

ACCIDENTS INVESTIGATION BRANCH
Department of Trade and Industry

**Piper Comanche PA 24-250 G-ATAE
Report on the accident at Bordesley Park
near Redditch, Warwickshire
on 12 June 1971**

List of Civil Aircraft Accident Reports issued by AIB in 1973

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14/73	Piper Comanche PA24-250 G-ATAE at Bordesley Park near Redditch, June 1971	October 1973

Department of Trade and Industry
Accidents Investigation Branch
Snell Mex House
Strand
London WC2R 0DP

11 October 1973

The Rt Honourable Peter Walker MBE MP
Secretary of State for Trade and Industry

Sir,

I have the honour to submit the report by Mr R D Westlake, an Inspector of Accidents, on the circumstances of the accident to Piper Comanche PA 24-250 G-ATAE which occurred at Bordesley Park near Redditch, Warwickshire on 12 June 1971.

I have the honour to be
Sir
Your obedient Servant

V A M Hunt
Chief Inspector of Accidents

Accidents Investigation Branch
Civil Aircraft Accident Report No 14/73
(EW/C385)

Aircraft: Piper Comanche PA 24-250 G-ATAE

Engine: Lycoming O-540-A1A5 250 HP

*Registered Owner
and Operator:* 'Alpha Echo Group', Four Oaks, Sutton Coldfield,
Warwickshire

Crew: Captain : Mr B Amesbury – Killed
Co-pilot: Mr T France – Killed

Passengers: Two – Killed

Place of Accident: Bordesley Park near Redditch, Warwickshire

Date and Time: 12 June 1971 at 1715 hrs

All times in this report are GMT

Summary

About 16 minutes after take-off from Birmingham airport the aircraft was seen near Redditch flying level below cloud. Shortly afterwards the engine noise was heard to reduce and the aircraft was seen to dive; as it pulled out of the dive there was a considerable increase in engine noise and the right wing separated from the aircraft which then further broke up. The four occupants were killed and the aircraft was destroyed but there was no fire.

The investigation established that the primary failure in the break-up sequence was the right wing in up-load. There was no evidence of defective material or faulty assembly or maintenance and there is no doubt that the wing failed because it was aerodynamically loaded beyond its design ultimate strength.

The overloading was almost certainly brought about by an application of excessive up-stabilator control but it has not been possible to establish any reason for this action.

1. Investigation

1.1 History of the flight

The aircraft took off from Birmingham at 1728 hrs to make an air test for the renewal of the certificate of airworthiness (C of A) following the appropriate scheduled maintenance. Mr Amesbury, the pilot-in-charge, occupied the left hand front seat and Mr France, as co-pilot, was in the right hand front seat. There were two passengers in the rear seats.

The pilot was given an Instrument Flight Rules (IFR) clearance for the area southwest of the airport to climb to flight level 50 (5,000 feet on an altimeter setting of 1013.2 mb). At 1738 hrs he reported clear of the Birmingham Control Zone and climbing to Visual Meteorological Conditions (VMC) on top of cloud. There was no further communication with the aircraft.

Several minutes later eye witnesses saw the aircraft about 12 miles south west of the airport flying below the main cloud base which was estimated to be about 4,500 feet above the ground. The aircraft behaviour was normal until a reduction of power described as a "popping and banging" was heard and the aircraft, which had been flying straight and level, was seen to pitch down into a dive. After a brief interval the aircraft nose was seen to rise above the horizontal and at about the same time the engine noise increased very considerably. At the peak of the engine noise the right wing separated from the fuselage and the aircraft then broke up further as it fell to the ground. The wreckage trail extended for almost a mile from where the engine and cockpit fell; there was no evidence of an explosion or fire but all four occupants were killed.

1.2 Injuries to persons

<i>Injuries</i>	<i>Crew</i>	<i>Passengers</i>	<i>Others</i>
Fatal	2	2	Nil
Non-Fatal	Nil	Nil	Nil

1.3 Damage to aircraft

Destroyed.

1.4 Other damage.

Nil.

