**ACCIDENT**

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|---|---|
| **Aircraft Type and Registration:** | Nord NC854S, G-BGEW |
| **No & Type of Engines:** | 1 Continental Motors Corp A65-8 piston engine |
| **Year of Manufacture:** | 1950 |
| **Date & Time (UTC):** | 20 September 2009 at 1130 hrs |
| **Location:** | Whistlers Farm, Tangley, Hants (Approx 4 miles North of Andover) |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - 1 (Fatal) Passengers - 1 (Fatal) |
| **Nature of Damage:** | Aircraft destroyed |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 60 years |
| **Commander's Flying Experience:** | 299 hours (of which 55 hours were on type)<br>Last 90 days - 4 hours<br>Last 28 days - 3 hours |
| **Information Source:** | AAIB Field Investigation |

## Synopsis

After taking off, the aircraft was seen to climb over rising ground with a nose-high attitude. Approximately 90 seconds later, at a height of between 250 ft and 300 ft agl, 1.5 nm to the west of the airfield, it departed from controlled flight and struck the ground in a steep nose-down attitude whilst rotating to the left. A post-impact fire ensued and the aircraft's structure was largely consumed. The aircraft's exhaust system was found to be in poor condition and the post-mortem examination revealed that the pilot's blood contained an elevated level of carbon monoxide.

## History of the flight

The pilot and passenger had arrived separately by car at Bourne Park, a private grass airfield near Andover and it is believed that they intended to fly to a private strip near Swindon before flying on to Popham. Two witnesses saw some or all of the pre-flight activity at the airfield. The pilot appeared in good spirits and took time conducting the routine pre-flight activities; one witness stated that he appeared to be explaining things about the aircraft to the passenger. The aircraft was seen by a witness to depart to the west, towards rising ground,[1] apparently taking off normally sometime between 1115 hrs and 1130 hrs.

**Footnote**

[1] The ground to the south of the climbout path was lower than the ground to the west of the airfield. In addition, the fields along the aircraft's track offered opportunities for a precautionary landing.

Various eyewitnesses reported seeing the aircraft after it took off. One witness saw it at a height of about 100 ft to 150 ft agl approximately 0.75 nm west of the airfield, tracking west and in a nose-up attitude. This witness, who had some flying and gliding experience, described the aircraft as rapidly dropping a wing to the left, recovering, then dropping a wing to the right, before recovering again. The engine noise sounded constant and the aircraft passed out of sight to the west.

Another witness, 1.2 nm west of the airfield, was unsure of the aircraft's height but described the aircraft as being much lower than normal and with the nose "up". The engine noise was constant, though seemingly running at low speed, and "it wasn't coughing or spluttering". The witness reported no change in the note of the engine until the aircraft went out of view.

A group of witnesses, outside of a property approximately 1.5 nm from the airfield, and some 200 m from the accident site, saw the aircraft fly almost directly overhead from east to west at about 250 ft to 300 ft agl. The engine sound was described as "running smoothly though without any thrust or power." They watched as the aircraft started a left turn before it suddenly turned and descended rapidly to the left. The aircraft descended out of sight behind a line of trees before they heard a loud noise, and saw a rising plume of smoke.

**Medical information**

Post-mortem reports stated that both occupants sustained severe injuries resulting from a relatively high speed impact and the associated deceleration forces. The accident was not survivable.

Toxicology analysis revealed unusually high levels of carbon monoxide in both occupants; 24.7% COHb and 9.0% COHb for pilot and passenger respectively. Although levels of 10% COHb can be found in a heavy smoker, it was determined that the pilot was not a smoker and, therefore, the significance of the elevated carbon monoxide levels in his blood could not be discounted[2].

**Aircraft description**

The Nord NC.850 (originally produced as the Aérocentre NC.850), from which the NC854S was developed, was a light aircraft developed in France in the late 1940s for use by French aeroclubs but which also saw military use as an airborne observation post. It is a high-wing, strut-braced monoplane with a fully enclosed two seat cabin (side by side configuration). The landing gear is fixed and of tailwheel configuration. The fuselage construction is welded tubular steel, the wings have a metal structure and the entire aircraft is skinned in fabric (Figure 1). A brief history of the type is shown below:

**NC.850** - prototype with single tail and Mathis G4F engine (1 built)

**NC.851** - version with Minié 4DA engine (9 built)

**NC.852** - version with Regnier 4EO engine (2 built)

**NC.853** - major production version with twin tails and Minié 4DC.30 engine (29 built)

**NC.853S** - NC.853 built by Nord (95 built)

**NC.853G** - NC.853 fitted with *aile flottante* system (1 converted)

**NC.854** - NC.853 with Continental A65 engine (2 built, plus many converted from NC.853)

**Footnote**

[2] It was reported that the source of the carbon monoxide was unlikely to have originated from the pilot's house, as a serviceable CO detector was fitted in the kitchen, or the pilot's car, as no symptoms of CO poisoning have been reported by other users of the car.


