ACCIDENT

Aircraft Type and Registration:	Extra EA 300/L, G-IIEX
No & Type of Engines:	1 Lycoming AEIO-540-L1B5 piston engine
Year of Manufacture:	1995
Date & Time (UTC):	26 May 2008 at 1351 hrs
Location:	Hastingleigh, near Ashford, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Serious)
Nature of Damage:	Extensive - aircraft damaged beyond economic repair
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	1,716 hours (of which 204 hours were on type) Last 90 days - 119 hours Last 28 days - 47 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was en-route from a flying display at Southend Airport, to its home base at Shoreham. Due to inclement weather, with a low cloudbase and poor visibility, the pilot planned to fly around the Kent coast, but having encountered better weather than expected when airborne, he set off across the county. Unfortunately the visibility deteriorated and the cloudbase lowered so he decided to abandon his route and re-trace his path. Instead of reversing his course, however, he turned through approximately 270°, and found he was flying up a valley. He elected to carry out a precautionary landing into a field, but lost control of the aircraft on final approach. The aircraft struck the ground at low speed while rolling and banked to the right. Although the airframe remained relatively intact and no ground fire occurred, both occupants were injured, one seriously. Three Safety Recommendations are made.

Background information

The pilot was to carry out a flying display at the annual Southend Airshow, and positioned his aircraft to Southend the day before the accident. He was a regular display pilot and aerobatic instructor, and a part owner of the accident aircraft. The aircraft was fitted with basic instrumentation and a GPS receiver, but not an artificial horizon (AH) or direction indicator (DI)[1]. The GPS, that

Footnote

[1] It is usual for aerobatic aircraft of this type not to have an AH and DI permanently fitted, as they are likely to sustain damage when the aircraft is manoeuvred aggressively.

appeared to be slow to refresh its position, was not his, and was set to the 'north up' mode and not his preferred 'track up' mode, Additionally, he explained, that for aerobatic flying, the circuit breaker for the stall warning system was routinely 'pulled', to avoid repetitive warnings during manoeuvres, which would otherwise be a nuisance and a distraction.

Before flying the display, he examined weather information on the internet. This suggested that, although the weather at Southend was poor, with a cloudbase of around 600 ft, it was expected to clear from the south as the day progressed. He took off and carried out a 'flat' display then landed to refuel the aircraft to full tanks in preparation for his flight to Shoreham.

The pilot stated that he had booked the aircraft until the following morning and could have left it at Southend for another night. However, he felt some pressure to get himself and his passenger home, and he was also concerned about rain getting into the cockpit if the aircraft was parked outside at Southend. He believed that this pressure and concern influenced his decision to make the flight to Shoreham.

History of the flight

The pilot decided to fly a substantially longer route[2] around the Kent coast, to avoid the high ground of the North Downs as the cloudbase was fairly low. He ascertained that the weather at Shoreham had improved from early low cloud and rain, and he considered it appropriate to fly. He secured his passenger in the front cockpit seat, and then took his normal place in the rear seat.

The pilot took off from Southend, in a visibility 5 km as given by the ATIS, and flew across the Thames Estuary, west along the north shore of the Isle of Grain, and then south. Just before he reached Gillingham, he turned east towards the Isle of Sheppey to a position north of Faversham at 600 ft amsl and contacted Manston Approach, requesting a Radar Advisory Service. The controller informed him that no radar service was available and passed the Manston QNH, which was acknowledged. The pilot then requested the latest Manston weather and was told that according to the most recent observation at 1320 hrs, the wind was 070/23 kt, visibility was 4,500 m in mist, and the cloud was five to seven octas at 600 ft aal.

The pilot saw that the cloudbase to the south of his position seemed higher and conditions looked brighter. He gained the impression that the forecast improvement in the weather had been correct and decided to alter his track to route overland across low-lying ground east of Ashford. He transmitted his intention to Manston Approach and then flew south for five or six miles, at about 1,200 ft amsl. He monitored his progress using the GPS receiver and identifying familiar landmarks on a map. As he continued the cloudbase ahead lowered so he decided to execute a 180° turn, as he was entering cloud, and retrace his route back to the better weather on the north coast of Kent.. He transmiited to Manston Approach that he was "REALLY STRUGGLING" to maintain VMC, and requested a radar position fix. The controller replied that he would arrange for the radar to be manned. The pilot then reported that he intended to make a precautionary landing.

Having made the turn, he did not recognise any of the features as those he had just overflown, and found that he was in a valley with cloud on the hill tops. There appeared no way out of the valley so he transmitted

Footnote

[2] Analysis of the two possible routes showed that the coastal route was approximately 125 nm, compared to the straight-line route from Southend to Shoreham that was approximately 56 nm.

to Manston that he was in difficulties. He told his passenger that he intended to carry out a precautionary landing, selected a large field, and overflew it to ascertain it was suitable for a landing. He recalled flying at 800 ft or 900 ft amsl, with patches of cloud below the aircraft. He remembered deciding to land downwind, but on the upslope in the field, rather than into wind and on the downslope. He recalled manoeuvring for an approach but had no recollection of the landing itself. His next recollection was that of assisting his passenger after the accident.