1.5 Crew information

Mr Bryan Thomas Amesbury age 35 held a valid Private Pilot's Licence (PPL) with instructor endorsement and with instrument meteorological conditions (IMC) and night ratings. He learned to fly in 1953 and at the time of the accident his total flying hours were 1,855 of which about 23 had been on the Piper PA 24-250. He is known to have carried out a C of A air test in a Cessna 150 aircraft in 1970 and was considered competent to carry out the PA 24-250 air test but he was not an experienced test pilot.

Mr Thomas William France aged 30 held a valid PPL with a night rating. His total flying experience was 130 hours of which 60 were in command

and 40 were on the PA 24-250. He was a member of a syndicate which owned the aircraft and had been a pupil of Mr Amesbury in 1970 when training for his PPL; they had previously flown together in G-ATAE.

1.6 Aircraft information

G-ATAE was a Piper PA 24-250 low wing metal monoplane, equipped with a Lycoming 250 hp engine, a Hartzell constant speed propeller and a retractable undercarriage.

The aircraft, constructors number 24-1322, was built in 1959 by the Piper Aircraft Corporation of America and flew for 586 hours in the United States before being sold and delivered to a private owner in the United Kingdom in 1964. A further 294 hours were flown before ownership was taken over by the "Alpha Echo Group" syndicate in 1967. The engine had been regularly serviced and had run a total of 475 hours since new.

The aircraft had been maintained in accordance with an approved schedule under a three year C of A which expired on 24 April 1971, some two months before the accident. The last maintenance check to the aircraft was of a routine nature and no major repairs or replacements were found necessary.

The Airworthiness Division of the Civil Aviation Authority (CAA) specify that for the C of A renewal airtest for this type of aircraft it should be loaded to 2,800 lb and the centre of gravity (c of g) should be at the aft limit for that weight; it is estimated that G-ATAE had a take-off weight of 2,727 lb and that the c of g was 87.5 inches aft of the datum. This c of g position is slightly forward of the position specified by CAA but it is not considered that this would have been of any significance in relation to the handling qualities of the aircraft.

1.7 Meteorological information

The actual weather for the time of the accident at Birmingham airport was:

Surface wind:	280°/8 knots
2,000 feet wind:	320°/5-10 knots
Weather:	Rain
Visibility:	10 kilometres
Cloud:	1/8 1,000 feet 3/8 2,000 feet 8/8 4,500 feet
Temperature:	Plus 13°C

The weather is not considered to have been a factor in this accident.

1.8 Aids to navigation

Not applicable.

1.9 Communication

Radio communications with the aircraft were normal until 1738 hrs, after which there was no further contact.

1.10 Aerodrome and ground facilities

Not applicable.

1.11 Flight recorder

Not fitted and not required.

1.12 Wreckage

1.12.1 *Examination at the accident site*

Most of the wreckage fell onto farmland of grass and standing crops the heavier parts being contained in a $\frac{3}{4}$ mile trail extending south eastwards, whilst the lighter pieces and documents were distributed up to three miles distance. Consideration of the wreckage trail and examination of the wreckage indicated that there had been an airframe failure in flight at an estimated height of 3,000 feet above the ground commencing with separation of the right wing structure in upload at a point close to the centre line of the fuselage. An extensive search resulted in the location and recovery of almost the complete structure which was then removed for detailed reconstruction and examination.

1.12.2 *Further examination*

In this type of aircraft longitudinal control is achieved by an 'all moveable' stabilator which takes the place of the more conventional fixed tailplane and elevator. A moveable tab is attached to the rear edge of the stabilator by six hinges and serves a dual function as longitudinal trim tab and anti-servo tab.

Because stabilator flutter was known to have occurred in a number of previous accidents and incidents to Piper aircraft with this type of stabilator this feature was most thoroughly investigated during an examination of the wreckage by the Structures Department of the Royal Aircraft Establishment (RAE) at Farnborough. The report of this examination is at Appendix 1. No conclusive evidence was found to indicate that stabilator flutter of damaging proportions had occurred prior to the detachment of the starboard wing.

