



Air Accident Investigation Unit Ireland

SYNOPTIC REPORT

SERIOUS INCIDENT

**Bolkow Bo-209 Monsun, D-EFJG
Navan Airfield, Co. Meath**

14 May 2019



**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 and contributory causes.

In accordance with the provisions of Annex 13¹ to the Convention on International Civil Aviation, Regulation (EU) No 996/2010² 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 **Annex 13:** International Civil Aviation Organization (ICAO), Annex 13, Aircraft 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 No. 460 of 2009, the Chief Inspector of Air Accidents, on 14 May 2019, appointed Mr John Owens as the Investigator-in-Charge, to carry out an Investigation into this Serious Incident and prepare a Report.

Aircraft Type and Registration:	Bolkow Bo-209 Monsun 160RV, D-EFJG	
No. and Type of Engines:	1 x Lycoming IO-320-D1B	
Aircraft Serial Number:	129	
Year of Manufacture:	1971	
Date and Time (UTC)⁴:	14 May 2019 @ 12.55 hrs	
Location:	Navan Airfield (EIHH), Co. Meath, Ireland	
Type of Operation:	General Aviation	
Persons on Board:	Crew – 1	Passengers – 1
Injuries:	Crew – Nil	Passengers – Nil
Nature of Damage:	Substantial (Impact damage to propeller blades and engine cowlings, engine shock-loaded)	
Commander's Licence:	Commercial Pilot Licence (CPL) Aeroplane (A) issued by <i>Luftfahrt-Bundesamt</i> (LBA – German Civil Aviation Authority)	
Commander's Age:	55 years	
Commander's Flying Experience:	2,000 hours, of which approximately 0.5 hours were on type	
Notification Source:	Airfield Owner	
Information Source:	AAIU Field Investigation	

⁴ **UTC:** Co-ordinated Universal Time. All timings in this report are quoted in UTC; local time on the date of the accident was UTC +1 hour.

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SYNOPSIS

The Bolkow Bo-209 Monsun aircraft, which was fitted with a retractable nose landing gear, took-off from Runway 09 at Navan Airfield (EIHH) with two occupants on board. The nose landing gear was retracted after take-off, as normal. Following one circuit of the airfield, a landing on the same runway was carried out. During the landing roll, the propeller and the lower engine cowling made contact with the surface of the grass runway, as the nose landing gear had not been extended prior to landing. The aircraft's propeller and engine cowlings sustained damage. The two occupants were uninjured and exited the aircraft unaided. There was no fire.

NOTIFICATION

The airfield owner informed the AAIU of the event shortly after it occurred. Two Inspectors of Air Accidents immediately deployed to the scene to commence an Investigation.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft's occupants, both of whom were pilots, were members of a group that had recently purchased the aircraft. They arrived into Ireland from Germany on the morning of the occurrence and intended to perform what was described as '*a short check flight*', comprising one circuit at Navan Airfield (EIHH), before flying back to Germany in the aircraft. The pilots had received familiarisation training in the aircraft a number of weeks previously at EIHH.

After take-off from Runway (RWY) 09 at EIHH, the Pilot (in command), who was seated in the left-hand seat, selected the nose landing gear to the up position and the aircraft's retractable nose landing gear retracted as commanded. Following the completion of one circuit of the airfield, the Pilot extended the aircraft's trailing edge flaps in preparation for landing back on RWY 09. During the landing roll, the propeller and the lower engine cowling came into contact with the runway surface, as the nose landing gear had not been extended prior to landing. The aircraft came to rest on the runway (**Photo No. 1**). The two occupants were uninjured and exited the aircraft unaided. There was no fire.



Photo No. 1: Final resting position of aircraft



1.2 Interviews

The Pilot and passenger (who was also a pilot) were interviewed by the Investigation. Regarding experience on the aircraft type, the Pilot stated that on 11 April 2019, each of them had flown *‘three or four traffic patterns’* at EIHH with a flight instructor on board. The Pilot and passenger informed the Investigation that sometime prior to the occurrence, another Bolkow Bo-209 owner had briefed them on the aircraft generally and had warned them of the possibility of forgetting to extend the nose landing gear, because similar-sized aircraft would not have a retractable landing gear. They said that this owner had advised them that there would be an aural warning if it was forgotten to extend the gear.

