

Slingsby T67M200, G-FLYV

AAIB Bulletin No: 10/96 Ref: EW/C96/5/1 Category: 1.3

Aircraft Type and Registration:	Slingsby T67M200, G-FLYV
No & Type of Engines:	1 Avco Lycoming AEI0-360- A1E piston engine
Year of Manufacture:	1988
Date & Time (UTC):	4 May 1996 at 1313 hrs
Location:	Old Warden Airfield, Bedfordshire
Type of Flight:	Aerial Work (Flying Display)
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - Fatal Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Basic Commercial Pilot's Licence with Night and IMC Ratings
Commander's Age:	48 years
Commander's Flying Experience:	3,675 hours (of which 2,500 were on type) Last 90 days - 94 hours Last 28 days - 31 hours
Information Source:	AAIB Field Investigation

Pilot's details

The pilot held a Basic Commercial Pilot's Licence, restricted to display flying only. The licence contained a type rating for Slingsby T-67 series aircraft. The latest Certificate of Test was signed in January 1989 and the latest Certificate of Experience (Six Month Period) was signed on 29 September 1995. The pilot held a Class 1 Medical Certificate issued on 12 January 1996. He also held a CAA Display Authorisation (DA) for single engine piston aeroplanes up to 600 hp. The DA specified minima of 30 feet agl for flypasts and 50 feet agl for Intermediate level aerobatics only.

The pilot's log books contained details of over 1,400 hours of aerobatic flying, mostly in the Slingsby T-67 series aircraft, and also indicated that he had given instruction in aerobatics to many other pilots. He first flew G-FLYV during 1988 and had participated in many flying displays in the aircraft since that time.

During 1993, the pilot commenced flying the Europa aircraft type. Since that time, his flying was mainly spread between the Europa and T-67 aircraft. In March 1996, G-FLYV began an annual inspection at the manufacturer's facility at Kirkbymoorside. While this was in progress, the pilot flew extensively in the Europa aircraft, including a series of demonstration flights in the USA. The planned display at Old Warden on 4 May was to be the pilot's first T-67 display of the 1996 season. It was his intention to fly a 260hp variant, registration GEF5M, at the display. Information from the manufacturer indicated that the 260 hp variant has a markedly better vertical performance than the 200 hp variant when carrying out aerobatic manoeuvres.

History of the flight

G-FLYV was returned to service on 2 May 1996, initially for a shakedown test flight. On 3 May, the pilot flew it to Leeds-Bradford Airport for some avionics checks to be carried out, returning to Kirkbymoorside later the same day. Some aerobatic manoeuvres were flown in G-FLYV during 3 May, but not a full display sequence. Two flights were also conducted in GEF5M later the same day. These also included aerobatic manoeuvres, but during the course of the flights the aircraft developed a technical defect.

On the morning of 4 May, the pilot could not start the engine of G-EF5M. He therefore decided to take G-FLYV, the 200 hp variant, to Old Warden for the display. The aircraft departed at 0916 hrs, arriving at Old Warden at 1017 hrs. For this positioning flight the pilot was accompanied by another pilot, who indicated that there were no technical defects apparent on G-FLYV and that sufficient fuel was on board to complete the display sequence and to land back at Old Warden.

The pilot took off from Runway 04 on schedule at 1307 hrs for the start of his display. Shortly after take-off, he rolled the aircraft inverted and climbed away in accordance with his normal display routine, before leaving the display area in order to allow another aircraft to perform. Once this was complete, G-FLYV flew in along the Runway 04 display line in a dive to gain speed. The aircraft pulled up and performed a vertical half roll, followed by a negative cap lomcovak manoeuvre. This was followed by a spin to the left. The planned sequence was to stop the spin and execute a negative 'g' push-out to the horizontal, then to perform a two point hesitation roll to become erect. However, on recovering from the spin there was insufficient height available to complete the push-out manoeuvre and the aircraft flew inverted into trees to the east of the display line, on the opposite side of the runway and away from the crowd.

The impact caused severe break-up of the aircraft but no fire. The pilot sustained immediately fatal impact injuries. The postmortem examination did not reveal any condition which would have led to the incapacitation of the pilot during the flight.