Examination of the engine and propeller revealed no evidence of any pre-crash defect or malfunction and it was established that the flaps and undercarriage had been in the up position at the time of the accident. It was not possible to determine the stabilator trim position.

The aircraft was fitted with lap-strap safety belts on all four seats. There was positive evidence that three of these belts had been fastened at the time of the accident but the belt on the right front seat was found undone. There was no evidence to indicate that the belt or its attachment fittings had been subjected to any strain or that the adjustment strap had pulled through the snubber. The RAE report concludes that this belt had not been fastened at the time of the accident.

1.13 Medical and pathological information

All four deaths were attributed to multiple injuries. Post mortem examination did not reveal any evidence indicative of a medical reason for this accident.

1.14 Fire

There was no fire.

1.15 Survival aspects

The accident was not survivable.

1.16 Tests and research

The PA 24-250 wing structure is designed to ultimate strength limits of 5.7 'g' positive and 3 'g' negative at the maximum permitted weight of 2,800 lb; this complies with the requirements of the US and UK Airworthiness authorities. Calculations show that at 2,800 lb an indicated airspeed (IAS) of approximately 170 mph would be required before the forces generated by an application of excessive stabilator control would be sufficient to produce the load factor which is considered necessary to bring about a total failure of the wing structure.

Flight tests have shown that at 170 mph in this type of aircraft the physical force a pilot would have to apply to the control column to produce an acceleration of 1 'g', can vary between individual aircraft from 20 lb to 40 lb according to the degree of static friction in the flying control circuit and the amount of backlash in the stabilator trim tab. Thus, at 170 mph IAS the theoretical stick force to produce the 4.7 incremental 'g' required to fail the wing could vary between 94 lb (4.7 x 20) and 188 lb (4.7 x 40).

Calculations and flying tests also indicate that if the aircraft is trimmed neutral for an airspeed of 40% above the stalling speed during the approach to the stall, and is not retrimmed during the recovery dive, then to maintain the aircraft in the dive the pilot will have to apply a progressively increasing push force on the control column as the airspeed increases. An airspeed of 170 mph IAS is attained in 8 to 9 seconds during such a dive and by that time the necessary push force has increased to about 70 lb.

If in this situation the control column was suddenly released then some degree of positive 'g' loading would be applied to the wing structure. However, even allowing for the full 70 lb stick force theoretically possible it would still be necessary for the pilot to pull an additional 24 lb to 118 lb according to the individual aircraft before the load factor reached a value sufficient to break the wing structure.

1.17 Other information

1.17.1 *Airworthiness aspects*

In the early stages of the investigation examination of the wreckage disclosed evidence which was then thought to be indicative of stabilator flutter, a phenomenon which had only previously been reported on this type of aircraft at high speeds. Since it is by no means unusual for a pilot to vary his sequence of test items, there was a possibility that the accident had occurred during the higher speed of the Never Exceed Speed (VNE) test rather than during the post-stall recovery.

Discussions took place with the manufacturer and with the UK and US Airworthiness Authorities and a thorough re-examination was made of the previous known and suspected cases involving stabilator flutter. It was established that these had occurred only in the higher speed range and on 20 July 1971 the UK Airworthiness Authority reduced VNE from 227 mph IAS to 200 mph IAS which was also the Normal Operating Speed (VNO). The relevant letter is at Appendix 2 to this report.

As a result of further tests by the manufacturer under the supervision of

the US Federal Aviation Authority (FAA) the latter issued an Airworthiness Directive 72-22-5 effective 31 October 1972 applying to a number of Piper aircraft and, in the case of the PA-24-250, calling for the following revisions to permissible speeds:—

Never Exceed Speed (VNE) reduced to 188 mph (CAS)
Normal Operating Speed (VNO) reduced to 167 mph (CAS)

After appropriate modifications to the rudder, in accordance with Piper Service Kit No 760705 or an FAA approved equivalent, these speeds could be increased to:—

VNE 203 mph (CAS)
VNO 180 mph (CAS)

A copy of this Directive, which the UK Airworthiness Authority extended to be applicable to all such aircraft on the UK Register, is given at Appendix 3.