The Pilot said that on the occurrence flight he had used the aircraft checklist for engine start-up and when taxiing prior to take-off. The Pilot said that on the final part of the approach the checklist item regarding the extension of the nose landing gear may have been missed *‘because of the layout of the checklist’* (Section 1.6.4). He subsequently advised that the descent items may have been partially obscured by a piece of paper inside the checklist cover. He said that he wouldn’t have expected *‘the gear item in a descent checklist, normally it’s a part of the approach checklist and double checked in the final [landing] checklist’*.

The Pilot also said that during the approach, the throttle was set to 18 inches⁵ and the flaps to *‘full’*, and that he did not see or hear any landing gear warning (an aural alert was not installed on this particular aircraft; Section 1.6.3 refers). He noted that weather conditions were sunny at the time, but that *‘it was bumpy on the final, due to the wind and the trees around’*. He said that during the flare, when the throttle was retarded, he was looking at the end of the runway and would not have noticed a warning at that stage.

1.3 Injuries to Persons

No injuries were reported to the Investigation.

1.4 Damage to Aircraft

The propeller’s two blades sustained bending damage and the engine was shock-loaded. The engine’s left and right cowlings and the lower air intake sustained minor damage. Repairs to the aircraft were on going at the time of writing.

1.5 Personnel Information

The Pilot held a CPL(A) issued by the LBA. The licence contained MEP (Multi-Engine Piston) (land) with PIC (Pilot-in-Command) and IR (Instrument Rating); SEP (Single-Engine Piston) (land) with PIC and IR; and TMG (Touring Motor Glider) with PIC Classes, all of which were valid until 30 June 2019. The Pilot’s Class 2 Medical Certificate was valid until 7 October 2019. The Pilot’s flying experience is outlined in **Table No. 1**.

Total all types:	2,000 hours
Total on type:	0.5 hours (one month prior to the accident)
Last 90 days:	35 hours (all types)
Last 28 days:	10 hours (all types)
Last 24 hours:	3 hours (all types)

Table No. 1: Pilot’s flying experience

⁵ As read on the aircraft’s manifold pressure gauge, which is graduated in inches of mercury; this reading provides an indication of engine power/throttle position.

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The passenger was the holder of a CPL(A) issued by the LBA, which also contained MEP (land) with PIC and IR; SEP (land) with PIC and IR; and TMG with PIC Classes, all of which were valid until 30 June 2019. The passenger had a total of approximately 1,650 flying hours at the time of the occurrence. A Class 2 Medical Certificate pertaining to this licence was valid until 6 February 2021.

1.6 Aircraft Information

1.6.1 General

The Bolkow Bo-209 Monsun 160RV is a single-engine, low-wing, all-metal aircraft with a tricycle-type landing gear. The main landing gear is fixed (non-retractable), whereas the nose landing gear is retractable. The Investigation notes that the cockpit design incorporates perspex panels in the sides and rear of the cockpit canopy. The subject aircraft, registration D-EFJG, was manufactured in 1971 and was fitted with two seats in a side-by-side layout. The aircraft's Lycoming IO-320-D1B reciprocating engine powered a two-blade, variable-pitch, metal propeller. A total of 1,778 operating hours was recorded in the aircraft's logbook up until 11 April 2019. The total number of flight cycles recorded was 2,345. The original Aircraft Manufacturer is no longer in existence following a series of mergers. The Type Certificate Holder for the aircraft is now the responsibility of a new organisation following these mergers.

1.6.2 Airworthiness Certification and Recent Maintenance History

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The aircraft's Certificate of Airworthiness was issued by the LBA on 12 December 1996. The aircraft's Airworthiness Review Certificate was issued on 10 January 2019 by a Continuing Airworthiness Management Organisation (CAMO) approved by the Civil Aviation Authority (CAA) of the United Kingdom (UK), and was valid until 9 January 2020. The aircraft logbook indicates that a 100 hour/Annual Inspection was completed on 9 January 2019 at a UK CAA-approved maintenance organisation. An overhaul of the nose landing gear and associated retraction checks were also carried out at this time.