**Figure 1**

A further development of the type, the 856A, was fitted with a 135 HP engine, and is listed as having a maximum climb rate of 984 fpm.

**Wreckage examination**

The aircraft struck the ground with a high rate of descent and negligible horizontal velocity, pitched approximately 50° nose down and rotating in yaw to the left with sideslip to the right. This was consistent with it having been in a spin, or incipient spin, to the left.

The impact caused substantial crumpling of the steel-tube fuselage structure around the cockpit, wing attachments and in the region immediately aft of the cockpit. The cylindrical fuel tank mounted 'cross-ship' immediately behind the seats was ruptured. An extremely intense post-impact fire engulfed the whole aircraft and destroyed all of the aluminium alloy components in and around the forward fuselage and cockpit, including much of the flying control operating systems in that area. All of the steel flying control cables survived the fire, however, and it was possible to establish from these, and from other steel components, that all primary flight controls were intact and connected at the time of impact. Critical parts of the wing flap operating system were destroyed completely by the fire and therefore it was not possible to establish the status of these components prior to impact. However, nothing was found in the wreckage to suggest that any malfunction of the flap system had occurred prior to the accident. The remnants of the flap surfaces were at positions consistent with their having been fully retracted at impact.

The throttle setting at impact could not be determined reliably. However, shattered fragments of propeller blade were projected large distances from the impact point within a narrow region aligned with the plane of the propeller disc, consistent with the propeller having been rotating at high speed. The engine power at impact was sufficient to fracture the hub portion of the propeller during the subsequent engagement between the stump of the broken blade and the ground, before the engine

itself impacted the ground. Evidence from the propeller therefore suggested that the engine was operating at high power at the time of the accident.

Post-accident disassembly of the exhaust system revealed significant deterioration and de-lamination of the four gaskets at the exhaust pipe/engine cylinder interface on each cylinder. The surfaces adjacent to the gaskets did not appear to have been exposed to the intense post-impact fire. Some gaskets displayed evidence of carbon deposits consistent with 'blow-by', indicating that exhaust gases may have been escaping whilst the engine was operating, Figures 2 and 3.

Further inspections revealed deformation of three of the four engine cylinder exhaust pipe flanges. The deformation observed seemed inconsistent with impact damage when the aircraft's attitude and orientation in the final moments of flight were taken into consideration, and it is possible that such deformation may have been introduced by over-tightening of the joints during routine maintenance.

Figures 4 & 5 display exhaust pipe flanges from the aircraft wreckage from two separate engine cylinders, showing the flange without deformation, and one of the three with deformation, respectively.

Flange curvature will prevent a gasket from making an effective seal, exposing it to the high temperatures of the exhaust gas stream. This may explain why the exhaust gaskets were found to be in such a poor condition. It is not known how long these particular gaskets had been fitted to the aircraft.

Guidance from the Light Aircraft Association (LAA) in relation to exhaust system maintenance stipulates that:

> *'Exhaust systems must give complete sealing; flanges, gaskets and air intake sealing must be regularly examined and maintained…Should a component be inaccessible for a thorough visual inspection or hidden by non-removable parts, remove the component and check for possible leaks.'*


**Figures 2 & 3**

Exhaust gaskets removed from the accident aircraft


**Figures 4 & 5**

Two of the exhaust flanges removed from the accident aircraft

Taking into consideration the difficulty experienced in accessing the gaskets during post-accident examination, it is probable that they were not readily accessible for visual inspection during normal maintenance.

**Aircraft documentation**

The aircraft's documentation, maintained by the owner-pilot, recorded recent work to crop the wooden fixed-pitch propeller from a diameter of 72" to 70", in an attempt to improve the aircraft's marginal climb performance, by increasing the engine's maximum achievable speed from 2,100 rpm to 2,300 rpm. Correspondence in the files indicated that the propeller had been cropped professionally by a specialist and that the work had included re-varnishing and balancing. Log book entries dated 2 August 2009, record this modification and that a post installation test flight of 1:05 hrs duration had taken place. The correspondence also showed that no prior application had been made to the LAA for the required technical approval for the propeller modification, because the owner had, until 4 August (when it was apparently drawn to his attention), been unaware of the requirement to do so. A retrospective application was made on 5 August, supported by the flight test results, and approval was granted by the LAA on 26 August 2009.