A passer-by called the emergency services, who responded promptly. A Search and Rescue helicopter flying nearby was directed to the accident site and transferred the injured passenger to hospital.

Meteorological conditions

The Met Office aftercast showed low pressure centred west of the Channel Islands, with:

> *'a slow moving, complex arrangement of fronts over southern England.'*

The aftercast summarised conditions relevant to the accident:

> *'Cloudy, with mist patches across Kent, but also patches of rain/drizzle. It is likely that there would be isolated patches of hill fog in the general area' and stated that 'Due to the patchy nature of the precipitation and mist, only a range of likely visibility can be given. That range would be 1,300 metres to 10 KM underneath cloud, but possibly less than 200 metres if the aircraft was in cloud or in hill fog.'*

Reports from the area indicated that cloud cover over Kent was generally between five and eight octas, base 600 ft to 1,000 ft amsl. The Met Office report commented that:

> *'It is feasible, if not likely, that in isolation over the peaks the cloudbase would be slightly lower than the reports available, and so isolated patches of cloud base 500ft AMSL and covering the highest hills should be considered possible.'*

The report stated that the wind at the accident site was 060/15 kt at the surface, 070/22 kt at 1,000 ft, and 080/27 kt at 2,000 ft.

Meteorological forecasts

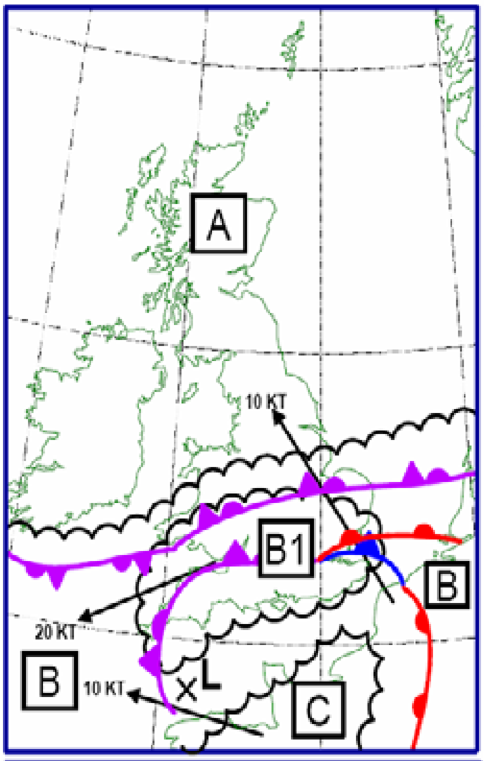
No record of precisely which forecasts and reports the pilot consulted before flight was available. However, a selection of relevant forecasts and reports are reproduced in Figure 1.

Terminal Area Forecasts (TAFs)

Manston

EGMH 260737Z 260716 04020KT 6000 -RA BKN010 TEMPO 0710 05022G33KT 2000 +RA RADZ BKN004 BECMG 1013 9999 NSW SCT015

EGMH 260906Z 261018 04020KT 6000 -RA BKN010 TEMPO 1019 05022G33KT 2000 RADZ BR BKN004 PROB30 TEMPO 1218 9999 NSW SCT012



Forecast Weather below 10000 FT

Met Office

Valid 260800 to 261700 Z MAY 08. Fronts/zones valid at 261200 Z

AREA	SURFACE VIS AND WX	CLOUD	0 C
A	30 KM NIL ISOL 7 KM HZ LAN W TL 09 Z ISOL 3000 M BR SEA COT MAINLY N OCNL SW (AND ISOL SW ... ... OF NORWAY) MTW MAX VSP 500 FPM AT 050 SW ISOL HILL FG	ISOL SCT/BKN CU SC 015-025 / 030-040 ISOL SCT/BKN ST 005-010 / 015 ... ... SEA COT MAINLY N	050 N 070 S
B	15 KM NIL / -RA OCNL (WDSPR FRONTS) 7 KM RA ISOL (OCNL FRONTS) 3000 M +RA ISOL 1500 M +TSRA ISOL (OCNL B1) ISOL (OCNL SEA COT W) B1 ISOL (OCNL B1) HILL FG	BKN/OVC AC AS (N) 080 / XXX ISOL (OCNL NEAR LOW) EMBD CB ... ... 020-040 / XXX AREAS BKN/OVC CU SC 015-030 / 060-080 ISOL (AREAS B1) SCT/BKN ST 007-012 / 015	080 N XXX S
C	30 KM NIL ISOL 7 KM SHRA ISOL 3000 M +SHRA/+TSRA	SCT/BKN CU SC 020-040 / 070-XXX ISOL CB 015-025 / XXX	070

All heights in 100's of feet above mean sea level
XXX means above chart upper limit
Cloud amount (Oktas) MOD / SEV ICE Speed of movement in KT
FEW: 1-2 SCT: 3-4 MOD / SEV TURB Temperatures in DEG C
BKN: 5-7 OVC: 8 TS / CB implies GR / / Hill FG implies VIS <200 M

This forecast may be amended at any time.
Issued by Met Office Exeter at 260315 Z
Forecaster: Duty Forecaster
Contact telephone 0870 900 0100
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F215

Outlook Until: 270000 Z
SIMILAR

Figure 1

UK Forecast Weather, Form F215

Lydd

(The TAF for the period beginning at 1000 hrs was the earliest produced.)

