1.8 Radio navigational and visual aids.....	16
1.9 Communications .....	16
1.10 Airport information .....	16
1.11 Flight recorders and other means of recording .....	16
1.12 Wreckage and impact information .....	16
1.12.1 Air accident location.....	16
1.12.2 Propeller .....	17
1.12.3 Landing gear.....	18
1.12.4 Engine .....	21
1.12.5 Engine monitoring system.....	21
1.13 Medical and pathological information.....	22
1.14 Fire .....	22
1.15 Search and rescue.....	22
1.16 Tests and research .....	22
1.17 Organisational and management information .....	23
1.18 Supplementary information .....	23

1.18.1	Consultation with the NTSB .....	23
1.18.2	Statement of the NTSB representative on the T-28B barrel roll.....	23
1.18.3	Statement of the NTSB representative on the T-28B landing gear system...	24
1.18.4	National legislation for T-28B operations regulated by Czech Republic .....	24
1.19	Useful or effective investigation techniques .....	24
2	Analyses.....	24
2.1	Pilot.....	25
2.2	Photographer .....	25
2.3	T-28B landing gear position during aerobatic manoeuvre .....	25
2.4	Technical condition of the aircraft .....	26
2.5	Probable course of the barrel roll.....	26
2.6	Operator.....	27
2.7	Weather .....	28
3	Conclusions.....	28
3.1	Pilot.....	28
3.2	Photographer .....	28
3.3	Barrel roll. ....	28
3.4	T-28B aircraft.....	28
3.5	Operator.....	29
3.6	Weather .....	29
3.7	Cause .....	29
4	Safety Recommendations .....	29
5	Appendices .....	30

**Abbreviations used**

AC	Altostratus
AGL	Above ground level
ALT	Altitude
ATCo	Air Traffic Control Officer
ATP	Airline Transport Pilot (US)
ASEL	Airplane Single Engine Land
ASES	Airplane Single Engine Sea
AMEL	Airplane Multi Engine Land
AMES	Airplane Multi-Engine Sea
AMSL	Above mean sea level
AVGAS	Aviation gasoline
BASE	Cloud base
BKN	Broken
CAX	Commercial Pilot Airplane (US)
CI	Cirrus
CS	Cirrostratus
CU	Cumulus
CHMI	Czech Hydrometeorological Institute
FEW	Few (amount of clouds)
FL	Flight level
FO	First Officer / co-pilot
FRS	Fire rescue service
IR	Instrument rating
KIAS	Knots indicated airspeed
MSL	Mean sea level
MEP (land)	Multi-engine piston (land)
NIL	None
NTSB	National Transportation Safety Board
CoA	Certificate of airworthiness
PCR	Police of the Czech Republic
PIC	Pilot in command
PPL (A)	Private Airplane Pilot Licence
REG QNH	Regional pressure, the lowest atmospheric pressure in the area (reduced to mean sea level according to standard atmospheric conditions)
SCT	Scattered
SEP (land)	Single-engine piston (land)
SYNOP	Report on surface synoptic observations made by weather stations

QNH	Atmospheric pressure in the area (reduced to mean sea level according to standard atmospheric conditions)
UTC	Coordinated Universal Time
VRB	Variable
VFR	Visual Flight Rules

### Units used

ft	Foot (unit of length – 0.3048 m)
hPa	Hectopascal (unit of atmospheric pressure)
kt	Knot (unit of speed – $1.852 \text{ km.h}^{-1}$ )
PSI	Pressure unit (pounds per square inch)

## A) Introduction

Operator: The Flying Bulls GmbH  
Aircraft manufacturer: North American  
Type of aircraft: T-28B  
Registration mark: OE-ESA  
Place of occurrence: approx. 300 m east of the village Jickovice, District Písek  
Event date and time: 20 June 2021, 14:45 UTC (all times are UTC)

## B) Synopsis

On 20 June 2021, the AAI was notified of an air accident of the North American T-28B Trojan aircraft in the vicinity of the village Jickovice, District Písek. Two aircraft were executing a group overflight from the Antidotum AirShow 2021 from EPLS (Leszno / Strzyzewice – Poland) to LOWS (Salzburg / W. A. Mozart – Austria). The pilot of North American T-28B Trojan, flying behind the lead aircraft North American B-25J Mitchell, performed a barrel roll aerobatic element at approximately 1800 ft ALT REG QNH 1008 hPa. While recovering from a descent, the aircraft crashed into the trunks of mature trees in the low-relief terrain in a forest belt and the aircraft wreckage landed on the edge of the forest, where it caught fire. The pilot died and the passenger was seriously injured.

The cause of the incident was investigated by the AAI Commission. The investigation team comprised of:

Commission Chairman: Ing. Stanislav PETRŽELKA  
Commission members: Karel BURGER  
MUDr. Zdeňka KOŠEK SLADKÁ, MIFM MUH

The Final Report was issued by:

AIR ACCIDENTS INVESTIGATION INSTITUTE  
Beranových 130  
199 00 PRAGUE 9 – Letňany

On 30 June 2025

### This Final Report consists of the following main parts:

- 1 Factual information
- 2 Analyses
- 3 Conclusions
- 4 Safety Recommendations
- 5 Appendices

## 1 Factual information

### 1.1 History of the flight

#### 1.1.1 Circumstances preceding the flight

On 20 June 2021, crews of 4 historical military aircraft planned to fly from Antidotum AirShow 2021 from EPLS to LOWS. These were North American T-28B Trojan OE-ESA (hereinafter the “T-28B”), North American B-25J Mitchell (hereinafter the “B-25J”), Lockheed P-38 Lightning (hereinafter the “P-38”), and North American P-51 Mustang (hereinafter the “P-51”).

In the morning, at about 7:00, the crews had breakfast together. At about 8:00, a briefing was given on photographic flights with Skyvan aircraft. At about 9:30–10:30, the first photographic flight took place. It was followed by lunch of the crews, and at about 12:00–13:00, the second photographic flight took place. This was followed by aircraft refuelling. The B-25J did not need refuelling and the T-28B was refuelled immediately. The P-38 and P-51 needed an extra hour to refuel and get ready. The B-25J and T-28B crews decided to depart from EPLS to LOWS together and early because the P-38 and P-51 were faster and thunderstorms were expected around Salzburg Airport.

The B-25J crew consisted of the PIC and FO and there were 3 passengers on board. The T-28B crew consisted of the PIC and a photographer (hereinafter the “photographer”) in the rear seat. The flight crews together with the passengers made preparations for an overflight. A formation flight plan in class G airspace was developed. The crews informed each other of important details related to the flight and agreed on the method of communication during the flight for the purpose of taking photo documentation during the flight. At approximately 13:45, the T-28B departed from EPLS in a group behind the B-25J with a planned flyover to LOWS.

