



**Australian Government**

**Australian Transport Safety Bureau**

**ATSB TRANSPORT SAFETY INVESTIGATION REPORT**

Aviation Occurrence Investigation – 200605843

Final

**In-flight break-up  
20 km NE Bathurst, NSW  
5 October 2006  
BAC 167 Strikemaster, VH-AKY**





**Australian Government**  

---

**Australian Transport Safety Bureau**

**ATSB TRANSPORT SAFETY INVESTIGATION REPORT**

Aviation Occurrence Investigation

200605843

Final

**In-flight break-up**  
**20 km NE Bathurst, NSW**  
**5 October 2006**  
**BAC 167 Strikemaster, VH-AKY**

*Published by:* Australian Transport Safety Bureau  
*Postal address:* PO Box 967, Civic Square ACT 2608  
*Office location:* 15 Mort Street, Canberra City, Australian Capital Territory  
*Telephone:* 1800 621 372; from overseas + 61 2 6274 6440  
Accident and incident notification: 1800 011 034 (24 hours)  
*Facsimile:* 02 6247 3117; from overseas + 61 2 6247 3117  
*E-mail:* [atsbinfo@atsb.gov.au](mailto:atsbinfo@atsb.gov.au)  
*Internet:* [www.atsb.gov.au](http://www.atsb.gov.au)

© Commonwealth of Australia 2008.

This work is copyright. In the interests of enhancing the value of the information contained in this publication you may copy, download, display, print, reproduce and distribute this material in unaltered form (retaining this notice). However, copyright in the material obtained from other agencies, private individuals or organisations, belongs to those agencies, individuals or organisations. Where you want to use their material you will need to contact them directly.

Subject to the provisions of the *Copyright Act 1968*, you must not make any other use of the material in this publication unless you have the permission of the Australian Transport Safety Bureau.

Please direct requests for further information or authorisation to:

Commonwealth Copyright Administration, Copyright Law Branch  
Attorney-General's Department, Robert Garran Offices, National Circuit, Barton ACT 2600  
[www.ag.gov.au/cca](http://www.ag.gov.au/cca)

ISBN and formal report title: see 'Document retrieval information' on page vi.

---

# CONTENTS

---

<b>THE AUSTRALIAN TRANSPORT SAFETY BUREAU .....</b>	<b>vii</b>
<b>TERMINOLOGY USED IN THIS REPORT .....</b>	<b>viii</b>
<b>FACTUAL INFORMATION .....</b>	<b>1</b>
History of the flight .....	1
Pilot information.....	1
Passenger information.....	2
Medical information.....	2
Meteorological information .....	2
Aircraft information .....	2
Aircraft history .....	3
Intended mission.....	4
Wreckage information.....	5
Engine .....	8
Right wing.....	9
Tail assembly .....	11
Cockpit instruments and switch positions .....	24
Fire information.....	24
Survivability information.....	24
Aircraft systems information .....	25
Flight Controls.....	25
Landing Gear .....	25
Fuel System .....	25
Hydraulic system.....	25
Aircraft fatigue index data.....	26
System of maintenance .....	26
Wing inspection requirement.....	27
Previous right wing defect .....	29
AKY maintenance documentation .....	31
Inspection procedure documentation .....	31
Limited category aircraft - permit index.....	31
<b>ANALYSIS .....</b>	<b>33</b>
In-flight break-up .....	33
Break-up sequence scenarios.....	33

Separation of the right wing, leading to separation of the tail surfaces .....	33
Separation of the tail surfaces, leading to the separation of the weakened right wing .....	35
Separation of the rudder mass balance weight .....	37
Damage observed – separation of the right wing .....	38
Bird strike .....	38
Meteorological event or condition .....	39
Pilot flight control input.....	39
Interference by the passenger .....	39
Damage observed – separation of the rudder lower hinge pin .....	39
Break-up sequence .....	39
Maintenance and documentation.....	40
Assistance from the aircraft manufacturer .....	40
Maintenance schedules .....	40
Documentation .....	40
Wing inspections .....	40
Operational oversight.....	41
Civil operation of ex-military aircraft.....	42
<b>FINDINGS .....</b>	<b>43</b>
Contributing safety factor .....	43
Other safety factors .....	43
Other key findings.....	43
<b>SAFETY ACTIONS.....</b>	<b>44</b>
<b>APPENDIX A: Civil Aviation Regulation 262AM – Limited Category Aircraft.....</b>	<b>45</b>
<b>APPENDIX B: TECHNICAL ANALYSIS REPORT .....</b>	<b>49</b>
SUMMARY.....	50
FACTUAL INFORMATION .....	51
Introduction.....	51
Scope of the examination.....	51
Recovered structure.....	51
Fracture characterisation.....	54
Right wing upper main spar connection .....	55
Right wing lower main spar connection .....	60
Right wing rear connection.....	61
Metallurgical characterisation .....	61

Material chemistry.....	61
Hardness.....	62
Historical experience.....	62
ANALYSIS.....	64
Wing separation.....	64
Spar lug cracking.....	64
Contribution of spar lug cracking to the accident .....	64
<b>APPENDIX C: RNZAF SP 1137.....</b>	<b>66</b>
<b>APPENDIX D: BAC Servicing Instruction CSI/Strikemaster/50 Issue 3 .....</b>	<b>72</b>
<b>APPENDIX E: UK CAA MPD 1995-109 R1 .....</b>	<b>91</b>
<b>APPENDIX F: CASA AD/Strikemaster/4.....</b>	<b>92</b>
<b>APPENDIX G: CASA AC 21-25(2).....</b>	<b>93</b>
<b>APPENDIX H: CASA AWB 02-018 Issue 4.....</b>	<b>101</b>
<b>APPENDIX I: UK CAA MPD 2007-002 R1.....</b>	<b>103</b>

---

## DOCUMENT RETRIEVAL INFORMATION

---

Report No.	Publication date	No. of pages	ISBN
200605843	9 May 2008	113	978-1-921490-24-8

---

### Publication title

In-flight break-up, 20 km NE Bathurst, NSW, 5 October 2006, BAC 167 Strikemaster, VH-AKY

---

### Prepared by

Australian Transport Safety Bureau  
PO Box 967, Civic Square ACT 2608 Australia  
[www.atsb.gov.au](http://www.atsb.gov.au)

### Reference No.

May2008/Infrastructure 08135

---

### Abstract

At about 1215 Eastern Standard Time on 5 October 2006, the pilot of a British Aircraft Corporation 167 Strikemaster aircraft, registered VH-AKY, took off from Bathurst, NSW, for a 25-minute adventure flight with one passenger. The flight was intended to include high-level aerobatics followed by a low-level simulated strike mission. When the aircraft failed to return, a search was initiated and the aircraft wreckage was located in the Turon State Forest about 20 km to the north-east of Bathurst. The ground impact started a fuel-fed fire that resulted in a large bushfire, which took several days to contain. The pilot and passenger were fatally injured.

The engine was producing significant power at the time of impact and the wing flaps and landing gear were retracted. The right wing and tail had separated from the aircraft. Separation of the right wing was precipitated by pre-existing fatigue cracking in the right wing upper main spar attachment lug.

During the low-level simulated strike mission, the aircraft broke up in flight. The majority of the available evidence was consistent with a break-up initiated by separation of the tail surfaces leading to the separation of the weakened right wing.

As a result of this occurrence, the Australian Transport Safety Bureau (ATSB) briefed the Civil Aviation Safety Authority (CASA) and the UK Civil Aviation Authority on findings relating to the separation of the wing and tail. CASA has released a number of Airworthiness Bulletins to alert Australian operators of issues relating to Strikemaster and Jet Provost aircraft. CASA has also approved the Australian Warbirds Association Limited to administer aircraft operating under the Limited Category.

---

---

# THE AUSTRALIAN TRANSPORT SAFETY BUREAU

---

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external organisations.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

## **Purpose of safety investigations**

The object of a safety investigation is to enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

## **Developing safety action**

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

**About ATSB investigation reports:** How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site [www.atsb.gov.au](http://www.atsb.gov.au).

---

## TERMINOLOGY USED IN THIS REPORT

---

**Occurrence:** accident or incident.

**Safety factor:** an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, risk controls and organisational influences.

**Contributing safety factor:** a safety factor that, if it had not occurred or existed at the relevant time, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

**Other safety factor:** a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report.

**Other key finding:** any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which ‘saved the day’ or played an important role in reducing the risk associated with an occurrence.

**Safety issue:** a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Safety issues can broadly be classified in terms of their level of risk as follows:

- **Critical safety issue:** associated with an intolerable level of risk.
- **Significant safety issue:** associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable.
- **Minor safety issue:** associated with a broadly acceptable level of risk.

---

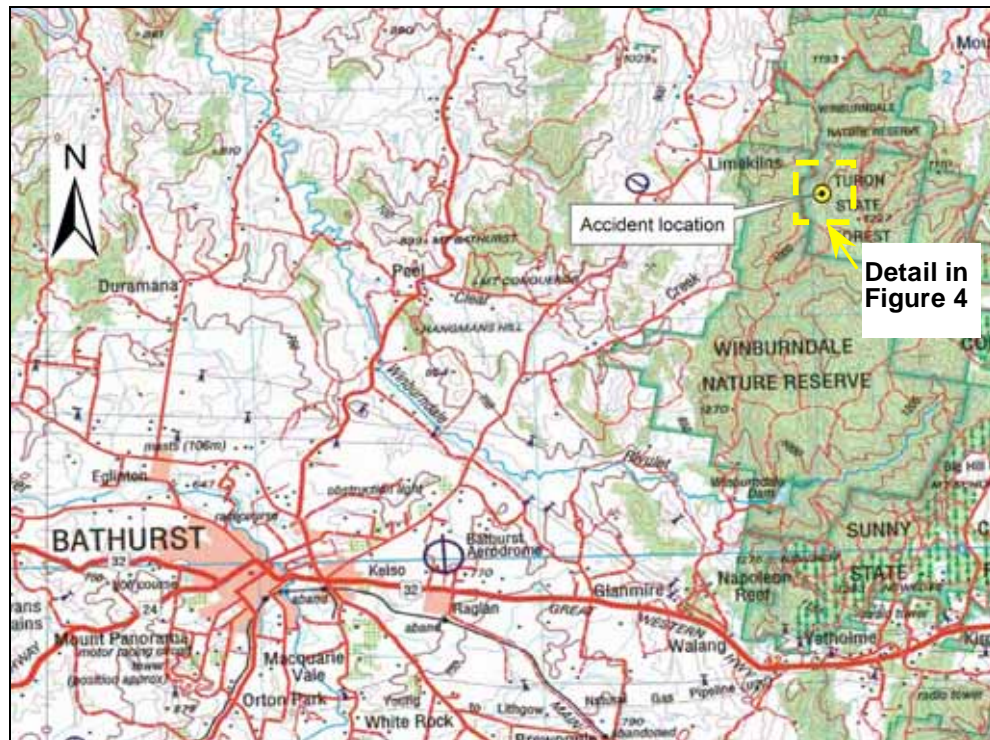
# FACTUAL INFORMATION

---

## History of the flight

At about 1215 Eastern Standard Time<sup>1</sup> on 5 October 2006, the pilot of a British Aircraft Corporation (BAC) 167 Strikemaster aircraft, registered VH-AKY, took off from Bathurst, NSW, for a 25-minute adventure flight with one passenger. The pilot briefed the passenger for the intended flight, which was to include high-level aerobatics followed by a low-level simulated strike mission on a ground feature located on a ridge line at the end of a deep valley in the Turon State Forest, before returning to Bathurst. When the aircraft failed to return, a search was initiated and the aircraft wreckage was located in the Turon State Forest about 20 km to the north-east of Bathurst (Figure 1). The ground impact started a fuel-fed fire that resulted in a large bushfire, which took several days to contain. The pilot and passenger were fatally injured.

**Figure 1: Accident location**



## Pilot information

The pilot held an Australian Commercial Pilot (Aeroplane) Licence issued by the Civil Aviation Safety Authority (CASA), endorsed for the Strikemaster aircraft type and was approved by CASA for low-level aerobatic flight to a minimum

---

<sup>1</sup> The 24-hour clock is used in this report to describe the local time of day Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

height of 500 ft above ground level. He held a valid CASA Class 1 civil aviation medical certificate and, according to his *Pilot's Logbook*, he had accumulated about 2,220 hours total aeronautical experience, about 835 hours on the aircraft type and about 2 hours in the last 30 days.

## Passenger information

The passenger did not hold any flying qualifications.

## Medical information

Post-mortem medical examination of the pilot did not reveal any physiological event or condition which may have contributed to the accident.

## Meteorological information

The Bureau of Meteorology reported fine and mostly sunny weather conditions for the Bathurst region on the day of the accident. Recorded meteorological observations indicated temperatures of a minimum of 3.5 °C and a maximum of 27 °C. The wind was recorded from the north-west at 13 to 31 kph, with maximum wind gusts of 52 kph. There were reports of moderate air turbulence below 5,000 ft in the Bathurst region.

## Aircraft information

The BAC 167 Strikemaster aircraft was a pressurised side-by-side two-seat low-wing monoplane (Figure 2). The aircraft was designed for basic and advanced military flying training duties, a weapons trainer and for operational strike duties. At the time of the accident, the aircraft was being utilised for commercial adventure flying operations.

A *Special Certificate of Airworthiness* was issued under the limited day VFR operation category. The *Certificate of Registration* was issued on 15 May 2006. The *Special Certificate of Airworthiness* and *Certificate of Registration* listed the aircraft manufacture date as being 1980. However, the actual date of manufacture was 1970. The aircraft was first registered in Australia on 7 October 1992.

<b>Aircraft manufacturer</b>	British Aircraft Corporation
<b>Model</b>	BAC 167 Strikemaster MK 84
<b>Serial number</b>	EEP/JP/1935
<b>Registration</b>	VH-AKY
<b>Year of manufacture</b>	1970
<b>Aircraft total time airframe hours</b>	5,082.4
<b>Date of last maintenance</b>	29 September 06
<b>Last maintenance type</b>	Periodic Inspection
<b>Maintenance release (hours and date)</b>	Expired 5,134.4 or 29 September 07

**Figure 2: VH-AKY in livery at the time of the accident**



Image reproduced with permission.

The aircraft was powered by a Rolls-Royce Viper Mk535 straight-flow turbo-jet engine, comprising an eight-stage axial compressor and a single-stage turbine. The maximum thrust of the engine was 3,310 lb at sea level conditions. The engine was mounted in the aircraft fuselage mid-section directly behind the cockpit.

<b>Engine manufacturer</b>	Rolls-Royce
<b>Model</b>	Viper 535-2D
<b>Serial number</b>	535066
<b>Manufacture date</b>	1969
<b>Date of last overhaul</b>	12 November 1984
<b>Date of last maintenance</b>	29 September 06
<b>Last maintenance type</b>	Periodic Inspection
<b>Hours since last overhaul</b>	665.4
<b>Hours remaining before overhaul</b>	1,134.6

## **Aircraft history**

The aircraft was delivered new from the British Aircraft Corporation to the Republic of Singapore Air Force (RSAF) in October 1970, where it operated in the role of advanced military flight training until the Strikemaster fleet was retired from service in November 1986. The aircraft had a long period of inactivity in Singapore before it was purchased as part of the complete RSAF Strikemaster inventory by an Australian company in 1989.

The aircraft underwent restoration in 1991-1992 and was placed on the Australian register in November 1992 as VH-AKY (AKY). The aircraft was initially utilised for the purpose of aerial and static displays at air shows, and required a permit to fly from CASA before every flight. The introduction of CASA Civil Aviation Regulation (CAR) 262AM, *Limited category aircraft-operating limitations*<sup>2</sup>, enabled the aircraft owner to conduct adventure flying operations with paying passengers from Bankstown and Bathurst, NSW, without the requirement for a CASA Air Operator Certificate. CAR 262AM is the CASA regulation that allows operators of ex-military aircraft to receive payment for adventure flying operations, without the need for an Air Operator's Certificate, provided that the paying passenger is made aware of the inherent risks involved in such operations, and an acknowledgement is signed by the passenger stating that he/she is aware of, and personally accepts, that inherent risk. A copy of the August 2003 issue of CAR 262AM is at Appendix A. In accordance with the provisions of CAR 262AM, the operator provided the passenger with a form detailing the risks associated with the flight. The passenger signed the form as having read, understood and accepted that risk.

At the time of the accident, the Australian Warbirds Association had not been approved by CASA to administer the operation of limited category (ex-military) aircraft in accordance with CAR 262AN, *Approved organisations*. The Association reported that they had been negotiating with CASA to obtain that approval.

AKY had accumulated a total of 198 flying hours in the 14 years that it had been registered in Australia; about 20 hours from 1992 to 2001, and 178 hours in the last 5 years of operations; an average of 14 hours per year. When operated by the RSAF, it had accumulated a total of 4,884.8 hours in 16 years; an average of 305 hours per year.

## Intended mission

The pilot provided a briefing that was video-taped, to the passenger regarding the route to be flown and the mission to be undertaken. The aircraft was to depart Bathurst to an area to the north in order to conduct upper air work sequences, including steep turns and aerobatics, at a height of between about 8,000 and 10,000 ft. The plan was then to descend to an area to the north-east of Bathurst for a simulated low-level strike mission, using a geographical feature in the region where the accident occurred, followed by a further simulated strike mission on a dam to the east of Bathurst, prior to returning for landing.

