MINISTRY OF TRANSPORT, CONSTRUCTION AND MARITIME ECONOMY
STATE COMMISSION ON AIRCRAFT ACCIDENT INVESTIGATION

Warsaw, 30 March, 2012

Reference number of air occurrence
1318/2011

FINAL REPORT

on investigation of an air occurrence to aircraft of a maximum take off weight equal to or below 2 250 kg *

This report is a document presenting the position of the State Commission on Aircraft Accident Investigation concerning circumstances of the air occurrence, its causes and safety recommendations. The report is the result of the investigation carried out in accordance with the applicable domestic and international legal provisions for prevention purposes only. The investigation was conducted without the need of application of the legal evidential procedure. In connection with the Article 134 of the "Aviation Law" Act (Journal of Laws 2006, No. 100, item. 696 with amendments), the wording used in this report may not be considered as an indication of the person guilty or responsible for the occurrence. The Commission does not apportion blame or liability. In connection with the above, any form of use of this report for any purpose other than air accidents and serious incidents prevention, can lead to wrong conclusions and interpretations. This report was drawn up in Polish. Other language versions may be drawn up for information purposes only.

1. **Type of occurrence:** ACCIDENT.
2. **Investigation conducted by:** SCAAI Investigating Team.
3. **Date and local time of the occurrence:** 14 October 2011, 15:05 hrs (LMT).
4. **Place of take off and planned landing:** Toruń aerodrome – EPTO.
5. **Place of the occurrence:** runway 29.
6. **Type, model, registration marks, owner of aircraft, user, description of damage:** SOCATA Rallye 235ED airplane; registration marks: SP-OAG; engine: Lycoming 0-540-B4B5 - maximum power 235HP (175 kW); aircraft serial number: 12906; manufactured in 1977. Fixed tricycle landing gear; Airworthiness Certificate DLG/10/006 valid until 17 March 2012. Owner and user - private. As a result of the accident the nose landing gear and both blades of the propeller were damaged and the engine was qualified for inspection „after propeller collision".
7. **Type of operation:** general flight (aerodrome traffic circuit training flight with instructor).
8. **Phase of flight:** landing roll.

9. **Flight conditions:** according to VFR, in VMC conditions.

10. **Weather factors:** no influence on the occurrence.

11. **Flight organizer:** Aeroklub Pomorski.

12. **Flight crew data.**

Instructor:

Pilot – aircraft commander, male, aged 70, holder of ATPL(A) licence issued by CAO on 3 July 2012, valid until 3 July 2014. Ratings entered into the licence:

- SEP(L) - valid until 23 May 2012;
- MEP(L) - valid until 31 May 2012;
- TR LetLk-410 - valid until 31 May 2012;
- FI - valid until 19 May 2013;
- IR - valid until 31 May 2012;
- IRI - valid until 23 May 2013;
- TRI LetL-410 - valid until 30 June 2014;
- AGRO - valid until 23 May 2012;
- FFF - valid until 30 April 2012;
- TRC500/550/560 - valid until 26 September 2011.

He was certified to maintain radiotelephony communication from the aircraft in Polish and English.

He held Class 1 Medical Certificate valid until 18 February 2012 and Class 2 Certificate valid until 18 August 2012. On the day of occurrence the pilot held valid OPC (Operator Proficiency Check) and ratings entered into his license with the validity dates as given above. The pilot passed Theoretical Knowledge Exam on 12 March 2011, valid until 12 March 2012.

Total flight time:	8642 hrs;
Flight time as an Instructor:	3587 hrs;
Flight time over the last 90 days:	7 hrs 58 min;
Flight time over the last 30 days:	7 hrs 58 min.

The pilot who was renewing his ratings:

Pilot, male, aged 53, holder of PPL(A) licence, issued by CAO on 10 June 2003, valid until 10 June 2014. Ratings entered into the licence:

- SEP(L) - valid until 14 May 2011.

He was certified to maintain radiotelephony communication from the aircraft in Polish. He held Class 2 Medical Certificate valid until 23 August 2012 with VNL limitation.

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* Form and scope of this report do not meet all the guidelines contained in Appendix "Form of the Final Report" of Annex 13 to the Convention on International Civil Aviation

The pilot passed Theoretical Knowledge Exam on 23 August 2011, valid until 22 August 2012. The pilot was renewing the ratings entered into his licence - SEP(L).