The flying display had been organised in accordance with the procedures laid down in CAA publication CAP403, and all of the necessary permissions had been granted by the CAA.

Video analysis

A number of video recordings of the display sequence were obtained by AAIB from spectators and from a specialist aviation video company. Detailed analysis of these recordings was carried out, and the following information was obtained:

Height attained at start of spin manoeuvre: Approx. 1,950 feet

Rotation rate (Turns 1 through 7): 2.2 seconds/turn

Rotation rate (Turn 8): 1.9 seconds/turn

The aircraft was seen to complete six full turns in a left spin with full left rudder, full up elevator and in-spin aileron controls applied throughout. Full out-spin rudder was applied one quarter of way round the seventh turn, followed by nose down elevator half a turn (about 1 second) later. Left aileron was maintained throughout. The aircraft then appeared to recover from the spin within half a turn. However, control inputs encouraged it to continue round to complete a further turn (probably for display line considerations), using a short period application of left rudder and up elevator combined with full left aileron control. About three quarters of the way round this turn (the eighth in total), the elevator went down to initiate the push-out manoeuvre, while still having full left aileron control applied. The ailerons were then centralised after a further quarter turn. At this stage, with the airspeed around 70 kt and the flight path almost vertical, the rate of descent was about 118 feet/second. The final turn took 1.9 seconds to complete, resulting in an additional height loss of 225 feet.

Speed on recovery from spin: 70 kt

Speed half way through push-out: 98 kt

Speed when last filmed before impact: 119 kt

During the progress of the push-out, there was a reduction in the amount of down elevator applied, which was coincident with the increase in negative 'g' being experienced.

During the inverted push-out, a few seconds before impact, an object fell from the approximate area of the pilot's knees to the cockpit canopy. The characteristics indicated that it was a fairly light object, taking 0.2 seconds to travel across the cockpit. It was most probably the pilot's display sequence card, which had been lodged between various protrusions on the instrument panel (noted on a preflight video sequence).

Another 0.25 seconds later, the aircraft yawed to the right, coincident with an increase in engine/propeller noise. Audio analysis carried out on the recording indicated that the final engine speed was 2,550 RPM, close to the maximum permitted. There was no evidence to suggest that the engine stopped at any time during the spin.

The aircraft did achieve an inverted horizontal attitude before impact, but the flight path angle was still downwards, albeit reducing progressively. Shortly before the impact, a roll to the right began.

The manufacturer's flight test report on the aircraft spinning characteristics indicated that the normal spin mode rotation rate was between 2 and 2.5 seconds per turn, which accords well with the 2.2 seconds per turn in this case. There was no evidence to suggest that there was any delay in spin recovery once the spin recovery controls had been applied. There was also no evidence to indicate

that the aircraft had experienced the "high rotation" spin mode, which may result from mis-application of spin recovery controls and exhibits a rotation rate of about 1 second per turn.

Flight test data indicated that the height loss per turn in the normal spin mode was around 250 feet per turn. A spin of seven turns would therefore have consumed around 1,750 feet. This figure, combined with the loss during the additional final turn fully accounted for the lack of height at the end of this manoeuvre.

A video recording of a previous G-FLYV display showed that a four turn spin was carried out. There was some variation in the content of individual displays to take account of local conditions. It was considered that four turn spins were the pilot's normal routine in this aircraft, with up to six turns being used when flying in the higher performance 260 hp variant.

Meteorology

An aftercast from the Met Office indicated that at the time of the accident there was a ridge of high pressure extending south-eastward to the west of the area resulting in a north-westerly surface airflow. The surface wind was from 340° at 10 kt, temperature +8°C, and the wind at 2,000 feet was from 330° at 10 kt. The visibility was 30 km, with no significant weather. There was scattered/broken cloud with a base around 4,500 feet. The mean sea level pressure was 1017 mb. Old Warden airfield is 110 feet amsl. The QFE was therefore 1013 mb, and this was set on the pilot's altimeter when it was located after the accident.