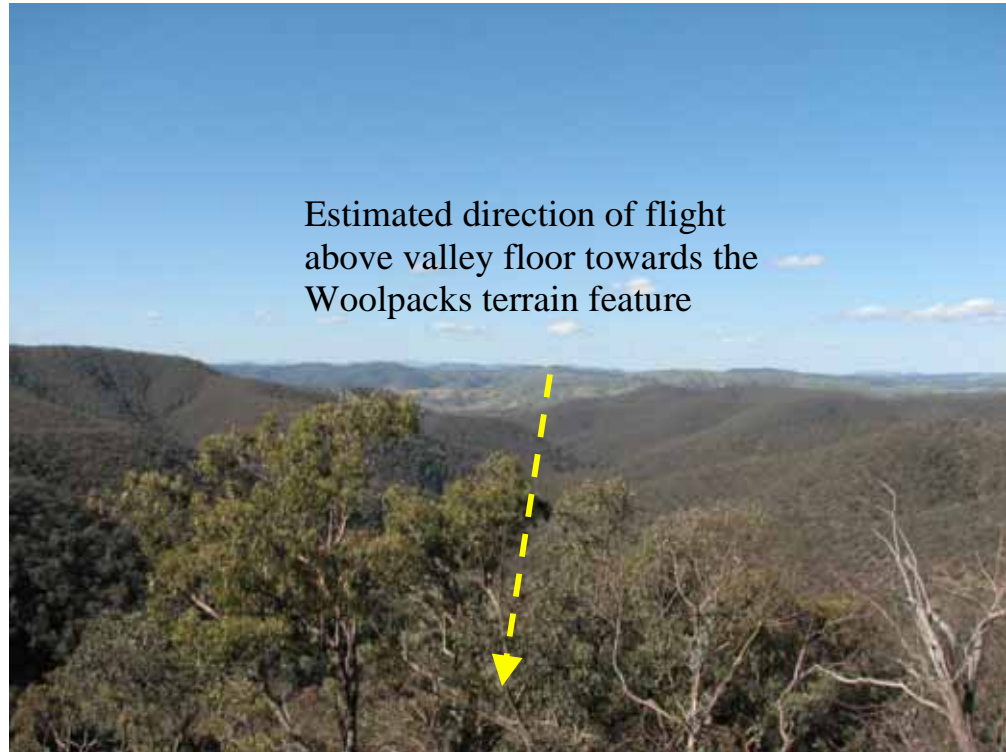
The first low-level strike sequence involved simulation of an attack on an enemy position located on a terrain feature known as the 'Woolpacks' feature. That involved a low-level high-speed approach in a valley, followed by a rolling manoeuvre over the Woolpacks feature (Figure 3), for a simulated weapons release, before rolling upright and continuing at low level to the next target. A pilot who had previously flown those missions for the operator reported that the sequence was usually flown at a speed of about 300 kts and at a height of about 300 ft above the valley floor. The speed and height that the pilot flew the mission on the day of the

---

2 Aircraft placed in the Limited Category of airworthiness, in accordance with Civil Aviation Safety Regulations 1998, 21.189, *Special certificate of airworthiness for limited category aircraft*, include ex-military, replica and historic aircraft.

accident could not be determined. A video recording of a similar adventure flight in AKY flown by the pilot about 2 weeks prior to the accident was provided to the Australian Transport Safety Bureau (ATSB). That video showed that the aircraft was well below the height of the hills surrounding the valley. The height of those hills above the valley floor was generally about 200 m (650 ft).

**Figure 3: View from top of Woolpacks terrain feature back along flight path**



## Wreckage information

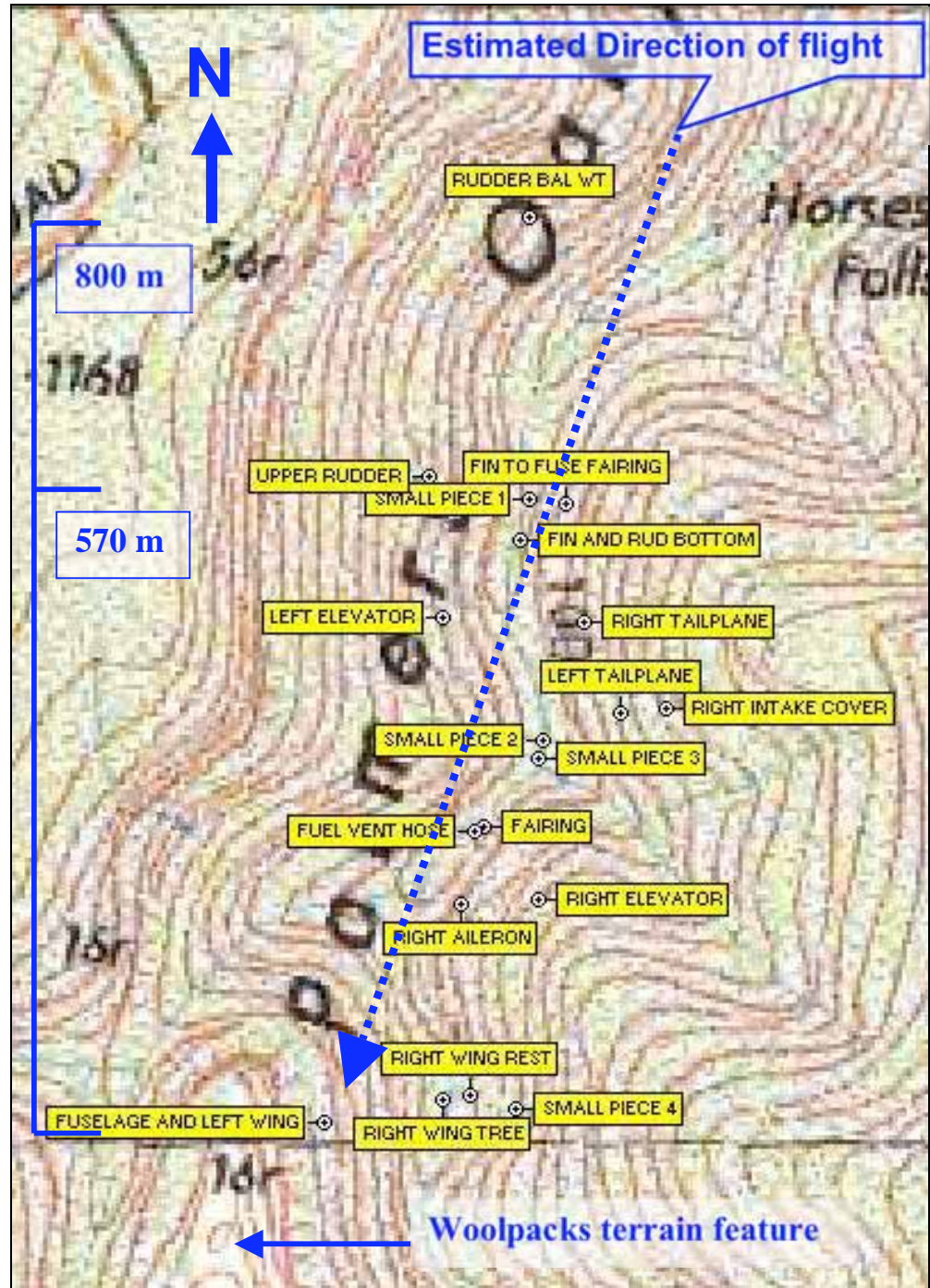
The aircraft wreckage was located on the north-eastern side of the Woolpacks feature and in the valley floor, distributed over about 800 m of sloping, treed, terrain (Figure 4). The main wreckage, which consisted of the fuselage, engine and left wing, was located about halfway up the north-eastern side of the Woolpacks feature, and was mostly destroyed by impact forces and the subsequent post-impact fires (Figures 5 and 6). Witness marks on trees in the vicinity of the main wreckage indicated a downward impact angle of about 50 degrees. The right wing, tailplane, tail fin, elevators and rudder had separated from the fuselage in flight prior to impact with terrain. Other items of wreckage were damaged to varying degrees by impact with the ground and trees, and by the bushfire. The rudder mass balance weight, attached to part of the upper rudder, was the first item found in the wreckage trail, and was located about 120 m from other empennage items<sup>3</sup>.

---

<sup>3</sup> The locations of the items of wreckage were determined using hand-held Global Positioning System (GPS) equipment. Most pieces of the aircraft wreckage were located by Australian Transport Safety Bureau (ATSB) investigators during the initial on-site investigation. However, the bushfire limited the search area, and the rudder mass balance weight was later located by a third party. The location of the mass balance weight was reportedly also determined using hand-held GPS equipment. In September 2007, ATSB investigators returned to the accident site and

The majority of the aircraft was identified at the accident site. The left flap and speed brake were not identified; however it is probable that they were destroyed with the left wing by the intensive post-impact fire.

**Figure 4: Wreckage distribution**



searched the valley to the north of the accident site. No further items of wreckage or aircraft components were found.

**Figure 5: Main aircraft wreckage**



**Figure 6: Main aircraft wreckage**



## Engine

The engine was destroyed by impact forces and the post-impact fire (Figure 7).

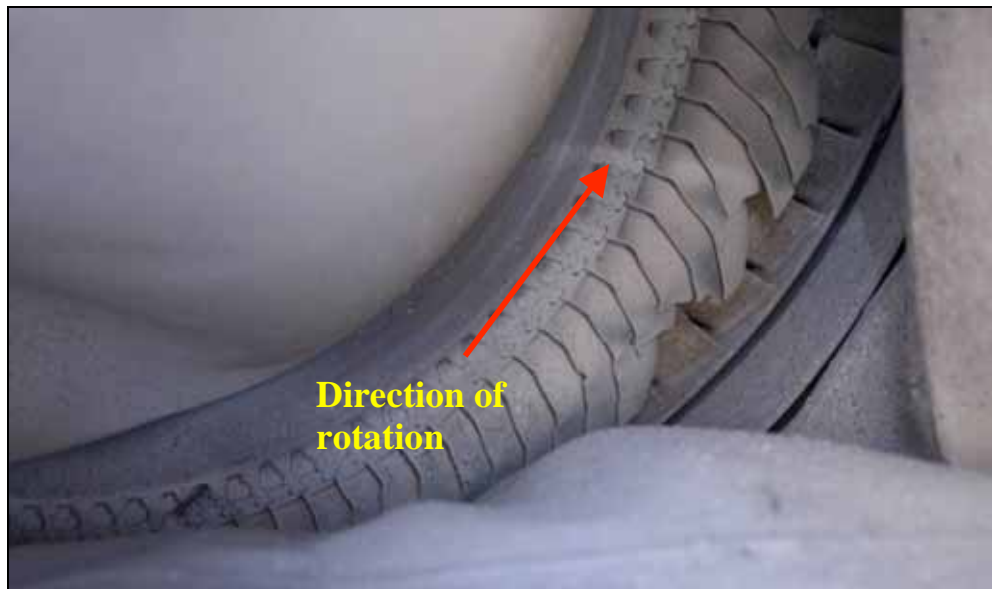
**Figure 7: Engine**



The turbine blades had been bent in the opposite direction to rotation and several blades had fractured at their mid section, which indicated that the engine rotor section was rotating and producing power at impact (Figure 8).

The continuity of the engine controls could not be confirmed due to the extent of impact and post-impact fire damage.

**Figure 8: Turbine section**



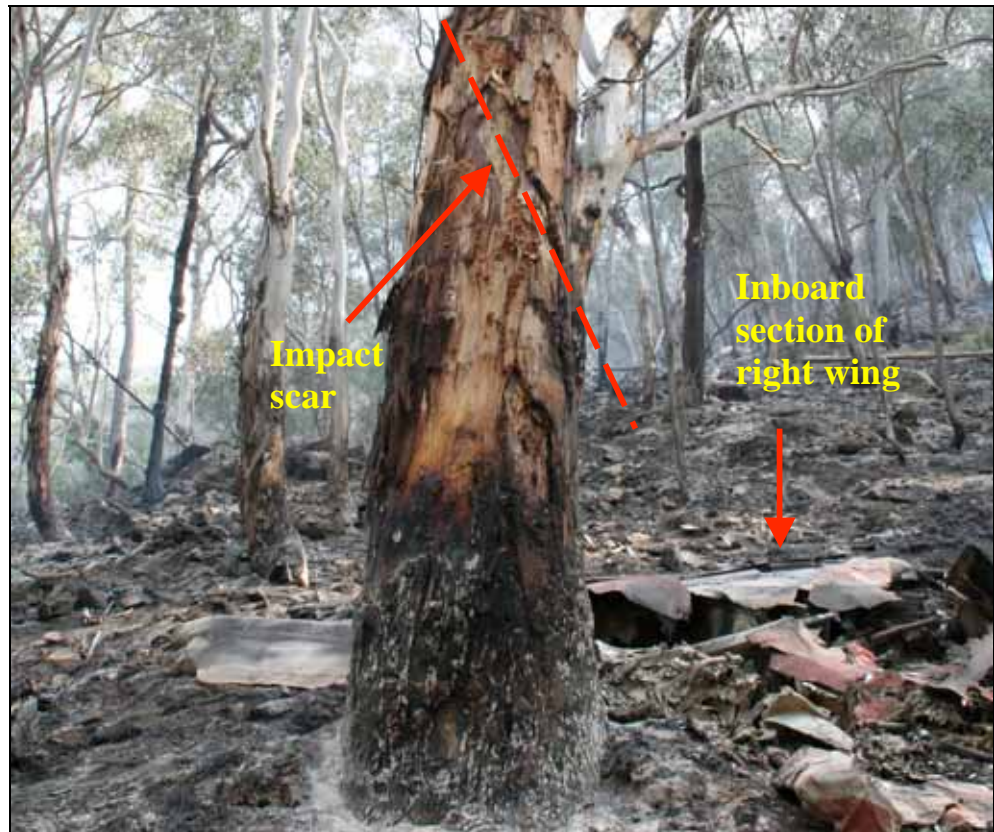
## Right wing

The right wing had separated from the fuselage in flight and was largely intact prior to impact with a large tree, at which point it broke into a number of pieces (Figure 9). It was located about 150 m from the fuselage. Marks on the tree indicated a break-up trajectory of about 200 degrees magnetic (Figure 10).

**Figure 9: Right wing**

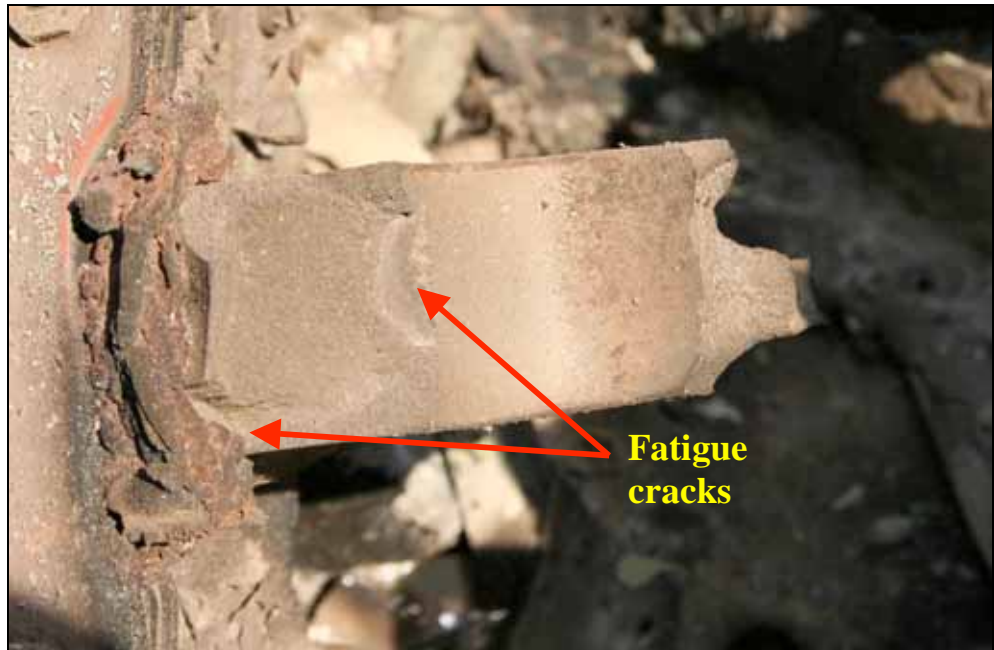


**Figure 10: Section of right wing at base of impact-scarred tree**

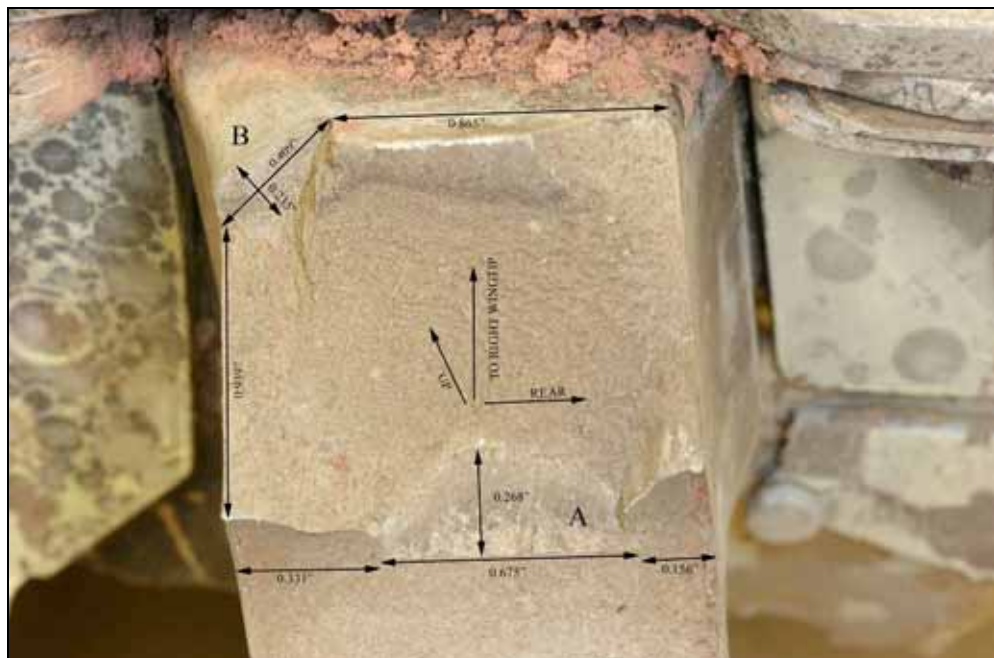


The right wing had separated from the aircraft under a single downward bending over-load that fractured the upper main spar attachment lug (Figure 11), then progressed down through the main spar web and finally fractured the lower and rear spar attachments. The investigation identified two areas of pre-existing fatigue cracks in the upper wing attachment lug, identified as positions A and B (Figure 12). Area A was the larger of the two cracks, with an origin at the lug bore surface. Area B had initiated from an area of prior surface/corner blending, which had been carried out for previous defect removal purposes. The attachment point and a section of its surrounding structure were retained for technical analysis at the ATSB's laboratory (Appendix B).

**Figure 11: Upper attachment point as found on the accident site**



**Figure 12: Fracture surface and dimensions**



## Tail assembly

A skeletal view of the Strikemaster tail assembly is depicted at Figure 13.