1.17.2 *Test Schedule aspects*

Amongst the documents recovered from the wreckage was the C of A test schedule report form which had been completed up to and including Item 6 (performance climb). The next item on the schedule, 7.1 (Handling), called for:—

Stalls (Trim to about 40% above stall speed.
Reduce speed at not more than 1 mph/second
until aircraft stalls).

Flaps up – power off – straight

Flaps fully down – power off – straight.

Subsequent items on the schedule were 7.2 (Balked landings) and 7.3 (Maximum Speed test, VNE).

On the evidence of this document and of the eyewitnesses there can be little doubt that the test being conducted at the time of the accident was the flaps-up stall and that the wing broke off during the recovery from the post-stall dive. Tests have shown that the probable maximum speed attained during such a manoeuvre would be about 170 mph IAS. (See 1.16). This is appreciably below VNE as reduced by the UK and US authorities. (See 1.17.1).

1.17.3 *Carriage of Passengers*

The aircraft had been released on a 'Certificate of fitness to fly' for the purpose of carrying out the air test for renewal of the C of A. This was issued by the maintenance organisation under the 'A Conditions' of Schedule 2 of the Air Navigation Order 1970 for aircraft having no valid C of A. Condition 5 states that the aircraft shall not carry any passengers or cargo except for passengers who are performing duties in connection with the flight. It is not known whether the pilots or the passengers were aware of this limitation or whether the passengers were aware of the purpose of the flight. This limitation on the carriage of passengers does not apply to renewal tests conducted during the period of validity of a C of A.

2. Analysis and Conclusions

2.1 Analysis

2.1.1 *Airworthiness considerations*

Final assessment of all the circumstances of this accident was considerably delayed by work directed to establishing accurate data on stabilator flutter in the PA 24 and related series of aircraft. This work had some common ground with a superficially similar accident to a PA 28R-200 aircraft which had taken place some six weeks previously. (Civil Aircraft Accident Report 14/72 refers). However the stabilator of the PA 28 series is of a different design to that of the PA 24 so that all the considerations were not necessarily the same for the two types of aircraft.

As stated in 1.17.1 both the US and UK Airworthiness Authorities took action to restrict the limiting speeds of the PA 24-250 type aircraft and therefore, although this report has been delayed, the relevant remedial and precautionary action has not been inhibited. A thorough examination has been made of all the relevant information available from the Manufacturer and the UK and US Airworthiness Authorities. Although the original belief that stabilator flutter had been a factor in this accident was not substantiated by the RAE examination of the wreckage nevertheless the work involved may well have served as a stimulus for the action to restrict limiting speeds pending certain modifications.

2.1.2 *Possible causes*

The evidence strongly suggests that the wing failed during a recovery from a post-stall dive in which the maximum speed that would have been attained, even after an interval of eight to nine seconds, is considered to be about 170 mph IAS. This implies that any flutter or vibration, if it occurred, did so at a speed below that of any previously recorded case and nearly 20 mph below the VNE which the airworthiness authorities, after full consideration of flight test data, considered safe without modification to the aircraft. On this evidence and that of the RAE Report it would not be reasonable to consider stabilator flutter or other vibration as a causal factor in this accident.

Section 1.16 shows that in the speed range appropriate to a post-stall dive in order to exceed the design limits of the wing structure a pilot would have to apply forces appreciably greater than those which an experienced pilot would be expected to apply except under some compelling influence. There is no evidence that any external factor such as a meteorological problem or the need for sudden evasive action could have been such an influence. The possibility that vibration could have impelled the pilot into some precipitate action is discounted by the points raised in the preceding paragraph. In any event a pilot encountering such a problem would be more likely to recover gently than by an abrupt pull-up manoeuvre.

