

AAIB Bulletin No: 7/94 **Ref:** EW/C94/4/1 **Category:** 1.2

Aircraft Type and Registration: Jet Provost T3A, G-BVEG

No & Type of Engines: 1 Rolls Royce Viper 102 turbojet engine

Year of Manufacture: 1964

Date & Time (UTC): 3 April 1994 at 1142 hrs

Location: Stanway near Colchester, Essex

Type of Flight: Private

Persons on Board: Crew - 1 Passengers - 1

Injuries: Crew - None Passengers - 1 Minor

Nature of Damage: Canopy and one seat destroyed; damage to the tailplane

Commander's Licence: Private Pilot's Licence (Groups A and B) with Night Rating

Commander's Age: 31 years

Commander's Flying Experience: 375 hours (of which 5 were on type)
 Last 90 days - 22 hours
 Last 28 days - 13 hours

Information Source: AAIB Field Investigation

Background

The aircraft was sold by the Royal Air Force in 1992 as XN 629. It was eventually transported in a partially disassembled state to Binbrook where it was re-assembled in the autumn of 1993 and modified in preparation for placement on the UK civilian register with a Permit to Fly. Permission to retain the RAF colour scheme was obtained and the aircraft was registered as G-BVEG. The main differences from the military standard were changes to the radio fit and removal of all the pyrotechnic devices from both ejection seats and the canopy jettison mechanism. Although powered by a jet engine, the aircraft had manual flight controls and simple mechanical systems. The vendor supplied the purchaser with copies of the RAF Aircrew Manual, flight reference cards (checklist) and a Flight Training Manual issued to RAF student pilots.

History of the flight

The pilot, who had no military flying experience, purchased G-BVEG in March 1994 and obtained flight training from an instructor qualified on type before taking delivery of his aircraft. The flight training included aerobatics and the procedures for abandoning the aircraft in flight. The pilot/owner

was not shown how to check the ejection seat for serviceability or correct locking and he did not seek such training because he understood the seat to be 'inert'. After the training, a crack was discovered in the canopy above the right-hand ejection seat (see Plate 2). The owner consulted the vendor and his instructor as to the cause of the crack. It was concluded that the crack had probably been caused by very slight movement of the instructor's seat which, at the time, was fully adjusted to its uppermost position. The canopy was changed but no specialist check of the ejection seat security was carried out. The next day the weather was unsuitable for further training and the aircraft was ferried to North Weald by the instructor.

A few days later the pilot decided to fly the aircraft with his brother as passenger. The passenger had no pilot qualifications and had never before flown in a jet aircraft with an ejection seat. Being aware of his brother's inexperience, the pilot briefed him carefully on the procedure for abandoning the aircraft which was to jettison the canopy, release himself from the seat by pulling the manual separation handle on the side of the seat, stand up, dive over the side towards the trailing edge of the wing and then, when well clear of the aircraft, pull the parachute ripcord 'D' handle which was just above his waist on his left-hand side. Whilst sitting on his own seat the pilot assisted his brother to strap-in and a youth standing outside the cockpit assisted the passenger with his shoulder straps. The passenger felt secure in his seat but whilst taxiing out he felt slightly uncertain about the procedure for abandoning the aircraft. He expressed his concern and so the pilot reviewed the procedure with him and the passenger felt for and found the location of his parachute 'D' handle. Both aircraft occupants were wearing military style helmets with boom microphones and the passenger was wearing a leather flying jacket with the collar turned up around his neck for protection from a cold wind.

The aircraft departed from North Weald for a short familiarisation flight over East Anglia. At some time the passenger dropped his sunglasses which he was unable to retrieve and so he lowered the tinted visor on his helmet. The navigation phase of the flight proceeded uneventfully and near Colchester the pilot decided to carry out some rolling manoeuvres. He handed his map and checklist to the passenger and then commenced an aileron roll to the right at 3,000 feet altitude and 220 kt. This roll was uneventful and so he executed a second roll to the left from a similar altitude. During the second roll the passenger felt his seat move slightly and then near the inverted flight position the seat suddenly slid up the rails, due to gravity forces, ruptured the canopy and left the aircraft.

The passenger was unhurt as he passed through the canopy but totally perplexed by the sudden absence of anything around him. He recalled falling in the seat for a second or two and then falling free of the seat for a few seconds. He reached for and found the parachute ripcord handle in the pre-briefed position and pulled it. His parachute opened and his rate of descent was arrested, but shortly after the parachute had inflated, he experienced difficulty in breathing. He was aware that his legs were unsupported and that the whole of his lower body was free to move, but his chest was

compressed and he could feel something hard pressing on his throat through the collar of his jacket. Despite being unable to breathe freely, he remained conscious, saw the ground and prepared himself for impact by bending his legs. He landed in long grass and was assisted by two persons who had observed his descent. Once the parachute had been removed, the passenger was able to breathe freely once more and he was soon assisted by the emergency services. He was taken to hospital, examined, treated and released the next day. His injuries were a strained neck, swollen tongue and swollen throat but there was no evidence of any entanglement in the parachute rigging lines.