Photographers on board of both aircraft took photos and videos of each other’s manoeuvres during the flight.

Witness’ statement on the technical condition of the T-28B before departure: *“No technical defects were recorded. On 19 June, in the afternoon, oxygen in the aircraft was replenished to 1,000 PSI. After each hour of flight, 5 litres of oil were always added. Before the flight, 237.5 litres of AVGAS were uplifted to full level.”*

#### 1.1.2 Flight of the T-28B in a group behind the B-25J

Two aircraft were flying under VFR rules in a group in class G airspace. Video footage and photographs taken by a photographer from the B-25J gun turret showed the T-28B in various flight attitudes.

The T-28B pilot was performing manoeuvres with high bank angles and at a significantly higher speed than the lead B-25J during group flight. Other images showed the T-28B almost in close proximity behind the B-25J, see Fig. 1 and Fig. 2.



Fig. 1 – Photograph T-28B taken by a photographer from B-25J aircraft



Fig. 2 – Static image from video taken by the T-28B photographer in close proximity behind the B-25J

The pilot manoeuvred the T-28B behind the B-25J near the area of wake turbulence. The photographer in the T-28B took in-flight photographs and cell phone video footage. Photographs taken from the T-28B by the photographer showed the close relative position of the aircraft behind each other in the group. There were two cameras on board the T-28B, in the rear part of the cockpit (photographer's position).



Fig. 3 – Manoeuvring the T-28B behind the B-25J

At 14:44:18, on approach to Jickovice, the B-25J maintained 1,800 ft ALT REG QNH 1008 hPa. Due to the altitude of the surrounding terrain, the B-25J was about 150 m AGL at about 190 kt GS. The PIC testified that at the time of arrival to the village of Jickovice, before the T-28B began the barrel roll, the B-25J maintained a speed of approximately 170 KIAS. The radar screenshot in Fig. 4 shows the flight data of the lead B-25J on approach to the village of Jickovice, prior to the barrel roll of the T-28B.

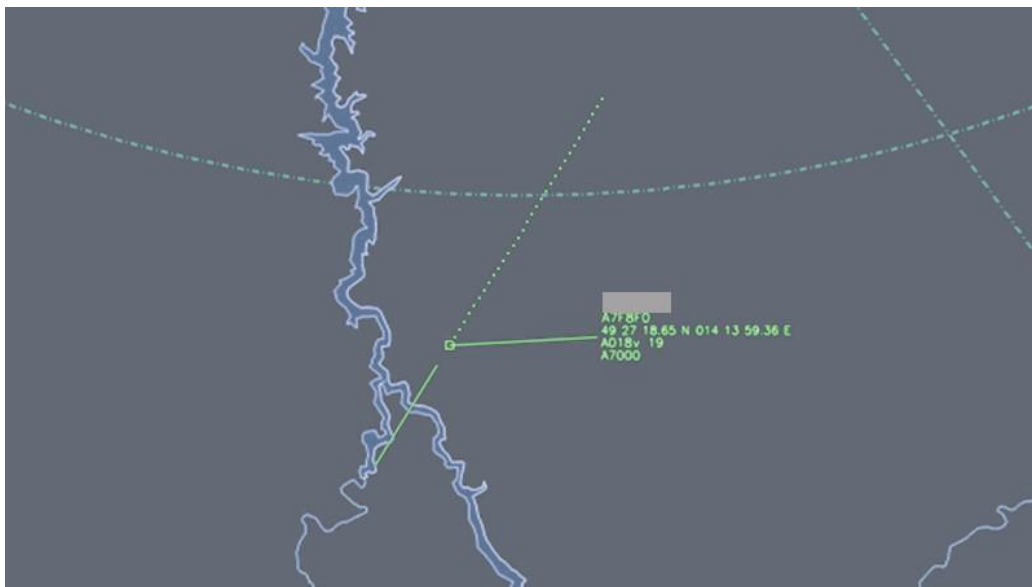


Fig. 4 – B-25J at 14:44:18 UTC, speed 190 kt, 1,800 ft ALT REG QNH 1008 hPa

The execution of the aerobatic manoeuvre barrel roll was preceded, according to a witness from the B-25J aircraft, by the arrival of the T-28B from the left side, with a descent of several meters below the level of the B-25J. The barrel roll was initiated by the T-28B pilot in the climb to the elevation behind the lead B-25J. At the same time, the witness testified that a few seconds before the barrel roll began, he stopped shooting video and then moved to the front of the aircraft.

While watching the barrel roll, he saw the T-28B drop into the woods near the end of the barrel roll at an angle of approximately 90° to the right to the direction of the flight. According to the witness, the T-28B then drew a flaming trail across the clearing into another forest. The witness immediately notified the crew of the situation and that the T-28B was on the ground. The B-25J crew declared distress and described the situation. After several turns over the accident site, the B-25J PIC checked the fuel quantity and decided to continue with the flight to LOWS.

### 1.1.3 Trajectory of the critical flight phase

The witness from the B-25J plotted and timed the trajectory of the T-28B barrel roll on a map base, see Fig. 5. The barrel roll began at 14:43:54. At 14:44:00, the aircraft was in the inverted attitude and, at 14:44:12, it was in the descent recovery phase. The witness timed the critical phase of the flight as long 18 seconds.

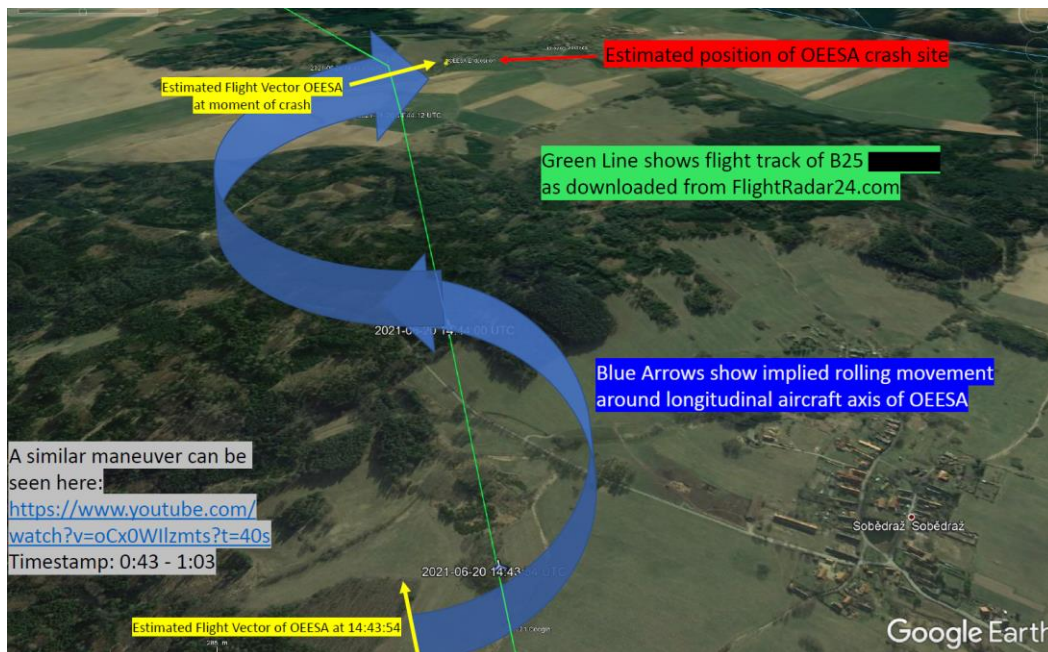


Fig. 5 – Trajectory of the barrel roll plotted and described by the B-25J witness<sup>1</sup>