EGMD 260906Z 261019 07030G40KT 8000 -RA BKN008 TEMPO 1013 3000 RA BR BKN004 BECMG 1114 9999 NSW BKN020 TEMPO 1519 8000 SHRA BKN014=

EGMD 261200Z 261319 07025KT 8000 -RA BKN008 TEMPO 1315 3000 BR BKN004 BECMG 1316 9999 NSW BKN020 TEMPO 1519 8000 SHRA BKN014=

Shoreham

(The TAF for the period beginning at 1000 hrs was the earliest produced.)

EGKA 260906Z 261019 04025G35KT 7000 -RA BKN012 PROB30 TEMPO 1014 3000 RA BR BKN008 BECMG 1114 06015KT 9999 NSW BKN020 TEMPO 1519 8000 SHRA BKN014=

Meterological Actual Reports (METARS)

Southend

EGMC 261320Z 06014G25KT 4500 BR SCT006 BKN008 12/11 Q1010=

Manston

EGMH 261350Z 07021KT 4500 BR BKN006 13/12 Q1009=
EGMH 261320Z 06023KT 4500 BR BKN006 14/13 Q1009=

Recorded information

No radar data was available for the accident flight; however, the pilot was using a Garmin GPS Pilot III that recorded position and time, but no height information. Processing of this data allowed the average ground speed between recorded points to be calculated, ie, based on the horizontal straight-line distance between successive points. The accident track is illustrated in Figure 2.

The first recorded point from the accident track was at 13:15:56, as the aircraft departed from Southend Airport. At 13:48:27, about six nm east of Ashford, the aircraft turned through 270°, to the left, before heading towards Ashford. The last recorded point was at 13:49:59, just prior to ground impact.

Figure 3 illustrates the last minute of the aircraft's track, together with the position of the initial ground-impact mark and main wreckage. The last two points recorded on the GPS unit were three seconds apart, suggesting an average ground speed of 69 kt between these points, and the last GPS point, initial ground-impact mark and main wreckage lie on a line with a track of 208°.

Figure 3 also shows the direction and strength of the wind taken from the Met Office aftercast, which illustrates a large tailwind component of the wind along the track from the last GPS point to the wreckage. The effect of such a tailwind with a groundspeed of 69 kt results in an airspeed of 56 kt.

Recordings of RTF communications between the pilot and ATC were also obtained.

Air display operations

In the UK, flying displays take place regularly throughout the year at a variety of locations both on and off airports. Aircraft participating in displays may be:

- Military
- Private - operated by enthusiasts who absorb the costs of their flying
- Commercial - operated by organisations or individuals aiming to make a profit, or seeking to recoup some of their costs

The pilot operated the aircraft on the flying display 'circuit' and was paid fees for his displays. He explained that, although the fees did not form the foundation of a profitable business, they were an important contribution to the costs of operating and displaying the aircraft. He enjoyed his display flying activities and said that he would not be able to fly so often without the income.

Many aircraft participating in displays are either historic or aerobatic. In either case, they are often not equipped, or flown by pilots qualified, to operate under IFR. Displays may be flown some distance from the operator or aircraft's base so lengthy transit flights are often associated with display flying. It was reported