1.6.3 Nose Landing Gear Operation and Indication

1.6.3.1 System Description

The aircraft's nose landing gear is selected to retract or extend by a wheel-shaped two-position switch located on the left-hand side of the aircraft's main instrument panel. Amber, red and green indication lights are fitted adjacent to the switch (**Photo No. 2**). The nose landing gear is retracted and extended by an electrically powered actuator. It can also be extended manually using a hand crank. According to the Aircraft Manufacturer's 'Technical Description' document, all three indication lights will be off when the nose gear is retracted; the amber light will flash on the approach to warn the pilot to extend the nose landing gear, and will flash on the ground with the gear extended if the switch is placed in the up position; the green light will illuminate when the gear is down and locked; and the red light will illuminate when the gear is in transit.



Photo No. 2: Nose landing gear extension/retraction switch and indication lights (circled)

According to the 'Technical Description' document, the amber light is activated by a throttle position switch, which should operate 'as soon as the throttle lever is pulled back to about 1/3 of its travel'. The 'Technical Description' document also states that commencing with aircraft serial number (S/N) 131 an aural alert horn is installed in parallel with the amber light. The S/N of the subject aircraft is 129 and the horn was not installed.

The Maintenance Manual for the aircraft includes wiring diagrams of the gear warning system. The diagrams show that an airspeed switch is installed which causes the amber light (and horn, if fitted) to activate, if the gear remains retracted and the airspeed is less than 65 knots (kts), independent of throttle position. The airspeed switch also prevents retraction of the nose landing gear at speeds below 65 kts. In addition, one of the diagrams shows that the amber warning light may also be activated by a flap position switch, whenever the flaps are set to more than 18 degrees (regardless of airspeed or throttle position). According to the Type Certificate holder, the flap position switch was only installed on aircraft commencing with S/N 131. The flap position switch and the 65 kt airspeed switch are not mentioned in the 'Technical Description' document.

1.6.3.2 Post-Occurrence Inspection

Following the occurrence and under the supervision of the Investigation, the nose landing gear was extended and the aircraft was recovered to a nearby hangar, where an inspection of the nose landing gear indication system was carried out. To facilitate retraction and extension of the nose landing gear, the nose of the aircraft was supported and an external air pressure source was used to simulate airspeed. With the aircraft on battery power, and the aircraft's airspeed indicator reading 50 kts, the nose landing gear was retracted using the landing gear switch. The throttle lever, having been placed in a forward position by the Investigation, was pulled back. When it reached the position shown in **Photo No. 3**, both the amber and red indication lights began to flash. When the gear was selected to down, both lights continued to flash until the gear had fully extended, following which, the green light illuminated and the amber and red lights extinguished.

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Photo No. 3: Throttle position required to actuate nose landing gear warning switch

To facilitate transit by road, the aircraft has foldable wings. With the permission of the Investigation, the Pilot recovered the aircraft by road and sea to Germany, where further inspections were carried out, in preparation for the repair of the aircraft.

The Pilot advised the Investigation that during examination of the landing gear warning system in Germany, it was found that the actuation mechanism for the throttle position switch was worn. This resulted in it not being possible to adjust the warning system to activate earlier than the position shown in **Photo No. 3**. The Pilot said that the subsequent examination also found that a wire had been directly soldered to one of the indication bulbs and that an additional resistor was installed in the circuit. The resistor was secured to the wiring with plastic tape. The Pilot said that this arrangement resulted in a burning smell during system testing. It was also found that a flasher unit was fitted, which was of a different part number to that listed in the Aircraft Manufacturer's parts list obtained by the Investigation. It was not possible to determine when this work was carried out.

The Aircraft Manufacturer's maintenance schedule for the aircraft requires a function check of the landing gear warning system, including the operation of the airspeed switch every 50 hours. The organisation where the recent 100 hour/Annual Inspection was performed advised the Investigation that the airspeed switch was replaced during this maintenance visit and that the warning system was tested and found to be functioning correctly. The organisation informed the Investigation that a detailed examination of the indication circuit wiring, which was located behind the main instrument panel, would not have been part of the recent 100 hour/Annual Inspection.