### 1.1.4 Transport of cameras on board the T-28B

The Commission obtained the video footage, which was taken before the critical phase of the flight and incidentally captured by a camera<sup>2</sup> located along the cockpit, held against movement only by the photographer's right foot. The photographer held the second camera<sup>3</sup> in his hand, or probably in both hands while taking photographs.

<sup>1</sup> Similar maneuver can be seen here (timestamp 0:43-1:03): <https://www.youtube.com/watch?v=oCx0WIlzmts?t=40s>, the link was provided by the witness B-25J

<sup>2</sup> Canon EOS 1Dx Mark II + Canon EF 100-400 mm.

<sup>3</sup> Canon EOS 1Dx Mark II + Canon EF 24-70 mm.

### 1.1.5 Memories of the photographer (includes an indicative translation of the direct speech)

The photographer presented some of his memories in a written report for the web portal mariborinfo.com. In a written report on the air accident, the photographer stated, translation from native language: “...Then a cry came to my mind that I still cannot define. I don't know if he just yelled (the pilot's name) out when he realised what was about to happen, if it was just a curse word, or words directed at me. It sounded scary, but I can't recall any image with the sound, it's just a scream in the dark,” he says<sup>4</sup>...”

### 1.1.6 Photographer's statement on the method of transporting the camera on board

The Commission wanted to know the photographer's opinion on how the objects were transported on board the aircraft and what measures had been taken by the crew beforehand.

1. Was it usual for you to fly with your camera on the floor, leaning against the side of the cockpit and held up by your foot? Situational video footage showed the camera lying loose, held by a foot.



Fig. 6 – Position of the camera on the floor and the second camera in a vertical position

The photographer replied: “I recall that in previous years, we always discussed with the PIC about the position of the photographic equipment that was on board during the flight in such a case, so that it would not interfere with the control of the aircraft. In addition, I also recall that when various manoeuvres were carried out, it was always coordinated with the PIC. In preparation for such a flight, it was common for the PIC to provide a full safety briefing for the planned flight, which I fully complied with, and he had no additional comments that if the camera was on the floor and under my control, it would affect the control of the aircraft in such a case. There were no such comments. In addition, I also remember that on flights

---

<sup>4</sup> Fotograf Miro Majcen si tudi po letalski nesreči, v kateri je za las ušel smrti, želi nazaj v pilotsko kabino. Online. In: Mariborinfo.com. 2021. Available at: <https://mariborinfo.com/novica/scena/fotograf-miro-majcen-si-tudi-po-letalski-nesreci-v-kateri-je-za-las-usel-smrti-zeli>. [cit. 2025-07-15].

*with other operators and other types of aircraft, I also followed their briefings and had the camera in similar positions and that it did not affect the control of the aircraft.”*

2. Where was the camera at the time of the barrel roll?

The photographer replied: ***“I don’t recall a barrel roll or any other manoeuvre at all. I take it that I was holding the camera as usual or had it fixed on the ground, because it wouldn’t have been professional of me to have the camera loose on the ground...”***

3. What was the briefing on the objects on board like?

The photographer replied: *“I spent a lot of time on this, but I can’t remember any details of this particular flight. I do recall, however, that the normal PIC’s procedure in the past after I entered the cockpit was to check the seat belts and make sure my seatbelt was fastened. At the time I was buckling my seatbelt, he usually held my gear so I could buckle my seatbelt safely. I have a little flashback, but I can’t remember if it’s from this flight or another, that the PIC asked me during my seatbelt buckling if I remembered the procedure for manual opening of the cockpit in the event of an occurrence requiring such an action. At the time of writing this text, I am unable to confirm whether this memory is directly related to our unfortunate flight. During this process of trying to recall events, I experience great emotional stress and upheaval, because I’d also like to find some answers within myself.”*

4. Was the Pilot-in-command informed of the presence and method of stowage of one of the two cameras on board? One of the cameras was placed on the floor during the flight.

The photographer replied: *“I can think that he was informed about it because it was also the case when flying with various operators when the PIC confirmed such a stowage position as normal. I’m also a trained and certified private pilot and from that perspective I understand all the flight procedures regarding personal items in the cockpit and how to handle them.”*

## 1.2 Injuries to persons

Tab. 1 – Injuries to persons

Injured	Crew	Passengers	Other persons (inhabitants, etc.)
Fatal	1	0	0
Serious	0	1	0
Light/No injury	0/0	0/0	0/0

## 1.3 Damage to aircraft

The aircraft was destroyed.

## 1.4 Other damage

Damage to forest cover has not been reported to the AAI.

## 1.5 Personnel information

### 1.5.1 Pilot,

- Male, aged 54 years, foreign national.

Licences and qualifications

- PPL(A) DE, PPL-US, CAX-US (ASEL/ASES/AMES),
- ATP-US (AMEL/CE-500/CE525S),
- Valid medical certificate 1/2,
- Valid English language clause,
- Valid radio operator licence.

#### Aircraft and qualifications

- TBM SET / PIC / IR,
- C525 / PIC / IR,
- Cessna SET / PIC/IR,
- MEP(land) / PIC / IR,
- SEP(land) PIC / IR / CRI,
- Aerobatic (A) 09.06.2012,
- The pilot had been a member of the DEUTSCHER AERO CLUB E.V. since 2016 and held an FAI aerobatic sports licence
- US-ATP (AMEL/CE-500/CE-525S) 05.10.2013.

The total number of pilot's hours flown as at the date of air accident could not be satisfactorily ascertained. The organisation's database registered the pilot to have flown 3,972 flight hours, of which 2,799 hours were IFR flights. He made 3,282 landings during the day and 154 landings at night. He gained experience on 14 types of single-engine aircraft and 7 types of multi-engine aircraft. He flew a total of 196 hours on the T-28 type.

#### 1.5.2 Photographer

- Male, aged 46 years, professional photographer, foreign national.
- PPL licence, extensive small aircraft experiences.
- T-28 previous flying experiences.