The absence of airworthiness or external factors implies some other unexpected event within the cockpit, possibly some form of distraction or interference with the controls. There is no evidence which could be construed as offering any support for such a possibility except the co-pilot's unfastened seat belt. This is entirely circumstantial and therefore, in isolation, cannot reasonably be considered as sufficient to indicate a probable cause. Consequently, on the evidence which is available, it has not been possible to reach any firm conclusion as to a reason for the

application of excessive up-stabilator control which almost certainly caused the overloading of the wing structure.

2.1.3 *Carriage of passengers*

It would appear that the presence of the two passengers was a breach of the regulations relating to the flight. The Airworthiness Division of CAA has taken steps to remind all those concerned with such flights of the need to conform strictly to the legal requirements in this matter. There is however no reason to consider that the presence of the two passengers would have had any significant effect on the handling characteristics of the aircraft and since they were certainly correctly strapped in their seats at the time of the accident they cannot reasonably be considered as contributory factors in the accident.

2.2 **Conclusions**

(a) *Findings*

- (i) The aircraft documentation was in order and the captain was correctly licensed and competent to carry out the flight.
- (ii) The aircraft had been properly maintained and prepared for the intended flight and there was adequate fuel on board.
- (iii) The aircraft weight was within the permissible limits and although the centre of gravity was slightly forward of the position specified by the test schedule this is not considered to be a significant factor.
- (iv) The aircraft broke-up during recovery from a post-stall dive, the primary failure being the right wing spar close to the centre section.
- (v) There had been symmetrical overloading of the wing structure which failed in up-load almost certainly as the result of the application of excessive up-stabilator control.
- (vi) There was no evidence of any defect of material, assembly or maintenance and no conclusive evidence that stabilator flutter or other tail vibrations of damaging proportions had occurred prior to the detachment of the right wing.
- (vii) There was no evidence that anything external to the aircraft had been an influence leading to the application of excessive stabilator control.
- (viii) There was no evidence of any medical factor in the accident.
- (ix) There was evidence which indicated that the right hand front seat belt had not been fastened at the time of the accident.
- (x) The carriage of two passengers appears to have been a breach of the "A Conditions" of Schedule 2 of the Air Navigation Order 1970. This was not a contributory factor in the accident.

(b) *Cause*

The right wing failed in up-load because it had been aerodynamically

loaded beyond its design ultimate strength. It has not been possible to establish a reason for the application of excessive up-stabilator control which almost certainly led to the over-stressing of the wing.

R D Westlake
Inspector of Accidents

Accidents Investigation Branch
Department of Trade and Industry

October 1973

ROYAL AIRCRAFT ESTABLISHMENT

Accident Note Structures 346

Note on the examination of the wreckage of Piper
Comanche PA24-250 G-ATAE

by

G. E. King

F. H. Jones, C.Eng., A.F.R.Ae.S

Ref YSE/129/06/FHJ

SUMMARY

On 12 June 1971 at about 1800 hours GMT Piper Comanche PA24-250 G-ATAE broke-up in the air whilst carrying out a series of standard tests which are part of the Air Registration Board Certificate of Airworthiness renewal procedure. At the request of the Chief Inspector of Accidents, Department of Trade and Industry, the wreckage was sent to the Accidents Section, RAE, Farnborough for examination. From the examination it is concluded that the first part of the aircraft to break was the starboard main-plane, which failed due to overstressing in upload.

No material defect or system malfunction was found to account for the accident.

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1 Introduction

Comanche PA24-250 G-ATAE crashed on 12 June 1971 in the vicinity of Redditch during a Certificate of Airworthiness renewal test flight. The aircraft broke-up in the air and all four occupants were killed.

At the request of the Chief Inspector of Accidents, Department of Trade and Industry, the wreckage was examined in detail by the Accidents Section at RAE Farnborough. This Note describes the results of that examination.

2 Circumstances of accident

The aircraft took off at 17.28 GMT and, according to a Flight Test schedule recovered from the wreckage, had completed a 5 minute climb check straight from take off to about 1800 m. No other entries appear in the test schedule. About 4 minutes after completing the climb check a radio call from the aircraft indicated that the pilot was climbing the aircraft through to clear conditions above cloud. At about 17.43 GMT the aircraft was seen flying normally below cloud by witnesses who also observed the subsequent break up. The wreckage was found scattered over an area about 110 m x 1200 m; the precise distribution is shown in Fig. 1.

