



Air Accident Investigation Unit Ireland

SYNOPTIC REPORT

INCIDENT

Roko Aero NG4 UL, OK-TUR 22
Near Wicklow town, Ireland
30 December 2014



An Roinn Iompair
Turasóireachta agus Spóirt

Department of Transport,
Tourism and Sport

FINAL REPORT

Foreword

This safety investigation is exclusively of a technical nature and the Final Report reflects the determination of the AAIU regarding the circumstances of this occurrence and its probable causes.

In accordance with the provisions of Annex 13¹ to the Convention on International Civil Aviation, Regulation (EU) No 996/2010² of the European Parliament and the Council, and Statutory Instrument No. 460 of 2009³, safety investigations are in no case concerned with apportioning blame or liability. They are independent of, separate from and without prejudice to any judicial or administrative proceedings to apportion blame or liability. The sole objective of this safety investigation and Final Report is the prevention of accidents and incidents.

Accordingly, it is inappropriate that AAIU Reports should be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

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¹ **ICAO Annex 13:** International Civil Aviation Organization, Annex 13 to the Convention on International Civil Aviation, Air Accident and Incident Investigation.

² **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.

³ **Statutory Instrument (SI) No. 460 of 2009:** Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009.



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In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No 996/2010 and the provisions of SI 460 of 2009, the Chief Inspector of Air Accidents, on 30 December 2014, appointed Mr John Owens as the Investigator-in-Charge to carry out an Investigation into this Incident and prepare a Report.

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|---|--|
| Aircraft Type and Registration: | Roko Aero NG 4 UL, OK-TUR 22 |
| No. and Type of Engines: | 1 x Jabiru 2200A |
| Aircraft Serial Number: | 019/2009 |
| Year of Manufacture: | 2010 |
| Date and Time (UTC⁴): | 30 December 2014 @ 12.45 hrs |
| Location: | Near Wicklow town, Co. Wicklow, Ireland |
| Type of Operation: | Private |
| Persons on Board: | Pilots - 2 Passengers - 0 |
| Injuries: | Pilots - 0 Passengers - 0 |
| Nature of Damage: | None |
| Commander's Licence: | Private Pilot Licence (PPL) Aeroplanes (A) issued by the Irish Aviation Authority (IAA) |
| Commander's Details: | Male, aged 51 years |
| Commander's Flying Experience: | 2,450 hours of which 630 were on type |
| Notification Source: | Dublin Air Traffic Control (ATC) |
| Information Source: | AAIU Report Forms submitted by both Pilots AAIU Field Investigation |

⁴ **UTC:** Co-ordinated Universal Time. All times in this report are UTC (the same as local time on the date of the occurrence).

SYNOPSIS

The microlight aircraft departed Newcastle Airfield (EINC), County Wicklow, with two pilots on board. The intention was to perform a short flight before returning to EINC. Approximately 20 minutes into the flight, a small amount of blue smoke was noticed in the cockpit, followed by a loss of engine oil pressure. The decision was made to carry out a forced landing and a suitable field was selected. To prevent engine damage, the Pilot shut down the engine during the approach to the chosen field. The aircraft landed and came to rest without further incident. There were no injuries and the aircraft was undamaged. Subsequent examination revealed that a hose supplying engine oil to the engine oil cooler had disconnected in flight, resulting in the loss of all engine oil.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft departed from Runway (RWY) 18 at EINC at approximately 12.30 hrs on a private flight. There were two pilots on board, referred to in this report as Pilot A (the Commander) and Pilot B.

