# Cessna U206F Stationair, G-BAGV

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| **AAIB Bulletin No: 6/2003** | **Ref: EW/C2002/05/03** | **Category: 1.3** |
| **Aircraft Type and Registration:** | Cessna U206F Stationair, G-BAGV | |
| **No & Type of Engines:** | 1 Continental IO-520-F piston engine | |
| **Year of Manufacture:** | 1972 | |
| **Date & Time (UTC):** | 5 May 2002 at 1955 hrs | |
| **Location:** | Strathallan Airfield, Perthshire | |
| **Type of Flight:** | Sport parachutist dropping | |
| **Persons on Board:** | Crew - 1 | Passengers - None |
| **Injuries:** | Crew - 1 (Minor) | Passengers - N/A |
| **Nature of Damage:** | Damage to fuselage, wing, nose landing gear, fin and propeller | |
| **Commander's Licence:** | Private Pilot's Licence | |
| **Commander's Age:** | 47 years | |
| **Commander's Flying Experience:** | 668 hours (of which 620 were on type) | |
| | Last 90 days - 40 hours | |
| | Last 28 days - 12 hours | |
| **Information Source:** | AAIB Field Investigation | |

## History of flight

The aircraft was operated by a parachuting club and was on its twelfth sortie of the day at about 1955 hrs (2055 hrs local time) operating on grass Runway 10. The visibility was good, with no cloud and only light winds. The aircraft was being flown by the Chief Pilot, who was also the Chairman of the club; it was his twelfth sortie that day and his eighth in G-BAGV. The accident was observed by a number of club members who were around the club buildings and hangar, abeam the threshold of the runway in use.

The pilot reported that the aircraft had behaved normally during a drop of parachutists from 4,500 feet altitude and the subsequent 'straight in' approach to landing. However, just as the aircraft crossed the airfield boundary, with full flap and "at about 70 mph", the nose dropped. The aircraft struck the ground nose-down and turned over. The pilot recalled hearing a bang just prior to the loss of control and also that he had trimmed the elevator control "all the way back" but was still holding a small amount of back pressure on the controls. The aircraft came to rest, inverted, some 75 metres inside the airfield boundary. The pilot sustained minor head injuries but, although he was upside down, he was able to escape from the aircraft through the cargo door with the assistance of the airfield staff. There was no fire.

A number of the eyewitnesses wrote down brief accounts of what they had observed during the accident. The accounts agreed in stating that the landing approach had appeared normal and a number commented that, at a late stage (one suggested 12 feet wheel height and the engine noise reducing at

the same moment), the nose had dropped and the rate of descent increased. The accounts were consistent in describing the nose leg collapsing as the aircraft struck the ground and the aircraft tipping over its nose onto its back.

## Aircraft recovery

The accident happened late in the evening of 5 May so the aircraft was left in position on the runway overnight with the aim of recovering it the following day.

On the morning of 6 May a visiting pilot examined the aircraft and noticed that the elevators seemed to move independently of the cockpit controls. It was decided, however, not to take the examination further until the manager of the aircraft maintenance company arrived for the recovery of the aircraft that evening. During this recovery the tailcone was removed and it was found that the hardware (nut, washers and bolt) were missing between the final rod in the elevator control system and the elevator bellcrank. There was no trace of the nut or the bolt but one washer of the correct size was found lying against the rear bulkhead, just forward of the bellcrank. The manager of the aircraft maintenance company was present during the discovery of the disconnection between the rod and elevator bellcrank and he did note, when the tailcone was removed, that a number of the securing screws around the tailcone were missing. Consequently, he undertook a review of the recent maintenance history of the aircraft.

## Recent maintenance history

G-BAGV had recently returned from an extended period at the maintenance company. The aircraft had been flown there on 3 March 2002 for a number of work items to be performed in advance of its Annual inspection. At that time, the airframe had operated for 7,357 hours having had a previous '150 Hour' check at 7,307 hours in September 2001. In the event, a number of other items needing attention were noted and the maintenance was extended, in agreement with the parachute club, to include a full '150 Hour' check and Annual inspection, concluding on 26 April 2002 with the completion of the CRS (Certificate of Release to Service). The aircraft then flew for about 20 hours between 26 April and the accident, for some 42 parachute jumps. There had been one defect noted when the flaps selection did not function on 3 May so the aircraft was returned to the maintenance company where the problem was rectified.

One of the additional maintenance items between 3 March and 26 April had been replacement of the fuselage rear bulkhead, which was cracked. This repair involved removal of the rudder, fin, both elevators and the tailplane. When this area was reassembled the rudder and elevator controls needed to be re-rigged, with duplicate inspections of the flying controls and a set of rigging checks.