The following safety recommendations are, therefore, made:

94-10 Where the procedure for abandoning an ex-military aircraft differs from the procedure contained in the military-issued Aircrew Manual or Pilots Notes, the abandonment procedure should be published as an official supplement to the Aircrew Manual/Pilots Notes and approved by the Civil Aviation Authority.

94-11 The CAA should take action to require that all occupants of civil registered aircraft equipped with ejection seats, whether inhibited or not, receive appropriate training, information and certification regarding the use of the seats and the equipment installed on the seats such as parachutes and oxygen systems.

According to an eyewitness who watched the aircraft rolling, two objects fell from it whilst it was inverted. The smaller object fell freely and after a few seconds a small drogue appeared above the larger object, followed by a parachute. The parachute appeared to deploy fully and the occupant was suspended in it for about 30 seconds. The unrestrained ejection seat struck the roof of a house causing minor damage but no injuries.

After the ejection seat fell out of his aircraft, the pilot orbited the area but was unable to see either the parachute or the ejection seat. Having lost his map and with his vision impaired by airflow through the large hole in the canopy, he had some initial difficulty in finding North Weald. He was also unable to hear very well because of wind noise but he broadcast a 'MAYDAY' message on RTF announcing his predicament and that he was returning to North Weald. Shortly afterwards he obtained assistance from a friend who was airborne in another aircraft which the Jet Provost pilot recognised and subsequently followed. He landed at North Weald without further incident and his aircraft was met by the volunteer fire service which assisted in making the aircraft safe and securing it in a hangar. Although the headboxes of both seats had been fitted with metal placards to indicate that the seats were inert, there was some initial difficulty in determining the status of the ejection seat because the placards were not immediately apparent to the fire crew as the standard method of identifying inert seats.

Examination of the aircraft and ejection seats.

Examination of the aircraft was conducted with the co-operation of the ejection seat manufacturer, Martin-Baker Aircraft Co Ltd. Initial observations showed that most of the cockpit canopy glazing had been lost and there was evidence of impacts on the empennage, which included a boot print low down on the right side of the fin. Inspection of the cockpit showed the right seat ejection gun to be still correctly located and bolted in place. The inner piston of the gun was fully down with the breech groove correctly aligned relative to the top latch window, the upper edge member of which was heavily and abnormally worn (see Plates 4 to 6 and Fig 1). Examination of the cockpit floor revealed a pair of small, but deep dents in a position which, with the right (passenger) seat installed, would have been directly below the bottom end of its right side main structural beam (see Plates 7 and 8). This beam end should, with the top latch fully engaged, have been about 1/2 inch clear of the cockpit floor.

Examination of the left (pilot) seat, which had remained in the aircraft, showed that this seat was fully and safely latched. A specific inspection was made to determine the status of the seat, since there was no manufacturer's procedure to render the seat explosively inert whilst still allowing the occupant to bale out over the cockpit side and, in such a condition, the seat is no longer an escape system as designed. This showed that, when the seat had been rendered inert, the upper ends of the trip rods for the barostatic time delay release mechanism and the drogue gun had, additionally and unusually, been lightly wirelocked onto their respective seat components; the lower end of the rods had been connected to the ejection gun crossbeam in the normal correct manner. The main parachute extraction line from the seat drogues, normally routed through the guillotine, had been disconnected from the parachute and removed from the guillotine. The attachments from the Personal Survival Pack to the parachute harness had been disconnected.

This configuration would have allowed the occupant to release himself and the parachute pack from the seat using the Manual Release Handle. In the event of the seat sliding more than about 2 inches upwards relative to the gun, the spring powered barostatic time delay release would have been activated when the telescopic trip rod pulled the sear from the mechanism. This in turn would have released the occupant and parachute from the seat 1.25 seconds later. Following either method of separation from the seat, the occupant would then have been able to deploy the main parachute using the 'D' ring ripcord. If the main parachute extraction line had not been disconnected from the drogues, the main parachute could not have been separated from the seat without the guillotine explosive charge being fired.