Pilot A reported that the engine oil level was checked during the pre-flight inspection and was found to be normal. Pilot B performed the take-off and the aircraft climbed in a southerly direction to an altitude of approximately 1,500 feet (ft), before it was turned onto a westerly heading. As there was some turbulence and as the aircraft was clear of controlled airspace, Pilot B climbed the aircraft to approximately 3,000 ft. The flight then headed south for a time before it was decided to return to EINC. At this point, Pilot A noticed a *“little puff of blue smoke”* in the cockpit (the aircraft cockpit heating was reported to be ON at the time). He said that he checked the engine oil pressure, which he noticed to be dropping *“fairly rapidly”*. This was followed by the illumination of the engine low oil pressure warning light. He said that he had checked the oil pressure earlier in the flight and it was reading normally, at 3.5 to 4 bar⁵ (350 to 400 kPa⁶). As he was more experienced, Pilot A took control of the aircraft and contacted EINC by radio, advising that he had an oil pressure problem and was going to land *“off field”*.

Pilot A reported that he reduced the engine power to idle and selected a suitable field in which to land. He said that at an altitude of approximately 300 ft, when he judged that he would be able to land safely in the chosen field, he shut down the engine to prevent it from damage, but considered that he could start it again if required. He reported that he touched down at 60-65 kts and switched off the fuel and the magnetos. He said when the aircraft came to a stop, he switched off the electrics and both he and Pilot B promptly exited the aircraft. There were no injuries and the aircraft was undamaged.

⁵ Bar: A unit of pressure.

⁶ kPa: Kilopascals, units of pressure. One kPa is equal to 1,000 Pa or 0.01 bar.



1.2 Landing site

The aircraft landed on a southerly heading in a large field to the south of Wicklow town. The surface of the field was covered in short grass and sloped gently away from the direction of landing. It was smooth, firm and obstruction-free (**Photo No. 1**).



Photo No. 1: Aircraft at site of forced landing.

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1.3 Aircraft Examination

When the aircraft was examined by the Investigation following the event, evidence of engine oil was apparent on the nose landing gear. The engine cowlings were removed and the source of the oil leak was traced to a flexible hose which had disconnected from a fitting installed in the engine oil filter adapter (**Photo No. 2**). The dipstick was examined and it indicated that the engine oil sump was empty.

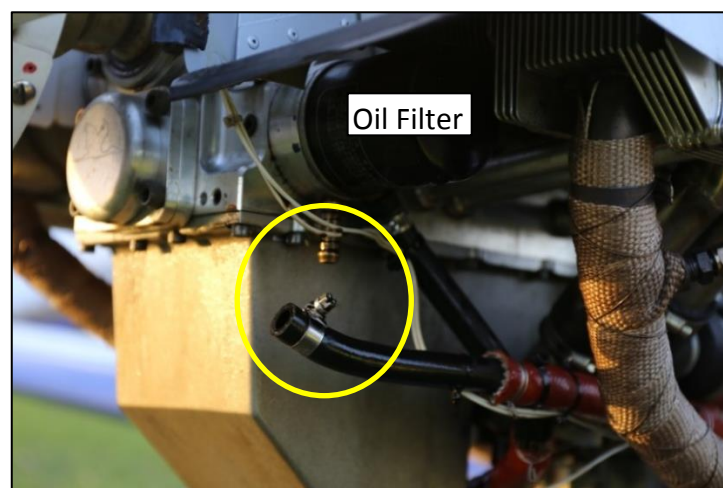


Photo No. 2: Supply hose to oil cooler found disconnected at engine oil filter adapter (circled).

Two flexible hoses, a supply and a return, route engine oil between the engine and an external oil cooler. The hoses are connected to the engine oil system through fittings installed in the oil filter adapter and are normally secured to the fittings by means of worm drive hose clamps/clips⁷. The disconnected hose was the hose that supplies oil to the cooler. The other end of the hose, where it was connected to the oil cooler, was noted to be not fully 'home' on its fitting (**Photo No. 3**).