The aircraft's documentation suggested that when it was built in 1950, the engine then installed was a Minié 4DC30, which produced around 80 HP. In 1963, this engine was replaced by a Continental C90 14F, which delivered a nominal 95 HP, and this in turn was replaced in 1975 by the Continental AA65-8 installed at the time of the accident. This engine delivers a nominal 65 HP. In 2004, prior to the pilot taking ownership of the aircraft, modifications were carried out that included installation of a battery, generator, starter motor, and an electrical fuel pump. Over its lifetime, therefore, the aircraft underwent a net reduction in power of the order of 15 HP, together with a weight increase of the order of 25 lbs.

**Pilot experience**

The pilot started flying in 1989 and was issued with his licence in 1991 after 81 hours of flying. He completed an IMC rating in 1998 by which time he had accrued 193 hours. In December 2004, with a total flying experience of 238 hrs, he purchased the accident aircraft and almost all of his subsequent flying was on this aircraft. He had flown about 48 departures from Bourne Park, where the aircraft had been parked in the open since August 2005[3].

**Footnote**

[3] The aircraft had recently been parked in a hangar, when space became available.

**Meteorology**

The Met Office provided an aftercast of the likely weather conditions prevalent at the time of the accident, as follows:

> Surface wind of 010°/5 kt, temperature 17°C dewpoint 11°C, visibility of 15 km with no cloud below 2,000 ft, QNH was 1023 mb. The 1,000 ft wind was considered to be 030°/10 kt.

**Weight and balance**

It was not possible to calculate the aircraft's actual takeoff weight and balance data due to the extensive post-crash fire. An estimate of the weight is outlined below.

The aircraft maximum takeoff weight (MTOW) was 1,342 lbs and its declared empty weight was 844 lbs. The pilot's weight at his last medical was 187 lbs. Based on post-mortem weights, the passenger was slightly lighter than the pilot and a dressed weight of 176 lbs has been assumed, which also allows for any personal items carried. The pilot had prepared a number of sample load-sheets and these allowed between 20 lbs and 40 lbs for the aircraft flight bag, assumed to contain documents, tie downs, small tools and some metallic components which were recovered from the wreckage. Using these weights, the aircraft's zero fuel weight was about 90-93% of its MTOW; this would have left between 95 lbs and 115 lbs available for disposable load. The fuel tank was capable of holding approximately 100 lbs of fuel. The extent of the post-crash fire suggested that a large fuel load was being carried.

**Propeller modification**

The correct LAA flight test schedule had been completed following modification of the propeller and was conducted by the pilot at an aircraft AUW of 1,222 lbs. On the day, he reported the conditions as 23°C, a QNH of 1022 mb and achieved a climb rate of 400 fpm for the first minute, 350 fpm for the next three minutes, followed by 300 fpm for the fifth minute. This modification met the LAA requirements and was approved by them on 26 August 2009.

**Previous LAA annual flight test reports.**

The LAA required that flight tests were conducted at no less than 90% of the aircraft's maximum permitted gross weight. They make available a six page guide describing how to conduct the flight test. All of the flight tests conducted on the accident aircraft had been recorded at or above this 90% requirement. (Table 1)

| Date | Weight, lbs (% of MAUW) | OAT, deg C | Pressure, mb | Time to climb 1,000 ft, secs, (fpm) | Airspeed, mph | Engine speed, rpm |
|---|---|---|---|---|---|---|
| Jun 2009 | 1325 (98) | 20 | 1018 | 257 (233) | 55 | 2100 |
| May 2008 | 1292 (96) | 17 | 1018 | 180 (333) | 60 | 2050 |
| Mar 2007 | 1226 (91) | 15 | 1023 | 172 (348) | 62 | 2050 |
| Dec 2005 | 1293 (96) | 5 | 998 | 188 (319) | 58 | 2050 |
| Aug 2004 | 1264 (94) | 21 | 1016 | 250 (240) | 53 | 2050 |
| Aug 2003 | 1214 (90) | 21 | 1021 | 161 (372) | 55 | 2000 |

**Table 1**

**Review of other data by the LAA**

The LAA retains annual climb performance data for other Nord 854s on the UK register (four aircraft). These figures show stall speeds in the range of 45-50 mph, climb speeds of 62-65 mph and average 1,000 ft climb times of 180 seconds (333 fpm).