1.6.4 Aircraft Checklists

The aircraft's Flight Manual (Revision LF-5D – 3/70), which contains the aircraft's checklists, is in German – the Pilot's first language. The Investigation obtained an English version of the Flight Manual, which has a similar revision number (LF-5E – 3/70). The 'Landing Approach' checklist from the English version of the Manual is shown in **Figure No. 1**. The revision date is the same as the German version (Rev. 1 – 6/70) and the layout is identical. The Flight Manual contains separate 'Descent' and 'Normal Landing' checklists. The 'Airspeed' in the 'Landing Approach' checklist is 70-75 kts. The 'Approach' speed in the 'Normal Landing' checklist is 70 kts.



<u>Landing Approach</u>	
+ Carb heat	ON
(Landing gear (below 104 Kt).....	DOWN)
Landing flaps (below 88 Kt)	15 ^o
Pitch control	HIGH RPM
Airspeed	70 - 75 Kt
Auxiliary fuel pump	ON
+) applies to engine with carburetor	

Figure No. 1: Flight Manual Landing Approach checklist (English version)

A poly-pocket-covered A4 page carried on board the aircraft also contained various checklists, including a checklist titled '*FOR DESCENT*' (**Photo No. 4**), which included the following point: '*at <104 kts nose gear down green light VITAL GREEN GEAR LIGHT ON!*'

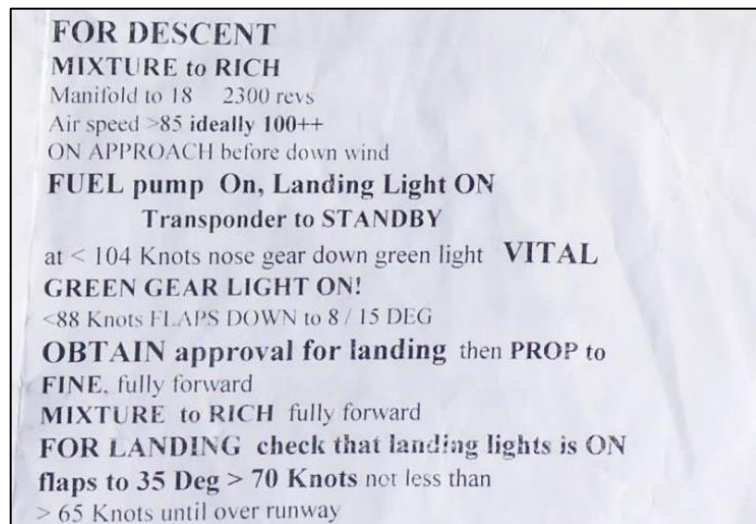


Photo No. 4: *FOR DESCENT* checklist from A4 page of checklists carried on board

1.7 Meteorological Information

Met Éireann, the Irish Meteorological service, provided the Investigation with the following meteorological information:

At the time of the occurrence, there was an area of high pressure over Ireland with a light to moderate south-easterly flow. The surface wind was east to south-east at 5 kts; the wind at 2,000 feet (ft) was south-east at 20-25 kts. Weather conditions were sunny, with a visibility of greater than 30 kilometres (km).

1.8 Airfield Information

The event occurred at Navan Airfield (EIH), which has two grass runways: RWY 07/25, which is 530 metres (m) long, and RWY 09/27, which is 700 m long.

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1.9 Inadvertent Gear-Up Landings

A review of AAIU Reports for General Aviation events that occurred in Ireland since 2006 found that there was only one other report relating to an aircraft landing with the landing gear inadvertently left in the retracted position. However, a review of the website of the Air Accidents Investigation Branch (AAIB) of the United Kingdom (UK), where the level of General Aviation activity is higher, and where there is a wider range of aircraft types, found that there were over 40 such events in the UK during the same period. A wide variety of causes was cited for those events, including:

- Distraction due to other aircraft operating nearby
- Not checking for correct indication before landing
- Operating in a shorter than normal circuit
- Interruption when completing final checks prior to landing
- Normally operating on aircraft with non-retractable landing gear
- Operating with a flight instructor present

Several of the aircraft involved had been fitted with aural warning systems that had functioned normally, yet the events still occurred.