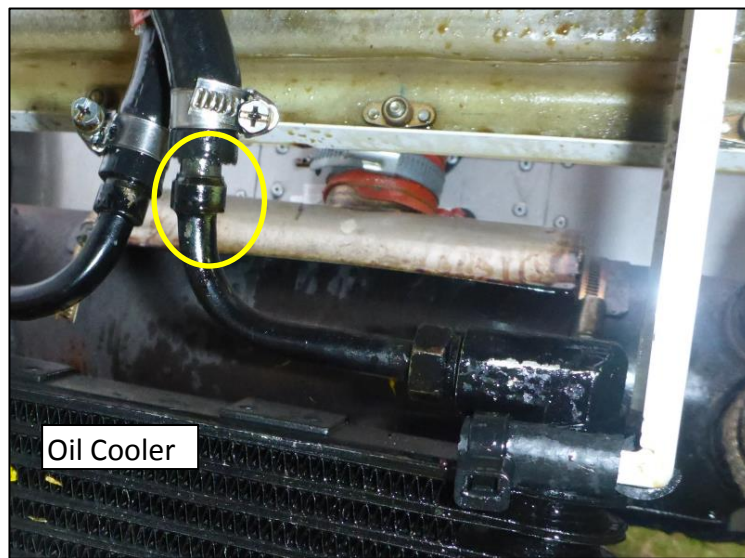


Photo No. 3: Supply hose to oil cooler not fully 'home' on its fitting (circled).

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1.4 Personnel Information

Pilot A held a PPL (A), issued by the IAA. He had a total of 2,450 hours experience with 630 hours on the type. Pilot B held a PPL (A) with a microlight rating with a total flying experience of 260 hours.

1.5 Aircraft Information

1.5.1 General

The aircraft, a Roko Aero⁸ NG4 UL, is a two-seat (side by side), low wing, aluminium alloy monoplane fitted with a fixed tricycle undercarriage. It is powered by a Jabiru 2200A engine. The aircraft was manufactured in the Czech Republic in 2010. The total aircraft operating hours at the time of the occurrence were 293.

To permit the Czech-registered aircraft to operate in Ireland without a Certificate of Airworthiness, the Irish Aviation Authority (IAA) issued a '*Permission*' document, which was valid until 15 November 2015. It was stated on this document that it was "*valid only when attached to the Technical Certificate*" for the aircraft, which was issued by the Light Aircraft Association of the Czech Republic on 26 November 2014.

⁷ **Worm drive hose clamps/clips:** Commonly known as '*Jubilee® Clips*', although not all such clamps are manufactured by '*Jubilee*'.

⁸ **Roko Aero:** Customer support is now provided by BRM Aero.



1.5.2 Maintenance History

To facilitate the validation of the *'Technical Certificate'*, a technical inspection was performed on the aircraft at EINC on 15 November 2014 by an Inspector approved by the Light Aircraft Association of the Czech Republic. The associated inspection report indicated that the fuel hoses were replaced. There is no indication that the oil hoses were replaced during this inspection, however, it was indicated on the report that a general inspection of the engine was carried out at this time.

Pilot A reported that he inspected the aircraft prior to the occurrence flight and that no oil leaks were noticed. The aircraft was previously flown on 22 December 2014 and this flight was also operated by Pilot A. He stated that prior to that flight, the engine cowlings were removed to inspect the engine and no anomalies were noticed.

1.6 Engine Oil Cooler and Associated Hoses

The Engine Manufacturer's *'Instruction & Maintenance Manual'* for the engine (dated 24 January 2003) states that the maximum engine oil pressure is 525 kPa (76 psi⁹) and that the maximum oil temperature is 118° Centigrade (C).

Section 13.4 of the Engine Manufacturer's *'Installation Manual'* (dated August 2009) contains an engineering drawing depicting *"an oil cooler installation of a Jabiru 2200"* in which the hoses are identified as *"oil hose"*, with a part number of *"PH0898N"*. The clamps are identified as *"hose clamp[s]"* with a part number of *"PH0616N"*. The Engine Manufacturer informed the Investigation that the use of these part numbers is a *"recommendation only"*. The *'Installation Manual'* also states that *"hoses should be nominally 10 mm (3/8") bore"* and that *"hoses must be changed every 2 years or if visible degradation (cracking, hardening) is visible at inspection"*.

