Jet Provost T Mk 5A, G-BWBS

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Aircraft Type and Registration:	Jet Provost T Mk 5A, G-BWBS
No & Type of Engines:	1 Bristol Siddeley Viper Mk 20201 turbojet engine
Year of Manufacture:	1972
Date & Time (UTC):	24 December 1998 at 1354 hrs
Location:	In the sea approximately 1 nm from the coast near Bradwell-on-Sea, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - None
Injuries:	Crew - Fatal - Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	40 years
Commander's Flying Experience:	259 hours (of which 90 were on type)
	Last 90 days - 13 hours
	Last 28 days - 4 hours
Information Source:	AAIB Field Investigation

Background

The pilot started flying in February 1992 on Gulfstream AA5As and 5Bs and was issued with a Private Pilot's Licence (PPL) in October 1992. In March 1997, having completed 181 hours on single piston aircraft, he purchased the Jet Provost Mk 5A and commenced conversion training. An oral technical examination on the aircraft systems and a type conversion flight test were carried out in June and July 1997 respectively. He had flown his first solo flight in the JP5A in June 1997 having completed almost 12 hours of dual instruction.

History of the flight

On the day of the accident the pilot took off from North Weald aerodrome at 1314 hrs and was seen to depart initially to the west. Several minutes later he was seen to over-fly the airfield heading due east. It was usual practice to operate the aircraft, on local flights, in an area clear of controlled airspace to the north of Cambridge. On this occasion however the pilot had decided to use an area 30 nm east of North Weald, by the Essex coast, where there was controlled airspace with a base altitude of 5,500 feet amsl.

The synoptic weather situation at the time showed a flat ridge of high pressure over the area ahead of a warm front advancing from the west across Wales. The visibility was 25 to 30 km with few clouds at 15,000 feet and scattered cloud at 25,000 feet. The wind at the surface was 230°/08 kt with an air temperature of +6°C and at 5,000 feet was 250°/35 kt with an air temperature of -3°C. The sea temperature, measured 1 nm from the Essex coast, was +5°C. The surface conditions recorded by the Coastguard gave a sea state of 3 with a sea swell of 1 metre, a wind force 4 and visibility of 4 nm.

Several witnesses saw the aircraft as it arrived in the area. Some teenage boys saw the aircraft as it flew from west to east. They described it as carrying out a loop followed by three slow rolls to the left. It then disappeared from their view.

Two witnesses, one positioned at Bradwell power station and another walking close by the sea wall, saw the aircraft carry out a series left-hand level turns as it flew north and south just off the coast. One witness estimated its height to be between 2,500 and 3,000 feet. The witness at the power station then saw the aircraft pull up to a near vertical climb reaching an estimated height of 3,500 feet. He described it as then 'hanging in the air momentarily' before entering a spiral descent to the right. A witness, standing by his house close to the sea wall and abeam the aircraft, saw it on a northerly heading and then moments later in what he described as a 'flat spin - like a sycamore seed'. As it descended he realised it was going to crash. He turned towards his house to telephone the emergency services when he saw a parachute separating from the aircraft. He then cycled to the sea wall expecting to see the aircraft or pilot on the foreshore. To his surprise he saw only the calm surface of the water.

One witness described the aircraft as being 'in a spin to the right, with is nose almost vertically down. It carried out 4 to 5 turns and at the end of the 5th turn the nose lifted to about 45° before it hit the water. The resultant spray rose level with the descending tailplane'. It was at this time that she saw 'a fully developed parachute canopy but almost immediately the parachute disappeared'. This witness checked the time as being 1354 hrs.

Radar information

Radar information, recorded from the radar head at Debden, showed the aircraft's track as it approached the coast. Only positional information was available as the aircraft's transponder mode 'C' (altitude encoding) was not received.

The recorded information showed the aircraft flying east over the Blackwater Estuary with a loop probably being carried out just to the west of Mersea Island. The aircraft's track then proceeded eastwards along the coast where several vertical or near vertical manoeuvres were evident. The aircraft then flew westwards towards Mersea before turning south to parallel the coast by Bradwell. Here a couple of normal left turns were evident before, whilst steady on a northerly track, the aircraft carried out one final vertical manoeuvre. At no time was the aircraft more than 1 km form the coast. The last recorded radar return was timed at 1354 hrs and 17.9 seconds.