Figure 2

Garmin GPS Pilot III final logged track for G-IIEX

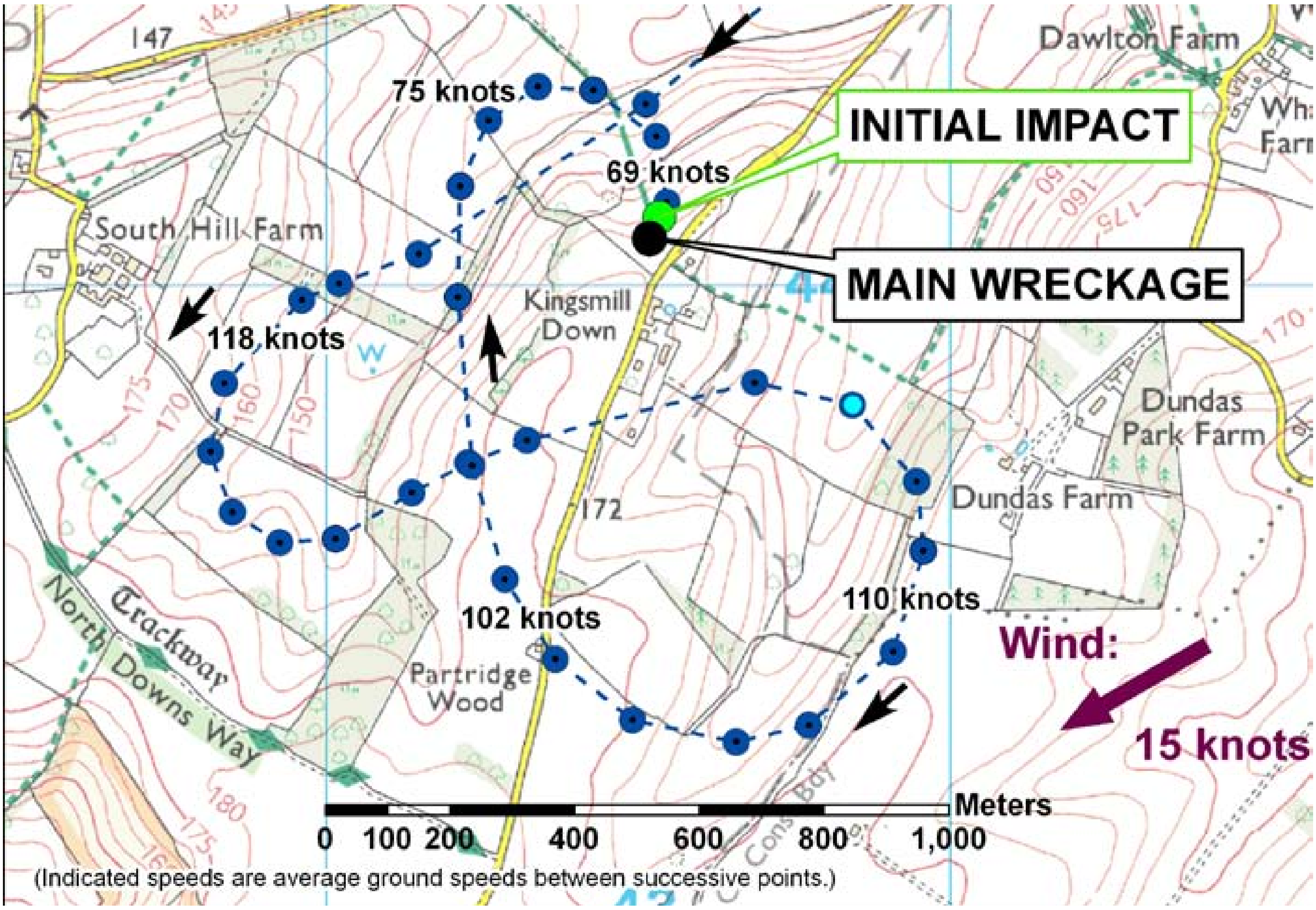

Figure 3

G-IIEX precautionary landing track

by various display pilots that, because display flying involves operations at low level, they perceived a habit amongst their peers to continue with transit flights under VFR in unsuitable conditions, and in particular, in poor visibility and low cloudbases.

Aircraft description

The Extra 300/L is a single-engine low-winged monoplane, designed to be fully aerobatic, Figure 4. It is qualified for manoeuvre load factors of ±10g. The aircraft is powered by a 300 shp piston engine driving a four-bladed constant-speed wooden propeller. The fuselage is constructed of a tubular steel frame covered with aluminium and fabric fairings; the wings are of carbon-fibre reinforced plastic (CRP). The ailerons are almost full span and there are no flaps. The aircraft is of tailwheel configuration with fixed landing gear. The wing section creates a 'conventional' turbulent flow. At maximum all-up weight, at 1g, the aircraft stalls at 55 kt.

The aircraft has two cockpits, in tandem, covered with a one-piece canopy. Each seat is constructed of a single-piece CRP moulding covered with a few millimetres of soft plastic foam overlaid with a thin leather lining. In the case of G-IIEX, both occupants were wearing parachutes; these provided a degree of occupant/seat padding but, with the parachutes

Figure 4
Configuration of G-IIEX

compressed under the occupant's weight, this would not be regarded as substantial. The rear cockpit seat is upright; the front cockpit seat is reclined by approximately 20°. In both cockpits, the underside of the seat pan is separated from the structure and various systems by several inches. A seven-point Sutton harness (aerobatic-type, with broad-straps) is fitted at each seat position. The fuselage framework intrudes into the cockpits in the form of a diagonal horizontal steel bracing tube in the upper part of each cockpit forward corner, angled inwards from aft to forward and spanning between the cockpit coaming and the instrument panel area, Figures 5 and 6. These tubes are sheathed in thin leather.

The front cockpit has aircraft flight and system controls and basic flight instruments, ie, an airspeed indicator, an altimeter and an inverted slipball. The rear cockpit has similar controls, system indicators and standard flight instruments, including a turn and slip gauge. A gyroscopic AI and DI can be fitted in the centre of the rear cockpit instrument panel, but neither was installed on G-IIEX. A GPS moving-map unit, powered from the aircraft electrical system, was fitted to the top of G-IIEX's rear cockpit instrument panel.

The initial model in the aircraft series, the Extra 300, was certificated by the German LBA in 1990, and by the FAA in the US in 1993. The Extra 300/L was certificated by the FAA in 1995.

G-IIEX was first registered in the UK in 2005. At the time of the accident the aircraft had accumulated around 920 flight hours from new and the engine around 135 hours.

Figure 5

G-IIEX front copckpit

Figure 6

G-IIEX rear cockpit

Accident site

The aircraft crashed 50 m from a country lane in a field of long grass in rolling hills, 5.2 nm east-north-east of the town of Ashford, Kent, at an elevation of 525 ft amsl. At the point of impact, the ground sloped 4° up and 9° down to the right relative to the flight path. The field boundary, in the direction of aircraft travel, was some 75m beyond the initial impact point, in the form of a low wire fence. Beyond the fence was a second field, virtually level, though with a slight upslope from east to west. It had a smooth flat surface covered with short grass that was unobstructed for its first 825 m, over a width of around 100 m.