Section 6.1 of the Engine Manufacturer's *'Instruction & Maintenance Manual'* contains instructions on how the engine oil should be changed during scheduled maintenance. The following warning is included: *"DO NOT drain the oil cooler during a normal oil change. The cooler holds only a small amount of old oil which has negligible effect on the new oil. Taking the hoses on & off the cooler can prematurely age the oil lines and lead to hoses slipping off the cooler"*.

The Aircraft Manufacturer informed the Investigation that the oil cooler was fitted to the aircraft during manufacture and that the hoses used had an internal diameter of 10 mm, a maximum operating pressure of 12 bar and a temperature range of -40°C to 100°C.

Examination of the hoses by the Investigation revealed evidence of identification/specification markings; however, they were so faded that they were illegible. No maintenance records were made available to the Investigation by the Owner other than the inspection report associated with the *'Technical Certificate'* (**Section 1.5.2**) and it was not possible to establish if the oil hoses were replaced since aircraft manufacture.

⁹ psi: Pounds per square inch – Imperial units of pressure.

The Aircraft Manufacturer advised that they had received no previous reports of oil cooler hoses disconnecting during engine operation, whereas the Engine Manufacturer stated that they were aware of one previous event of this nature, which was suspected to be caused by installation error. Information obtained by the Investigation suggests that there were previous instances of oil cooler hoses that were secured with worm-drive hose clamps/clips disconnecting during engine operation. It was highlighted that in some cases, this can be caused by poor clamp pressure or if the hose is installed when the inside of the hose or the outside of the fitting is wet with oil. Also, in 2004, another aircraft manufacturer issued a Service Bulletin (SB) relating to oil hose security in relation to a different engine type. This SB advised owners to secure the oil cooler hose clamps to the oil cooler hose fitting with lock wire to prevent inadvertent detachment of the hose.

The aircraft Owner informed the Investigation that the oil cooler hoses and fittings have since been replaced with a 'screw-on' type (**Photo No. 4**). The Engine Manufacturer advised the Investigation that the use of hoses with 'screw-on' fittings was considered, but that there were *"no problems with the current system"* and that there *"is less cost involved when the hoses need to be changed"*.



Photo No. 4: New hoses with screw-on fittings.

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1.7 Tests and Research

To establish the cause of the disconnection, the Investigation first attempted to reinstall the detached hose without first loosening its clamp/clip. This was not possible. The clamp was then loosened, the hose refitted and the clamp tightened. It was found that the hose could be rotated with the clamp tightened, albeit with some effort, but it was not possible to remove the hose by pulling on it.

When the securing clamp on the other end of the detached hose and the clamps securing the other hose were loosened, the hoses were found to be difficult to remove from the fittings on the oil filter adapter and the oil cooler, i.e. not loose. Both hoses were removed from the aircraft and measured. The hose that had disconnected was found to be 86 centimetres (cm) in length. Its internal diameter was approximately 9.6 millimetres (mm).



The outside diameter was found to be approximately 15.3 mm when disconnected from its fitting and 16.2 mm when reconnected. The dimensions of the other hose were the same, except for the length, which was measured as 84 cm. The length of both hoses appeared to be sufficient. Each of the four hose clamps was found to be stamped with '16-27', indicating the hose diameter (in mm) for which it is suitable.

The fittings were removed from the oil filter adapter and the hose that had detached was reinstalled on its fitting. The hose clamp was tightened and the clamp, in its tightened state, was examined. It was noted that a large portion of the threaded band of the clamp was protruding at the screw head end (**Photo No. 5**), and that the clamp had almost reached its minimum diameter (**Photo No. 6**).



Photo No. 5: Hose clamp/clip in its tightened state, with large portion of threaded band protruding at screw head.



Photo No. 6: Other side of hose clamp/clip showing it to be almost at its minimum diameter.