The examination also showed that the leg restraint lines had been pulled as far forward as possible through the snubbing units on the underside of the seat pan forward edge, rolled into a coil and the coil bound with lockwire. This procedure had left short lengths of each leg restraint, with their floor attachment fitting at the end, hanging free from the 2:1 ratio rollers attached to the front of the bottom end of the seat main structural beams. These were in such a position that, unless positive steps were taken to ensure that they did not, the floor attachment fittings naturally and repeatedly fell into positions where they came to rest between the bottoms of the seat beams and the cockpit floor. In this position they obstructed the seat from being lowered sufficiently onto the ejector gun to allow full engagement of the top latch. Comparison showed that the distance between the two dents, in the floor beneath where the right seat had been fitted, matched the spacing of the side plates of the leg restraint line floor attachment fitting. It was observed that the floor attachment fittings of both leg lines on this seat were distorted and the frangible shear rivet of one, broken.

The right (passenger) seat had been retrieved from where it had fallen, by the RAF Wittering duty Explosive Ordnance Disposal team, and taken to RAF Wittering where it was confirmed to be inerted with no cartridges fitted. The seat and parachute were then taken to the RAF Institute of Aviation Medicine and a full examination of all the equipment was performed.

Examination of the parachute showed it to be undamaged, with no evidence of its having become entangled whilst deployed. The condition of the shrouds, rigging lines and the canopy material indicated that the parachute had inflated very gently. When deployed normally in an ejection sequence, the parachute would be extracted rapidly from its pack by the seat drogues and inflate very quickly.

Examination of the seat showed that its leg restraint lines had been coiled in an identical manner to those already noted on the left seat (see Plate 9). The floor attachment fittings of both the leg restraint lines showed clear evidence of being crushed and the frangible shear rivet of one, broken, this evidence being more severe on the fitting attached to the right main seat beam. Examination of the seat mechanisms showed that the spring-powered barostatic time delay release mechanism had operated normally after the seat had left the aircraft, and thereby released the passenger's harness from his seat.

As a result of these observations, the following safety recommendation is made:

94-12 The CAA should require all operators of aircraft fitted with inerted Martin-Baker ejection seats to take the seats out of the aircraft in order to remove completely the leg restraint lines from the seats. Before refitting the seats they should ensure that the cockpit floor in the area below the seat is completely free of obstructions.

Examination of the top latch plunger assembly showed unusual signs of wear on the two angled faces of the engaging end of the plunger, one side being more severely worn (see Plates 10 to 12 and Fig 1). This wear was in a position which was consistent with the latch being only partially engaged, with the angled face of the plunger in contact with the upper edge of the top latch window on the ejection gun (see Plate 5). It also revealed that the threads at the visible end of the plunger, on which the seat extraction tool is fitted to remove the seat, had been damaged at a regular spacing as if the latch had been 'prised out' by a series of levering actions (see Plates 13 and 14). The latch engagement spring and the latch safety indication system were undamaged and working correctly.

As a result of these observations, the following safety recommendations are made:

94-13 The CAA, in conjunction with Martin-Baker Aircraft Co Ltd, should establish set procedures by which each particular ejection seat installation may be rendered inert if such action is desired and acceptable.

94-17 The CAA, in conjunction with Martin-Baker Aircraft Co Ltd, should establish the requirements for the examination of maintenance personnel in order to approve them as competent to work on both inert and live ejection seats in the civilian environment and require that all work on ejection seats, including their removal for access to other equipment and subsequent re-installation, must be carried out and certificated by such approved persons.

Inspection of the broken canopy which had been removed on 29 March 1994, after the training flights, showed that the centre of the cracking had been immediately above the scissor shackle locking plunger housing of the right seat. On the right seat, this housing is normally very close to the canopy glazing and is, by design, chamfered to give greater clearance (see Plates 1, 2 and 3). The seat structure, to which this housing is attached, cannot move perceptibly up and down on the guide rails if the top latch is properly engaged. Vertical adjustment of the seat pan height does not involve movement of the seat structure. No evidence of the canopy replacement appeared in the servicing documentation and, so far as can be established, no attempt was made to obtain a new Flight Release Certificate from an approved engineer.

The following safety recommendation is therefore made:

94-18 The CAA should consider clarifying the wording of each Permit to Fly and its associated Operational Limitations such that the actions necessary to maintain the validity of the Permit are clear.

Survival

The ejection seat's spring-powered barostatic time delay release mechanism had operated normally and thereby released the passenger's harness from the seat. After pulling the parachute ripcord, the parachute canopy inflated fully and correctly. Unfortunately, the passenger was not properly strapped into the parachute because the crotch straps had been not been correctly routed through rings on the seat lap straps and over the shoulder harness lugs. This allowed the harness to ride up the passenger's body after deployment and he was restrained by the waist strap and lap straps which rose to his armpits. His breathing was restricted by tension in these straps and by the harness Quick Release Box which was pressing on his throat. The attached diagrams show the correct and incorrect fitting of the parachute harness to a volunteer who was not involved in the accident (see Plates 15 and 16).