## 1.6 Aircraft information

### 1.6.1 North American T-28B Trojan

The T-28B Trojan was a two-seat, piston-engined trainer. It was used by the United States Air Force (USAF) and the US Navy.

- Type, model, serial number: T-28, B, 138179
- Registration mark: OE-ESA
- Manufacturer, year of manufacture: North American, 1954
- Total cycles: 1,328
- Total hours: 954:07
- CoA, valid until 20 July 2022: Restricted Certificate of Airworthiness
- Power unit, serial number: R-1820-86 B, BL520164
- Total hours: 326:39
- Propeller, serial number: 43D50-313, N199247
- Total hours: 10:33
- Maximum take-off weight: 3,900 kg / 8,600 lb
- Fuel quantity: 671L AVGASS 100 LL
- Travel speed: 370 km/h (200 kt)

- Maximum speed: 552 km/h (298 kt)
- Flying range: 1,706 km
- Service ceiling: 10,820 m

The original T-28B OE-EA cockpit is shown in Fig. 7 with the aircraft controls and systems. The landing gear control lever does not have a latch. Cycle length of 4–6 sec for landing gear extension is described in the Flight Manual<sup>5</sup>.



Fig. 7 – Landing gear control in a yellow frame

The red circle on the control panel shows the indicator *Engine Monitoring System*, which was used to check and evaluate the function of the power unit.



Fig. 8 – Display *Engine Monitoring System* in a red circle

<sup>5</sup> NAVAIR 01-60FGB-1 page 1-25 NATOPS FLIGHT MANUAL T-28B/C.

## 1.7 Meteorological information

Analysis of the meteorological situation. On 20 June 2021 at 14:47, a warm air advection from the south was peaking over the Czech Republic along the leading edge of a trough of low pressure over Western Europe.

- Ground wind: initially 090–120° / 6–8 kt
- Upper wind: 2,000 ft VRB / 06 kt 5,000 ft VRB / 06 kt, 10,000 ft MSL 240° / 14 kt  
 Visibility: 30–40 km
- Weather: broken, no precipitation
- Cloudiness: BKN Ci, Cs base ABV 18,000 ft AMSL
- Zero isotherm level: 14000 ft AMSL
- Turbulence: NIL
- Ice: NIL
- QNH pressure: 1010 hPa slight decline
- REG QNH pressure: 1008 hPa

Abstract from SYNOP reports from the Temelín synoptic station (about 35 km south of Jickovice).

Tab. 2 – Abstract from SYNOP reports

Day / hour	N wind / kt	visibility	cloud cover (m AGL)	temperature / dew point / °C
20 / 13	6 050° 6	35 km	1 Cu 1500 6 Cs 6000	30,6 / 14,3
20 / 14	7 100° 4	35 km	1 Ac 2400 7 Cs 6000	31,1 / 13,4
20 / 15	6 090° 8	35 km	6 Cs 6000	30,6 / 14,7

Cloud radar image on the left from 20 June 2021 at 14:45 (the cross indicates the approximate location of Písek). Right cloud cover image from the MSG satellite.

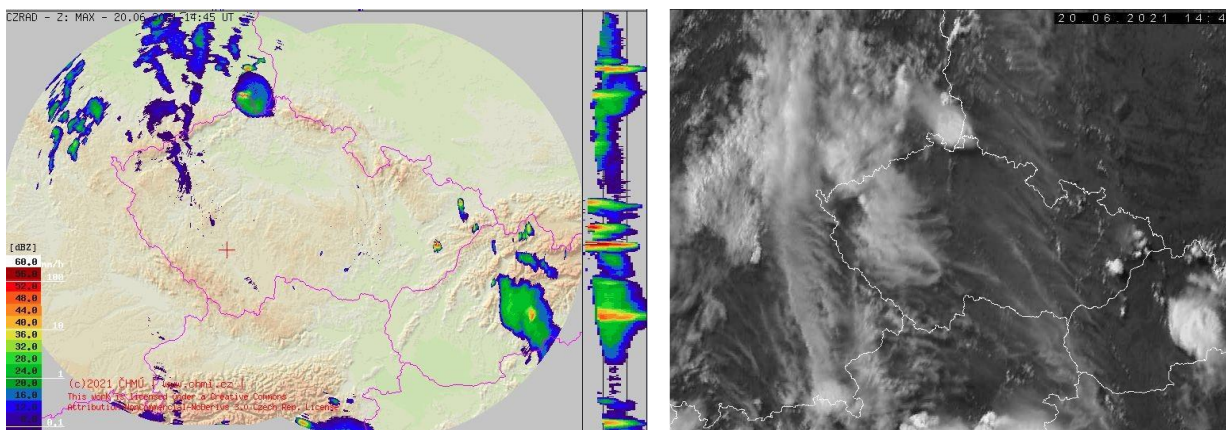


Fig. 9 – Radar (left) and satellite cloud cover (right)

Conclusion: In the area of the aircraft accident near the village of Jickovice, District Písek, a light easterly wind was blowing of around 6–8 kt. Visibility was about 35 km. At the time of the accident, the sky was covered by a layer of high Cs clouds, as seen in the satellite

image. Temperature in the observed area was about 30 °C. Dangerous phenomena (frost, turbulence, Cb, thunderstorms) were not recorded.

## 1.8 Radio navigational and visual aids

NIL

## 1.9 Communications

The crew of the B-25J reported the occurrence of the T-28B accident on the frequency of PRAHA INFORMATION in the standard manner. They confirmed their own location and cooperated with ATCo to resolve the emergency.

## 1.10 Airport information

NIL

## 1.11 Flight recorders and other means of recording

The aircraft was equipped with a system to monitor the operating parameters of the aircraft's power unit, which was destroyed by fire during the air accident. There was no other usable recording equipment on board the aircraft. There is no record of communication between the aircrew members.

## 1.12 Wreckage and impact information

### 1.12.1 Air accident location

The aircraft, while recovering from a descent, flew through the tree tops of the forest belt at the beginning of a ravine. The first contact of the aircraft with the terrain was around the nose gear (Fig. 10, left). This was followed by an impact with the right half of the wing into mature trees on the right slope of the ravine (Fig. 10, right), causing extensive damage to the structure of the aircraft and a fuel leak from the ruptured tanks. At a distance of about 4–5 m to the left of the first contact with the trees, a mature tree, the trunk of which was about 40 cm in diameter, was struck and severed by the impact.



Fig. 10 – Contact of the nose gear wheel tyre with the ground (left) and the point of impact of the aircraft into trees in rising terrain relief (right) with an arrow showing the direction of wreckage movement after impact

This was followed by the right side of the fuselage nose hitting the slope, breaking off a propeller blade, the whole propeller from the propeller shaft, three engine cylinders on the lower right side, and fuel explosion. A crash into a rising slope (Fig.10, right) in a forest belt and the subsequent explosion threw the aircraft wreckage over the edge of the slope.