Search and recovery

Thames Coastguard received a 999 call at 1355 hrs. The Rescue Co-ordination Centre (RCC) at Kinloss were contacted and a rescue helicopter from RAF Wattisham was requested. The Bradwell Coastguard was also tasked as was the West Mersea lifeboat. The Essex police launch in Bradwell marina and the police helicopter were also alerted.

At 1415 hrs the Bradwell coast guard arrived on the scene and on the sea wall met one of the witnesses. They could see no trace of the aircraft or pilot. Shortly afterwards the other units arrived on the scene and commenced searching procedures. At 1428 hrs the Essex police helicopter reported sighting a dark object in the water which they believed to be the aircraft. At 1436 hrs the police launch recovered the pilot's helmet from the water. As the pilot had still not been located the search was expanded and the Clacton Atlantic and Walton lifeboats were launched. These were joined by an angling boat and shoreline Coastguard search teams from Mersea and Clacton.

By 1630 hrs, with the onset of darkness, all units except the Clacton and Walton lifeboats were recalled. They remained on task to carry out a search at low water. At 1948 hrs, as the low water search commenced, the weather deteriorated to heavy rain and although the Essex Police helicopter was available it could not participate because of the poor conditions. By 2037 hrs the aircraft fuselage had been positively located by the Coastguard. They could not however approach due to the incoming tide. The Clacton lifeboat confirmed that the pilot was not in the cockpit and that the left ejector seat appeared to have been fired. A buoy was attached to the wreckage as a marker. The Clacton lifeboat then checked other buoys in the entrance to the River Blackwater in case the pilot had managed to swim to one of them. By 2141 hrs all units had returned to their bases. The search was resumed the following day and at 0939 hrs the Wattisham helicopter located the body of the pilot at the location indicated in Figure 1.

Safety and survival

The pilot was dressed in a light weight flying suit over normal everyday clothing. He wore a flying helmet, an oxygen mask, leg restraint garters but no a life jacket. The ejector seat was not equipped with a dinghy. A sea temperature of 5°C was measured by the police launch at the time of the rescue attempt.

The CAA General Aviation Safety Sense leaflet No 21A deals with ditching and in particular with sea survival. Relevant extracts are reproduced below:

> Whilst properly fitted lifejackets can prevent people from drowning none can provide any protection against hypothermia.
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> Hypothermia is defined as lowering of the 'core' body temperature. In cold water, the skin and peripheral tissues cool very rapidly, but it can be 10 to 15 minutes before the temperature of the heart and brain begin to decrease. Intense shivering occurs in a body's attempt to increase its heat production and counteract the large heat loss. Decreasing consciousness, mental confusion and the loss of the will to live, occur when the deep body temperature falls from the normal 37°C to about 32°C. Heart failure is the usual cause of death when the 'core' body temperature falls below 30°C.

Survival times for individuals in cold water will vary greatly depending on water temperature,

individual build, metabolism, fitness and the amount of clothing worn.

In addition, several other responses to the shock of sudden immersion in cold water can cause death:

(a) Heart failure is possible for those with weak circulatory systems, particularly the elderly.

a. Hyperventilation can increase the risk of swallowing water.
b. Cold makes coordinated movement difficult.
c. Ability to hold ones breath is severely curtailed, perhaps to just a few seconds, thus reducing the chances of successful escape from submerged aircraft.

The graph shows average survival times:

Aircraft description and history

The aircraft, which is of all metal construction with a pressurised cockpit, is powered by a single Rolls Royce Viper Mk 102 turbojet engine, located in the fuselage immediately aft of the cockpit, capable of producing some 2,500 lbs (1,134 kg) static thrust. This particular aircraft was fitted with wing tip fuel tanks. The primary flight controls, which can be locked by a pilot operated locking system for use when on the ground, are controlled manually. The flaps and the retractable tricycle landing gear are hydraulically powered.

The aircraft was built in 1972 as a Jet Provost Mk 5A for service in the RAF (XW431) as a side-by-side two seat basic jet trainer. It was placed onto the UK civil register as G-BWBS in early 1995, having flown for some 5,340 hours. Its most recent Permit to Fly was issued on 25 August 1998. A condition of that Permit was that a Certificate of Validity (usually valid for a period of 12 months) must be issued following a satisfactory inspection; this aircraft's certificate was valid until 24 August 1999. At the time of the accident it had flown for a total of some 5,415 hrs.