Summary of safety recommendations

As a result of this investigation, the following safety recommendations have been made:

- 94-10 Where the procedure for abandoning an ex-military aircraft differs from the procedure contained in the military-issued Aircrew Manual or Pilots Notes, the abandonment procedure should be published as an official supplement to the Aircrew Manual/Pilots Notes and approved by the Civil Aviation Authority.
- 94-11 The CAA should take action to require that all occupants of civil registered aircraft equipped with ejection seats, whether inhibited or not, receive appropriate training, information and certification regarding the use of the seats and the equipment installed on the seats such as parachutes and oxygen systems.
- 94-12 The CAA should require all operators of aircraft fitted with inerted Martin-Baker ejection seats to take the seats out of the aircraft in order to remove completely the leg restraint lines from the seats. Before refitting the seats they should ensure that the cockpit floor in the area below the seat is completely free of obstructions.
- 94-13 The CAA, in conjunction with Martin-Baker Aircraft Co Ltd, should establish set procedures by which each particular ejection seat installation may be rendered inert if such action is desired and acceptable.

- 94-17 The CAA, in conjunction with Martin-Baker Aircraft Co Ltd, should establish the requirements for the examination of maintenance personnel in order to approve them as competent to work on both inert and live ejection seats in the civilian environment and require that all work on ejection seats, including their removal for access to other equipment and subsequent re-installation, must be carried out and certificated by such approved persons.
- 94-18 The CAA should consider clarifying the wording of each Permit to Fly and its associated Operational Limitations such that the actions necessary to maintain the validity of the Permit are clear.