The position of the point of the first contact of the aircraft with the ground: N 49°26'59,98", E 14°13'28,59"(Fig. 10, left)  
Location of the main aircraft wreckage after impact: N 49°26'59,35", E 14°13'26,09", 423 m ASL

The destruction of the fuselage and both wing halves after hitting the trees caused the explosion of the fuel residue flowing from the punctured tanks. After bouncing off the rising slope, the fuselage remains and the separated aircraft wreckage parts continued its flight path over the grain field to a distance of about 52 m and landed on the edge of the forest, where they caught fire. The photographer was ejected from the rear of the cockpit and found outside the aircraft at a distance of approximately 43 m from the point of impact with the slope. The drag brake was in the extended position. The left leg of the main landing gear was almost in the extended position and unsecured. The aircraft wreckage was located in a cone of about 45° on both sides of the direction of its trajectory.

### 1.12.2 Propeller

The three-bladed adjustable metal constant-speed propeller was badly damaged. All the damage was caused by the propeller coming into contact with trees and hitting the slope of the ravine. One propeller blade was broken off at about two thirds of the blade length. The fracture was of a brittle nature, i.e., it was caused by a short but intense inertial forces during the impact (Fig. 11). The second propeller blade (Fig. 12) was damaged at the leading edge, corresponding to the blade probably having come in contact with trees and then the ground. Further damage was found on the trailing edge of the blade. However, these were broken pieces of material, which was consistent with the fact that such damage occurred after the entire propeller had been torn from the engine shaft. The third blade (Fig. 13) sustained relatively the least damage. The blade was slightly bent backwards and sustained some damage in the form of small nicks in the final third at the leading edge. The propeller head (Fig. 14) was compact and, judging from the tracks, was broken out of the engine propeller shaft probably by the forces generated when the broken blade struck the ground or vegetation.



Fig. 11 – Broken propeller blade



Fig. 12 – Blade with damaged edges



Fig. 13 – Least damaged blade

Fig. 14 – Blade setting mechanism in the propeller head

### 1.12.3 Landing gear

The aircraft landing gear was retractable, wheeled, nose type, controlled by a hydraulic system. There was one wheel on each landing gear leg. The wheels on the main landing gear legs were fitted with lamellar hydraulic brakes and the front wheel was steerable. In the extended position, the landing gear legs were secured by breaking struts and when parked by mechanical pins. In the retracted position, the legs were secured by mechanical locks of the eye-hook type, where the eye is part of the landing gear leg and the hook is located in the landing gear shaft. The first impact with the ground destroyed the front landing gear leg web, ripping it out of the airframe structure (Fig. 15). The leg had an undamaged retracted position lock eye. The nose wheel tyre was damaged and bore traces of soil on its surface from the first contact of the aircraft with the ground.



Fig. 15 – Damage to the front landing gear leg.

The right main landing gear leg (Fig. 16) remained fixed in the remains of the right wing half structure and was in a nearly extended position. The eye of the retracted position lock was clean and undamaged. The landing gear covers were partially deformed. The counterpart of the retracted position lock bore traces of fire, but was not deformed or otherwise mechanically damaged (Fig. 17). The hydraulic brake piston blocks bore the marks of impact with trees and the ground.



Fig. 16 – Wreckage (remains) of the aircraft after impact destroyed by fire



Fig. 17 – Right landing gear leg lock hook

The left main landing gear leg was torn out of the wing structure. The position of the left main landing gear leg could not be determined. The lock eye of the retracted position was severely deformed by an impact with a tree. The hydraulic brake piston blocks bore the marks of impact with trees and grass clumps from the place of the first impact. In the fragment of the left half of the wing, in the landing gear shaft, the retracted position lock hook was found, which also carried traces of fire, but was not deformed or otherwise mechanically damaged (Fig. 18).



Fig. 18 – Left landing gear leg lock hook

The heavily wedged wooden splinters under the roller of the left landing gear retracted position lock eye proved the contact of the landing gear with the trees, i.e., that the legs of the main gear were in a position close to full extension when hitting the trees (Fig. 19).



Fig. 19 – Wooden splinters wedged in the left landing gear leg lock eye

#### 1.12.4 Engine

The engine was damaged by the deformation forces of a direct impact more than by the fire. The lower three engine cylinders on the right side were torn off. Two pistons of the three cylinders that were struck were torn off the connecting rods. The deformed cooling fins and the surface of these cylinders bear the traces of a strong impact primarily into the tree cover and secondarily into the ravine slope. Also, pieces of the engine inlet ring and the front part of the fuselage remains showed traces that were indicative of the aircraft's striking the slope with its right front.

The exhausts on the right side of the engine were torn off the cylinders and the protective anti-corrosion deflector under the exhaust pipes on the right side was torn off the fuselage structure. On its surface, there were traces of dirt from the place of the first impact of the aircraft into the slope of the ravine.

The oil cooler, which was on the lower left side of the engine, was only slightly damaged and was not destroyed because it was not subjected to a direct impact. The air inlet to the oil cooler was deformed by the inertial forces exerted during the impact.

The engine cooling flaps were damaged and were torn off their hinges and left attached to their control rods. The right flap was more deformed than the left.

The engine showed no signs of seizure or other mechanical failure. There was probably sufficient oil in the engine and oil system.

The power units on the drive box at the rear side of the engine were almost undamaged and their mechanical drives were fine.

#### 1.12.5 Engine monitoring system

The control panel bore marks of destruction and fire. *The Engine Monitoring System* was ripped out and completely destroyed by fire. Engine monitoring systems use sensors located at various places on the aircraft engine to gather information about engine performance. The sensors provide pilots with real-time information on engine operation and also capture data for analysis of engine performance over time.