Total flight time:	71 hrs 37 min;
Flight time on type:	
Zlin Z- 42M	47 hrs 41 min;
Morane MS-892A	3 hrs 51 min;
Morane MS-893E	2 hrs 6 min;
Koliber PZL-110	10 hrs 51 min;
SOCATA Rallye 235	7 hrs 8 min;
Flight time over the last 90 days:	7 hrs 8 min;
Flight time over the last 30 days:	7 hrs 8 min.

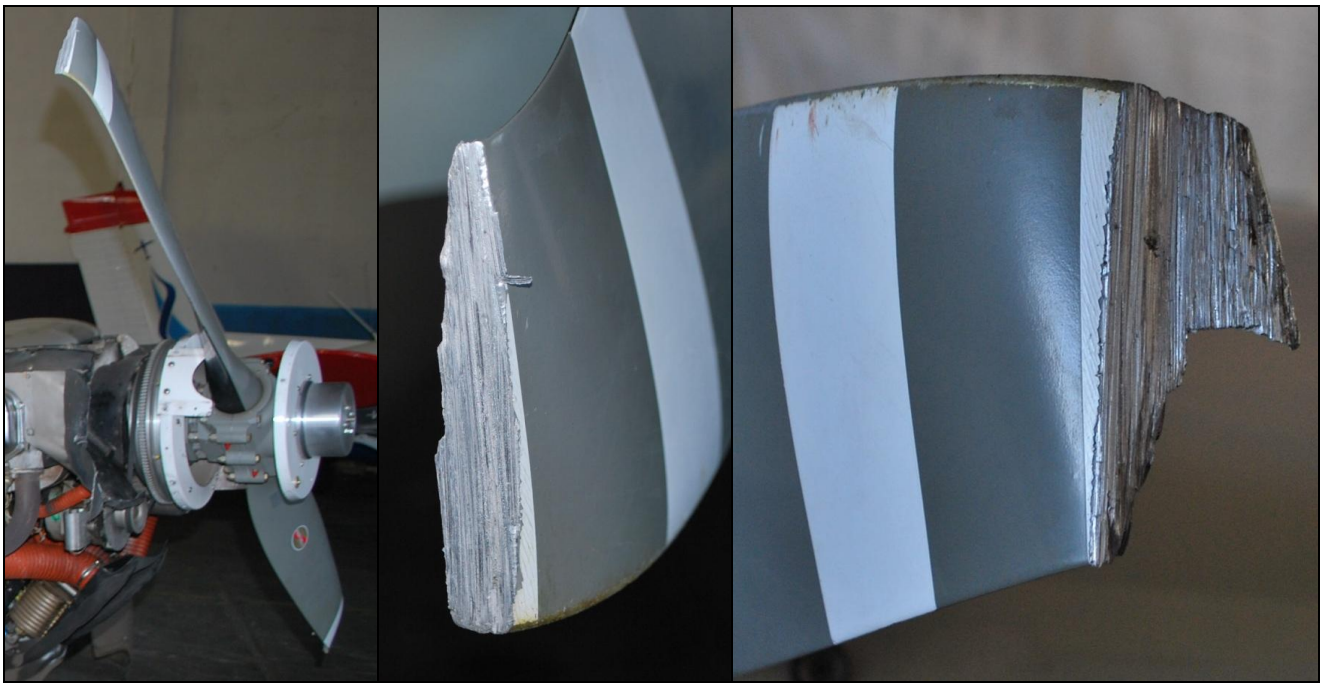
13. **Injuries to the crew and passengers:** no injuries.

14. **Course and circumstances of the occurrence.**

On 14 October 2011 at 14:59 (LMT) a SOCATA Rallye 235 airplane took off and performed a flight in accordance with Task II exercise 2 (aerodrome traffic circuit training flight for reneval of SEP(L) ratings. After touchdown, in the final part of the landing roll the instructor pilot ordered a student to deviate slightly from the central axis of the runway (approximately 30° to the right) and perform U-turn (back-track). After this maneuver (at a very low speed) the pilots felt very strong vibration, and the instructor noticed the nose landing gear wheel rolling on the right side of the aircraft.