Impact parameters

The aircraft entered the water on the Dengie Flats (51° 42.725'N, 000° 58.98'E), approximately 1.5 nm to the east of the shore between the high and low water boundaries (see Figure 1). At the time of the accident it was high tide with some 12 to 14 feet of water covering the mud flats. Examination of the wreckage distribution at low water and after recovery, showed that the aircraft had entered the water with a high vertical speed, little or no horizontal velocity and in a left wing and nose low attitude of some 30° and 45° respectively. The close proximity of the aircraft's canopy and ejection seat to the main wreckage on the mud flats indicated that the escape system had operated immediately prior to the aircraft striking the water.

Wreckage recovery

Due to the unusual characteristics of the accident site (see Figure 1) access to the wreckage was only available at low water. The fact that the aircraft was not always fully uncovered at low tide, the soft nature of the mud, unsuitable weather and availability of salvage equipment resulted in the recovery of the wreckage taking place over a period of several weeks. This was accomplished, mostly, by the use of a flat bottomed tug equipped with a hydraulic crane, that could be beached close to the wreckage at low water. The aircraft was recovered in sections for, although the crane had the capacity to lift the dead weight of the aircraft, significant quantities of mud had been washed into the structure, considerably increasing its mass. However, almost all of the aircraft was eventually recovered to the AAIB at Farnborough for examination.

Examination

Initial examination of the wreckage at the site, and its distribution, indicated that the aircraft had been complete and structurally intact prior to impact with the sea. Both ailerons and flap surfaces had detached as the aircraft entered the water, but had remained close to the wreckage. Severe structural disruption had occurred to the fuselage around the engine location and the left outer wing was found partially detached. All structural failures and related deformation, however, were consistent with being caused by impact with the water at a high vertical speed A detailed examination of the wreckage did not reveal any evidence of fire, pre-existing defects or foreign objects within the flying control systems, all failures being attributed to excessive forces applied during the accident or deliberate cutting during the recovery. The configuration of the aircraft at impact was with the flaps and landing gear fully retracted, but with the cockpit canopy and left ejection seat missing. The control lock system was found in the disengaged position, with no evidence to suggest that it had been restricting the primary flight controls at the time of impact.

After recovery, the engine was removed from the fuselage and examined with assistance of the manufacturer. The wing spar 'carry through' structure in the fuselage, located beneath the engine, had been forced up into the compressor casing and had caused localised damage to the central part of the compressor. This resulting damage, and deformation to all the turbine blades, indicated that the engine had been running at a reasonably high power level at the time the aircraft entered the water. Evidence from photographs of the wreckage in the water, taken shortly after the accident, indicated that there was a significant quantity of fuel leaking from the wreckage after the impact (see Figure 1).

Escape system

The aircraft was fitted with two Mk 4 Martin Baker ejection seats, the original standard equipment used when it was in service with the RAF. Examination of the pilot's seat (left seat) showed it to have operated correctly. The right ejection seat, which was found still within the cockpit, was in a serviceable condition with all its safety pins installed. The aircraft records indicated that both seats had been serviced in April 1998 by a specialist company operating, in this case, under the authority of the aircraft's maintenance organisation.

Civil Aviation Authority publication (CAP) 632, titled 'Arrangements for the Operation of Ex-Military Aircraft on the UK Register with a 'Permit to Fly', details the operational considerations that should be applied to specialised equipment and systems. Paragraph 6.6, reproduced below, deals with ejector seats:

> 'Where ejection seats are an integral part of the aircrew escape system, as specified in the relevant Pilots Notes or Aircrew Manuals, they must be fully serviceable for all flights, unless specifically exempted, and all occupants must be suitably trained in their use and medically fit before being allowed to fly in the aircraft. For swept-

wing aircraft fitted with ejection seats it is unlikely that the Authority would allow them to be flown unless the equipment was fully operational'.