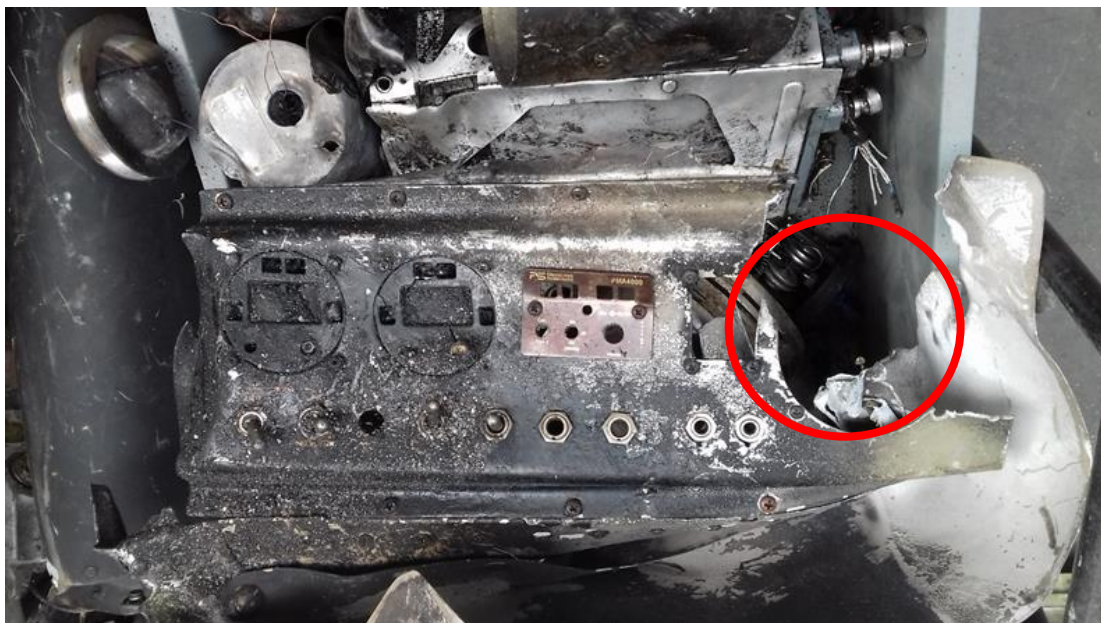


Fig. 20 – Control panel destroyed and missing *Engine Monitoring System*

### **1.13 Medical and pathological information**

The pilot's body could not be clearly identified at the site. The identity of the pilot was confirmed by autopsy and DNA analysis. The photographer was found at the air accident site and was taken to hospital. There were torn and charred remains of seat belts in the aircraft wreckage. The immediate cause of the pilot's death was polytrauma with devastating injuries to his head, torso and limbs. The injuries were fatal because of their general nature. The fire affected the pilot's body after his death. Before his death, the pilot did not breathe any fumes of imperfect combustion (e.g., from the penetration of exhaust gases into the cockpit of the aircraft in flight), as shown by the results of the toxicological examination. Mechanism of injury – the traumatic changes were caused by the effect of directly and indirectly applied violence, which acted with great force over a large area on the whole body. Typical injuries were found on the right upper limb, which correspond in their nature to the fact that the pilot was gripping a cylindrical object, e.g., the steering lever, at the time of impact with the ground. The left upper limb was also in front of the body. It cannot be ruled out that it could also have been on the steering lever or leaning on a fixed part of the cockpit, such as the instrument board. Neither the autopsy nor the supplementary CT scan revealed any traumatic changes in the pilot's body that could not be explained by the mechanism of the accident in question, such as gunshot wound, explosion of explosives on board, etc. The autopsy and subsequent histological examination of the pilot's tissue samples did not reveal any lesions that could have contributed to the accident or been necrosis-related. The pilot's weight, as determined at autopsy, was 60 kg, including clothing. According to the AAI Commission communication, the pilot was a holder of a valid class I and II medical fitness certificate dated 21 December 2020, with glasses restriction. The toxicological examination did not show that the pilot was under the influence of alcohol, addictive substances or drugs prohibited for aviation duty. The biochemical examination of tissue samples collected during pilot's autopsy has been performed to determine his somatopsychic condition. On the basis of the results of the examination, the results of the autopsy and additional laboratory tests, statistical evaluation of the parameters of the biochemical examination and analysis of the available data on the course of the flight, it can be stated that the pilot's energy metabolism was activated shortly before death, drawing on carbohydrate reserves, which indicates the development of negative psychological emotion (stress), at a time relatively short before death. The pilot was therefore conscious, when the emergency situation arose suddenly and after a while, the pilot died. It follows from the complex forensic medical analysis results that the air accident at issue was not caused by any health condition.

### **1.14 Fire**

The fire completely destroyed most of the wreckage of the aircraft. The accessibility of the air accident site allowed the firefighters to quickly extinguish the fire upon arrival and prevent it from spreading into the forest.

### **1.15 Search and rescue**

Air Traffic Control and direct witnesses of the air accident informed the FRS units and the Czech Police.

### **1.16 Tests and research**

NIL

## 1.17 Organisational and management information

The operator of the aircraft in question was asked to provide evidence of the existence of SMS documentation or any of the following:

- operating procedures / manuals for group flights,
- operating procedures / manuals for flights between home airport and airshow airports,
- operating procedures / manuals for flights with another person on board during the above flights (photographers, persons outside the company, etc.),
- SMS documentation – Hazard and Risk Register,
- existing records of incidents (potentially hazardous incidents) related to the performance of low altitude manoeuvres or aerobatic manoeuvres during flights to/from airshows, if any.

All of the above questions were answered negatively by the operator.

## 1.18 Supplementary information

### 1.18.1 Consultation with the NTSB

The Commission requested the cooperation of NTSB representatives in two specific areas of investigation. The first area concerned the piloting of the T-28B during a low-altitude barrel roll and the second area focused on the aircraft's landing gear system. The NTSB representative described the specifics and circumstances that were directly related to the safety of performing the aerobatic element. By describing the function of the landing gear system, he defined the time during the critical phase of flight when the system was activated and the landing gear deployed. His statement led to important conclusions for the investigation.

### 1.18.2 Statement of the NTSB representative on the T-28B barrel roll

*“The accident referenced here is, unfortunately, a type of accident that occurs all together too frequently. I keep track of fatal Warbird accidents every year and a large percentage of our accidents are low level aerobatics/aircraft maneuvering, followed by loss of control. These are almost always fatal accidents.*

*With respect to the specific accident in question here, it's hard to say exactly "what may be the minimum safe altitude to perform a barrel roll maneuver in the T-28." It depends on the number of factors, most importantly the skill and experience levels of the pilot. Fatigue, pilot distraction, dehydration, density altitude, and aircraft performance issues would also all play into deciding what is a safe altitude. What really matters is the altitude at the top of the maneuver and the energy available when the maneuver is initiated.*

*Maybe more important than the altitude though, is the impromptu nature of the event. The pilot apparently decided to perform a barrel roll while on a cross-country flight enroute home from an airshow. Professional pilots that regularly perform low level aerobatics do so as part of a very well rehearsed routine, that has been briefed, that has a predetermined precise sequence of maneuvers, and is done in waived airspace. Accidents that result from low level aerobatics/aircraft maneuvering and loss of control are most often the result of an impromptu decision.”*

The Commission requested the cooperation of NTSB representatives what the minimum altitude should be to start a barrel roll with this type of aircraft (T-28B) for the pilot to safely complete this element at an entry manoeuvre speed of 170–190 kt. The Navy T-28 B/C "NATOPS" manual describes and the Barrel Roll listed under "Allowable Maneuvers", but there was not minimum altitude specified.