Surface marks and the examination of the wreckage showed that G-IIEX had initially made ground contact with its right wingtip, with the aircraft banked an estimated 30° to the right, and whilst rolling to the right, causing the outboard one third of the right wing to detach. The right main landing gear struck the ground 4 m further on, almost immediately followed by the propeller blades, the left main landing gear, the undersurface of the forward fuselage and the left wing. The aircraft then slid and bounced across the field, coming to rest 34 m from the initial ground contact point.

The evidence indicated that, at the time of ground impact, the aircraft had been tracking approximately 214ºM, with a descent path in the order of 10º-15º to the horizontal; groundspeed was estimated at 60-70 kt. The fact that the wooden propeller blades had shattered, and their associated ground marks, showed that the engine had been turning at substantial speed at impact.

Aircraft examination

The aircraft had remained generally intact, although the canopy transparency had shattered. The canopy frame, together with the outer part of the right wing and the main landing gear, had detached, the engine mounts had fractured and the propeller blades were fragmented. The engine was not displaced substantially relative to the fuselage and the GPS unit had broken free from its mounts. The fuselage framework sustained some damage to its lower portion, but was not appreciably deformed, and there was no significant incursion of the fuselage structure into the cockpits. Both the fuel system and the electrical system escaped significant damage. There was no fire.

Detailed examination of the aircraft revealed no sign of pre-impact failure of the structure, powerplant or control systems. Two 2A circuit breakers in the rear cockpit for the turn and slip indicator and for the stall warning system, were found tripped, ie, their respective systems were isolated from the electrical power supply. Eleven other circuit breakers, mounted close by on the panel, were found with the expected settings and it appeared likely that the settings of all the breakers corresponded to their pre-impact settings.

The harnesses in both cockpits remained attached to the aircraft and with all buckles intact. In the rear cockpit, the seat pan had partially fractured near its right side, reducing the vertical stiffness of the pan. The seat attachments remained intact. The pilot's helmet exhibited a number of areas of substantial impact damage and the visor had fractured in two. Red smears on the front left of the helmet corresponded with the colouring of the canopy release handle, which had broken off. Cuts in the leather sheath on the diagonal bracing tube at the left forward corner of the cockpit were consistent with the effects of a strike by the helmet and visor. Impact markings on the left rear of the helmet indicated that it had forcibly contacted a vertical steel tubular A-framework located just behind the normal head position.

The front seat and its attachments were undamaged. Although no evidence was found that the passenger had struck any part of the structure or equipment in the front cockpit, there were numerous hard points adjacent to both sides of the seat in the form of the exposed fuselage framework and various controls. It also appeared possible that, even with the occupant restrained by the harness, violent longitudinal, vertical and/or lateral aircraft deceleration could cause head contact with the diagonal bracing tubes at the forward corners of the cockpit, and/or with the cockpit coaming.

Survivability issues

Advice was obtained from a biomedical specialist from the Royal Air Force (RAF) Centre for Aviation Medicine (CAM) at RAF Henlow, who examined the aircraft after its removal from the site and who provided a report on occupant crash injury aspects.

The pilot in the rear cockpit was wearing a HISL Alpha helmet; the passenger in the front cockpit was not wearing a helmet.

G-IIEX's pilot sustained a fractured left wrist and a cut to the forehead. The specialist concluded that the pilot had initially flailed forwards and to the left, causing the helmet strike on the canopy release handle and the left bracing tube. He then flailed backwards, causing the helmet strike on the A-frame. The specialist noted that the helmet was designed to conform to British Standard BS6658 (with reservations), which is similar to that worn by UK military fast-jet aircrew and affords the same protection standard. He judged that, while the impacts may have caused the pilot to lose consciousness, the helmet had prevented significant head injury. He noted that the seat pan fracture had acted to attenuate the vertical loads on the pilot.

The passenger was described as much smaller in stature and lighter than the pilot. She suffered fractures to her ribs, the left shoulder blade, skull and a vertebra. The CAM specialist observed that she had escaped head contact with the front left side of the cockpit possibly because, being smaller, it was outside her head's forward flail envelope. He assessed that her chest and shoulder injuries probably resulted from impact with the left side of the cockpit. Rearward flailing probably caused her head to strike the hard, rigid, plastic rear coaming of the cockpit, resulting in skull fracture. Impact with the detached GPS unit may have contributed to this fracture. The specialist judged it likely that the skull fracture would have been less serious, or even prevented, had the passenger been wearing a helmet.

The CAM specialist concluded that the passenger's spinal injury had resulted from the transfer of impact loads into her back from the seat. The rigid mounting of the seat, and the absence of appreciable padding between the seat and the occupant, would have provided little load attenuation. He also noted that, consequent on her relatively light build, attenuation had not been provided by fracturing of the seat.