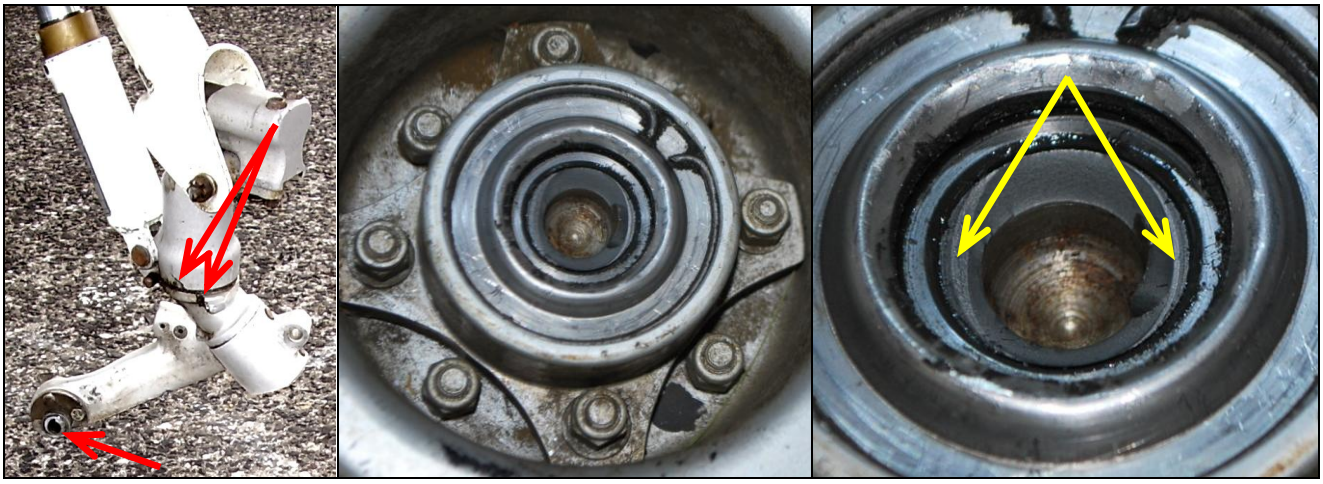
1, 2 – Landing track on a concrete and the airplane after coming to rest - attention is drawn to the lack of the nose landing gear wheel and damaged propeller. Photo T. Dunajski.

The landing roll was completed on the leg of the nose landing gear within the runway limits with the loss of direction by about 30°. When the airplane came to rest the pilot shutdown the engine. The nose landing gear wheel separated as a result of breaking of its axle. This caused further damage to the leg of the nose landing gear and the propeller blades.



3, 4, 5 – Damages to the propeller blades . Photo SCAAI.

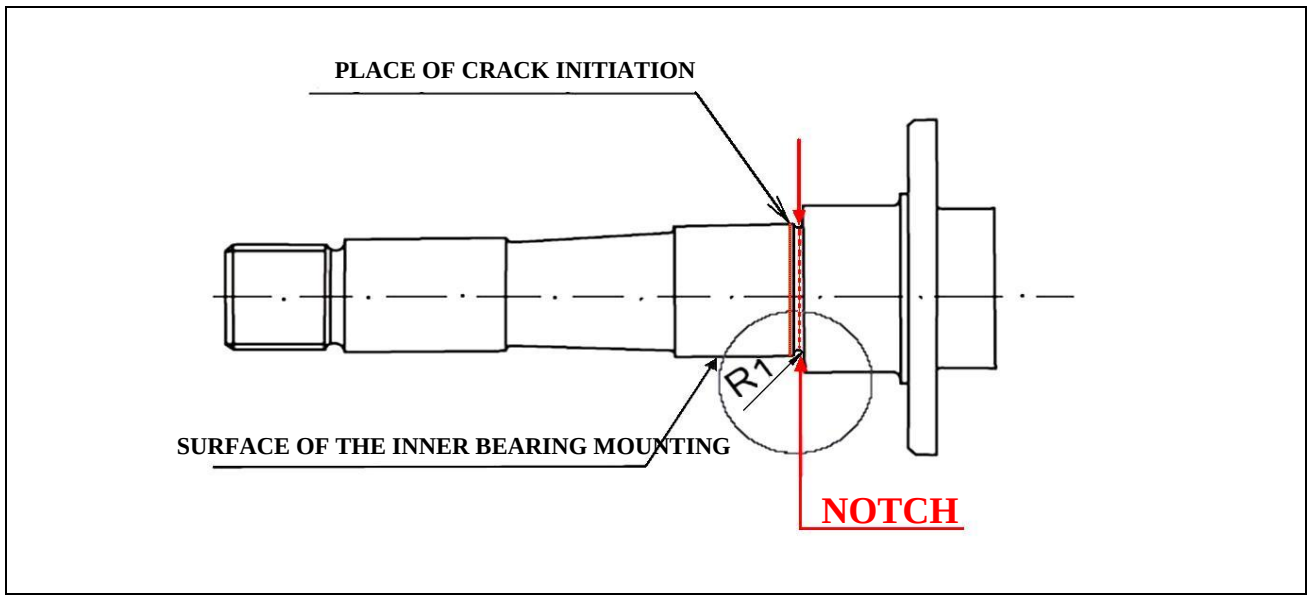
The fracture of the nose wheel axle showed a typical fatigue nature. Comparison of the geometry and dimensions of the damaged axle with the dimensions shown in the engineering drawing of the manufacturer led to the conclusion that the radius of the curvature (of R1 dimension) between the inner bearing track (Ø20g6) and cylindrical surface ($Ø26^{-0,1}/Ø27^{-0,2}$) extending to the flange, which is fixed by four pins to the nose landing gear fork, was practically eliminated, which created a notch.