To check the effects of oil being present on the exterior of the fitting/hose interior, the Investigation installed the hose, in both dry and wet states, onto one of the fittings that was removed from the oil filter housing. It was found that with the hose clamp tightened, the hose could be rotated, albeit with some effort, when it was fitted in the 'wet state', but it was not possible to remove it without first loosening the clamp. When the clamp was loosened, it was much easier to remove the hose that had been fitted in the wet state.

When the fitting and hose were dried and the hose was refitted and the clamp tightened, it was found that it was not possible to rotate the hose relative to the fitting, although the clamp could be rotated about the hose with some effort.

To check the effects of clamp size, the Investigation fitted a hose clamp with a lower range of diameters to establish if such a clamp could be tightened sufficiently to prevent the hose from being able to rotate. When the smaller clamp was fitted and tightened, it was still possible to rotate the hose with some effort, when the hose was fitted in the wet state.

The tests were repeated with a new hose having the manufacturer's recommended internal diameter of 10 mm and the results were the same, in that when the hose was installed in the wet state, it was possible to rotate it regardless of whether the original clamp or one with a smaller diameter was used.

2. ANALYSIS

If a hose carrying high pressure oil disconnects in flight, as in this case, all engine oil is quickly lost. If the engine is not immediately shut down, engine damage and/or failure are likely. When engine power is lost in flight, a suitable landing site must be quickly selected and a forced landing performed. In this case, the forced landing was successful in that there were no injuries and the aircraft was undamaged. However, forced landings are not always successful, particularly if power is lost shortly after take-off, when altitude is low and choices of a suitable landing site are limited. Such cases can result in aircraft damage, injuries or even fatalities.

The Aircraft Manufacturer advised the Investigation that the oil cooler was installed during manufacture and that the hoses and clamps used at the time were in accordance with the Engine Manufacturer's engineering drawing. The Engine Manufacturer's *'Installation Manual'* states that the "hoses should be nominally 10 mm (3/8") bore" and that "hoses must be changed every 2 years or if visible degradation (cracking, hardening) is visible at inspection". No maintenance records were provided to indicate if the hoses were replaced since initial installation. However, the hoses found fitted were measured and found to have an internal diameter of approximately 9.6 mm which equates to 3/8 of an inch (9.525 mm) and were therefore in accordance with the Manufacturer's recommendations in this regard. The identification markings on the hoses were badly faded, which suggests that the hoses had not been replaced.

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The Engine Manufacturer's *'Instruction & Maintenance Manual'* warns against disconnecting the hoses at the oil cooler during oil changes as this can lead to premature ageing of the hose and cause it to slip off the cooler. It was noted by the Investigation that the end of the disconnected hose, where it connects to the oil cooler, was not fully in position on the oil cooler fitting. This may have been due to the hose not being pushed fully 'home' during installation or as a result of hose deterioration caused by disconnecting and reconnecting the hose during oil changes, as warned against by the Engine Manufacturer. When the hose clamp was removed at the oil cooler, it was difficult to remove the hose, indicating that the hose was not loose and was therefore most likely not pushed fully 'home' during installation.

The Investigation could not refit the hose that had detached from the fitting in the oil filter housing without first loosening the clamp. When the hose was refitted and the clamp tightened, the clamp was found to be almost at the limit of its travel. It was possible to rotate the hose with some effort but it was not possible to remove it without first loosening the clamp. These observations indicate that the clamp was performing a clamping function. However, the Investigation considers that the use of a clamp rated from 16-27 mm on a hose with an external diameter of 16.2 mm is less than ideal and may result in ineffective clamp pressure.

Information obtained by the Investigation suggests that installing an oil-moistened hose can lead to subsequent detachment. Furthermore, it was identified during testing conducted by the Investigation that the presence of oil on the exterior of the hose fitting/interior of the hose in the vicinity of the fitting had a significant adverse effect on the security of the hose.