1.18.3 Statement of the NTSB representative on the T-28B landing gear system  
*"The landing gear system consists of two parts – mechanical and hydraulic.*

*Raising the landing gear:*

*Mechanical: When the gear handle is selected UP after take-off, mechanical linkages to both main gear and the nose gear cause the down lock pin to retract. At the same time, mechanical linkages to the up-lock hook is armed to catch the up-lock roller on each of the gear legs. When the roller satisfactorily engages the up-lock hook, a microswitch sends a signal to each of the gear position indicators to indicate UP.*

*Hydraulic: When the landing gear is selected UP after take-off, a pushrod from the handle mechanism moves the selector valve to hydraulically retract the gear.*

*Note: After take-off, once all hydraulic components are in the inflight condition (Gear UP, Flaps UP, Speed brake IN, Hook UP and the canopy system not activated, then a signal is sent to the depressurization valve to cycle hydraulic fluid from the pump back to the reservoir, thus depressurizing the system.*

*During normal flight, the hydraulic system pressure should read 0-100 psi. The mechanical up locks hold the landing gear in the up position. A disruption of hydraulic pressure during initial impact of the trees would not cause the gear to extend as the system was already depressurized. For the gear to extend, the gear handle must be moved at least a certain amount out of the UP position, which would release the up locks."*

1.18.4 National legislation for T-28B operations regulated by Czech Republic  
Statement by the Civil Aviation Authority (CAA) on the applicability of legal regulations relating to the critical flight of the T-28B Trojan aircraft:

*"For the operation of aircraft falling within the scope of Annex I to Regulation (EU) 2018/1139, which are therefore excluded from the applicability of that Regulation and of the implementing acts adopted pursuant thereto, national legislation shall apply, including aviation regulations whose binding force within the legal order of the Czech Republic arises from the provisions of Section 102(2) of Act No. 49/1997 Coll., on Civil Aviation."*

## **1.19 Useful or effective investigation techniques**

NIL

## **2 Analyses**

In its analyses, the Commission used witnesses' statements and the NTSB consultant's report, photographs and video footage before the critical phase of flight, analysed facts from the wreckage examination, used ANS radar footage of the flight, weather analysis, and evaluated critical information about the T-28B.

## 2.1 Pilot

He was medically fit, held a pilot's license and had flown a total of 3,972 flight hours on 14 types of single-engine and 7 types of multi-engine aircraft. He had sufficient experience in aerobatics on the subject type T-28B on which he flew a total of 196 hours. During the preparation for the flight, he probably did not sufficiently instruct the photographer on the safe way of transporting an unauthorised item – large camera located on the floor of the aircraft cockpit, or tolerated such way of transport. According to available records, during an overflight in the group behind the B-25J, he performed manoeuvres in close proximity behind the lead aircraft with changes in altitude, speed and at high bank angles for the sake of taking video footage and photographs. By flying behind the lead aircraft, he risked flying into wake turbulence. At low altitude over unfamiliar terrain, he decided to perform a barrel roll, not taking into account the altitude of the flight above the terrain, the objects carried in the cockpit, and probably the weight of the aircraft loaded with fuel.

## 2.2 Photographer

The photographer aboard the T-28B was a professional photographer with a great deal of experience in the aviation environment. According to his own statement, he was experienced enough and he also had experience in piloting small sport aircraft.

The method of transporting the photographic equipment aboard the T-28B was standard for him and he did not consider it a safety hazard. According to his own words, the camera was not freely placed on the floor.

He was unable to comment on the barrel roll when asked by the inspectors and said he did not remember anything regarding the manoeuvre.

The memories, which included a fragment from the final phase of the flight, were published by the photographer in an interview for the Slovenian portal mariborinfo.com. This indicates that he remembered some of the sketchy details of the critical phase of the flight. In his recollection, he states that he heard the pilot scream, which means that the pilot was conscious and for some reason thrown out of concentration.

## 2.3 T-28B landing gear position during aerobatic manoeuvre

The nature of the damage to the landing gear locking mechanism on the landing gear legs and in landing gear shafts – intact condition of the left and right landing gear leg lock hooks, which were not bent or seriously damaged, and **wooden** chips in the left landing gear leg lock eye are indicative of extending of the landing gear prior to impact with the trees. The landing gear was in a nearly extended position when it hit the trees. **Traces of the first contact of the nose wheel tyre with the ground also testified to the extension of the landing gear** before hitting the trees.

In order for the landing gear to extend, the landing gear control lever **had to** be moved at least a bit from the extreme upper position to release the locks on the retracted position of the landing gear. Due to the time of 4–6 sec stated in the Flight Manual of the type needed for extension, it was necessary to move the landing gear lever from the upper position to the lower position probably after putting the aircraft to climb and start of the barrel roll spinning. The impact of both wing halves into trees and their separation from the fuselage caused the **break of the hydraulic system tubes and thus the break of the landing gear control**. It could not be satisfactorily determined from the known facts at which stage

of barrel roll spinning the extension of the landing gear occurred, it could be only defined in time.

## 2.4 Technical condition of the aircraft

According to video recordings and photographs, the aircraft was fully controllable shortly before the critical phase of the flight. The witness' testimony did not indicate any communication between the aircraft that was related to a technical malfunction of the aircraft. Due to the condition of the damage to the wreckage by fire and the destroyed aircraft powerplant operating parameter monitoring system, it was not otherwise possible to satisfactorily demonstrate changes in aircraft speed or clearly demonstrate short-term reduction in powerplant performance during the aerobatic manoeuvre. The aircraft's engine was running at low, probably idle speed before hitting the tree trunks, based on the nature of the damage to the propeller and the tracks on the slope. **Extension of landing gear was initiated by moving the landing gear control lever from the upper position during an aerobatic manoeuvre.**

## 2.5 Probable course of the barrel roll

Video footage and photographs from the B-25J recorded the T-28B flight at high bank angles with changes in altitude and pitch. The T-28B pilot was moving behind the lead aircraft in a manner that risked flying into wake turbulence. The group of both aircraft maintained approximately 1800 ft ALT REG QNH 1008 hPa, (150–180 m AGL) before approaching the village of Jickovice. During the group flight before the start of the barrel roll, the photographer in the T-28B cockpit was holding one of the cameras in his hands. The Commission obtained a video recording that was made before the critical phase of the flight and accidentally captured a camera placed along the cockpit, held by the right foot only and leaning against the cockpit wall. The photographic device weighing about 3 kg was lying on the cockpit floor and the photographer was holding it down with his foot only. The lead B-25J, according to the CPT's testimony, maintained a speed of about 170 KIAS. According to the witness, the T-28B aligned with the B-25J before starting the climb from the witness' left side at a higher speed than the B-25J and then started climbing. By starting a climb, the pilot initiated a barrel roll and immediately thereafter commenced a left turn. In the case of the T-28B, it is easier and faster to execute the barrel roll in the direction of the reaction moment from the propeller. It is not possible to determine at which stage of the barrel roll the landing gear control lever was moved from the upper position to the lower position. Due to the extension and failure to lock both main landing gear legs, the movement of the landing gear control lever occurred no earlier than 4 sec and no more than 6 sec before the aircraft impacted the forest belt. It is not known at what pace, i.e., at what speed of rotation the barrel roll was initiated. Nor can we rule out the pilot's possible intention to perform only part of the barrel roll and follow up with another aerobatic element.