Pilot's notes

Pilot's notes for the JP5 contain entries on 'Stalling in Manoeuvre', 'Spinning Characteristics', 'Incipient Spin Recovery' and 'Spin from Manoeuvre'. These are reproduced below:

> *Stalling in Manoeuvre.* Stall warning during manoeuvres is given by mild airframe buffet and the aircraft is easy to fly at the buffet. Forward movement of the control column effects immediate recovery. At speeds above 240 kt the 'g' limit is reached before the onset of buffet.
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> *Spin Characteristics.* The spin may take up to three turns to become developed. The first turn is quite slow and very little height is lost; during the second and third turns, the rate of rotation increases and the attitude steepens. In a steady spin the attitude is approximately 45° nose-down, the speed is generally below 130 kt and the height loss is about 800 feet per turn. At low fuel states the spin may be oscillatory, and in such cases the aircraft may recover rapidly as recovery action is taken.
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> *Incipient Spin Recovery.* Only the first turn of a spin can be considered as incipient and, during this stage, recovery can be effected by centralising the controls. If, after recovery action has been taken, buffet is still present or recurs, it is because the control column is being held aft of the neutral position and must be moved forward to the correct position; this eliminates buffet. If incipient spin recovery action proves ineffective, the full spin recovery action must be taken. However in this case it is important that the control column is moved from whatever position it has been in to a position just forward of neutral with the aileron central. If commencement of recovery action is delayed beyond the first turn the full spin recovery action is to be taken.
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> *Spin from Manoeuvre.* The aircraft is reluctant to spin if the controls are mishandled during manoeuvres. If effective control is lost, use the incipient spin recovery drill. The spin entry is less predictable than a spin from straight and level flight; if recovery is delayed, standard spin recovery is effective but recovery time may be longer than a spin from straight and level flight. When carrying out intentional spins from manoeuvre the speed on entry should not exceed 110 kt. To reduce the likelihood of a high rotational spin, apply full pro-spin rudder and elevator and maintain until recovery action is commenced.

Organisational control manual

The pilot was a member of an independent organisation set up in accordance with the operational requirements detailed in Civil Aviation Publication (CAP) 632 for the operation of ex-military aircraft. The organisation was administered by an ex-RAF pilot who is a very experienced Jet Provost Qualified Flying Instructor (QFI).

The Organisational Control Manual for the organisation set out the operational procedures under which the aircraft would be operated. It included, amongst other subjects entries concerning; conversion training, periodic checks, safety equipment usage policy, and ejection seat policy. It was updated and re-issued on 1 October 1998.

Follow-up action

As a result of the accident the organisation's Chief Pilot issued a flight safety notice to all the pilot/owners of the organisation. In general terms the notice re-emphasised that:

1. No solo aerobatics were to be undertaken below 5,000 feet until a suitable individual standard had been met and further training given in order to obtain a display authorisation.

2. Aerobatics should be completed in the range 5,000 to 9,000 feet.

3. 'Stall Turns' could only be attempted solo by those pilots specifically authorised.

4. Full and incipient spin recovery techniques should be a reflex action.

5. The correct flying and safety equipment coupled with the knowledge of how to operate it is an essential requirement if pilots are to have the best possible protection in the event of a mishap.

Conclusion

Radar evidence and witness statements suggest that the pilot was carrying out aerobatic manoeuvres in an area adjacent to the coast. A total engine failure or partial loss of thrust in this position would have allowed him to turn towards the coast where he could either carry out a forced landing on land or eject over the land. His final manouevre culminated in either an attempted 'wing-over' or 'stall-turn'. During this manoeuvre the aircraft pitched up to the near vertical, lost most of its energy and inadvertently entered an incipient spin which turned into a fully developed spin to the right. The number of turns achieved during the near vertical descent was described by one witness as being 4 or 5. An average height loss of 800 feet per turn would indicate that the spin started at a height of 3,200 to 4,000 feet above the sea.

Corrective action, if applied, was not effective leaving the pilot with the only option to abandon the aircraft. A successful ejection from a position over the sea meant that the resultant parachute descent would be into the water. Although the ejection sequence was initiated at a very low level the ejector seat and its associated sub-systems functioned correctly depositing the pilot gently in the sea from a fully developed parachute.

The sea temperature was 5°C and the transition from a warm cockpit environment to near freezing temperatures would have been in the order of a few seconds. This would have resulted in a tremendous thermal shock to the pilot's body possibly causing the rapid onset of incapacitation. He did however have time to release himself from his parachute harness and to remove his helmet.

Had he been wearing a life jacket and been able to inflate it he would, although lapsing rapidly into unconsciousness and suffering from hypothermia, most probably have survived with his head supported clear of the water, for the 20 minutes or so that it took for the airborne rescue services to arrive on the scene.