The CAM report concluded that:

> *'if similar injuries are to be prevented in similar circumstances in future accidents, it should be recommended that protective helmets should be worn by both the front and rear seat occupants*

> *and consideration be given to fitting energy attenuating foam cushions to the front and rear cockpit seats.'*

Additional information

Published research shows that substantial attenuation of shock loads transmitted to a seat occupant's spine can be achieved by use of an energy-absorbing foam cushion. The information included reports of testing carried out in 1986 by the RAF Institute of Aviation Medicine and, in 1995, by the Defence Research Agency, Farnborough, in relation to seating in gliders. The results suggested that flexible domestic foam cushions generally provide little attenuation of spinal loads and, in some cases, may increase them. However, a one to two inch thick cushion of highly damped seating foam, which remains rigid under normal loading but crushes under impact shock loading, has been shown to reduce substantially the spinal loads induced by vertical deceleration in a crash situation. Trials of such foam showed that it did not appear to suffer significant deterioration in performance due to normal service use.

Published information also suggests that occupant head injury in potentially survivable aircraft crash situations is common, caused by the occupant striking parts of the aircraft, and is likely to have a major influence on survivability. This type of injury can be substantially reduced by use of inflatable occupant restraint systems. Such systems, designed particularly to protect the head and torso, have been available for aircraft for some years. A system used in civil aircraft is generally similar to the air bags typically used for road vehicles, but with the bag stowed in the lap-strap portion of the seat belt and deploying forwards in a crash situation. When deployed, the bag helps to pre-tension the restraint, which aligns the spine better to withstand vertical loads. The units have been certificated and employed in both public transport and General Aviation (GA) aircraft, at crew and/or passenger seat positions, both from new and as retrofit equipment. A leading manufacturer of the system has reported that deliveries for GA aircraft began in mid-2005 and that, by mid-2008, around 13,000 units were in service in GA aircraft. The manufacturer claimed that, in 2008, over 80% of new single-engine GA aircraft had front seats equipped with the airbag. No inadvertent deployments have been reportedly experienced to date.

Effect of 'wet wings'

The pilot commented that the aircraft's stall characteristics, in terms of stall speeds under specific loading and the characteristics of the onset of the stall, may have been influenced by the fact that the aircraft flew through rain and drizzle, and that the wings were wet. Information relating to this phenomenon is available. One relevant research paper was identified, *'Potential Influences of Heavy rain on General Aviation Airplane Performance,'* produced by NASA's Langley research Centre in 1986[3], and contained some relevant information. The report stated that aerofoils subjected to rain may behave differently depending on whether they have laminar flow or turbulent flow. The paper identified that the performance of laminar flow aerofoils is degraded when they are subjected to rain, and went on to say:

> *'Airfoils which are normally operated with a turbulent boundary layer have also been tested in simulated rain spray. However, these tests were conducted with small scale models and the*

Footnote

[3] AIAA-86-2606 *'Potential Influences of Heavy rain on General Aviation Airplane Performance'* by RE Dunham Jr.

scaling laws are not known for extrapolating the results to full scale. The results so far tend to indicate that heavy rain causes a performance loss for these airfoils.'

In response to this subject, the manufacturer has stated:

'…….it is known that an airfoil will have performance decrements when it is exposed to heavy rain environment or icing conditions.

Considerable loss in performance is expected only for the laminar airfoil sections. For a conventional turbulent airfoil in a high lift configuration, the rain influence occurred mostly at the higher angles of attack (reduced lift and increased drag). The performance penalty for a turbulent airfoil is normally the consequence of premature separation.

Anyhow, with regard to the EA 300/L we did not find any abnormal behavior or handling characteristics while flying in rain.'

Analysis

Operational aspects

Display flying

Weather in the UK is a recurring factor in aircraft accidents, often involving pilots 'pressing on' in inclement or worsening weather. The variable nature of the British weather, even in summertime, and the regular need for transit flying by 'VFR only' aircraft and/or pilots involved in display flying, has, therefore, the potential to bring together a combination of factors which may increase the risk of such accidents occurring. The fact that some display aircraft are operated in a commercial or quasi-commercial manner may introduce the additional factor that pilots may feel 'obliged' to position the aircraft in accordance with a timetable in order not to miss any planned display. The pilot stated that he had booked the aircraft until the following morning, and could have left it at Southend for another night. However, he felt some personal pressures to get himself and his passenger home, and he was also concerned about rain getting into the aircraft's cockpit if it was parked outside at Southend. He believed that this pressure and concern influenced his decision to fly.

The pilot considered that the routine 'pulling' of the stall warning circuit breaker prevented repetitive warnings during display flying, and that this avoided the possibility of a pilot becoming conditioned to accepting the warning as normal.

Safety action

The CAA has taken 'Pressing on' as a theme for safety discussion throughout 2009, and will publish an editorial in *'Display Flying News'* on this topic, as well as promoting awareness of the potential problem during safety evenings attended by general aviation pilots. They have asked the pilot to give a presentation at a display pilots' seminar, explaining some of the factors which contributed to the accident.

Forecasting

It is clear that the weather conditions in the south-east of England on the day of the accident were changeable and inclement. The Met Office Form F215, showed an occluding frontal system lying along the Thames Estuary, and described the associated weather in detail. It showed fronts valid at 1200 hrs and gave an indication that they would pass over the Southend area at about 1200 hrs.