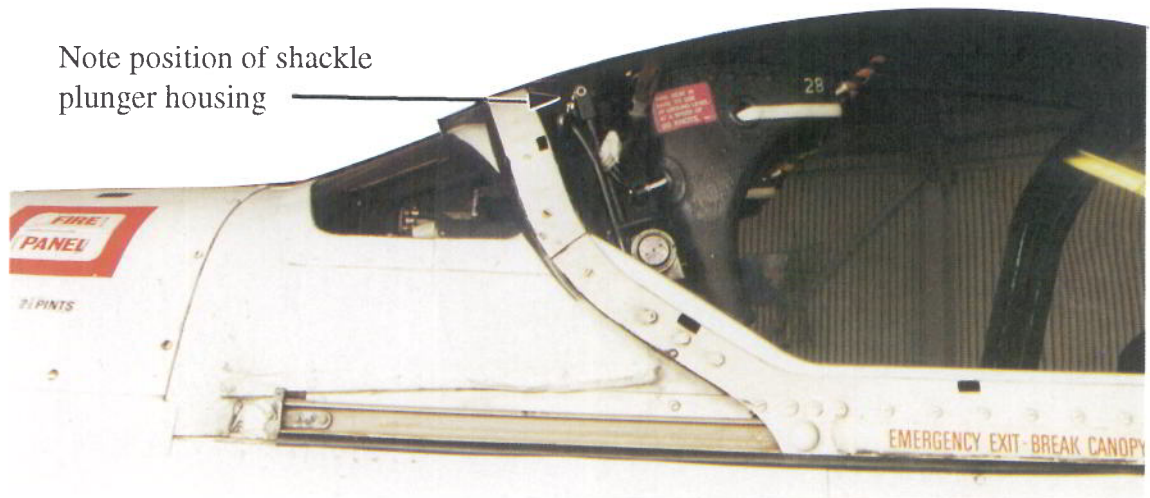


Plate 1 View of right side of rear of Jet Provost 3A cockpit canopy

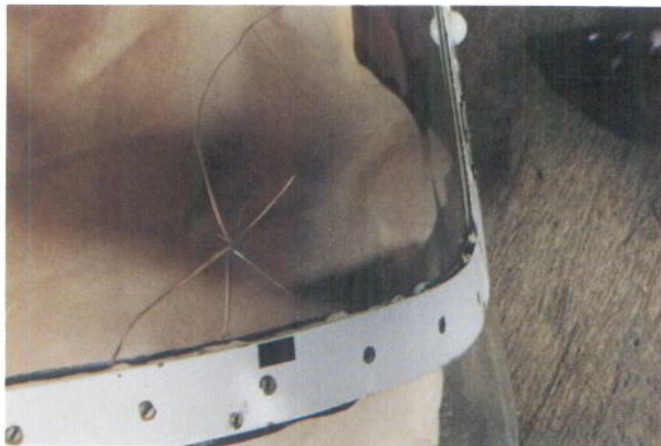


Plate 2
Cracked canopy which was removed

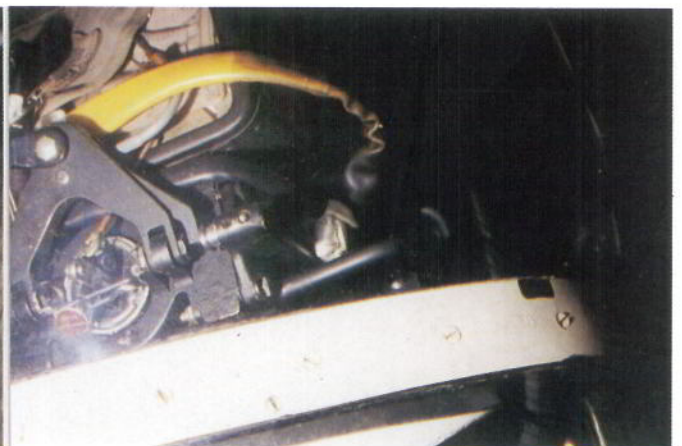


Plate 3
Position of plunger housing on intact canopy from similar angle

Note inner piston of gun still fully retracted and scoring of latch window top frame.

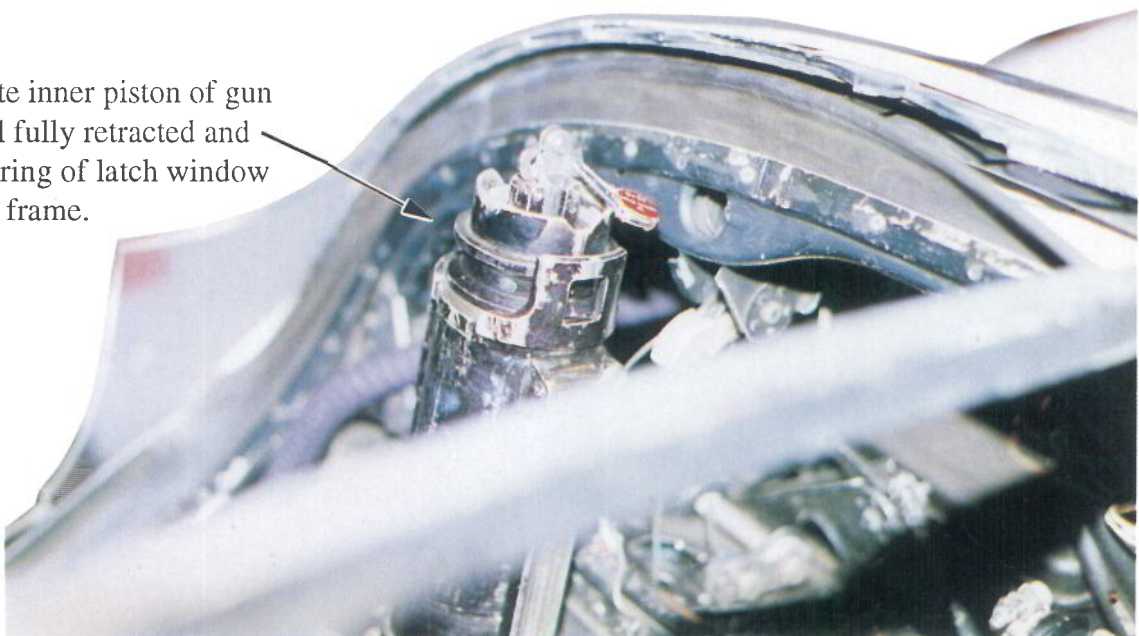


Plate 4 Right seat ejection seat gun in situ. (closer view of latch window at Plate 5)