6, 7, 8 – Nose landing gear fork with marked damages (red arrows) and wheel hub with the broken axle inside (yellow arrows indicate the areas of fatigue crack initiation). Photo SCAAI.

The elimination of the curvature radius was a result of systematic "tightening" of the main nut on the wheel axle in order to eliminate the bearing clearance (according to the aircraft Maintenance Manual). After a sufficiently large number of cycles of such "tightening" one of the elements of the inner bearing housing (i.e. closer to the axle flange) came into contact with

the axle surface exactly in the location of R1 curvature. The resulting friction between the two elements caused gradual destruction of such a transition curvature and formation of a notch.



9 - Sketch of the axle of the nose landing gear with the crack place and its geometrical features.

The Commission has already been familiar with similar occurrences: one concerned PZL-110 Koliber airplane, registration marks SP-ARM (also in Toruń - see Final Report No 372/06) and two others demonstrated by Air Service company at Modlin airport (in both cases similar destruction of the transition curvatures were found on the axles of the nose wheels, removed from airplanes in order to replace - one from PZL-110 Koliber and the other from Rally).
A notch formed in a critical place, combined with the phenomena caused by the friction heat, led to the local accelerated material fatigue.

Commission findings:

- the axle of the nose landing gear wheel was broken near to its flange which is fixed to the fork of the landing gear.
- the fracture was of the fatigue nature.
- the surface of the fracture has a shape resembling a cone with the top angle of about 45^{o}.
- the radius of curvature (of R1 dimension) between the inner bearing track (Ø20g6) and cylindrical surface ($Ø26^{-0,1}/Ø27^{-0,2}$) extending to the flange, which is fixed by four pins to the nose landing gear fork, was practically eliminated, which created a notch initiating fatigue phenomena in the material. In these circumstances, cumulation of bending and tensile stresses combined with increased temperature, created favorable conditions for the fatigue crack formation and growth.
- elimination of the curvature radius is a result of systematic "tightenings" of the main nut on the wheel axle in order to eliminate the bearing clearance (according to the aircraft Maintenance Manual).
- after a sufficiently large number of cycles of such "tightening" one of the elements of the inner bearing housing (i.e. closer to the axle flange) came into contact with the axle surface

exactly in the location of R1 curvature. The resulting friction between the two elements caused gradual destruction of such a transition curvature and formation of a notch.

15. Cause of the occurrence:

Fatigue crack of the axle of the nose landing gear wheel, caused by its local mechanical wear resulting from the design and maintenance features.

16. Contributing factors: None.

17. Proposed systemic changes and/or other remarks and comments:

President of the Civil Aviation Office *:

in consultation/cooperation with the aircraft manufacturer or by itself: consider introduction of an airworthiness directive for users of Morane-Saulnier/SOCATA Rallye aircraft (and, if necessary, PZL-110 Koliber and other aircraft with identical technical design) specifying with the safe margin:

- service life of the axle of the nose landing gear wheel (expressed as number of landings - cycles) including the permissible number of "tightenings" of the main nut on the wheel axle in order to eliminate the bearing clearance
  or
- the number of landings (cycles), beyond which intervals between technical inspections of the axle of the nose landing gear wheel should be shortened and setting the new intervals, with particular attention to be paid to the dimension of clearance between the flange and the inner bearing.

*Note: *In accordance with Article 18 par. 1 of the Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC the addressee of a safety recommendation shall acknowledge receipt of the transmittal letter and inform the State Commission on Aircraft Accident Investigation within 90 days of the receipt of that letter, of the actions taken or under consideration, and where appropriate, of the time necessary for their completion and where no action is taken, the reasons therefor.*

Composition and signatures of the Investigating Team:

Investigator-in-Charge: MSc (Eng.) pilot Waldemar Targalski

Member: MSc (Eng.) Piotr Lipiec

Member: Eng. Tomasz Makowski