The weather at Southend at the time G-IIEX departed was poor; a strong and gusty surface wind, a visibility of around 5 km - 4,500 m, scattered cloud at 600 ft aal and broken cloud at 800 ft aal, are challenging conditions for VFR flight. The forecasts for aerodromes along the pilot's planned route painted a complex picture. The 0700 hrs to 1600 hrs forecast for Manston predicted that by 1300 hrs, rain and drizzle would have ceased, the visibility would be 10 km or more and cloud would be scattered at 1,500 ft aal The later, 1000 hrs to 1900 hrs forecast, however, indicated very different weather, predicting that at 1300 hrs the visibility would be 6 km in slight rain and, temporarily, 2,000 m in rain, drizzle and mist, the cloudbase would be broken at 1,000 ft aal and temporarily broken at 400 ft aal. There was a 30% probability that temporarily, after 1200 hrs, the visibility would be 10 km or more, rain and drizzle would cease and the cloud would be scattered at 1,200 ft aal. The worst of these conditions would almost certainly preclude legitimate VFR flight, although the conditions predicted with 30% probability would be acceptable. It was not possible to determine which forecasts the pilot examined.

The 1000 hrs to 1900 hrs forecast for Lydd (the first available) indicated that by 1400 hrs, the visibility would be 10 km or more, rain would have ceased, and the cloudbase would be broken at 2,000 ft AAL. These conditions would again be appropriate for VFR flight. The later 1300 hrs to 1900 hrs forecast predicted that conditions would be markedly worse.

Thus, it seems very possible that the pilot did not obtain forecasts later than the 0700 hrs to 1600 hrs set and was, therefore, not aware of the worse conditions predicted in the later forecasts. This influenced his plan to fly across the Thames Estuary and around the Kent coast, which he could have done at low level without concern for terrain, and in compliance with the regulations relating to low flying. Had he seen the later forecasts, he may have realised that the previously forecast improvement in weather was not now expected.

The planned flight

The pilot described his plan to fly across the Thames Estuary and then around the coast of Kent. His GPS recorded track was across the Estuary, west along the north shore of the Isle of Grain and then east towards the Isle of Sheppey. His original plan was to remain clear of terrain by following the coast and this plan was followed initially.

Progress of the flight

Having reached Faversham, the pilot changed his mind and decided to route to the south across the county, albeit aiming to overfly the low-lying land east of Ashford. Although this meant initially overflying the North Downs, his impression was that he was flying into the widespread improvement in weather, forecast earlier in the day. However, it transpired that he was entering a less widespread area of benign weather, with poorer surrounding conditions. He was probably influenced in making this decision by his familiarity with the area across which he flew.

Having realised that the weather was now not suitable to continue the flight to the south, the pilot decided to turn back towards the better weather. However, instead of turning through 180°, he turned through 270° and found himself flying up a valley with weather closing in above and around him. The imprecision of this turn was probably a consequence, in part, of the poor weather conditions in which it was executed, and partly because of a lack of basic flight instrumentation and the 'slow updating' of the GPS receiver.

Examination of the field chosen for the landing, adjacent to that in which the aircraft crashed, showed it to be suitable. However, the pilot assessed the combination of slope in the field and the wind and decided on a downwind, upslope landing, and it was as he made his curving final approach that he lost control of the aircraft.

Loss of control

Evidence from the GPS receiver showed that the aircraft was manoeuvred over the chosen landing site until, on the curving final approach to land, control was lost. The downwind aspect of the approach, together with evidence gathered during the on-site examination of the aircraft, lead to the conclusion that the aircraft stalled on the approach with insufficient height in which to recover.

When approaching to land, an aircraft's speed must be carefully controlled, particularly when manoeuvring in the turn on to final approach. In assessing speed at low level, pilots use a number of cues: primarily the airspeed indicator, but also the power setting and attitude, the feel of the controls and the impression of speed, sensed in the peripheral vision, by the rate at which the ground texture passes by. This last cue has been identified as being particularly powerful and difficult to ignore, and is known to have been a factor in the context of downwind landing accidents. It is possible that this impression of increasing ground speed as the aircraft turned downwind influenced the pilot inadvertently to allow the airspeed to reduce until the aircraft stalled, at which point there was insufficient height in which to recover control. In addition, the curving approach itself was probably a contributory factor, as the stall speed would have risen in proportion to the increased load factor (g) in the turn.

Had the stall warning device been operable, it might have warned the pilot of the impending stall in sufficient time for him to take action. However, the pilot stated that the device was routinely disabled to avoid nuisance activation, and it is probable that the circuit breaker had not been re-instated before the accident flight.

A further contributory factor may have been the fact that the wings were wet from the rain. Although research showed that models of turbulent-flow wings did exhibit a *'performance loss'*, the lack of appropriate scaling laws prevented the extrapolation of this finding to full-scale wings. Nonetheless, it is probable that 'turbulent flow' wet wings do exhibit different characteristics close to the aerodynamic stall and generally become less efficient, than dry wings, with a measure of increased drag for a given lift and a higher stall speed. However, this effect could not be quantified in the context of this accident.

Engineering analysis

Analysis of the ground marks and wreckage showed that the aircraft had struck the ground while in a moderate rate descent, at relatively low groundspeed, in an appreciable bank to the right, and whilst rolling right. No signs of pre-impact anomalies with the aircraft were found, except that circuit breakers had probably been set to de-activate the stall warning system and the turn and slip indicator.