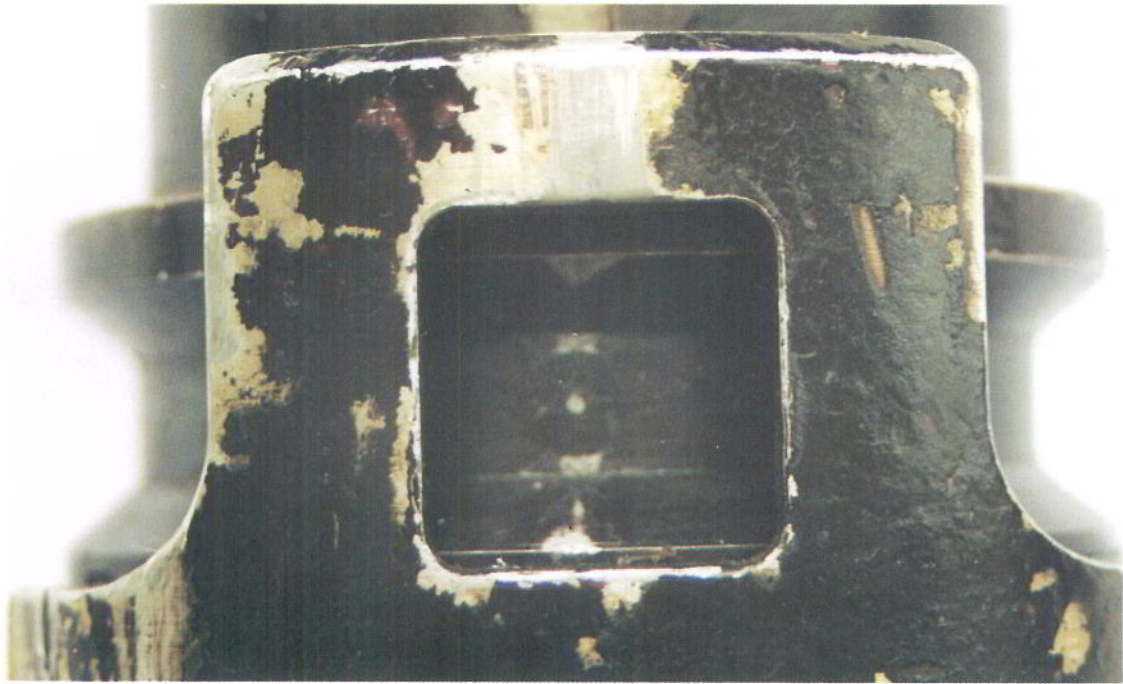


Plate 5 Latch window of right seat ejection gun
Note heavy scoring of top frame member and rounding of its edge
Note also position of latch groove relative to window.

Compare with latch window from left seat gun



Plate 6 Latch window of left seat ejection gun

Plate 7 View of base of ejection gun and cockpit floor.

Note dents on floor

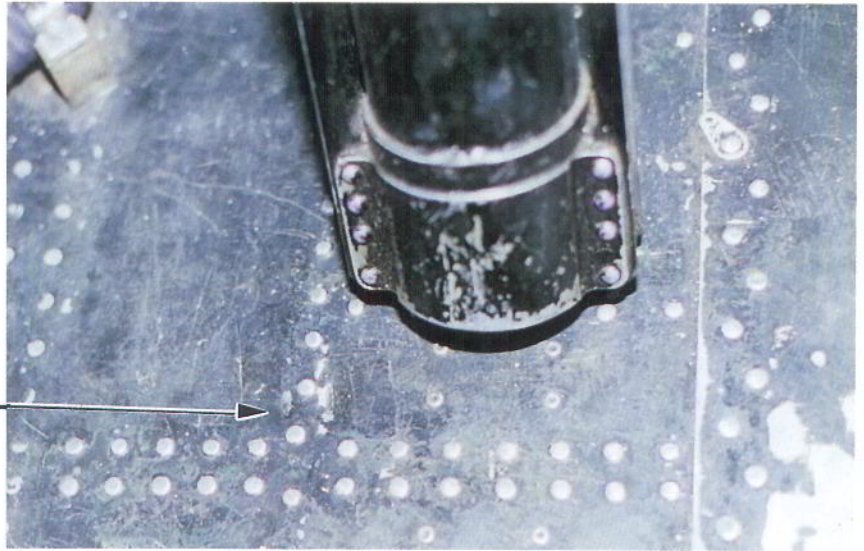


Plate 8 Dents on cockpit floor with leg restraint floor attachment fitting held beside it.

Plate 9 View of underside of seat with leg restraint lines still in snubbers and wirelocked into coils.

Note line passing behind roller on bottom of seat beam.

Bottom of seat beam on left of picture has been broken off but is still tethered to seat by leg line.