Aircraft description

The T67M200 is a single-engined low wing monoplane of glass reinforced plastic (GRP) construction with non-retractable landing gear. Two seats are fitted, side-by-side, each provided with a five-point harness as standard equipment. G-FLYV was also provided with a lap strap for the left seat as a backup for the main harness. The flight control systems are conventional. The elevator and ailerons are stick operated by a rod and bellcrank system and the rudder is driven by twin cables connected to two layshafts in the forward end of the cockpit, each operated by two rudder pedal mechanisms. These each incorporate an adjustment mechanism whereby the foot pedal part of the assembly can be translated fore and aft in a slider and locked in the selected position by a spring-loaded plunger. The flaps are manually operated via a rod and bellcrank system by a cockpit lever with a plunger operated locking mechanism.

Accident site

The aircraft impacted a copse of mature English Oak and Scots Pine trees close to farm buildings (Figure 1); all the wreckage remained within the copse. The impact point was within the airfield boundary, 214 m south-west of the Runway 30 threshold. The ground in the area was generally level and at approximately the same altitude as the runways. Tree top height in the copse was generally around 80 ft but reduced markedly at the southern end of the copse, just to the south of the impact point.

Examination of the site and the wreckage showed that initial impact had been between the outboard part of the left wing and the 16 inch diameter trunk of a pine tree at a point 20 ft above ground level, causing severe disruption of the left wing. This had been very shortly followed by a minor impact of

the right wing with the branches of an oak tree and by major impact of the right wing with the trunks of a second oak, which had partially broken up the wing structure and destroyed the forward fuselage and had uprooted and snapped the tree in two. Propeller chop marks were evident on this tree. The main part of the aircraft came to rest on the ground 22 metres from initial impact with the remains of the wing structure loosely attached. The engine was thrown 15 metres beyond the main wreckage, striking a third oak tree on the way and snapping its trunk in two places. Wreckage was strewn over an approximately 35x45 metre area of the copse.

The evidence indicated that at initial impact GFLYV was flying on a track of 060°M, with the fuselage at a height of 26 ft agl. The aircraft was inverted, with a bank angle of 200° right, and the pitch attitude and flight path were fairly close to the horizontal. Ground speed at impact could not be accurately quantified from the site examination but was estimated to have been between 100-150 kt. The propeller was turning at the time of contact with the second oak tree. Flaps were retracted and pitch trim was approximately neutral at impact.

Detailed wreckage examination

The aircraft sustained very severe break-up of the forward fuselage and the wing structure in its passage through the trees. The empennage suffered little damage and remained attached to the fuselage. Both seats and the seat harnesses were structurally released from the cockpit.

The right seat harness was found fastened, with all straps engaged in the release fitting and knotted together such that they were retained close to the seat back and base and well clear of the cockpit flight controls. In the case of the left seat, both the harness and the lap strap were found released and it was established that this had not been done in the course of rescue attempts. The release fitting for each was operated by rotation of a 3 inch diameter wheel through approximately $\pm 30^\circ$. In both cases only a fairly low torque (in the order of 4 lb in) was required to release the harness, when the straps were under no load. The release fitting wheels each had a number of raised vanes on the forward face, to provide a grip. It was noted that when the harness and strap were worn, the two release fittings would have tended to contact each other and the possibility of mutual interference could not be dismissed. However, the video evidence made it clear that the pilot had remained in his seat during the final negative push-through manoeuvre and no signs of loose straps prior to impact were apparent. Additionally, severe overload damage to the fuselage attachments for the left seat harness and the lap strap indicated that both had been fastened at the time of initial impact.

Some additional evidence found suggested that the engine had been at a high power setting at impact and confirmed that the airspeed had been in excess of 100 kt. The aircraft had been complete at impact, including all flying control surfaces.

Primary and secondary flight control systems were examined in detail; all the components of the systems were recovered. Particularly close scrutiny was given to the rudder system, including consideration of all service difficulties reported to the aircraft manufacturer. No signs of pre-accident problems were found, although the possibility of a control restriction could not be totally dismissed, given the severity of the break-up. The space beneath the cockpit floor appeared to be the region where a foreign object would have the greatest potential for interfering with the controls runs but it was noted that there were few paths into this region from the cockpit or from other parts of the aircraft. The evidence showed that at initial impact the pilot's rudder pedals had been in the fully aft length adjustment position and the adjustment locking plunger on each assembly had been engaged.

The examination revealed no evidence of pre-impact failure or malfunction of the aircraft.