**Figure 13: Strikemaster tail section**

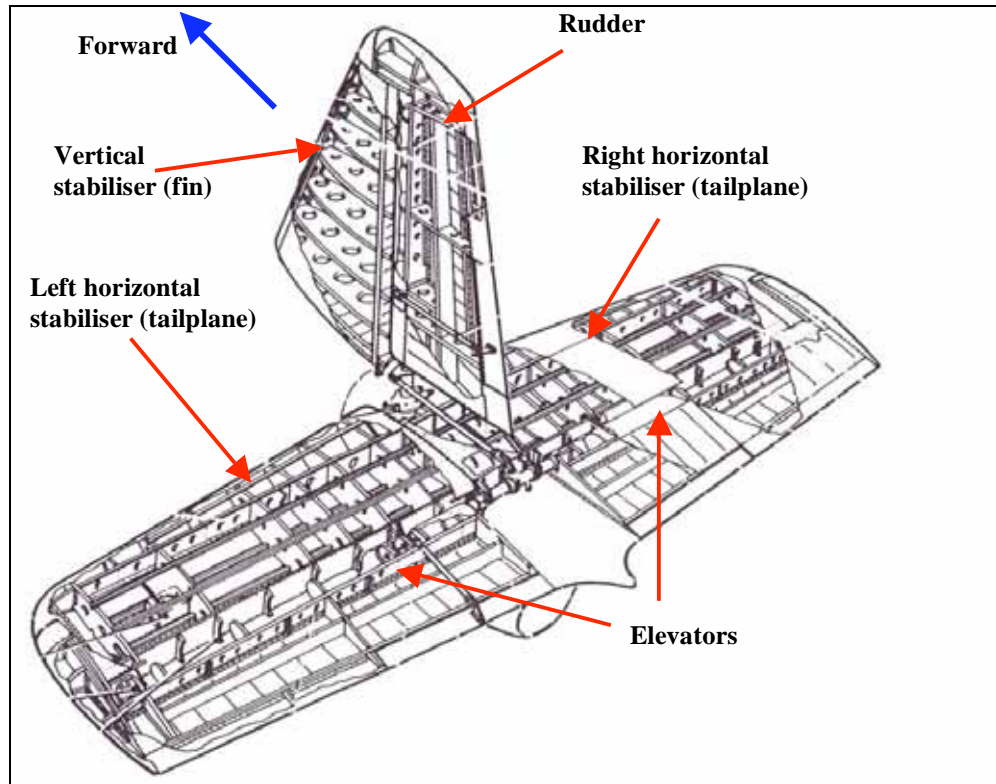


Image source: BAC 167 Strikemaster Airframe student course notes.

### ***Vertical stabiliser***

The vertical stabiliser attachment points had been fractured in overload. Fracture surfaces and compression ripples on the left side of the tailplane showed that the fin had experienced severe air loads acting from right to left relative to the longitudinal axis in the direction of flight (Figures 14 and 15).

**Figure 14: Vertical stabiliser**

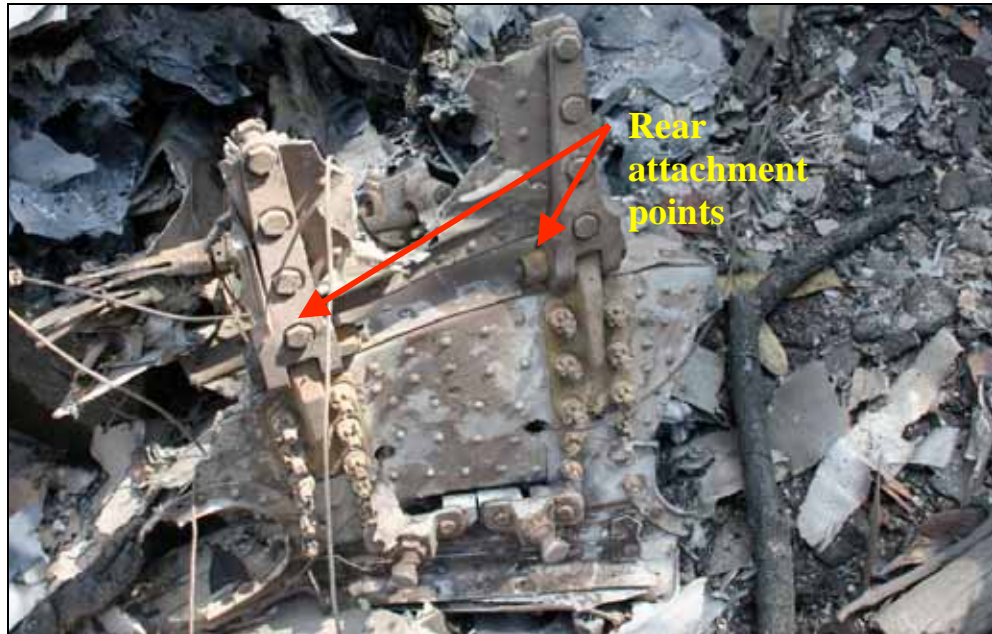


**Figure 15: Vertical stabiliser trailing edge**



The vertical stabiliser attachment points had been torn from the vertical stabiliser in overload (Figure 16).

**Figure 16: Vertical stabiliser rear attachment point**



### ***Rudder***

The aircraft rudder had broken into three pieces, comprising the mass balance weight, upper rudder section and lower rudder section (Figures 17 and 18). The mass balance weight had separated from the upper rudder in a manner such that the forward tip was pried over the top of the rudder (blue arrow in Figure 18), producing localised trailing edge buckling and tearing at the corners of the upper hinge cut-out.

The lower surface of the mass balance weight had several marks of a shape and profile consistent with multiple impacts against the upper surface of the vertical stabiliser (Figures 19 and 20). An indentation in the lower surface of the mass balance weight, collocated with the other marks, suggested an impact with a blunt object. There was no corresponding mark on the vertical stabiliser to indicate that it was the origin of the impact.

**Figure 17: Rudder**

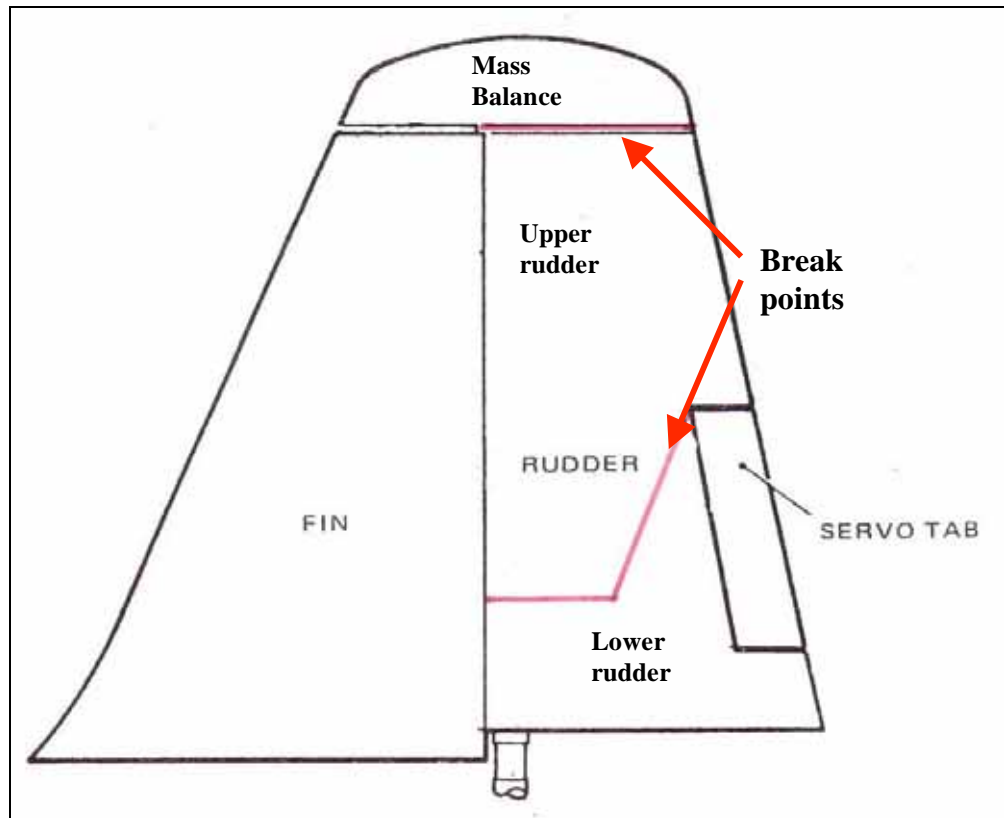


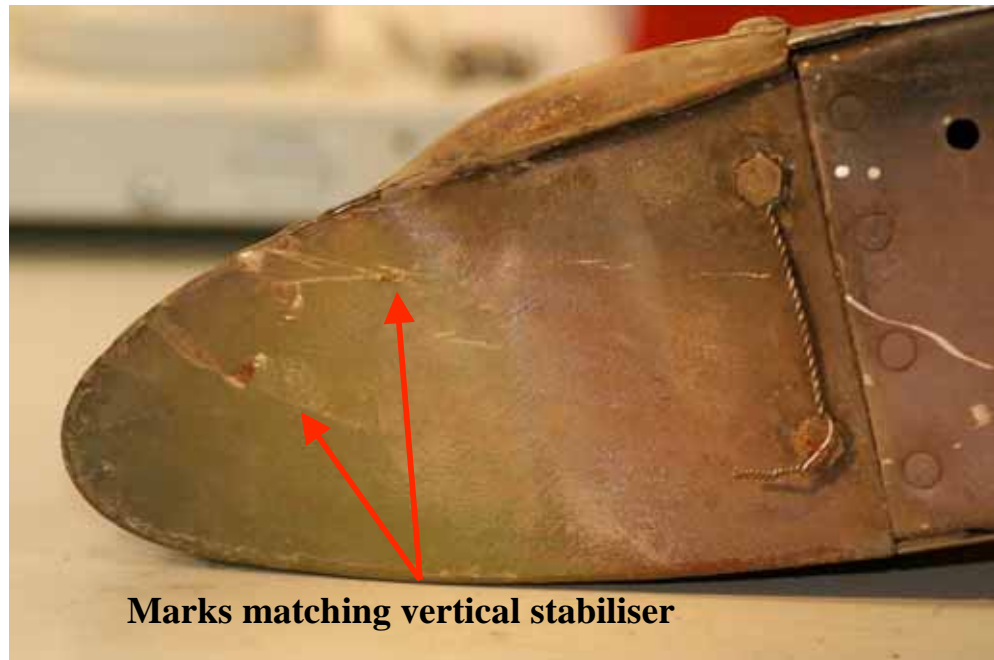
Image source: BAC 167 Strikemaster Airframe student course notes.

**Figure 18: Rudder pieces (note horizontal stabiliser in background)**

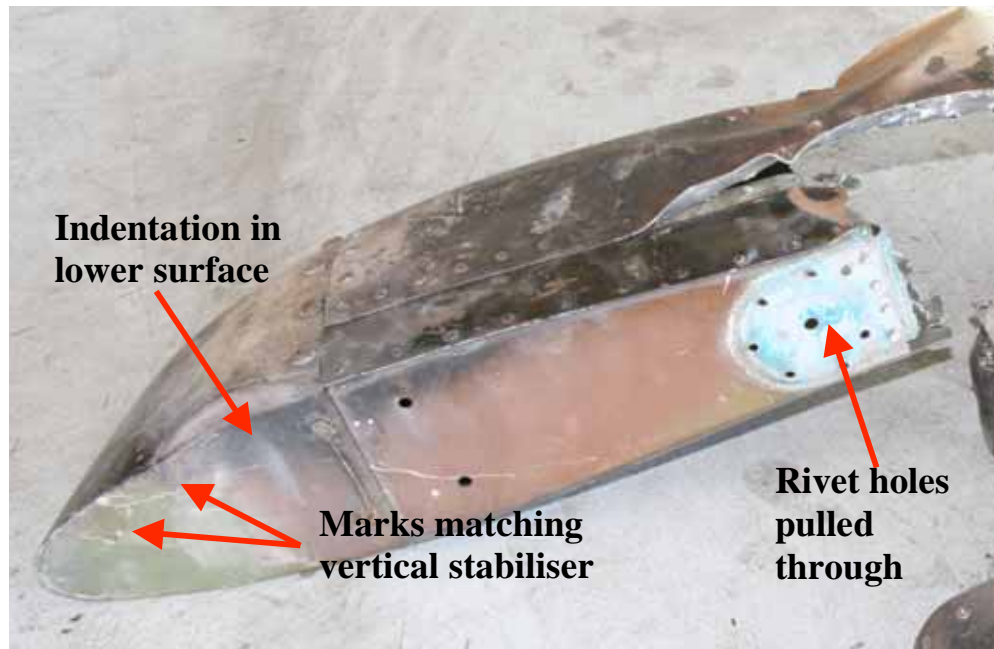


Note: The blue arrow indicates the direction of mass balance separation from the vertical stabiliser.

**Figure 19: Lower surface of rudder mass balance**



**Figure 20: Lower surface of rudder mass balance**



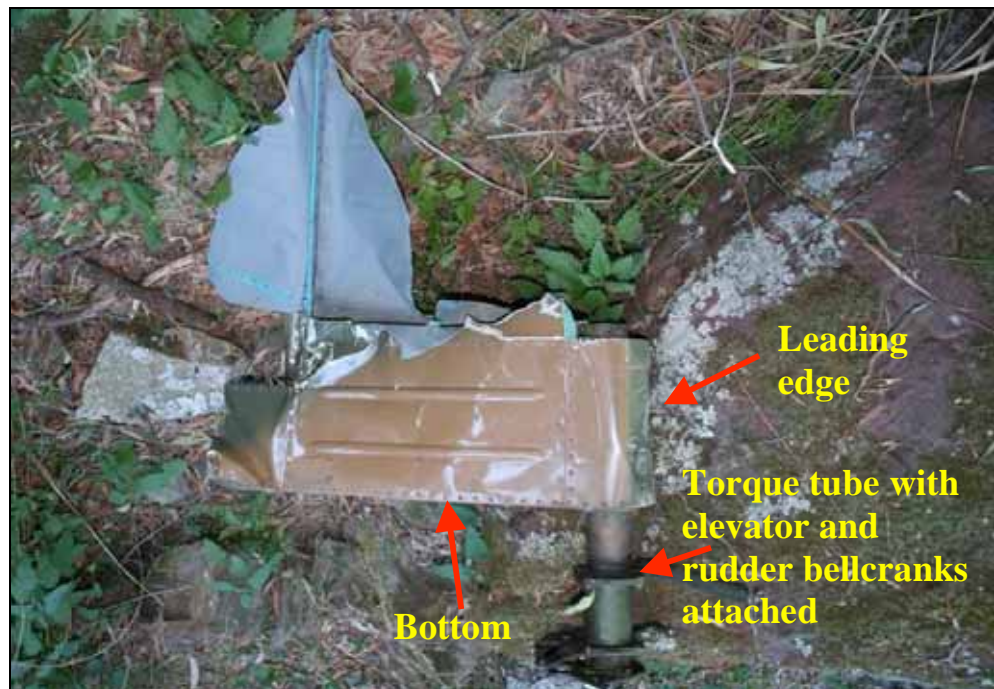
The upper section of rudder had a large crease from the upper attach point across to the trailing edge. The bottom section had fractured at the rudder torque tube upper end at the leading edge and rearwards to the upper part of the trim tab recess at the trailing edge. All fractures were due to overload (Figure 21).

**Figure 21: Rudder upper section**



The lower part of the rudder had broken just above the torque tube at the leading edge. The damage in that region was consistent with the failure initiating at the leading edge and progressing rearward. There was no evidence of pre-existing damage or defects on any of the fractures examined (Figure 22).

**Figure 22: Lower section of rudder**



***Rudder trim tab***

The rudder trim tab was still attached to the lower part of the rudder, the control linkage had broken in overload, and the remaining section of control linkage that was still attached to the rudder mid-section was destroyed by post-impact fire.

### **Rudder lower hinge pin**

The Strikemaster rudder was designed with a two-point attachment arrangement, incorporating an inverted, open-ended upper hinge and an axial pivot pin supported by a dual-race ball-bearing. The axial pivot pin (Figure 23 - item 35) was secured beneath the empennage deck with a single 5/16" UNF castellated nut (item 34). The open-ended nature of the upper hinge allowed for the efficient removal of the rudder during maintenance, by the removal of the four fasteners that secured the base of the rudder torque tube to the upper (elevator) bellcrank. The rudder could be lifted upward, which released the hinge pin from the bearing and bracket affixed to the rear edge of the vertical stabiliser.

**Figure 23: Lower pivot pin assembly. Pivot pin (green) and lower castellated nut (red)**

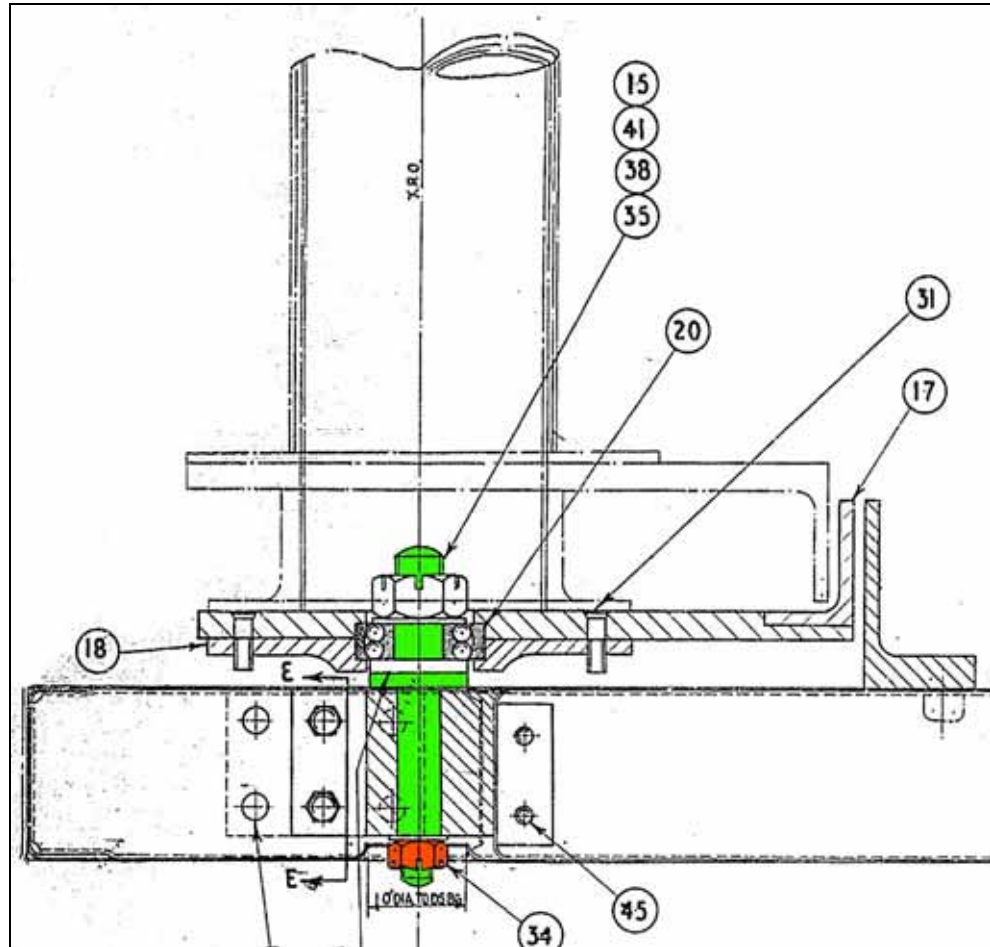


Image source: BAC drawing number K145-12-667.