This was the case regardless of whether a new hose or a smaller diameter clamp was fitted. Although this effect was most noticeable when attempting to remove a hose with the clamp loosened, it is possible that when the engine is operating and the hose is subjected to vibration and hot oil under pressure, the effect of wet assembly may be exacerbated. The potential for hose detachment due to premature ageing as a result of disconnecting and reconnecting the hose during oil changes is highlighted in the Engine Manufacturer's *'Instruction & Maintenance Manual'*. However, there is no warning included in relation to wet assembly. The following Safety Recommendation is therefore issued to the Engine Manufacturer:

Safety Recommendation No. 1

Jabiru Aircraft Pty Ltd should include a warning in the Instruction and Maintenance Manuals for the Jabiru 2200 engine and similar Jabiru engine types, highlighting that if oil cooler hoses are installed with oil on the hose fittings or, with oil on the inside of the hose in the vicinity of the fittings, hose security may be adversely affected. (IRLD2015008).

The cause of the hose detachment in this particular case could not be positively established. The hoses were considered by the Investigation to be of sufficient length and therefore this was not a factor. The detachment may have been caused by ineffective clamp pressure, assembly when wet, age-related deterioration or a combination of these factors. Nevertheless, the event highlights the importance of following the Engine Manufacturer's guidelines in relation to the use of the correct parts, the replacement of hoses every two years and not disconnecting the hoses when changing the engine oil. To highlight this event to users of Jabiru engines, the following Safety Recommendation is issued to the Engine Manufacturer:

Safety Recommendation No. 2

Jabiru Aircraft Pty Ltd should, with the aid of a suitable publication, promulgate de-identified details of the subject event to users of its engines (IRLD2015009).

It should be noted that the Investigation was informed that following the event, the aircraft Owner replaced the hoses on OK-TUR-22 with a screw-on type, which the Investigation considers to be a more secure arrangement for pressurised hoses.

3. CONCLUSIONS

(a) Findings

1. The aircraft was operating in Ireland on a valid 'Permission' document issued by the IAA.
2. The engine suffered a loss of engine oil pressure, necessitating a forced landing.
3. The loss of engine oil pressure was caused by the detachment of a hose supplying oil to the engine oil cooler from a fitting located in the oil filter housing, which resulted in the loss of all engine oil.
4. The hose between the engine and oil cooler had been secured with worm-drive hose clamps.
5. A Technical Inspection was performed on the aircraft on 15 November 2014 by an Inspector approved by the Light Aircraft Association of the Czech Republic.
6. The Engine Manufacturer recommends that the oil cooler hoses should be replaced every two years. It was not possible to establish if the hoses were replaced since initial installation.

(b) Probable Cause

Loss of engine oil in flight, due to the detachment of a hose supplying oil to the engine oil cooler.

4. SAFETY RECOMMENDATIONS

| No. | It is Recommended that: | Recommendation Ref. |
|-----|--|-----------------------------|
| 1. | Jabiru Aircraft Pty Ltd should include a warning in the Instruction and Maintenance Manuals for the Jabiru 2200 engine and similar Jabiru engine types, highlighting that if oil cooler hoses are installed with oil on the hose fittings or, with oil on the inside of the hose in the vicinity of the fittings, hose security may be adversely affected. | IRLD2015008 |
| 2. | Jabiru Aircraft Pty Ltd should, with the aid of a suitable publication, promulgate de-identified details of the subject event to users of its engines. | IRLD2015009 |

[View Safety Recommendations](#) for Report 2015-013

- END -

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No 996/2010, and Statutory Instrument No. 460 of 2009, Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulation, 2009, the sole purpose of this investigation is to prevent aviation accidents and serious incidents. It is not the purpose of any such investigation and the associated investigation report to apportion blame or liability.

A safety recommendation shall in no case create a presumption of blame or liability for an occurrence.

Produced by the Air Accident Investigation Unit

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