A series of interviews were conducted by the AAIB with the manager of the maintenance company, the engineer who signed the CRS, and the engineer who had assisted in the rigging checks and signed for the duplicate inspection of the flying control system. The accounts given by each, both in verbal and written form, were consistent with the maintenance worksheets. When the elevators were replaced it was with new hinge bearings and the final stages of the elevator control were then refitted. Evidence of backlash at the forward end of the final drive rod was found and the maintenance records indicate that new nut and bolt hardware were fitted. At the aft end of the rod, the engineer judged the hardware as being serviceable and so he re-used the existing 1/4 inch bolt and washers, and the 7/16 inch 'Kaylock'-type stiffnut, which is a cadmium-plated article. Both engineers, who were highly experienced and who did not consider themselves to be under time or other pressure during the maintenance actions, were adamant that the controls had been correctly assembled and checked.

## Kaylock stiffnut

The Kaylock type of stiffnut used in this case is a widely used form of all-metal self-locking fastener, where the self-locking mechanism is the elastic deformation of the elliptical female thread of the nut to the round thread of the mating bolt.

A few weeks after the accident, the AAIB received from the parachute club a 7/16 inch Kaylock nut found within the front of the cabin of G-BAGV. The nut ran easily on a 1/4 inch bolt thread and appeared to have become polished through use, losing most of its cadmium plating. This nut had not retained its locking function and had a distinctly different appearance to the darker cadmium finish of the sample nuts.

## Discussion - the accident

It could not be positively determined whether or not the nut found later within the cabin of G-BAGV was from the elevator bellcrank connection. From its polished appearance and complete lack of locking function it appeared an unlikely candidate. This reflects the paradox in this accident, in which an apparent disconnection of the elevator control system followed maintenance work by experienced engineers within an established JAR-145 maintenance organisation. In summary, in this accident there was no evidence to ascertain at what point the nut became undone.

## Use of self-locking fasteners

Discussions during the investigation with a variety of engineers showed a diversity of practice concerning the two forms of stiffnuts most often found in light aircraft: all-metal stiffnuts (such as 'Kaylock' types) and fibre or nylon stiffnuts (such as 'Nyloc' types). This diversity is reflected in the printed material in that the Maintenance Manual for the Cessna 206 does not address the re-use of all-metal stiffnuts. However, the Maintenance Manuals for the same manufacturer's business jets apparently state that stiffnuts should be used only once, although the maintenance company for G-BAGV would not have had access to these manuals.

Advisory Circular (AC) 43.13-1B issued by the Federal Aviation Administration (FAA) of the USA allows for the re-use of all-metal self-locking nuts and even for the re-use (provided the nut can meet the 'minimum prevailing torque values') of fibre or nylon stiffnuts. On the other hand, Leaflet 2-5, entitled '*Locking and Retaining Devices*' of the CAA's 'Civil Aircraft Airworthiness Information and Procedures' (CAP 562) advises:

*8.1 Fasteners with a fibre or nylon friction element should only be used once, and must not be used in locations where all-metal stiffnuts are specified. All-metal stiffnuts should not be re-used in locations vital to aircraft safety (e.g. control runs) but may be re-used in other locations providing the locking quality remains satisfactory.*

*8.1.1 Most aircraft manufacturers lay down the assembly conditions (e.g. dry or lubricated) and acceptable limits of in-built torque for the re-use of stiffnuts, and require that each nut should be checked with a torque wrench during assembly.*

*8.1.2 A recognised method of checking the friction elements of small stiffnuts which are not being used in locations vital to aircraft safety is to screw the nut onto the male thread, using finger pressure only. If it is possible to turn the nut far enough for the male thread to protrude through the friction element the locking is unsatisfactory. This test is suitable for small nuts where the torque applied by the fingers approximates to the in-built torque requirement of the nut specification, but is unrealistic for larger nuts.*

*8.1.3 Unsatisfactory locking may also result from a worn male thread. If either of the above tests leads to rejection of a stiffnut the male thread should be closely inspected. If a new stiffnut fails to provide adequate friction then it may be necessary to replace the bolt or stud on which it is to be assembled.*

During this investigation the AAIB found some confusion about the status in the UK of FAA advisory material such as FAA AC 43.13-1B. The view of the CAA, as the UK regulator, is that in every case the aircraft should be maintained in accordance with the manufacturers' published instructions. Where no guidance is available from the aircraft manufacturer relating to general maintenance standards, reference to the regulators' advisory material is recommended and this may include both FAA (Advisory Circulars) and CAA (Civil Aircraft Airworthiness Information and Procedures - CAP 562) as appropriate.

## Safety action

Stiffnuts are widely used in light aircraft and this usage is, in general, satisfactory. Their use in vital systems, such as the flight controls, must be properly controlled and the CAA's advice contained in CAP 562 'Civil Aircraft Airworthiness Information and Procedures' (CAAIP) is sound. It is therefore recommended that:

## Safety Recommendation 2003-26

The Civil Aviation Authority should re-iterate its advice regarding the use and re-use of self-locking fasteners, contained in Leaflet 2-5 of CAP 562, in a document likely to be widely read by and easily accessible to aircraft maintenance engineers and technicians.