The lower section of the rudder included the rudder torque tube, rudder control bellcrank and elevator control bellcrank. The rudder control bellcrank contained the lower hinge pin, which normally attached it to the fuselage structure (Figure 24). The thread on the lower hinge pin contained thread remnants from the retaining

nut<sup>4</sup> (Figure 25). Examination of the hinge pin threads indicated that the nut thread had failed in a shear overload mode (stripping).

**Figure 24: Rudder lower hinge pin**



**Figure 25: Thread remnants on rudder lower hinge pin**

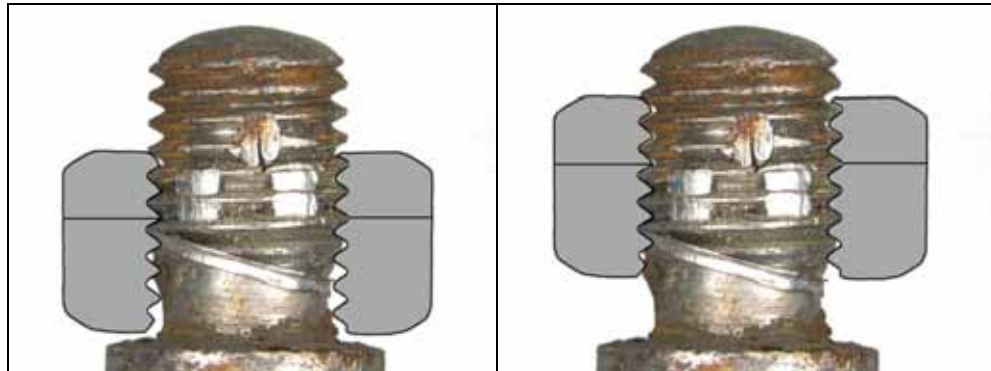


---

4 The retaining nut was not recovered from the wreckage.

The ATSB found that the lower castellated nut had been screwed down the threaded shank such that only one full thread of the nut body had engaged the pin threads. The majority of the nut threads had entered the unthreaded, reduced-section shank between the threads and the main body of the pin (Figure 26).

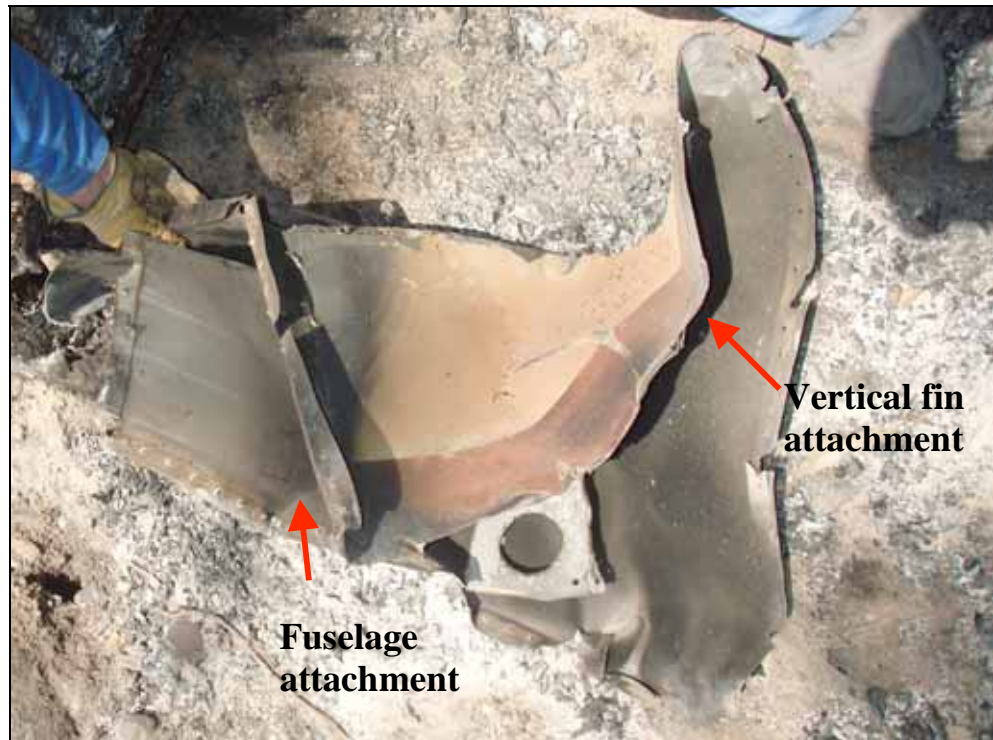
**Figure 26: Illustration of over-engaged (left) and normally-engaged (right) pivot pin nuts**



### ***Fin-to-fuselage fairing***

The fin-to-fuselage fairing had failed in overload and was bent from right to left relative to the longitudinal axis of the aircraft. That was also consistent with the deformation of the vertical stabiliser (Figures 27 and 28).

**Figure 27: Fin-to-fuselage fairing**



**Figure 28: Location of fin-to-fuselage fairing (outlined)**



### ***Horizontal stabiliser***

The Strikemaster horizontal stabiliser (tailplane) was constructed as a single-piece assembly. It had broken off either side of the empennage attachment points (Figure 29).

**Figure 29: Horizontal stabiliser and elevator assemblies**

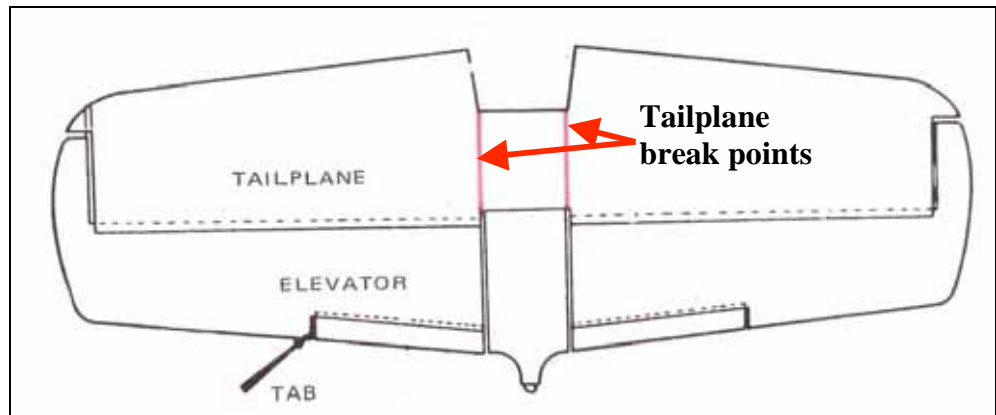


Image source: BAC 167 Strikemaster Airframe student course notes.

The deformation and fracture of the tailplane primary load-bearing structures (main and rear spars) was consistent with exposure to upward bending forces that exceeded the structural capability of the assembly. However, there was some evidence of compression in some of the lower surface secondary structure (or stringers), which suggested that the tailplane had also experienced a large

downward bending load. All fractures had occurred due to overload (Figures 30 to 32).

**Figure 30: Right section of tailplane**



**Figure 31: Left section of tailplane**



**Figure 32: Tailplane and fin-to-fuselage fairing**



### ***Elevators***

The left and right elevators had separated and had been found relatively intact with the tabs still in place. All attachment points were intact. The fracture surface of the left elevator tab control rod was destroyed by the post-impact fire and therefore, the failure mode of that component could not be established (Figure 33).

**Figure 33: Left elevator**

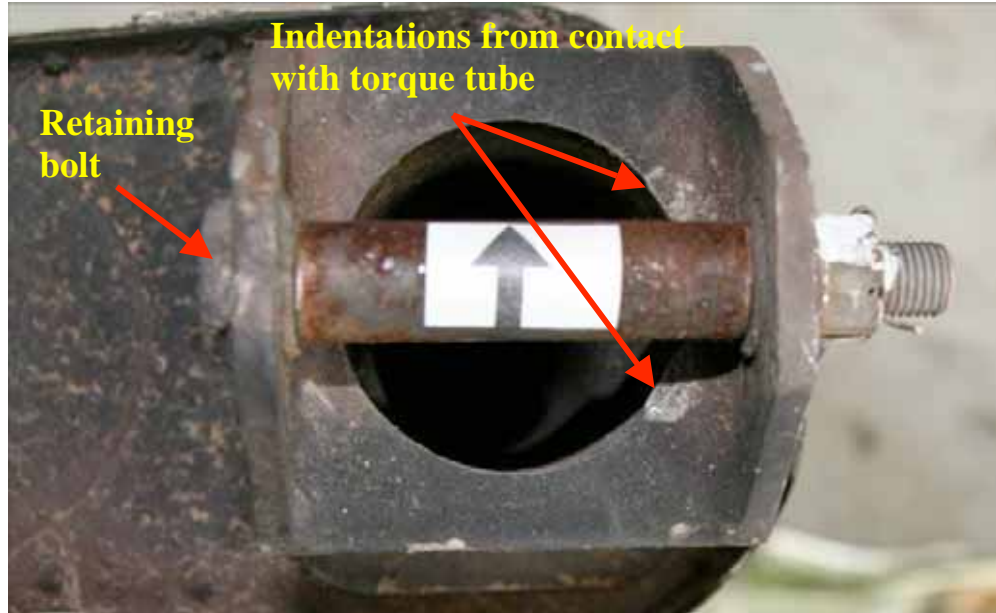


### ***Elevator attachment points***

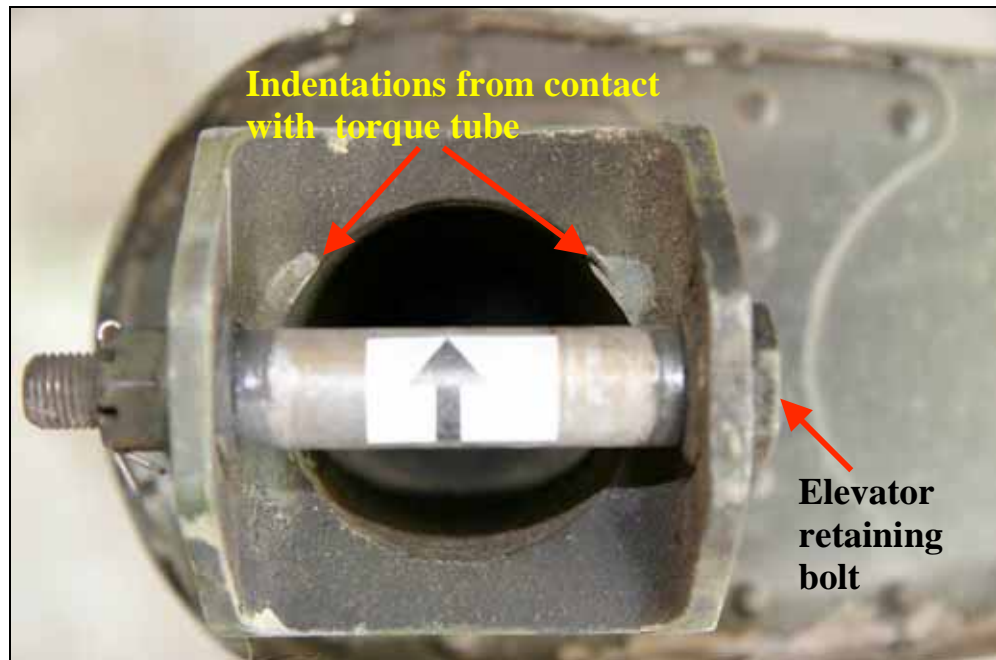
Both left and right horizontal stabilisers had separated from the aircraft in upward bending. Both elevator torque tube connections exhibited evidence of an upward deflection of the left and right sections of the horizontal stabiliser (Figures 34 to

36). Some structural elements of the left horizontal stabiliser also exhibited evidence of a downward deflection. There were no pre-existing defects identified within the stabilisers or elevators.

**Figure 34: Left elevator inboard attachment point**



**Figure 35: Right elevator inboard attachment point**



**Figure 36: Elevator torque tube as found**



## **Cockpit instruments and switch positions**

Due to the destruction of the cockpit by impact forces and the post-impact fire, no readings or observations could be made (Figure 37).

**Figure 37: Cockpit area**



## **Fire information**

There was no evidence of an in-flight fire.

## **Survivability information**

The accident was not survivable. An Emergency Locator Transmitter was not fitted to the aircraft, nor was it required to be in accordance with CASA CAR 252A.

## Aircraft systems information

### Flight Controls

Due to the destruction of the aircraft by impact forces and the post-impact fire, continuity of all flight controls could not be established.

### Landing Gear

The retractable tricycle landing gear was in the retracted position (Figure 38).

**Figure 38: Right main landing gear**



### Fuel System

Fuel was carried in the wings and the wing tip tanks. The aircraft was refuelled on the day prior to the accident and had a total of 1,200 litres (960 kg) of fuel on board prior to the accident flight. That fuel quantity was sufficient for the intended flight. Based on the normal flight profile for the mission being flown, it was estimated that the aircraft had been flying for about 20 minutes prior to the accident. Several other aircraft utilised the same batch of fuel on the same day and subsequent days after the accident with no difficulties reported.

### Hydraulic system

Due to the destruction of the aircraft by impact forces and the post-impact fire, continuity and serviceability of the aircraft hydraulic system could not be established.

## Aircraft fatigue index data

Fatigue meters had been fitted to BAC Strikemaster aircraft to record acceleration exceedences. Recorded fatigue index data was used to monitor the fatigue life of the aircraft. It was also used to determine if the airframe had been overstressed on a particular flight. Due to the destruction of the aircraft from impact forces and the post-impact fire, the fatigue meter was not identified in the wreckage.

The fatigue life of the airframe was monitored using a Fatigue Index (FI), which was a number representing a percentage of the fatigue life used. The service life of the airframe would be reached at 100 FI, at which point it must be retired. Prior to exceeding 70 FI, the aircraft manufacturer required wing structure modifications and additional maintenance inspections to ensure continued safe operation. The FI for the aircraft was calculated using a formula, which utilised the numbers recorded by the fatigue meter. On 29 September 2006, the FI for AKY was calculated as 59. Consequently, the wing modifications had not been carried out.

Different military operators of Strikemaster aircraft had been using different fatigue index calculation methods. In order to ensure that the fatigue life of their respective aircraft was not exceeded, the aircraft manufacturer had provided some of those operators with a multiplication factor that was to be applied to their FI calculations. Information provided to the ATSB suggested that a multiplication factor of 1.9 had been provided to some of those military Strikemaster operators. In response to an ATSB query regarding multiplication factors that had been applied to AKY, the aircraft manufacturer stated that:

The application of fatigue factors was recommended to a number of operators but we believe that the factors varied in magnitude based upon information that was available at the time; as such, we are unable to provide a definitive answer reference specific applicability.

There was no evidence to indicate if a multiplication factor was required to be applied to the FI for AKY.

A fatigue meter reading was carried out on AKY three days prior to the accident. In the 36 airframe hours preceding the accident flight, the fatigue meter recorded 90 instances which exceeded +5G. In the preceding 146 airframe hours, the fatigue meter recorded nine instances which exceeded +5G.

## System of maintenance

The Strikemaster aircraft type was provided technical support by the aircraft manufacturer throughout its military service. That support included (but was not limited to):

- provision of aircraft maintenance schedules
- assistance regarding maintenance documentation, inspections and component overhaul
- advice to aircraft operators regarding aircraft maintenance issues and service difficulty reports
- provision of assistance and advice regarding maintenance training
- aircraft parts logistics.

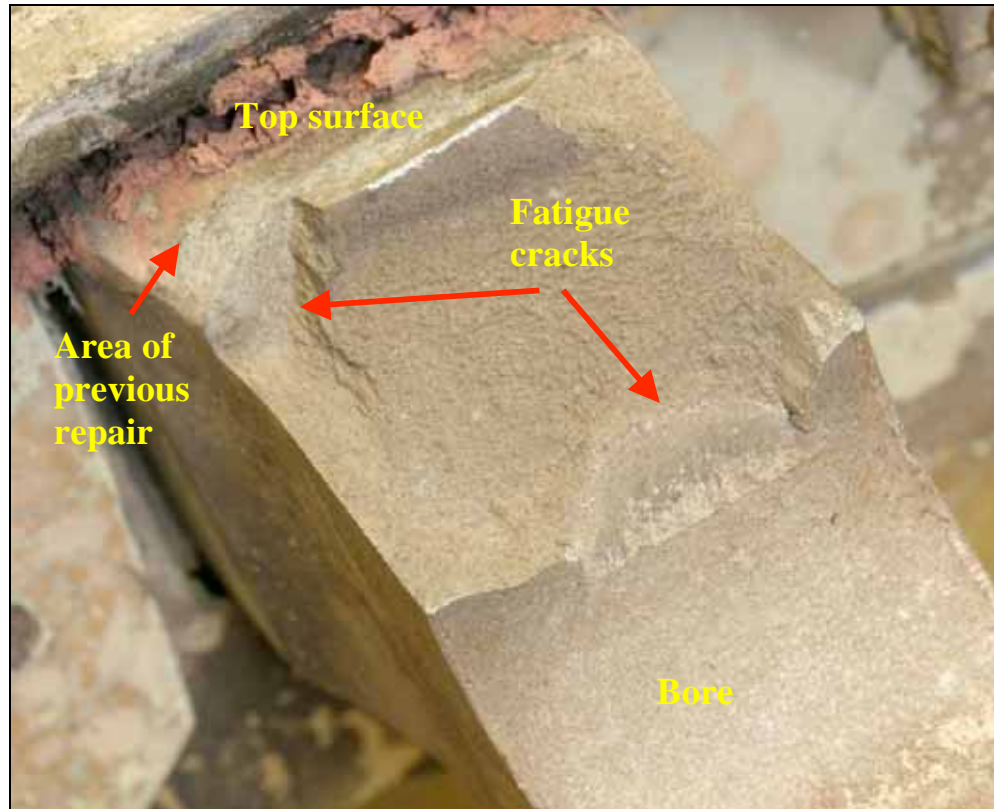
When Strikemaster aircraft were retired from military service, the aircraft manufacturer was not required to provide technical support to the new civilian operators of those aircraft.