The LAA provided a copy of a "*Fiche de Navigabilite No 5*" for the Nord series aircraft. This document dated, 1955, amended in 1957 and 1958, bears the mark of the "Secretariat General a l'Aviation Civile". It is in French, and appears to consist of performance data for a range of Nord types. For the Nord 854S it lists '*Vz 2 m/s de 0 a 360m'*. This implies a climb rate of 393 fpm up to 1,100 ft.

**Analysis**

The aircraft was seen by various witnesses between the departure airfield and the accident site flying in a nose-high attitude. The first witness, positioned approximately 0.75 miles from the airfield, estimated the aircraft's height at 150 ft agl at a point where the ground was approximately 50 ft above airfield elevation. Thus, the aircraft was making a height gain of about 250 ft per mile. The final group of witnesses estimated the aircraft's height at about 250 ft agl shortly before the accident, which occurred 1.5 nm west of the airfield, where the local ground was about 125 ft above the airfield. Thus, when the aircraft departed from controlled flight, it had climbed approximately 375 ft since take off. By the time the accident occurred, the aircraft was estimated to have been airborne for 90 seconds, giving an approximate mean rate of climb of 250 fpm and a mean groundspeed of around 60 mph.

On 26 August 2009, after the propeller had been modified, the aircraft apparently achieved an average climb of 350 fpm when test flown by the pilot, and this broadly compares with the French document indicating 393 fpm for a new aircraft, and the mean of the historical figures for this aircraft held by the LAA, of 307 fpm.[4] Therefore the estimated performance on the accident flight is not significantly different to the theoretical performance of the aircraft, although the apparent slightly lower rate of climb could possibly be accounted for by the high nose up attitude of the aircraft reported by the witnesses.

The witness's description of the aircraft's departure from controlled flight suggests a stall and incipient, or full, spin to the left, as the aircraft descended out of sight. This was consistent with the analysis of the wreckage which indicated that the aircraft was pitched steeply nose down and yawing to the left at impact. A loss of control at approximately 250 ft agl would have offered little or no prospect of recovery in the height available.

The aircraft performance under test conditions was similar to the performance that appears to have been achieved on the accident day. This relatively poor climb performance could have been further compromised by any number of factors, for example, downdrafts in the lee of trees or terrain. However, the ground to the south of the climb-out path was lower and it may have been that the pilot was reluctant to make a turn at such a low height. It is not known if the poor state of the exhaust system could have impaired the power output of the engine, and hence the climbing performance of the aircraft.

Between the departure point and the accident site, with the exception of the wooded area near one of the witnesses, the terrain was generally suitable

**Footnote**

[4] Caution must be used in assuming a mean of these figures as the sample size (seven flights) is very low and the variance between the figures (from 233 to 372 feet per minute) is relatively large.

for an off-airfield landing with some fields offering excellent prospects. Therefore, if the pilot had become concerned about the progress of the flight, there was ample opportunity to have made a precautionary landing. Should this have resulted in aircraft damage, it probably would have been less likely to involve the non-survivable forces generated in a near vertical impact resulting from a spin.

Although it cannot be ruled out that the carbon monoxide found in both occupant's blood originated from another source, it is likely that it originated from an exhaust leak, or leaks, at the exhaust pipe/engine cylinder interface, where all four gaskets and three of the pipe flanges were found to be in very poor condition. It is possible that the exhaust gasses may have passed from the engine bay into the cockpit by either mixing with the slipstream around the cockpit, or by passing through various small apertures in the firewall. It was the opinion of the pathologist that a COHb level of 24.7% in the pilot would have resulted in a severe headache, nausea and a feeling of grogginess to the extent where the pilot's judgement and performance may have been compromised. Thus, his decision making ability to opt for a precautionary landing or to change track towards lower ground, and/or his ability to interpret his instruments correctly, could have been impaired.

The pilot seemed committed to continue to climb over the rising ground, and he would have been faced with the situation that the aircraft was climbing imperceptibly, relative to the ground. This may have led him to believe that he had no other option but to attempt to continue flying along the original path, rather than turn towards lower ground or manoeuvre for a precautionary landing, whilst at a low height and, probably, at low speed.

A spin related loss of control would be the expected outcome of a stall at full power. Due to the scale of the post crash fire, other possibilities that could lead to such a stall, such as a misreading air speed indicator, could not be ruled out.