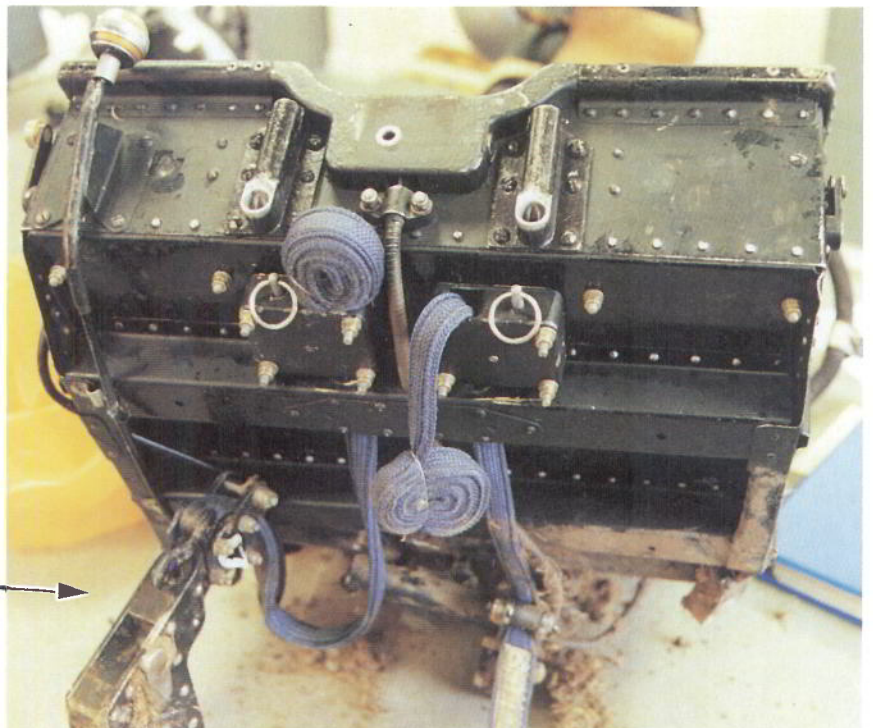




Plate 13
Side view of plunger

←
Brass extraction tool
fits on threads on
top portion of plunger

Plate 11 →
Plunger
angled face

Note heavy abrasion
on this face

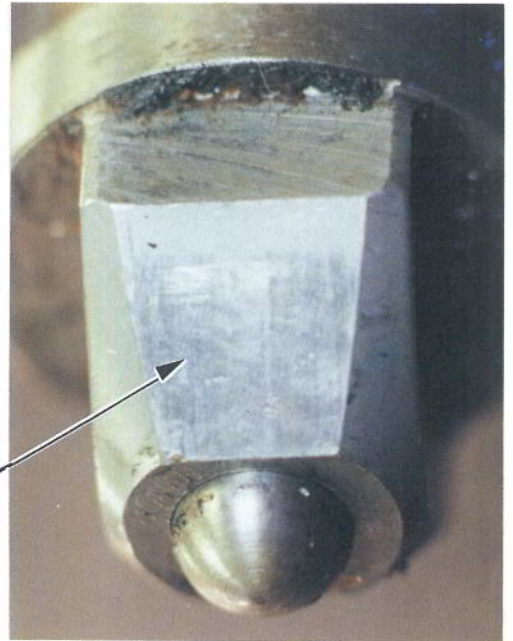


Plate 10 →
Plunger end &
angled faces

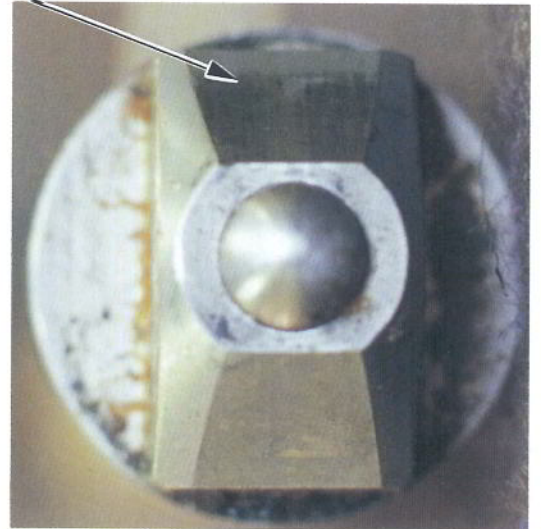


Plate 14
←
View of plunger threads
showing intermittent
damage to threadform

Plate 12 →
Plunger
angled face



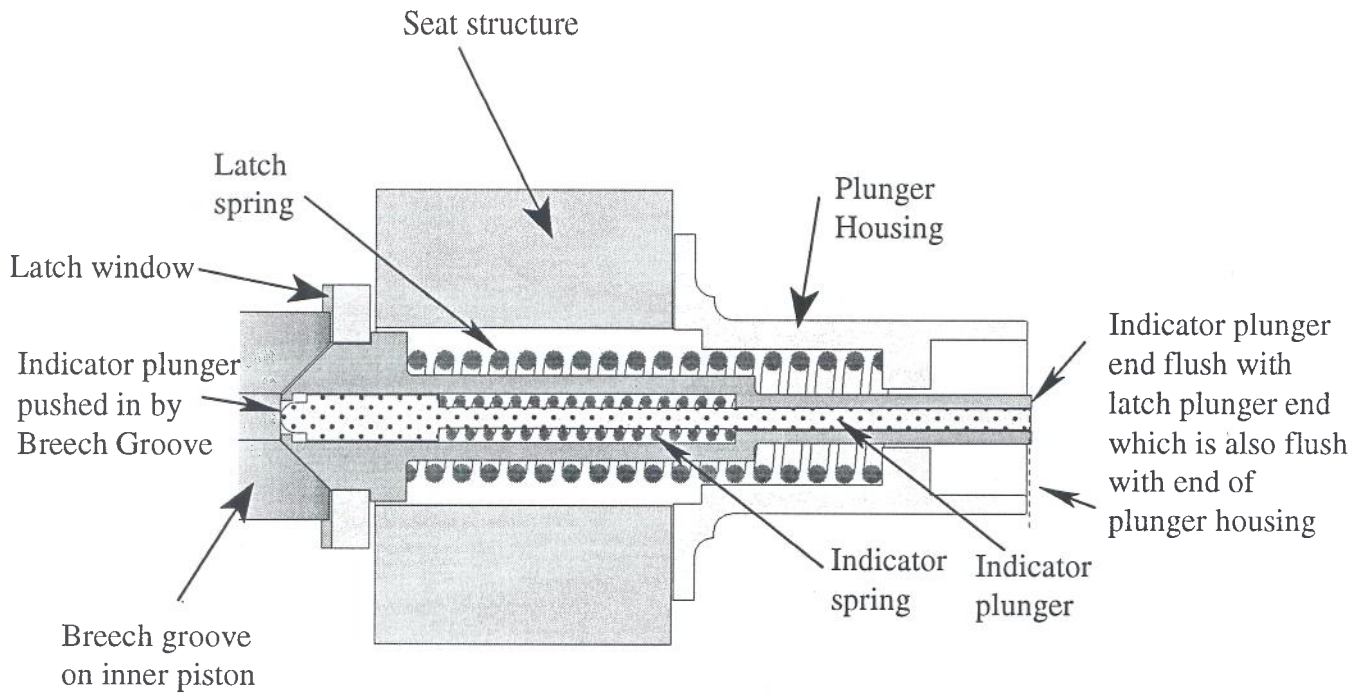