3 Examination of the wreckage

3.1 General

The aircraft had broken into six major portions and a miscellany of minor items. The major items, shown in Fig. 2, consisted of:

- (a) *Starboard mainplane* from a station against the side of the fuselage to the tip.
- (b) *Port mainplane* from the tip through to the fuselage starboard side and including some cabin floor.
- (c) *Forward cabin*, controls, engine, propeller and nose wheel.
- (d) *Fuselage section* from aft of the mainplane to forward of the empennage.
- (e) *Fuselage aft section and stabilator*.
- (f) *Fin and rudder*.

3.2 Starboard mainplane

This was recovered with the flap and flap lock torn off but in otherwise good condition. The main spar, which consists of two tee section booms with a sheet web rivetted between, had failed in the upper boom by compression collapse whilst the lower boom had failed by bending tip upwards (Fig. 3). The rear attachment plate was still bolted to the wing and had detached from the fuselage by rivet shearing in the sense of attachment bolt moving upwards. The front attachment is by means of a single bolt onto the forward fuselage structure. Part of this structure and some fuselage side skin was still attached to the mainplane and had torn out from the fuselage when the mainplane had folded tip upward to a position roughly parallel with the fuselage side, ie a tip upward movement through about 90°.

3.3 *Port mainplane*

This was recovered complete in essentially good condition together with the main spar centre joint and a portion of fuselage underskin attached. The port section of the exposed main spar between the centre joint and the fuselage side was intact but of the corresponding starboard section, the outboard half of the top boom together with some web had detached and was not recovered (Fig 4). The portion of starboard half top boom still in place had moved backwards and downwards to fail the top connecting plate at one end and the other end showed a bending/compression fracture which must have matched to the missing piece. The lower boom had bent upwards from the bottom connecting plate and the outboard end showed a fracture to match that on the starboard mainplane. The tubular centre support assembly was in position and only slightly distorted.

3.4 *Forward cabin, controls, engine, propeller*

This portion of wreckage had hit the ground inverted and was severely disrupted. It had detached from the centre lower fuselage portion (3.3) by a tension failure along the starboard side of the underskin lap joint rivet line. The separation had changed to skin tearing from the centre line to the port side. The forward starboard side of this section showed the failure corresponding to the starboard mainplane front fitting tearing out as described in 3.2.

3.5 *Fuselage section*

The forward end of this section had failed in tension along the lower half lap joint rivet line, whilst the upper half showed a compression crease coupled with tearing from right to left across the cabin roof. The entire section showed a twist in the sense of anti-clockwise front movement looking towards a fixed rear end.

3.6 *Fuselage aft section and stabilator*

The aft section had separated from the fuselage by a tension failure on the port side of the lap joint and skin tearing on the starboard side. Some twist was also present in the same sense as in the fuselage section. The trim jack, push rod and tabs were still connected; cable pulling during the fuselage separation had run the trim jack past its stop, shearing the collar pin in so doing (Fig 5).

The stabilator and anti-balance tabs were still attached to the aft section and showed damage which had been caused by a variety of loadings. The whole assembly had struck the ground in a nose down attitude so that the full force of the impact was taken on the projecting balance arm and weight. The torque tube was found to be bent 0.51 mm in a tip forward sense in the plane of the balance arm. The torque tube fittings in each stabilator half had moved to shear rivets in a tip forward sense. Just to the rear of these fittings the skin was creased on the upper and lower surfaces of both stabilator halves at a point where a discontinuity occurs in the end ribs (Figs 6 and 7). The lug joining the trailing edges of the stabilator halves had failed in tension and the tab horns showed evidence of the tabs having moved part spanwise.