When AKY was first placed on the Australian register, maintenance was carried out in accordance with the Republic of Singapore Air Force (RSAF) system of maintenance<sup>5</sup> until 1996. From 1996 until the day of the accident, the aircraft was maintained in accordance with the Australian Warbirds Association schedule of maintenance, which was largely based on the Royal New Zealand Air Force (RNZAF) system<sup>6</sup>. That maintenance schedule was approved by CASA.

### Wing inspection requirement

Two areas of fatigue cracking were identified in the right wing upper attachment lug. One crack was located on the forward top surface and the other crack was located in the bore of the lug. The crack in the top surface had propagated from the area of a previous repair (Figure 39).

**Figure 39: Right wing upper attachment lug**



---

5 The RSAF system of maintenance was based on flight time limitations for scheduled checks and did not include calendar time limitations.

6 The RNZAF system of maintenance was based on both flight time and calendar time limitations for scheduled checks.

The aircraft manufacturer (BAC) had previously identified an area in the wing upper attachment lugs on the lug top surface which was susceptible to the formation of fatigue cracks. As a consequence, the aircraft manufacturer designed Non-Destructive Testing (NDT) inspection procedures to identify cracks in the upper attachment lug area. The RSAF identified the procedure as SI/STK/56. The RNZAF identified the procedure as SP 1137 (Appendix C).

At the time of the accident, AKY had been maintained in accordance with the New Zealand requirements listed in SP 1137. The location which was identified in SP 1137 as an area where fatigue cracks may form is depicted at Figure 40. A top view of the left and right wing upper attachment lug scan areas is at Figure 41. SP 1137 instructed that NDT eddy-current inspections<sup>7</sup> of the wing upper attachment lugs were required every 100 flying hours. There was no requirement to remove the wings as part of that procedure. It was possible for the NDT inspection area of the procedure outlined in SP 1137 to be covered by sealant or paint.

**Figure 40: Required scan area - wing upper and lower attachment points**

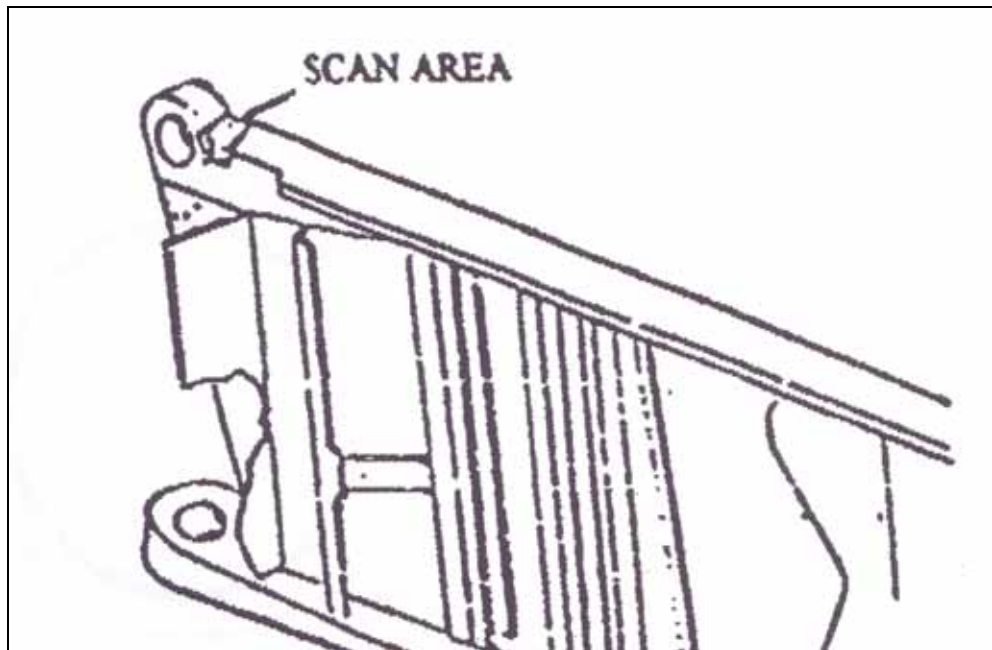


Image source: CSI/Strikemaster/50 Issue 3.

---

<sup>7</sup> Eddy-current inspection uses electromagnetic induction to detect flaws in conductive materials.

Limitations include:

- the surface of the material must be accessible
- the finish of the material may affect the readings
- the depth of penetration into the material is limited
- flaws that lie parallel to the probe may be undetectable.

Figure 41: Required scan area - left and right wing upper attachment lugs

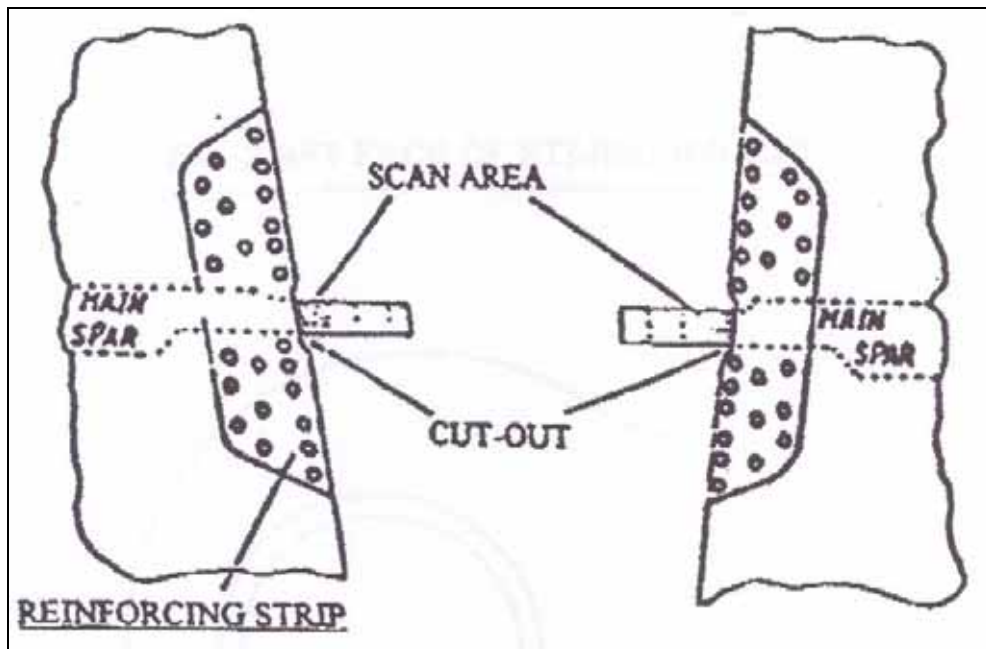


Image source: CSI/Strikemaster/50 Issue 3.

In accordance with the requirements of SP 1137, the area of the required eddy current scan is depicted at Figure 42. The areas highlighted in red are the locations where the two cracks were identified in AKY.

Figure 42: SP 1137 eddy current scan area - upper attachment lug

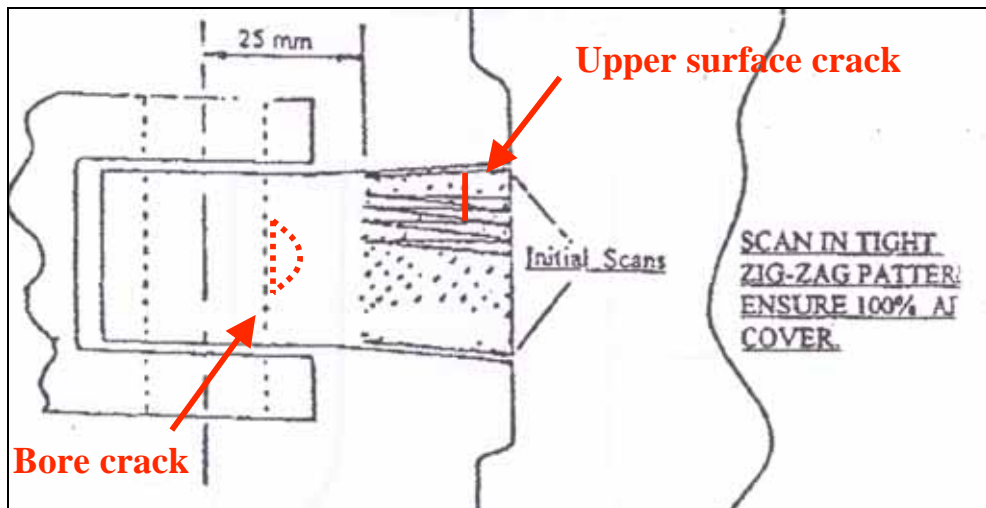


Image source: CSI/Strikemaster/50 Issue 3.

### Previous right wing defect

A review of the RSAF maintenance records for AKY revealed that a crack had been detected in the right wing upper attachment lug in 1984 after NDT inspection SI/STK/56 was carried out. A repair was carried out which involved blending out

the material where the crack was located to the depth required to completely remove the crack. The SI/STK/56 inspection requirements were reduced from 100 hours to 25 hours due to the previous crack detection and removal. Several NDT eddy current inspections were carried out on the repaired area over a period of a year following the repair. The reduced time between inspections was not included in the system of maintenance when the aircraft was placed on the Australian civil register.

The last NDT inspection was carried out in accordance with the RNZAF requirements (SP 1137) on 27 September 2005, which was 14.4 flying hours prior to the accident. The upper attachment lug top surface crack was not identified during that inspection.

#### **CASA Airworthiness Directive AD/Strikemaster/4**

Due to cracking found in the wing upper attachment lugs around the lug bore of several other Strikemaster aircraft, the aircraft manufacturer issued a company servicing instruction (CSI/Strikemaster/50 Issues 1, 2 and 3) in order to detect cracks in those areas. Issue 3 of the servicing instruction was released in 1996. The instruction required the removal of the wings from the fuselage in order to carry out an NDT eddy-current inspection around the attachment lug bore. The lug top surface was also inspected, similar to that of the SI/STK/56 and SP1137 inspections. CSI/Strikemaster/50 was scheduled to be carried out every 150 flight hours (Appendix D).

The United Kingdom Civil Aviation Authority (UK CAA) mandated the inspection requirement in the UK under Mandatory Permit Directive (MPD) 1995-109 R1 (Appendix E).

The Australian Civil Aviation Safety Authority (CASA) mandated the inspection requirement in Australia under Airworthiness Directive AD/Strikemaster/4 (Appendix F). The area required to be scanned is depicted at Figure 43.

**Figure 43: Required scan area - wing upper attachment lug**

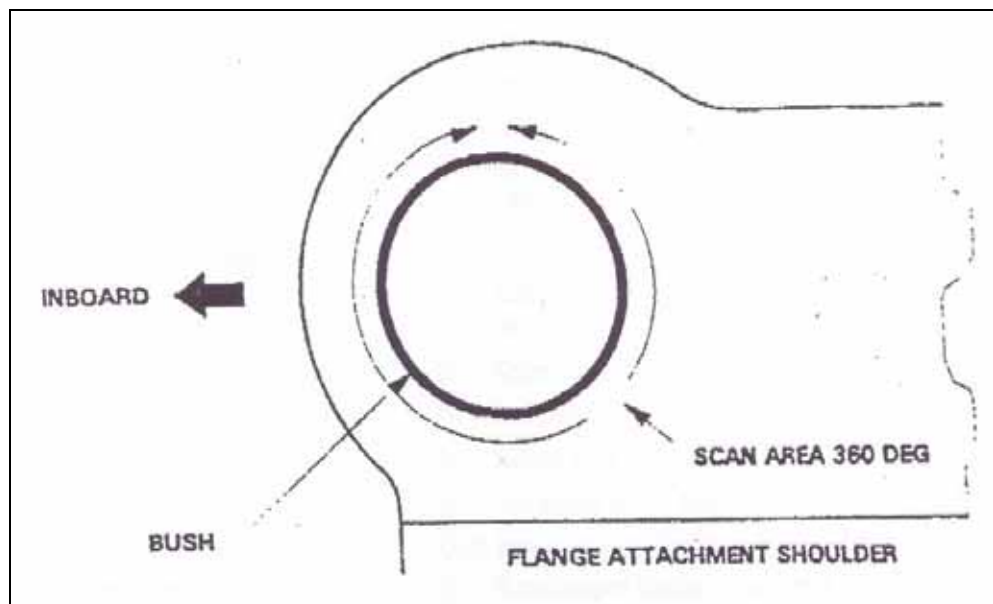


Image source: CSI/Strikemaster/50 Issue 3.

## **AKY maintenance documentation**

A review of maintenance documentation revealed that AKY had sustained minor damage after it had been involved in a previous accident in January 1995, when an in-flight electrical failure resulted in a wheels-up landing at Bankstown Airport. At that time, the wings were not removed to facilitate repair, the wing attachment points were not inspected, and a heavy landing inspection was not carried out.

According to the maintenance documentation for AKY, AD/Strikemaster/4 was certified as having been carried out in September 2003, 37.5 flying hours prior to the accident. That documentation stated that 'nil defects were evident'.

AD/Strikemaster/4 stated that the inspection was to be carried out in accordance with CSI/Strikemaster/50 Issue 3, which required removal of the wings from the aircraft. That would have included draining of the wing fuel tanks and disconnection of flight controls and electrical equipment. There was no record in the maintenance documentation for AKY to indicate that those actions had been carried out.

An NDT inspection was required to be conducted by a person approved by CASA. That inspector was required to provide an NDT inspection report to the licensed aircraft maintenance engineer (LAME). The LAME was then required to certify in the aircraft maintenance documentation that the inspection had been carried out. The NDT inspection report was then to be appended to the aircraft maintenance documentation. The ATSB found no evidence of an NDT inspection report to support the AD/Strikemaster/4 inspection certified in September 2003.

## **Inspection procedure documentation**

CASA AD/Strikemaster/4 required inspections to be carried out in accordance with CSI/Strikemaster/50. At the time of the accident, CSI/Strikemaster/50 Issue 3, dated 22 March 1996, was current. The ATSB did not find evidence of any organisation in Australia that possessed a copy of CSI/Strikemaster/50 Issue 3. The operator and the previous maintenance organisations responsible for AKY held copies of CSI/Strikemaster/50 Issue 2, dated 27 June 1995. In addition, all the copies of CSI/Strikemaster/50 Issue 2 obtained by the ATSB were incomplete and missing a number of pages relevant to the wing attachment lug inspection procedures. CSI/Strikemaster/50 Issue 3 involved a more comprehensive inspection procedure than that specified in CSI/Strikemaster/50 Issue 2.

## **Limited category aircraft - permit index**

Aircraft that are not a type-certificated civil design, or are no longer supported by a current manufacturer, such as historical, replica or special purpose aircraft, may be flown in Australia as a limited category aircraft with the application of appropriate safety conditions. CASA introduced a system of risk assessment, known as a Permit Index, to provide a series of benchmarks against which each aircraft may be assessed, in relation to the risk incurred in operating it. That system is contained in CASA Advisory Circular AC 21-25(2), *Limited Category Aircraft – Permit Index*, dated March 2002 (Appendix G).

The Strikemaster aircraft type is listed in Attachment 3 to AC 21-25(2) as a Permit Index 2 aircraft. The Jet Provost and Provost T Mk1 aircraft are listed as Permit Index 3 aircraft. Index 3 involves a higher calculated risk. The Permit Index for

Strikemaster aircraft had not been calculated in accordance with Attachment 1 of AC 21-25(2). The issue of the Permit Index listed for the Strikemaster aircraft type was not relevant to the accident; however it was identified as an apparent anomaly during the course of the investigation.

VH-AKY broke-up in flight during a low-level simulated strike mission on a terrain feature located on a ridge line at the end of a deep valley in the Turon State Forest, NSW. It was clear from the wreckage evidence that the right wing separated from the aircraft prior to impact with terrain. That failure was precipitated by pre-existing fatigue cracking in the right wing upper main spar attachment lug. It was also clear that the tail surfaces had separated from the aircraft prior to impact with terrain.

## **In-flight break-up**

The in-flight break-up was the result of two possible scenarios:

- separation of the right wing, leading to separation of the tail surfaces
- separation of the tail surfaces, leading to the separation of the weakened right wing (due to pre-existing fatigue cracking).

Either scenario would have led to the accident and the fatalities of both occupants; however it is important to seek the reason why that occurred in order to prevent a recurrence. There was evidence to support both scenarios. In consideration of either scenario, it must be understood that the aircraft attitude, speed and height above the valley floor at the time of the in-flight break-up could not be determined.

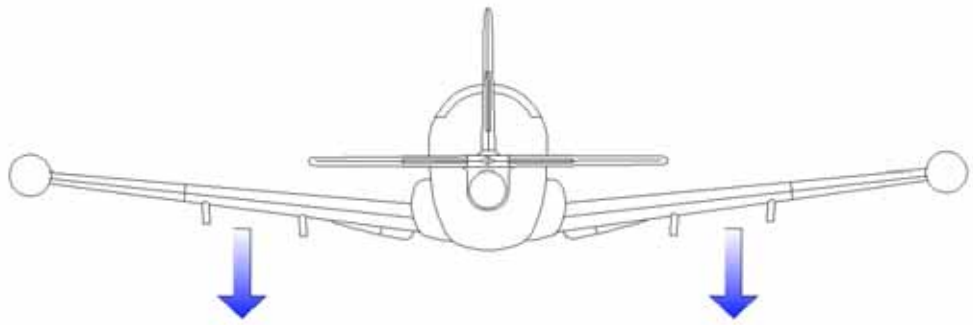
## **Break-up sequence scenarios**

### **Separation of the right wing, leading to separation of the tail surfaces**

Under normal flight conditions, aerodynamic loads on the left and right wings act in the same direction. Differences in the magnitudes of those aerodynamic loads result in a roll. If the right wing separated first, there would have been a large aerodynamic imbalance, resulting in a rapid roll rate. As the evidence from the fractures of the right wing upper main spar attachment lug indicated, the aircraft wings were loaded in a downward direction at the moment of failure (Figure 44). As such, separation of the right wing would have resulted in the left wing instantaneously continuing in a downward motion, resulting in a rapid left roll (Figure 45).