Plate 16 Parachute harness correctly fastened.
 (shown without wearer to show straps more clearly)
 Note crotch straps coming from base of back pad
 and looped into both lap and upper torso harnesses.

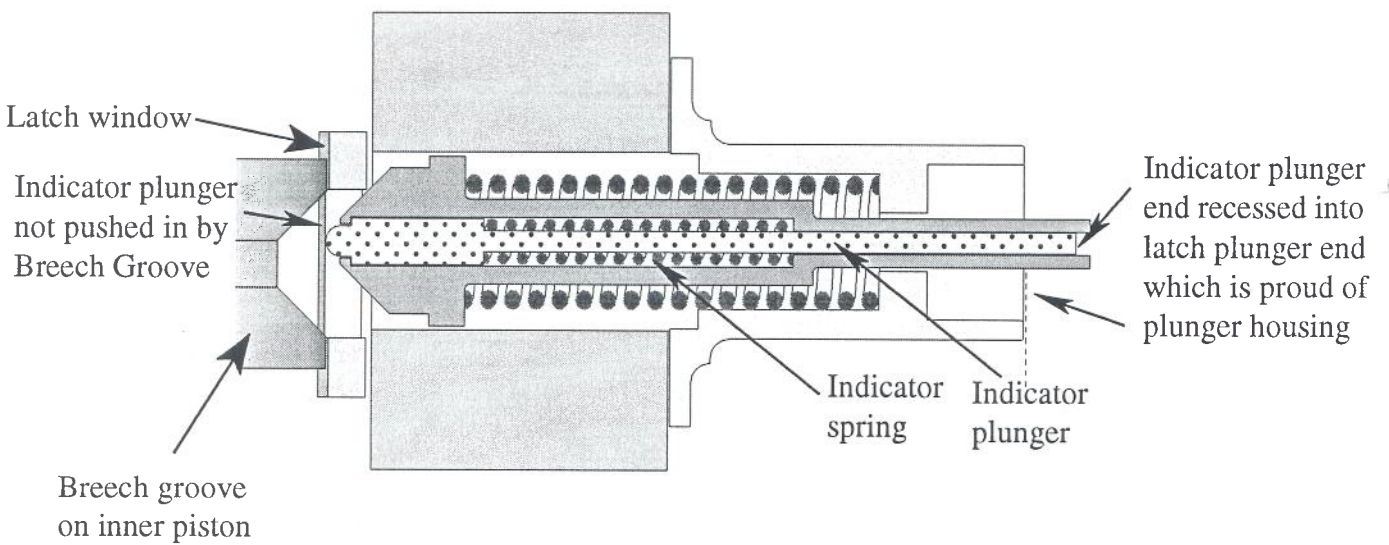


Plate 15
 Demonstration of how parachute harness will rise
 under armpits if the crotch straps are not fastened.

Fig 1 Cross section through Top Latch mechanism showing both safe and unsafe indications



a Safe



b Unsafe