The stabilator port half was found with a piece of radio headset cable jammed in the tab hinge line. The main spar was completely broken just outboard of where the double spar section changes to single and there was associated skin damage on the top and bottom surfaces. Examination showed that this half had been air loaded tip downward to failure; the section outboard of the break had reached an angle of about 45° to the remainder before the top boom failed. About 2.5 cm of the lower boom was missing but the remainder showed evidence of compression (Figs 8 and 9).

The stabilator starboard half had been hit by the twin rear seat on the leading edge at a rib station. Figs 10-13 show respectively the seat, the paint mark, the seat corner fitting the damaged leading edge and the resulting position of the seat. This blow had caused the whole spar at the change from double to single section, to move backwards about 4 mm; there was associated skin buckling (Fig 14). Paint smears were present on the upper surface in the area of this skin buckling. Examination showed that they must have been there before the buckling occurred.

Further outboard from the spar 'set' was another large area of damage which matched up with the fin and rudder striking as shown in Fig 15. Smears on the fin from the leading edge damage show that the fin strike was subsequent to the seat strike (Fig 16). There was a compression crease on the lower skin running across the twin spars just outboard of the torque tube fitting. Further examination showed the lower spar booms to have collapsed in the manner shown in Fig 17.

The anti-balance tabs showed damage consistent with the loadings which had caused the damage to the stabilator. The tabs were removed and the hinges were found to have various amounts of fore and aft ply to a maximum of 0.53 mm.

3.7 *Fin and rudder*

The fin and rudder had become detached by bending top to starboard from the fuselage aft section under air loading at a time when the rudder was at neutral. Damage to the fin to fuselage fairing showed that the fin was in place when the fuselage aft section became detached from the fuselage but, as previously described, the fin and rudder had then folded over to hit the stabilator. The rudder horns* were both failed by downward bending.

3.8 *Flying controls*

The stabilator, aileron and rudder cables were still attached to their respective control components in the fuselage front portion. The stabilator cables had failed in tension at the point where they had been torn out of the two rearmost pulleys. The port aileron cable was intact with part of the port aileron horn attached. The starboard aileron cable had pulled out of its swaging and the aileron horn had also failed. The aileron balance cable was intact, being still attached to the starboard aileron at one end and attached to a piece of failed port aileron horn at the other. Both rudder cables had pulled from their swagings and the rudder horns had also failed. The stabilator

* The term 'horn' is used in the manufacturer's literature to describe what is known in the UK as an 'operating-arm' or 'lever'.

trim cable is, in effect, continuous and runs from the cabin control aft and around the jack drum and then forwards again to the control pulleys. One side had failed in tension, the trim jack had then been pulled past full travel, and the other side had then failed.

Both flap cables were intact, the port being in position and the starboard having the flap lock mechanism from the starboard mainplane attached. The flap common cable, which runs forward to the operating lever, had failed in tension.

The above evidence shows the control circuits to have been connected and complete at the time of the accident.

The two control columns, although distorted by ground impact, showed no evidence of jamming and elsewhere in the circuits no evidence of jamming was found.

3.9 *Seat belts*

The aircraft was fitted with lap straps on all four seats. The starboard rear seat strap was not recovered but a short length of centre attachment cable showed a tension failure; the other attachment had torn away from the fuselage. The port rear adjustment strap was in place from the centre attachment point up to the snubbing block, where a tension failure had occurred; the remainder was not recovered. The other attachment for this belt had torn out from the fuselage but the snubbing block and failed fixing loop was recovered. The port front seat strap was recovered intact and it showed a partial tension failure of the adjustment strap at the snubbing block and both attachment brackets were in place, having been torn from the fuselage. The starboard front seat strap was found undone and each half was still attached to the fuselage in the normal manner. Unlike the other belts recovered, the adjustment strap showed no signs of pulling through the snubber before gripping. The snubber was examined and found serviceable. It is therefore concluded that this belt was not fastened at the time of the accident.

3.10 *Configuration*

When the accident occurred, the flaps and undercarriage were in the up position. It was not possible to determine the stabilator trim position.