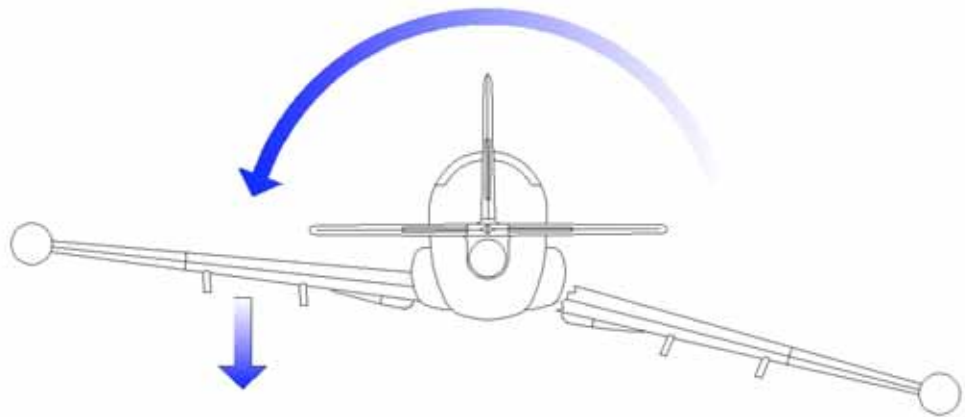
The magnitude of the resultant roll rate was typically such that the aerodynamic and inertial loads imparted on the tail surfaces would have bent all surfaces in the same sense and opposite to that of the roll as depicted in Figure 46.

**Figure 44: Downward wing loading**

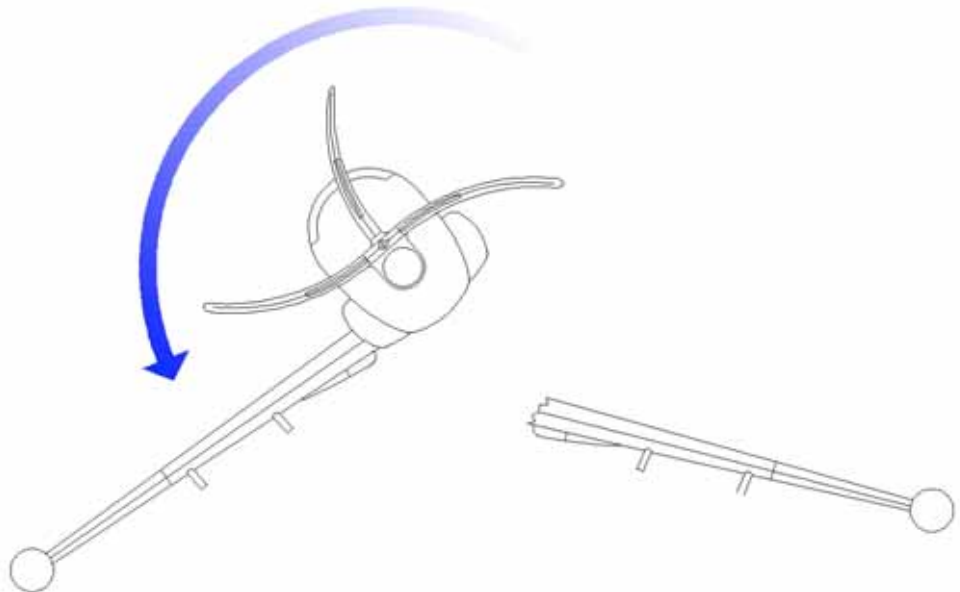


Note: Nose of aircraft models pointing into page.

**Figure 45: Rapid left roll**

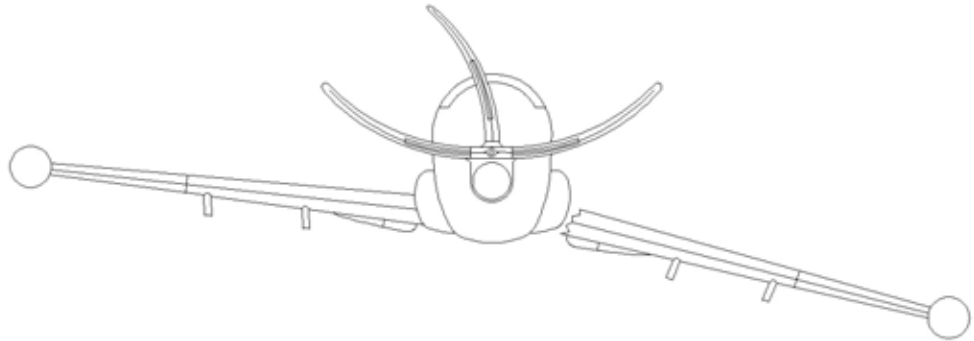


**Figure 46: Resultant bending of tail surfaces**



However, examination of the wreckage indicated that the failure of the tailplane and fin were in the manner shown in Figure 47.

**Figure 47: Observed tail damage**

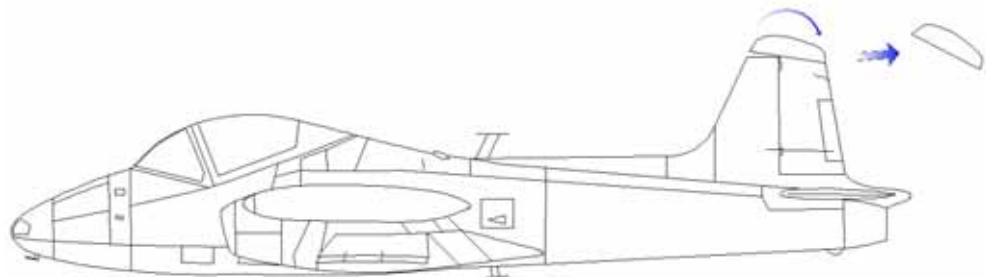


### **Separation of the tail surfaces, leading to the separation of the weakened right wing**

Examination of the recovered items of the tail section and assessment of the distribution of the items indicated that the rudder mass balance was torn off over the top of the rudder at an early stage in the break-up sequence. If the rudder mass balance weight was the first item to separate from the aircraft, the break-up sequence would likely have progressed in the following manner:

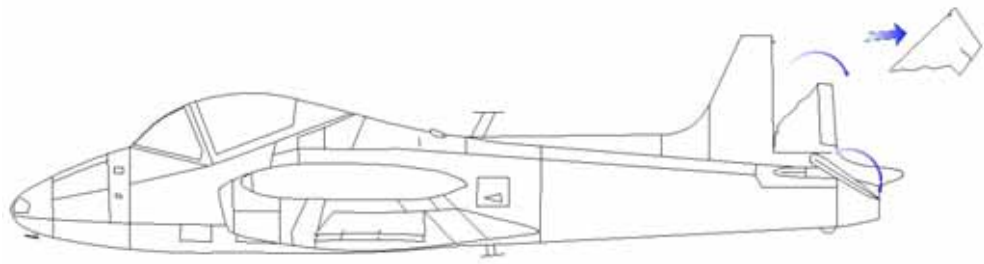
The rudder mass balance experienced a vertical load that was sufficient to break it over the top of the rudder as shown in Figure 48.

**Figure 48: Rudder mass balance separation**



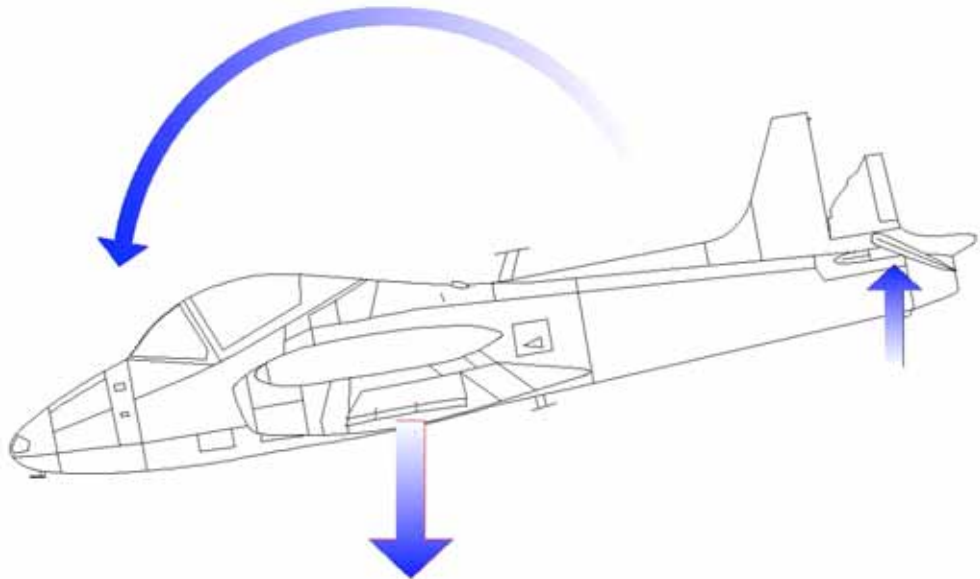
The prying action that removed the mass balance weight would have also pulled the top hinge pin out of the hinge bracket, allowing the top section of the rudder to be forced rearward. The air loads on the rudder were then sufficient to tear the rudder in two, with the upper section separating from the lower section and the aircraft. The design of the rudder and elevator control system was such that rearward movement of the lower section of the rudder would result in a down-elevator input (Figure 49). At speeds of at least 300 knots, the force from the rudder pushing the elevator down would be quite large and capable of imparting an abrupt elevator input.

**Figure 49: Upper rudder separation and elevator input**

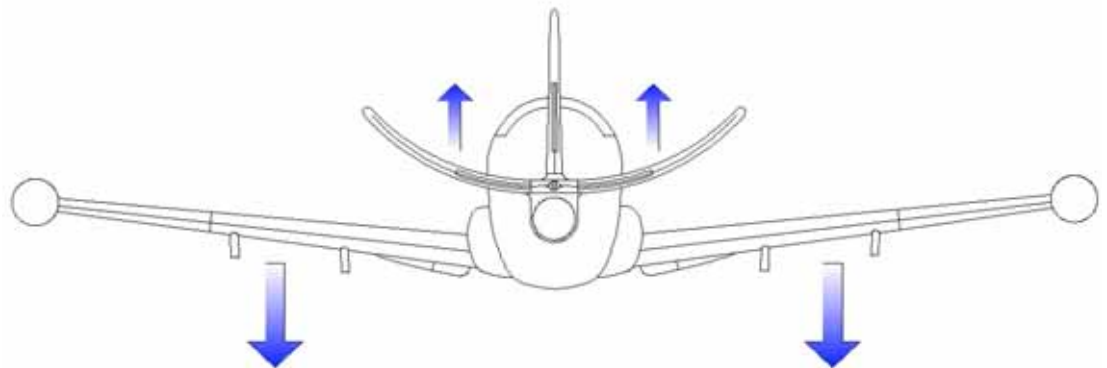


The downward deflection of the elevator resulted in a sudden upward load on the tailplane, which in turn produced an abrupt pitch-over of the aircraft as shown in Figure 50. The effect of the pitch-over was to place a negative load on both wings as depicted in Figure 51.

**Figure 50: Pitch-over due to elevator input**

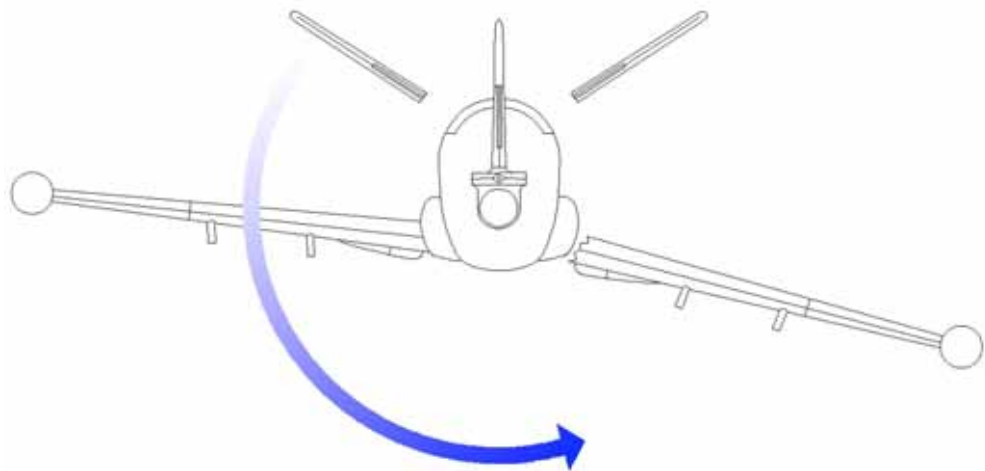


**Figure 51: Resultant loading of wings and tail**



The loads on the tail increased until the tail fractured and separated from the aircraft. The right wing, being weaker than the left due to the fatigue cracks, also fractured and separated from the aircraft. As with the wing-first separation scenario, the loss of the right wing resulted in a rapid left roll (Figure 52).

**Figure 52: Tail and wing fracture**



The resultant nose-down pitch, roll and yaw then exposed the side of the fin to the airflow. That imparted a large aerodynamic force on the fin, which resulted in it fracturing at the base and separating from the aircraft.

### **Separation of the rudder mass balance weight**

It could not be conclusively determined from the wreckage examination what imparted the vertical load on the rudder mass balance weight. However, the marks on the underside of the rudder mass balance weight and the local compression damage in the tailplane lower stringers (that should have displayed tension failures in an upward bending case) suggested that there may have been an alternating upward and downward bending load at the root of the tailplane. The magnitude of that alternating load appeared to have increased until the vertical load pulses through the airframe overloaded the rudder mass balance resulting in its separation from the top of the rudder. Whether that alternating load was the result of either a pilot-induced control oscillation, or flutter<sup>8</sup> of the tailplane, could not be determined from the wreckage examination.

---

8 For the purposes of this investigation report, flutter may be described as:

An oscillation of definite period but unstable character set up in any part of an aircraft by a momentary disturbance, and maintained by a combination of the aerodynamic, inertial, and elastic characteristics of the member itself (Audels New Mechanical Dictionary, 1972).

Aircraft are designed so that there is a margin between the aircraft's maximum operating airspeed and the airspeed at which flutter can occur. However, if that airspeed is exceeded, or the elastic characteristics of the aircraft have changed such that the margin no longer exists, the aircraft structure may experience flutter.

As there was no Flight Data Recorder fitted to AKY, it could not be determined if the aircraft exceeded the maximum operating airspeed. There are many factors that could affect the elastic characteristics of the aircraft, and may include loose fasteners, cracks in the aircraft structure, excessive control surface play or control cable tensions. There was no evidence of pre-existing cracking in the tailplane structure, however, due to the destruction of the aircraft from the accident and subsequent fire, it could not be determined if any other parts of the airframe or control system had degraded in a manner that would affect the elastic characteristics.

There was also an indentation in the lower surface of the rudder mass balance weight indicating that it had been struck by a blunt object in an upward direction. The origin of that indentation could not be determined.

## **Damage observed – separation of the right wing**

The right wing separated from the aircraft under a single downward bending overload that fractured the upper main spar attachment lug, then progressed down through the main spar web and finally fractured the lower and rear spar attachments. Two areas of pre-existing fatigue cracks in the upper wing attachment lug were found; one originating at the lug bore surface, and a second which had initiated on the upper surface from an area of prior surface/corner blending, which had been carried out for previous defect removal purposes. As the fracture surface at the section of the lug attached to the right wing displayed no evidence of a secondary strike with the inboard section of the lug, the separation of the wing must have been instantaneous.

If it was the case that there was sufficient material in the lug, unaffected by the fatigue cracks, to allow the wing structure to remain intact under normal flight loads, an initiating event must have occurred in order to place sufficient force on the wing structure and accordingly, the weakened upper main spar attachment lug, to overload the lug in downward bending. Such initiating events may include:

- bird strike
- meteorological event or condition
- an intentional or unintentional pilot flight control input
- interference by the passenger
- a failure in the tail section (discussed previously, refer page 35).

### **Bird strike**

Although a possibility, there was no evidence from the aircraft wreckage that the aircraft had encountered a bird strike.

## **Meteorological event or condition**

Despite there being reports of moderate air turbulence on the day of the accident, there was no evidence of a meteorological event or condition which may have contributed to the accident.

## **Pilot flight control input**

At a likely height of about 300 ft above the valley floor and a speed of about 300 kts, it is unlikely that the pilot would have conducted a manoeuvre requiring the application of negative 'g' loading. Further, the downward bending force required to overload the right wing upper main spar attachment lug, albeit weakened by the pre-existing fatigue cracks, would have required an uncomfortable manoeuvre. Had such a manoeuvre been attempted, it is likely that the accident would still have occurred, but with different characteristics.

There was no evidence of a physiological event or condition affecting the pilot that could have contributed to the accident. Although the attitude of the aircraft at the time of the in-flight break-up could not be determined, the possibility of a flight control input by the pilot contributing to the aircraft break-up cannot be discounted.

## **Interference by the passenger**

The passenger had no flying qualifications. There is no evidence to suggest that intentional or unintentional interference by the passenger may have contributed to the accident.

## **Damage observed – separation of the rudder lower hinge pin**

Although the effective nut-pin engagement was estimated at being less than two effective full threads, it was calculated that tensile loads in excess of 15 kN would have been required to produce the failure of the connection as it existed. While an assessment of the dynamic flight loads carried by the connection was outside the scope of the investigation, it was considered unlikely that those loads would have approached such a magnitude, under any variation of flight within normal operational parameters.

Despite the deficiency identified in the lower nut engagement, it is probable that failure of the lower rudder pivot pin connection resulted from overload events associated with the aerodynamic break-up of the aircraft.

## **Break-up sequence**

There is evidence to support either break-up sequence scenario. However, the majority of the available evidence was consistent with a break-up initiated by separation of the tail surfaces leading to the separation of the weakened right wing. Notwithstanding which event occurred first, either scenario would have led to the accident and the fatalities of both occupants.

## **Maintenance and documentation**

### **Assistance from the aircraft manufacturer**

As AKY had been retired from military service, ongoing support from the aircraft manufacturer had ceased. Since the aircraft had been on the Australian civil aircraft register, this important part of the maintenance system was no longer available to the operator.