An article⁶ on the Australian Civil Aviation Safety Authority's '*Flight Safety Australia*' website on avoiding gear-up landings (November 2015) notes how frequent this type of occurrence is and describes common causal factors, such as pilot distraction and deviation from normal routine. The article's author suggests that one reason why gear-up landings are so common is that pilots '*do not take the time during a retractable gear check-out to ingrain a new habit pattern for landing, one that is different from that used in fixed-gear aeroplanes*'.

The article offers recommendations on how to avoid such an occurrence, including the following:

- *Always make a short-final [the last section of the final approach] gear position check.*
- *Recognise that modified or interrupted traffic patterns [and] strong or gusty surface winds [...] frequently contribute to a gear-up landing. Be especially gear-conscious if you find yourself in these conditions.*
- *Understand the limitations [of] gear advisory systems, and actions you may take that inhibit their function. Don't depend on warning systems to the exclusion of good landing gear discipline.*

The article concludes by stating:

'Anyone can forget to extend the landing gear on any given day. Total time and time-in-type alone do not protect us from natural human limitations. We have to work consciously to avoid a gear-up landing every time we land the aeroplane. Concentrate on extending and verifying the landing gear every time you land [...].'

⁶ <https://www.flightsafetyaustralia.com/2015/11/those-who-wont-avoiding-gear-up-landings/>
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Chapter 11 ('transition to complex airplanes') of the United States' Federal Aviation Administration's 'Airplane Flying Handbook' (2016), gives the following guidance:

'Establish a standard procedure consisting of a specific position on the downwind leg at which to lower the landing gear. Strict adherence to this procedure aids in avoiding unintentional gear up landings'.

2. ANALYSIS

2.1 Operational, Technical, and Human Factors Aspects

2.1.1 General

An unintentional gear-up landing is an acknowledged safety risk. In this case, several factors may have contributed to its occurrence. In particular, both the Pilot and the passenger had very limited experience on the aircraft type (which had the unusual configuration of a fixed main landing gear, and a retractable nose-landing gear), and only had flown 'three or four traffic patterns' several weeks prior to the occurrence flight. Consequently, there would not have been the opportunity to 'ingrain a new habit pattern for landing' specific to an aircraft with a retractable (nose) landing gear, as recommended in the article on avoiding gear-up landings on Flight Safety Australia's website. The event occurred during landing following a single circuit of the airfield – such a flight would not have afforded sufficient time to acquire further familiarity with the aircraft and prepare for an approach and landing.

In addition, the layout of the 'FOR DESCENT' checklist, as contained in the on board page of checklists that the Pilot said he was using, was not clear. Furthermore, according to the Pilot, the checklist may have been partially obscured by a piece of paper located inside its cover. The 'Landing Approach' checklist contained in the aircraft's Flight Manual is of a more conventional layout and contains individual steps with clear separation between an item and the action to be taken, and between each successive item. The Investigation considers that it would be less likely for an item to be missed on a checklist with such a layout.

The wind conditions, as contained in the meteorological information provided by *Met Éireann* following the occurrence, indicate that although the wind was 20-25 kts at 2,000 ft (from the east), the surface wind was only 5 kts (east to south-east). However, the Pilot stated that the approach to the runway was bumpy. This may have increased any challenge already present as a result of the lack of familiarity with the aircraft type, and could have served as a distraction contributing to the omission of the extension of the nose landing gear.

2.1.2 Landing Gear Warning System

The sequence of events leading to an unintentional gear-up landing includes omitting to extend the landing gear in the first place, and not performing a confirmation check while on short finals to ensure that the gear is correctly extended. However, warning systems are usually installed on aircraft with retractable landing gear to assist in warning a pilot that the landing gear has not been extended as required. These include indication lights and/or aural alerts that may be triggered by throttle position, and/or flap position, and/or airspeed, consistent with the aircraft being on final approach.