4 Discussion

From the examination of the wreckage the main features to be noted are:

- (a) The manner of detachment of the starboard mainplane was common at the rear, main and front spar positions. As the rear and main spar attachments are to the cabin centre area and the front spar attachment is to the forward cabin area, then the forward and centre cabin areas must have been in place as a single item when the starboard mainplane detached.

- (b) Disruption of the cabin area was consequent upon the failure of the starboard mainplane.
- (c) The stabilator was struck by the twin seat and also a piece of headset cable.
- (d) The fin and rudder impact on the starboard stabilator half was after the seat impact.

Thus it can be shown from the above that detachment of the starboard mainplane must have preceded the other detachments. This is further supported by the twist in the fuselage and the nature of the damage caused by the control cables when the six main items (Fig 2) separated.

The failure to starboard of the fin and rudder, together with the downward failure of the outer position of the port stabilator and detachment of the aft section of the fuselage, are likely to have been caused by a single air loading arising during tumbling manoeuvres of the aircraft following the detachment of the starboard mainplane and opening up of the forward fuselage.

The detailed examination of the fractures causing the separation of the starboard mainplane showed that the failure had originated in the compression collapse of the upper boom and web of the main spar. The maximum rearwards deflection of this boom occurred midway between the fuselage starboard side and the centre joint. Tests on the boom and web material showed that it satisfied appropriate specifications and no defect was seen in the structure adjacent to the origin of failure. Although a short length of upper boom was not recovered it is unlikely that this contained any feature that led to a premature collapse of the spar.

It is concluded therefore that the starboard mainplane had failed as a result of excessive uploads on a sound structure. No feature was found during the examination of the wreckage to indicate how or why such a loading was imposed on the mainplane. There was no evidence of jamming and sudden freeing of control circuits, neither had there been any control circuit failure.

Consideration was given to the possibility that a vibration or flutter of the stabilator and/or its tab had occurred thereby causing the pilot to initiate some unpremeditated action which brought about failure of the starboard mainplane.

There have been instances on other aircraft of the same family of design, using the same stabilator where tab vibration had occurred due to faulty repair or wear of the tab hinges. The hinges of the tab on G-ATAE showed some signs of wear, and although no precise engineering knowledge is available as to the allowable wear with respect to the question of inducing vibration, the wear seen was well within a general FAA requirement for trailing edge movement.

Flutter has also occurred on stabilators of this family and a stabilator half from a previous flutter incident was available for comparison. In addition a report from NASA was available concerning an incident in America. The stabilator from G-ATAE showed damage in similar areas as the other two incidents. However, the damage is consistent with the variety of loadings described in 3.6. Thus, so far, if flutter had occurred, then its features would have been masked by the subsequent loadings. Further examination showed that whilst the other two non-catastrophic incidents produced cracked top and bottom spar booms just outboard of the double stub spar, no cracking was evident in the case of G-ATAE. The starboard stabilator half was obviously crack free at this position whilst although the port half had failed completely, the bending distortion was consistent with sound booms at the time. Therefore flutter had not occurred up to the amplitude experienced in the two non-catastrophic comparison incidents. Further some paint smears on the stabilator starboard upper surface just outboard of the stub spars, had been deposited by an impacting object at a time when the upper surface was flat, ie before any of the buckling seen had occurred. Thus if flutter had occurred, it could only have been of such a low amplitude and magnitude, that no buckles were produced. Information from recorded and documented instances of flutter shows that flutter occurs at about 30 Hz, that the amplification is very rapid and in one or two seconds amplitudes of damaging proportions could be reached.

There is thus no conclusive evidence from the wreckage to indicate that stabilator flutter of damaging proportions occurred prior to the detachment of the starboard wing.

5 Conclusions

It has been concluded from the examination of the wreckage of Piper Comanche G-ATAE that:

- (a) Structural failure in the air commenced in the main spar of the starboard mainplane, just outboard of the centre joint where compression collapse of the upper boom and web had occurred.
- (b) The mainplane failure had occurred under an upload and no material defect or weakness was seen that could have led to a premature failure.
- (c) No feature was found in the wreckage that could have initiated or contributed to the onset of the loading necessary to cause mainplane failure.