### **Maintenance schedules**

Both the Republic of Singapore and Royal New Zealand Air Force maintenance schedules were designed for personnel specifically trained to operate and maintain this aircraft type. In contrast, the Australian civil aviation system does not require personnel to be trained on specific aircraft types. Furthermore, the maintenance schedules were specifically designed for the high aircraft utilisation experienced in the military environment.

### **Documentation**

Specific maintenance documentation for AKY was transferred with the aircraft from the previous military operators to the civil operator. Significant maintenance information pertaining to AKY, such as year of manufacture, special inspection requirements and previous repairs had not been identified by the civil operator and incorporated in the system of maintenance. The reason for that could not be determined; however it is likely that this was due to unfamiliarity with the military system of maintenance. In addition, there is no avenue for civil operators of retired military aircraft to obtain assistance from the military aircraft manufacturers in establishing a system of maintenance for the continued airworthiness of their particular aircraft.

There is also no avenue for civil operators of retired military aircraft to obtain advice and information from the previous military owner. In the case of AKY, that access was particularly important with respect to the previous cracking in the right wing upper attachment spar lug top surface and the resultant reduction in the inspection period while in service with the previous military operator.

That transfer of aircraft maintenance documentation, aircraft history and corporate knowledge is applicable to all aircraft that have been retired from previous military service. Accordingly, additional vigilance must be paid to ensure that ex-military aircraft are being maintained to ensure continued airworthiness.

### **Wing inspections**

#### ***AD/Strikemaster/4***

Civil Aviation Safety Authority (CASA) Airworthiness Directive AD/Strikemaster/4 was certified as having been carried out in 2003. To complete that inspection, the wing and associated systems were required to be removed in order to gain access to the wing upper attachment lug bore. There was no evidence that the wings had been removed or an NDT inspection had been carried out.

AD/Strikemaster/4 referred to the aircraft manufacturer's company servicing instruction CSI/Strikemaster/50. The issue current at the time of the accident was Issue 3; however the operator did not have a copy of Issue 3. In addition, all the copies of Issue 2 obtained by the ATSB during the course of the investigation were incomplete and missing a number of pages relevant to the lug inspection procedures. Issue 3 involved a more comprehensive inspection procedure than that specified in Issue 2. Accordingly, the operator was missing vital information required to carry out the wing spar attachment lug inspection.

Had the inspection been carried out in accordance with the requirements of either CSI/Strikemaster/50 Issue 2 or Issue 3, it is reasonable to conclude that, had the crack been present at the time in the top surface of the right wing upper attachment lug, it should have been detected.

### ***RNZAF SP 1137***

The next opportunity to detect a crack in the wing attachment lug upper surface was in September 2005, when RNZAF SP 1137 was certified as having been carried out. That inspection was about 14 flying hours prior to the accident and no cracks were noted in the NDT report. The NDT inspection area of the procedure outlined in SP 1137 may be covered by sealant or paint. Therefore, there exists the potential for a crack to remain undetected.

### ***The attachment lug bore crack***

The attachment lug bore crack was not detectable using either AD/Strikemaster/4 or SP 1137. The method for finding cracks in the bore specified in AD/Strikemaster/4 concentrates on the outer surface of the lug. This method will identify cracks that have progressed from the lug bore to the outer surface. Due to the limitations of that method, cracks in the bore that do not exist in the outer surface may not be detected without directly inspecting the bore surface. AD/Strikemaster/4 provided a procedure for inspection of the bore inner surface, however it was only required to be carried out if cracks had been detected on the outer surface of the bore, or if the bore sleeve was loose. In the case of AKY, the crack was in the inner surface of the bore only and therefore, the inspection procedure would not have identified the inner bore crack.

SP 1137 was only concerned with the area of the wing attachment lug top surface.

## **Operational oversight**

### ***The Civil Aviation Safety Authority***

While operators are still required to satisfy the Civil Aviation Regulations and other CASA regulatory requirements, due to the provisions of Civil Aviation Regulation 262AM, CASA provided a limited level of regulatory oversight of adventure flying operations.

### ***Australian Warbirds Association***

At the time of the accident, the Australian Warbirds Association had not been approved by CASA to administer the operation of limited category aircraft in

accordance with CAR 262AN. As such, they had no delegated authority for operational oversight of aircraft being operated under the limited category.

### ***The aircraft manufacturer***

Military aircraft are generally designed for a specific military requirement and service life, to a significantly different standard than civil aircraft, and operated and maintained in an environment which is particular to military operations. There is no requirement for military aircraft manufacturers to provide ongoing product support to aircraft that have been retired from military service.

## **Civil operation of ex-military aircraft**

It is clear from the evidence gained throughout this investigation that continuing maintenance support for most ex-military aircraft used in civil operations would not likely be to a similar level as in military service. However, many of these aircraft are being operated in a similar manner to their former military service.

---

## FINDINGS

---

From the evidence available, the following findings are made with respect to the in-flight break-up involving BAC 167 Strikemaster, VH-AKY, on 5 October 2006 and should not be read as apportioning blame or liability to any particular organisation or individual.

### Contributing safety factor

- During a simulated strike mission as part of an adventure flight, VH-AKY broke up in flight. The majority of the available evidence was consistent with a break-up initiated by separation of the tail surfaces leading to the separation of the weakened right wing.

### Other safety factors

- The right wing main spar upper attachment lug contained two pre-existing fatigue cracks that had not been detected.
- The inspection procedures current at the time of the accident would not have detected a crack in the bore of the upper wing attachment lug that did not extend to the outer surface. [*Safety issue*]
- The aircraft was flying at high speed and at a low altitude.
- There was no evidence that the inspections required by AD/Strikemaster/4 had been carried out on AKY, despite being certified as having been completed in 2003.
- The reduced inspection period for the wing spar attachment lug upper surface, implemented by the previous military operator, was not incorporated in the system of maintenance for AKY.
- The aircraft manufacturer's servicing instruction CSI/Strikemaster/50 held by the operator and the previous maintenance organisation responsible for AKY, was incomplete and not the current issue.
- The transfer of aircraft systems of maintenance from the military to the civil environment has the potential to reduce the level of safety, due to the probability of incomplete documentation and a lack of specialist aircraft type knowledge. [*Safety issue*]

### Other key findings

- Many of the safety factors identified throughout this investigation are not limited to the circumstances involving AKY, but may be applicable to all operations involving ex-military aircraft.

---

## SAFETY ACTION

---

Any safety issues identified during this investigation are listed in the Findings section of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

### **Civil Aviation Safety Authority**

As a result of this occurrence, the Australian Transport Safety Bureau (ATSB) briefed the Civil Aviation Safety Authority (CASA) on preliminary findings relating to the wing failure. CASA subsequently released the following *Airworthiness Bulletins (AWB)*:

- *AWB 02-018 Issue 1* on 10 October 2006
- *AWB 02-018 Issue 2* on 20 October 2006
- *AWB 02-018 Issue 3* on 16 November 2006

In September 2007, the ATSB provided further briefings to CASA and the UK Civil Aviation Authority (CAA) on the findings relating to the failure of the aircraft tail components. CASA subsequently released *Airworthiness Bulletin AWB 02-018 Issue 4* on 2 November 2007, which applied to all BAC 167 Strikemaster and Jet Provost aircraft (Appendix H).

CASA have also included information on their website regarding adventure flight safety. Further information may be obtained from <http://casa.gov.au/publicinfo/warbirds.htm>.

### **United Kingdom Civil Aviation Authority**

The UK CAA issued *Mandatory Permit Directive MPD 2007-002 R1* on 3 August 2007, which applied to all BAC 167 Strikemaster and Jet Provost aircraft (Appendix I).

### **Australian Warbirds Association**

The Australian Warbirds Association Limited has subsequently received approval from CASA to administer aircraft operating under the Limited Category. The aircraft must be operated and maintained in accordance with the Australian Warbirds Association Limited manual or have a specific approval issued by CASA to operate. Further information may be obtained from [www.casa.gov.au](http://www.casa.gov.au) or [www.australianwarbirds.com.au](http://www.australianwarbirds.com.au).

# APPENDIX A: CIVIL AVIATION REGULATION 262AM – LIMITED CATEGORY AIRCRAFT

414

*Civil Aviation Regulations 1988*

- function in the operation or is needed to accomplish the work activity directly associated with the special purpose;
- (b) carrying a flight crew member for the purpose of giving the flight crew member training in carrying out a special purpose operation for which the aircraft is type certificated;
  - (c) carrying material on a special purpose operation for which the aircraft is type certificated, if the material is needed to carry out the special purpose operation or the work activity associated with it.
- (5) The operator and the pilot in command of a restricted category aircraft must not permit a person to be carried on the aircraft if the person is not a person mentioned in subregulation (6).  
Penalty: 50 penalty units.
- (6) Subregulation (5) does not apply to the following:
- (a) a flight crew member;
  - (b) a flight crew member under training;
  - (c) a person who performs an essential function in a special purpose operation for which the aircraft is type certificated;
  - (d) a person who is needed to accomplish the work activity directly associated with the special purpose.
- (7) A person must not operate a restricted category aircraft if a shoulder harness is not installed for each seat located at a flight crew member station, and each seat located beside a seat at a flight crew member station.  
Penalty: 25 penalty units.
- (8) An offence against subregulation (1), (3), (5) or (7) is an offence of strict liability.

*Note* For *strict liability*, see section 6.1 of the *Criminal Code*.

## **262AM Limited category aircraft—operating limitations**

- (1) A person may operate a limited category aircraft only in:
- (a) a special purpose operation for which a special certificate of airworthiness in the limited category is in force under regulation 21.189 of CASR; or
  - (b) an operation permitted under subregulation (2).
- Penalty: 50 penalty units.
- (2) A limited category aircraft may be used for any of the following operations in support of a special purpose operation for which the special certificate of airworthiness was issued:
- (a) participation in an air display;
  - (b) taking the aircraft to or from a place where a demonstration or display of the aircraft is to take place, or has taken place, during an air display;
  - (c) practice flying of the aircraft for participation in an air display;

*Legal Services Group  
Civil Aviation Safety Authority*

Replacement Page Amdt No. 12  
December 2005

*Amended CAR – 2<sup>nd</sup> Ed  
August 2003*

- (d) taking the aircraft to or from a place where maintenance on the aircraft is to be done, or has been done;
  - (e) testing the aircraft after maintenance;
  - (f) training a person to qualify for an aircraft endorsement for an aircraft of the type or category in which the aircraft is included;
  - (g) practice in flying the aircraft, or training in a special purpose operation for which the aircraft is certificated;
  - (h) carrying out a demonstration or test of the aircraft for sale;
  - (i) delivering the aircraft to a person under a contract of sale;
  - (j) an operation necessary to accomplish the special purpose operation.
- (3) Except as permitted by subregulation (7), a person must not operate a limited category aircraft for a purpose mentioned in paragraph 206 (1) (b) or (c).  
Penalty: 50 penalty units.
- (4) A person must not operate a limited category aircraft carrying a passenger if each of the following requirements is not satisfied:
- (a) no more than 6 (or a greater number approved by CASA or an authorised person) people are on board;
  - (b) the operator or the pilot in command ensures that each passenger is told about the matters mentioned in subregulation (5):
    - (i) if the passenger is being carried as permitted under subregulation (7) and pays for the flight before boarding the aircraft—before the passenger pays for the flight; or
    - (ii) in any other case—before the passenger boards the aircraft;
  - (c) a placard bearing the warning stated in subregulation (6) is displayed inside the aircraft in a way that is conspicuous to, and can be easily read by, each person in the aircraft.
- Penalty: 50 penalty units.
- (5) For paragraph (4) (b), the matters about which a passenger must be told are that:
- (a) the design, manufacture, and airworthiness of the aircraft are not required to meet any standard recognised by CASA; and
  - (b) CASA does not require the aircraft to be operated to the same degree of safety as an aircraft on a commercial passenger flight; and
  - (c) the passenger flies in the aircraft at his or her own risk.

- (6) For paragraph (4) (c) the warning is:

"WARNING

PERSONS FLY IN THIS AIRCRAFT AT THEIR OWN RISK

THIS AIRCRAFT HAS BEEN DESIGNED FOR SPECIAL OPERATIONS AND IS NOT OPERATED TO THE SAME SAFETY STANDARDS AS A NORMAL COMMERCIAL PASSENGER FLIGHT".

- (7) A person may carry passengers in a limited category aircraft in circumstances where payment is made for carriage, and subregulation 2 (7A) does not apply, only if:
- (a) the pilot in command holds a commercial pilot licence, or an air transport pilot licence, with appropriate ratings and endorsements for a flight of that kind; and
  - (b) the aircraft departs from and returns to the same aerodrome without landing anywhere else; and
  - (c) the flight does not involve training or flight testing, and is not a scenic flight; and
  - (d) the aircraft:
    - (i) is a replica aircraft, ex-military aircraft or historic aircraft; or
    - (ii) is being operated for the purpose of parachute jumping, mock combat or aerobatics; or
    - (iii) is being operated only to carry passengers as part of an intrinsically hazardous recreational activity; and
  - (e) each passenger has acknowledged in writing that the passenger has been told about the matters mentioned in subregulation (5).
- Penalty: 50 penalty units.
- (8) The aircraft operator:
- (a) must keep an acknowledgment required under paragraph (7) (e) for at least 3 months; and
  - (b) must not keep it in an aircraft.
- Penalty: 10 penalty units.
- (10) A limited category aircraft may be operated over the built-up area of a city or town only if:

- (a) CASA or an authorised person has assigned it, under subregulation (14), a permit index of 0; or
- (b) CASA or an authorised person has assigned it a permit index of 1 and:
  - (i) it is only flown over the area to the least extent necessary to allow it to take off from, or land at, a particular aerodrome, or follow a procedure approved by CASA or an authorised person for the safety of other airspace users and persons on the ground or water; and
  - (ii) if it is using an aerodrome in a capital city—it follows an access route approved by CASA or an authorised person for the purpose; or
- (c) CASA or an authorised person has approved it to do so.

Penalty: 50 penalty units.

- (11) In considering whether to grant an approval under paragraph (10) (c), CASA or the person authorised under that paragraph must take into account the aircraft's permit index and anything else CASA or the authorised person considers relevant for the safety of other airspace users and persons on the ground or water.
- (12) A person must not operate a limited category aircraft in another country's airspace if the operation of the aircraft is not in accordance with the approval of the appropriate authority of the country.  
Penalty: 10 penalty units.
- (13) A person must not operate a limited category aircraft for a purpose mentioned in paragraph 206 (1) (a) if the person is not the holder of an appropriate AOC.  
Penalty: 10 penalty units.
- (14) CASA or an authorised person must assign a permit index (that is, a whole number between 0 and 3) in accordance with Advisory Circular 21.25 issued by CASA, as published from time to time, to a limited category aircraft for the purpose of applying appropriate safety conditions to the operation of the aircraft.
- (15) An offence against subregulation (1), (3), (4), (7), (8), (10), (12) or (13) is an offence of strict liability.

*Note* For strict liability, see section 6.1 of the Criminal Code.

#### **262AN Approved organisations**

- (1) CASA may approve an organisation to administer the operation of limited category aircraft engaged in a special purpose operation mentioned in subregulation 21.189 (3) of CASR if CASA is satisfied that the organisation:
  - (a) is suitable, and has enough suitably qualified and competent personnel, to ensure that the administration of relevant aircraft

**ATSB TECHNICAL ANALYSIS REPORT**

26/07

Ref: BE/200600027

**Examination and analysis of wing separation  
BAC 167 Strikemaster, VH-AKY  
5 October 2006**

## SUMMARY

During the high-speed, low-level phase of a commercial adventure flight, an ex-military BAC 167 *Strikemaster* aircraft broke up and impacted terrain near Bathurst NSW, fatally injuring both the pilot and passenger.

Preliminary investigations found that the right wing had separated from the aircraft during the breakup sequence, and that this wing contained evidence of pre-existing cracks within the upper attachment lug that secured the wing to the aircraft.

Technical examination and analysis confirmed the presence of two separate fatigue cracks within the wing attachment lug. Both cracks had initiated in areas of the lug that were known to be susceptible to fatigue cracking and were the subject of mandatory periodic inspection. The appearance of the cracks suggested they had been developing over an extended period.

While the presence of the fatigue cracks would have reduced the ultimate strength of the wing connection, anecdotal evidence from two previous occurrences suggested that the cracks were of insufficient size to have produced failure under normal operational loads.

It is probable therefore, that the wing separation from VH-AKY was a result of abnormal loading conditions arising from a precursor event.

# FACTUAL INFORMATION

## Introduction

On 5 October 2006, an ex-military BAC167 Strikemaster aircraft, registration VH-AKY, serial number EEP/JP1935 Mk84, was destroyed after breaking up in flight and impacting the ground near Bathurst, NSW. Both the pilot and the passenger were fatally injured.

During the preliminary examination of the wreckage by ATSB investigators, it was evident that the aircraft's right wing had separated from the main fuselage during the break-up sequence, with the wing located some 130 m from the fuselage and left wing. The wing had separated at the point of structural interconnection to the fuselage.

An intense, fuel-fed fire severely damaged or destroyed a good proportion of the aircraft fuselage and left wing structure. Further damage to the wreckage was sustained during a bushfire that was ignited by the accident and burned through the wreckage field during the following days.

Despite the fire damage, ATSB investigators were able to recover the majority of the heavier sections of the aircraft's wing connection structure, including the upper and lower spar boom interconnections and the inboard central section of the right wing. The left wing spar boom connections had been entirely destroyed during the post-impact fire. The recovered wing and fuselage structures were transported to the ATSB's Canberra laboratories for detailed technical analysis.

## Scope of the examination

Examination and analysis of the right wing terminal structure from VH-AKY was carried out in an attempt to ascertain:

- The nature of the mechanism by which the right wing separated from the fuselage
- The condition of the wing terminal structure, including the identification and characterisation of any pre-existing material or structural anomalies
- The role of the wing failure in the development of the accident

## Recovered structure

Figures 1 – 5 illustrate the main fuselage and wing structural sections recovered from the accident site. Of the fuselage components, only the main lower crossbeam and the upper terminal fittings had survived the post-impact fires; the associated thinner aluminium sections having completely melted and oxidised. Of the wing sections, both lower spar booms and lugs had remained engaged with the fuselage crossbeam. The left boom carried a small amount of adjoining structure, whereas the right boom had fractured just outboard of the lug connection. The upper spar boom and lug of the left wing had been completely destroyed by the fires and was not recovered. The right wing spar boom and lug were recovered with the

separated wing; the lug having fractured through the point of connection with the terminal fitting, and through the flanged interconnection with the lower boom.