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In this case, a warning system that included an amber light, a throttle position switch, and an airspeed switch was installed. During the Investigation's post-occurrence examination of the aircraft, which was conducted with the nose of the aircraft supported, it was found that with battery power applied, and an external air source used to simulate an airspeed of 50 kts, it was possible to retract and extend the nose landing gear using the landing gear switch in the cockpit. This indicates that the airspeed switch was actuating at this speed. The switch is also part of the nose landing gear warning system and therefore may not have triggered the warning system at speeds higher than 50 kts. However, the Investigation notes that even if the airspeed switch was operating at the specified 65 kts, this is lower than the 'Approach' speed listed in the Flight Manual 'Normal Landing' checklist (70 kts) and would provide limited warning to extend the nose landing gear.

According to the aircraft's 'Technical Description' document, the amber light should flash when the throttle is retarded to about 1/3 of its travel and the nose landing gear is in the retracted position. However, the Investigation's post-occurrence examination of the aircraft found that the light did not activate until the throttle was closer to the idle position. It was also found that once the amber light began to flash, the red light (normally only illuminated when the gear is in transit) also flashed. This may have been due to the condition of the electrical circuit as observed during further examination of the aircraft. In addition, a flap position switch was not installed on the aircraft.

It is therefore likely that the amber (and red) light did not flash on the occurrence flight during the approach, even with a low power setting and full flap, and only began to flash as the throttle was further retarded for the flare. The Pilot said that at this stage he was looking at the end of the runway and would not have noticed a warning indication. The cockpit design incorporates perspex panels in the sides and rear of the cockpit canopy and it is also possible that the conspicuity of the indication light was adversely affected by the sunny conditions noted in the meteorological report and evident in **Photo No. 1**. Furthermore, no aural alert was fitted to the landing gear warning system on this particular aircraft (S/N 129); this was only fitted to aircraft S/N 131 and higher.

A correctly functioning gear warning system serves as an additional barrier in helping to prevent an inadvertent gear-up landing. Notwithstanding this, the Investigation found during its review that several of the aircraft involved in inadvertent gear-up landings had been fitted with warning systems that had functioned correctly, yet the events still occurred.

3. CONCLUSIONS

3.1 Findings

1. The airworthiness certification for the aircraft was valid.
2. The Pilot-in-Command was appropriately licensed for the flight, but had limited experience on the aircraft type.
3. The 'FOR DESCENT' checklist on board the aircraft was not of a conventional layout and some of its contents may have been obscured on the occurrence flight.



4. The nose landing gear was not extended prior to landing.
5. As the nose of the aircraft was lowered during the landing roll at EIHH, the propeller and the lower engine cowling made contact with the grass runway.
6. The propeller's two blades sustained bending damage and the engine was shock-loaded. The engine's left and right cowlings and the lower air intake sustained minor damage.
7. Post-occurrence examination found that a simulated airspeed of 50 kts, and not 65 kts as specified by the Aircraft Manufacturer, was sufficient to operate the nose landing gear airspeed switch to permit the retraction of the nose landing gear.
8. Post-occurrence examination by the Investigation also found that the nose landing gear warning system activated at a throttle position that was closer to the idle position than the '*1/3 of its travel*' position described in the aircraft's '*Technical Description*' document.
9. The Pilot believed that there would have been an aural alert if the nose landing gear was not extended prior to landing.
10. An aural alert horn was not fitted to the aircraft (S/N 129); such a device was only fitted to aircraft S/N 131 and higher.
11. Non-standard repairs had previously been carried out to the electrical circuit for the landing gear warning lights. This was not a factor in the occurrence.

3.2 Probable Cause

The aircraft's nose landing gear was not extended prior to landing, resulting in damage to the propeller and engine cowlings, and the engine being shock-loaded.

3.3 Contributory Cause(s)

1. Lack of operational familiarity and experience on the aircraft type.
2. The layout of the '*FOR DESCENT*' checklist carried on board the aircraft and possible obscuration of some of its contents during the occurrence flight.
3. The activation point of the throttle position switch was closer to idle than the position specified in the aircraft's '*Technical Description*' document.

4. SAFETY RECOMMENDATIONS

This Report does not sustain any Safety Recommendations.

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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