The Commission was unable to determine whether the pilot decided to stop the aircraft in the inverted attitude and continue the climb in that position. A barrel roll in almost its entirety would allow the pilot to make visual contact with the B-25J. However, the time course of the barrel roll described by the witness from the lead B-25J is too long in the case of only one barrel roll. The approximate duration of a standard barrel roll by the T-28B at various flight altitudes was determined from available resources. In a similar case, the execution of the entire barrel roll with the climb phase would take less than 8 sec.

A properly executed barrel roll without stopping or interrupting the rate of spin with full aileron deflection and sufficient positive gravity load factor would allow an unsecured camera to be maintained on the cockpit floor even in the aircraft's inverted attitude. There is no testimony to confirm the interruption of the T-28B's spin in the inverted attitude or a noticeable slowing of the spin rate. Assessing the direction of the overload is virtually impossible from the perspective of a witness outside the aircraft. It can be confirmed with certainty that during the T-28B's barrel roll, the landing gear extension occurred with an associated undesirable increase in aerodynamic drag, the development of negative pitching moment (along the transverse axis, i.e., nose-heavy) and the change in the assumed roll trajectory. The likely reduced engine performance led to a significant loss of T-28B's power and a further increase in the pitching moment, which was added to the landing gear pitching moment. Loss of aircraft energy and an increase in the pitching moment in the second half of the barrel roll resulted in a significant nose drop accompanied by a loss of altitude at the end of the roll.

The photographer's testimony revealed that he had no idea that the pilot would suddenly decide to perform an aerobatic manoeuvre at an altitude of about 150–180 m AGL. The photographic device weighing about 3 kg was lying on the cockpit floor and the photographer was holding it down with his foot only. The loss of positive gravity load factors and the effect of negative ones, for example, in the aircraft's inverted attitude, thus clearly caused the heavy camera to move uncontrollably around the cockpit. As the T-28B's cockpit is not separated by any dividing partition, and the aircraft was slowing down, it is very likely that the camera could have been moving in the cockpit. It is uncertain whether the T-28B pilot was simultaneously aware of the risk associated with the T-28B's relatively heavy fuel load. He probably had no idea, or forgot, that the photographer had a heavy and bulky camera on the floor in the back of the cockpit.

From the results of the investigation of all known facts, it can be stated with high probability that it was, in general, an unprepared and improvised demonstration of an acrobatic element at low altitude over unknown terrain. The pilots confirmed from all available information and the essential facts affecting the execution of the barrel roll, that the natural reaction of a flight crew member to the movement of an unsecured object in the cockpit would be to try to catch it with his/her hands. Due to the disturbing sensations of moving objects around the cockpit and the effort to intercept them, controls such as the landing gear control lever, engine and aircraft controls might have been interfered with. In his memoirs, the photographer said he had heard the pilot scream, which means, among other things, that the pilot was conscious. But the pilot's scream at the same time meant that he had been thrown out of concentration by some circumstance. The loss of concentration affected his piloting performance of the aerobatic manoeuvre. The aircraft, in the descent phase of an uncontrolled barrel roll, crashed into the trunks of mature trees. The aircraft wreckage bounced off the rising profile of the terrain wave and landed in a field where it caught fire.

## 2.6 Operator

The operator of the aircraft is engaged in various types of aviation activities, mainly performances at air days with various types of historical aircraft. During the investigation of the operational aspects of the organisation with regard to the conduct of the critical flight, no documents were submitted to the Commission to demonstrate the proactive formal preparedness of the organisation. The organisation did not have any procedures in place for flights with other persons on board, their training, securing of cargo, etc. There was also no documentary evidence of a risk assessment of the organisation's aircraft operations.

## 2.7 Weather

It had no impact on occurrence of the air accident.

## 3 Conclusions

### 3.1 Pilot

- Was medically fit.
- Was the holder of a pilot licence and type rating.
- Had experience in aerobatics.
- Had sufficient flying experience on the type in question.
- During the preparation for the flight, he probably did not sufficiently instruct the photographer on the safe way of transporting the large camera in the aircraft cockpit, or tolerated such way of transport.
- During the overflight in the group behind the B-25J, he constantly performed manoeuvres in close proximity behind the lead aircraft with changes in altitude, speed and at high bank angles.
- Risked flying into wake turbulence behind the lead aircraft.
- Decided to perform a barrel roll at a low altitude over unknown terrain.
- Was knocked out of concentration while performing a barrel roll.
- Was unable to perform the aerobatic element after the landing gear extension was initiated.

### 3.2 Photographer

- Considered himself experienced with knowledge of aviation issues.
- Did not consider transporting a photographic device on the floor of aircraft in flight as a safety hazard, but as a perfectly normal and customary way.
- Stated that he had no recollection of the circumstances of the barrel roll.

### 3.3 Barrel roll.

- An Aerobatic manoeuvre was attempted in low level flight.
- The barrel roll very likely caused unwanted movement of an unauthorised item in the aircraft cockpit, which may have resulted in interference with controls and aircraft control.
- Landing gear extension reduced the airspeed of the aircraft and affected the changes in the barrel roll trajectory.

### 3.4 T-28B aircraft

- Was airworthy.
- Was fully controllable.
- There were unauthorised unsecured items in the aircraft cockpit.
- Extending the landing gear was preceded by moving the landing gear control lever from the upper position.

- The *Engine Monitoring System* of the aircraft was destroyed by fire so the flight data could not be analysed.

### 3.5 Operator

- Did not have any operational procedures in place regarding flying in a group and with passengers.
- Did not maintain any documentation that included a hazard and risk register relating to flights to/from airshows with passengers.

### 3.6 Weather

- It had no impact on occurrence of the air accident.

### 3.7 Cause

The cause of the T-28B's air accident during a flyover from the AirShow was the pilot's failure to perform an improvised barrel roll at low altitude over unknown terrain. The contributing factors that negatively affected the course of the air accident included landing gear extension during the aerobatic manoeuvre, loss of pilot's concentration during piloting, and the unsecured photographic equipment lying on the cockpit floor.

## 4 Safety Recommendations

The AAI recommends the National CAA Austro Control GmbH to focus its audit of the safety management system in The Flying Bulls GmbH on the development and implementation of operating guidelines and procedures to ensure safe operation for flights in formation and with other persons on board.

The AAI recommends The Flying Bulls GmbH to develop operating procedures for flights in formation and with passengers on board, and to establish a register of hazards and risks associated with specific air activity.

## 5 Appendices