Although G-IIEX came to rest relatively intact and no ground fire occurred, both occupants were injured, the passenger seriously. The accident site features indicated that initial ground contact would have been followed by a rapid yaw to the right and an appreciable nose down pitch, with substantial vertical and horizontal decelerations imposed during the main ground impact. The nose down pitch probably generated somewhat higher vertical deceleration loads in the front cockpit than in the rear as the nose struck the ground.

The deceleration loads on the pilot in the rear cockpit, with his significantly higher body mass than the passenger, partially fractured the seat pan, thereby rendering the seat more flexible. This would have attenuated the vertical loading he experienced. The visor on the pilot's helmet probably fractured due to impact with the canopy release handle and/or the bracing tube at the left forward corner of the cockpit, and may have then caused the cut on his forehead. It was probable, given the significant impact damage to the pilot's helmet, that the helmet saved him from receiving a substantial head injury.

The passenger in the front cockpit suffered serious injury. The aerobatic-type harness fitted would, if tight, be expected to provide good occupant restraint. Analysis of her injuries showed that the damage to her back resulted from high deceleration loads applied by the seat. Additional ground impact loads, generated by the nose down pitch, had probably been a factor, in combination with her comparatively light body mass and the relatively high stiffness both of the seat and of the fuselage structure of the aircraft, which is qualified for high manoeuvre load factors. Also, whereas virtually all of the longitudinal deceleration loads on the occupant of an upright seat would be reacted by the harness, the appreciable angular recline of G-IIEX's front seat meant that longitudinal deceleration would generate a significant axial load component into the passenger's back from the seat pan. The minimal seat padding present would have provided relatively little attenuation of these loads.

Additionally, it appeared that in a crash situation, the harness, although robust, would not necessarily prevent passenger contact with hard points in the cockpit, particularly torso and/or head contact. In this regard, the absence of significant padding on the bracing tubes intruding into the forward corners of the cockpit appeared to represent a particular potential danger. The pilot's helmet had prevented serious head injury from this cause; the passenger had probably escaped head contact with the tubes only by virtue of her relatively small stature.

Safety Recommendations

It was considered anomalous that substantial occupant injury should result from a ground impact of moderate severity, when the fuselage remained intact, with virtually no compromise of the cockpit volumes, and where substantial harnesses were being worn and which remained fastened and attached. While there was no post-crash fire, displacement of the engine after its mounts failed created the potential for fuel release and ignition sources. The occupants' injuries may have rendered both unconscious and, in any event, were likely to have hindered or prevented their evacuation without assistance.

It appeared that the severity of the passenger's injuries and the potential severe impact injuries to the pilot's head, had he not been wearing a helmet, could have been substantially reduced by more effective padding in a number of areas. Calculations show that increasing the displacement over which an impact acts by a relatively small amount, results in a major reduction of the peak deceleration loads experienced. Energy-absorbing plastic foams, that remain rigid under normal loading but progressively crush when subjected to crash impact loads, have been available for some years. The addition of a cushion of such foam between the occupant and the seat pan, and of padding material to areas of the cockpit that might be contacted by the occupants in a survivable crash, would be likely to reduce occupant injury substantially. It appears that sufficient space is available in the Extra 300/L for the installation of such measures, and it is likely that the cost, weight and maintenance penalties would be relatively small.

The following Safety Recommendation is therefore made:

Safety Recommendation 2009-013

It is recommended that aircraft manufacturer, Extra-Flugzeugbau GmbH, develop modifications for the Extra 300/L, and other models of similar configuration, to substantially improve the cockpit environments by the addition, for example, of energy absorption provisions for seats and relevant areas of the cockpit, with the aim of reducing the likelihood and severity of occupant injury during an accident.

It was also considered anomalous that this and other aircraft should have been certificated without a requirement for better provisions for protecting the occupants from injury in a crash. Passive means of impact load attenuation using energy-absorbing foams and other padding have been available for some time. Active systems, such as air bags, have been fitted as basic equipment to most road vehicles for many years, apparently with considerable success in improving crash survivability, without major added cost and without excessive inadvertent deployment problems. Air bags have also been available for aircraft fitment for some time. With substantial numbers in service, they have not reportedly suffered inadvertent deployments. While such systems are now widely fitted to new GA aircraft, this is not standard. The following Safety Recommendations are therefore made:

Safety Recommendation 2009-014

It is recommended that the European Aviation Safety Agency revise their certification requirements applicable to light aircraft crash survivability, with the aim of reducing occupant injury in otherwise survivable accidents. Detailed consideration should be given, for example, to requiring energy absorption provisions for seats, improved padding of aircraft components that might be impacted by an occupant and the fitment of air bag systems for both crew and passengers.

Safety Recommendation 2009-015

It is recommended that the European Aviation Safety Agency consider requiring the modification of light aircraft types for which they have airworthiness responsibility, where the extant restraint systems are unlikely to prevent contact of the occupants with hard parts of the aircraft, with the aim of reducing the likelihood and severity of occupant injury in an otherwise survivable accident. Detailed consideration should be given, for example, to requiring energy absorption provisions for seats, improved padding of aircraft components that might be impacted by an occupant, and the fitment of air bag systems for both crew and passengers.