Both flanges and the pin from the right wing rear yoke connection were also recovered; the flanges having fractured away from the fuselage fitting.

**Figure 1. Fuselage cross member and wing attachment fittings**



**Figure 2. Right wing attachment fittings – lower**



**Figure 3. Left wing attachment fittings - lower**



**Figure 4. Right wing spar boom - upper**



**Figure 5. Right wing rear attachment yoke**

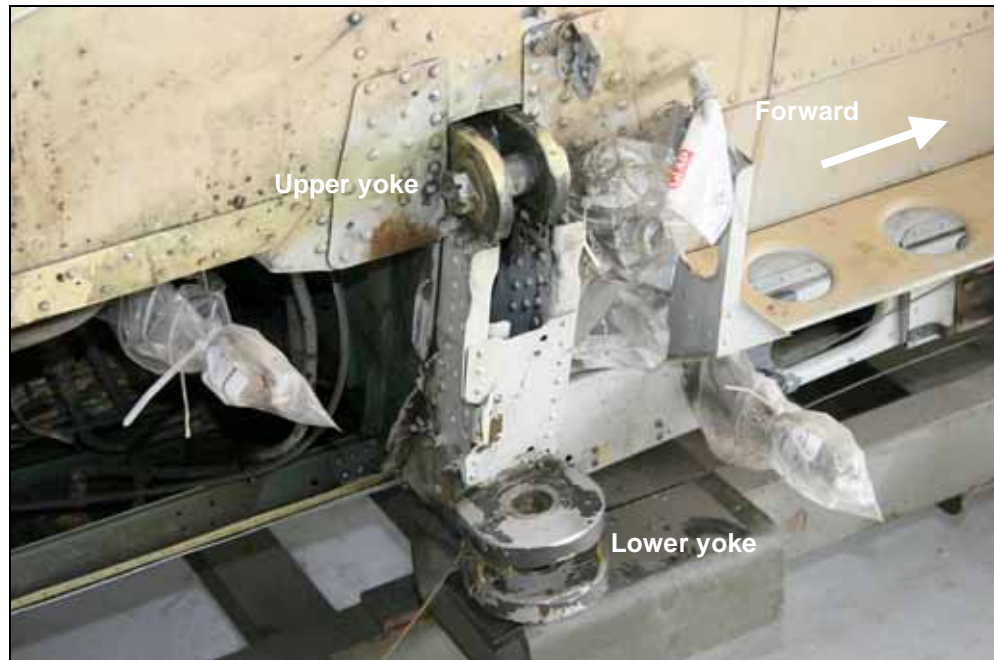


## **Fracture characterisation**

The BAC 167 Strikemaster design provided for securing both wings using a pinned yoke arrangement (Figure 6). Primary flight loads were transferred to the fuselage from lugs at the ends of the upper and lower main spar caps. A third smaller yoke towards the wing trailing edge balanced the wing drag loads.

Separation of the right wing from VH-AKY in the break-up sequence was associated with structural fracture at, or adjacent to each of the primary wing connection points.

**Figure 6. Right wing main spar attachment yokes from a similar aircraft**



### **Right wing upper main spar connection**

Failure of this element had occurred via fracture of the vertical lug at the end of the spar boom (Figure 7). Two regions of fracture were evident; an upper diagonal plane of predominantly ductile-tensile fracture with two atypical regions, and a lower transverse zone of ductile fracture at the base of the lug, that had turned to an axial orientation and bisected a line of fasteners at the upper edge of the main spar web (Figure 8).

**Figure 7. Fractured right wing upper attachment lug**



**Figure 8. Underside of right wing attachment lug showing tearing along flange section**

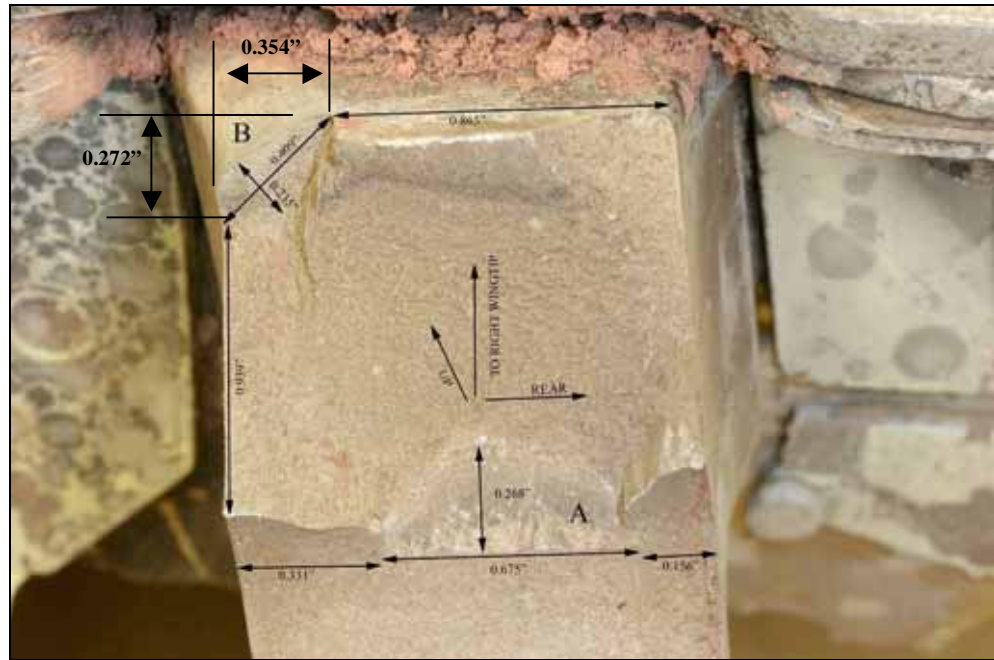


Under low power stereomicroscopic examination, the two atypical areas on the upper diagonal fracture (Figures 9 and 10) presented surface characteristics indicative of the initiation and growth of fatigue cracking. The larger of the two areas (area 'A') had initiated within the bore of the spar lug and propagated along a semi-elliptical crack front, to a maximum depth of 6.8 mm (0.268") and length of 17.1 mm (0.675") along the bore. The smaller cracked area was located at the forward-facing corner of the spar boom where it transitioned into the lug section. The corner exhibited a locally chamfered geometry, typical of having been ground and blended during some prior maintenance activity. Cracking of the corner region (area 'B') had propagated to a depth of 6.9 mm (0.272") and width of 9.0 mm (0.354"). In combination, the approximate area of both cracked regions represented around 30% of the total cross-sectional load-bearing area of the lug upper section.

**Figure 9. Fracture detail – right wing upper attachment lug**

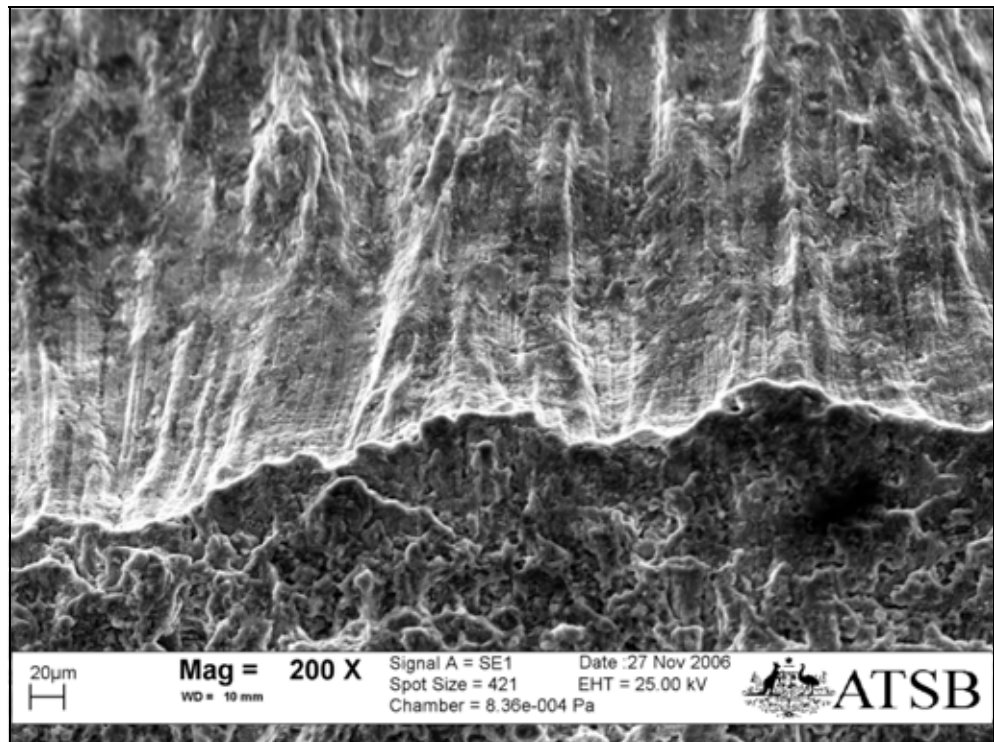


**Figure 10. Lug fracture detail with dimensions and orientation**



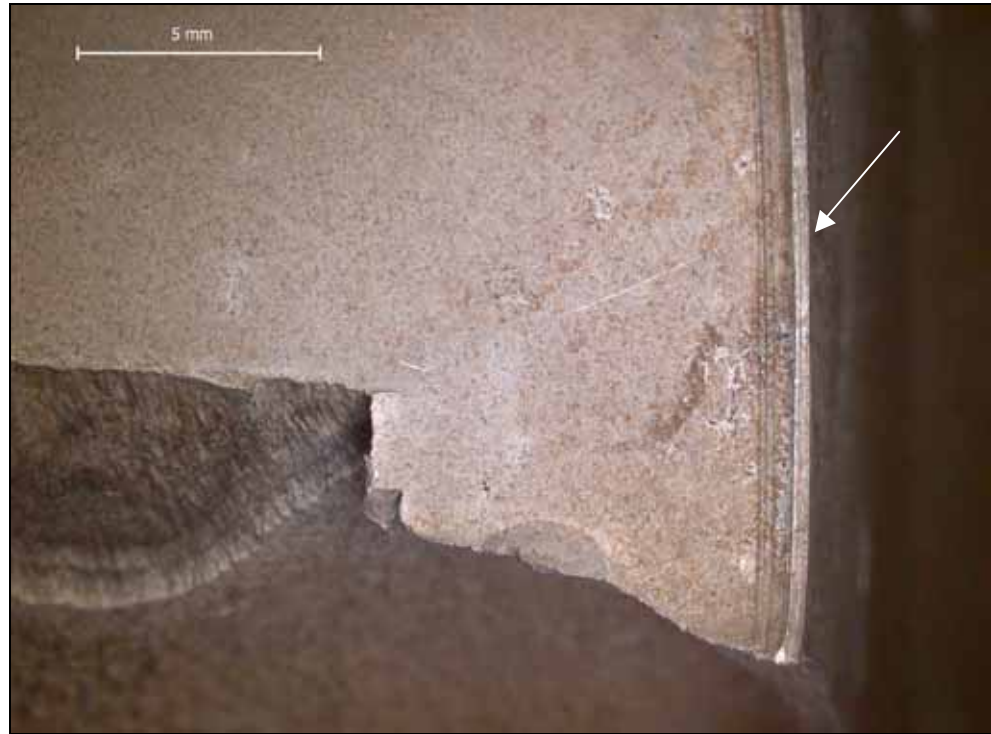
Scanning electron microscopy (SEM) of the two regions of cracking identified surface striations in both regions – confirming high-cycle fatigue cracking as the mechanism of propagation (Figure 11). Both regions showed evidence of multiple origins, however the heavily oxidised, pitted and generally fire-damaged condition of the surfaces prevented any further detailed examination of value.

**Figure 11. SEM fractograph of the fatigue / ductile fracture transition boundary. Fine striations are evident within the fatigue (upper) region**



Evidence of localised compressive deformation of the lug material was observed at both ends of the lug bore, with distinct ridges formed where the steel bore sleeve had compressed the central underlying material (Figure 12). Measurements confirmed the lug bore ridges to correspond with the chamfers at the external corners of the bore sleeve. Optical profiling of the lug corners showed the ridging to have been raised approximately 1 mm (0.04”) above the compressed lug bore surface (Figures 13 and 14).

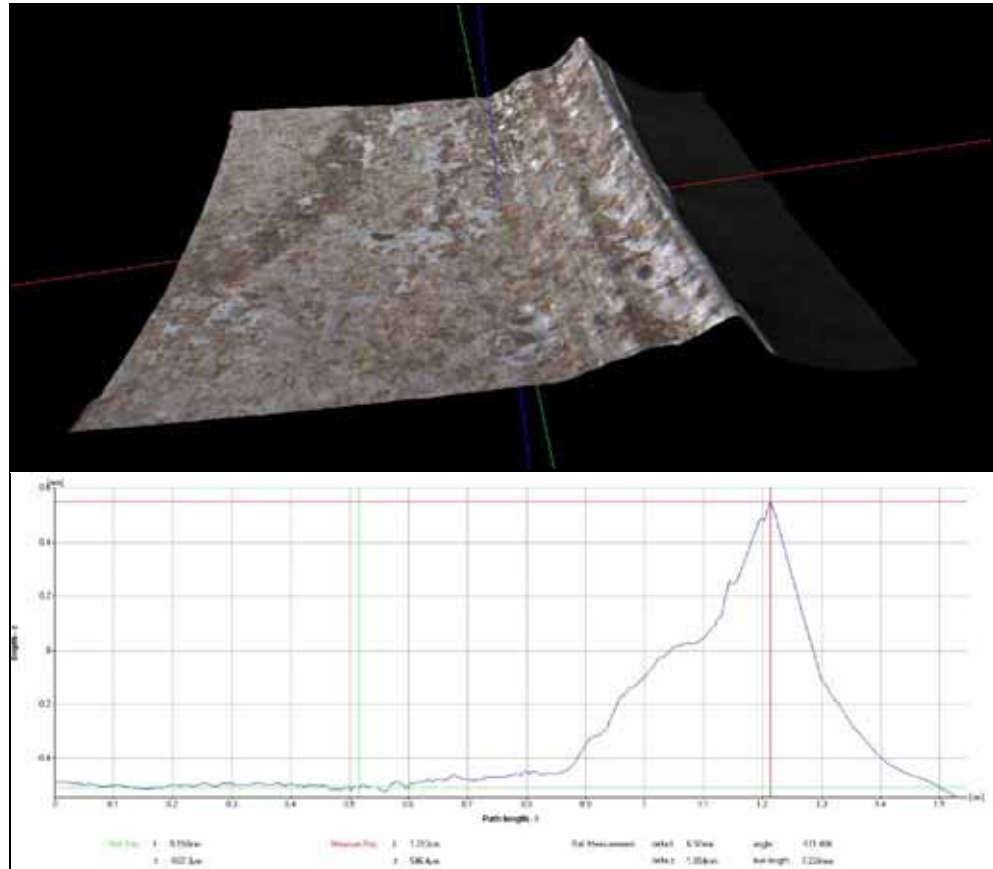
**Figure 12. Compressive deformation of the lug bore produced a ridging of material at the bore ends (arrowed)**



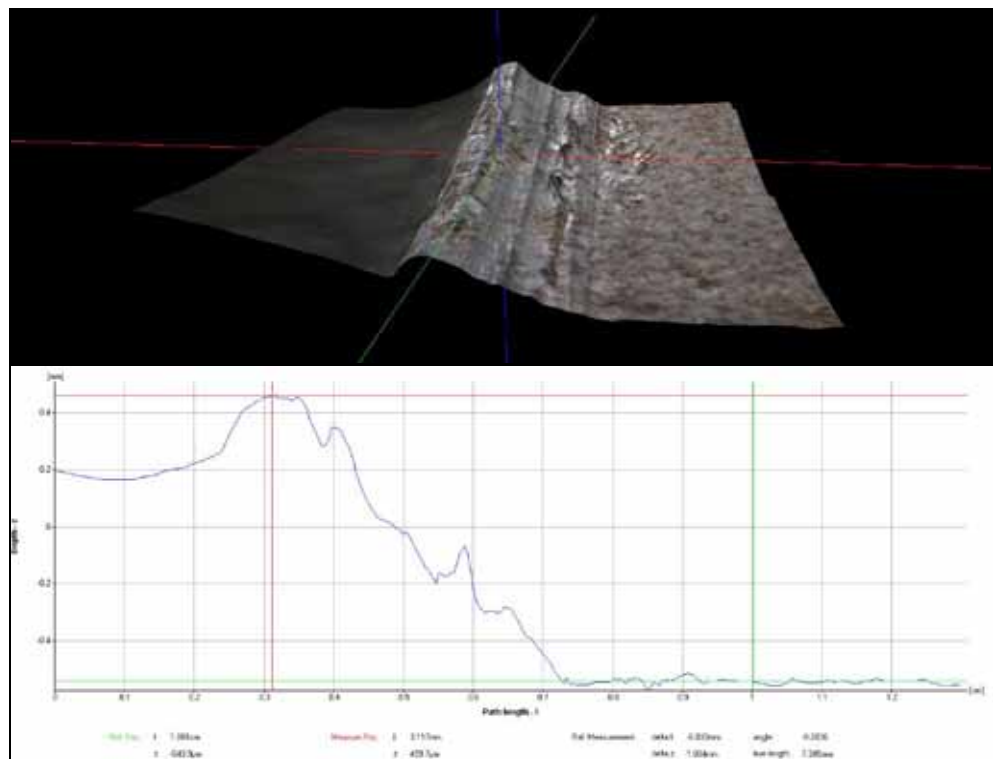
Study of the lug lower fracture detail found no evidence of pre-existing cracking or damage. The morphology of all regions was typical of ductile failure under tensile overstress conditions.

The tensile characteristics of the upper fracture detail and the path of fracture through the fasteners along the spar web were strong indicators of the upper main spar connection having failed under wing downward bending forces. Under normal, positive-g, non-inverted flight, the loads on the wing upper main spar connections are upward and compressive in sense, resulting from the classic cantilever wing attachment design.

**Figure 13. Three-dimensional image and profile of the ridging effect at the forward end of the lug bore**



**Figure 14. Image and profile of the ridging at the aft end of the lug bore**



## Right wing lower main spar connection

The right wing lower main spar had separated from the fuselage by transverse fracture of the spar boom, approximately 200 mm (8") outboard from the horizontal lug centreline. The lug had remained engaged and secure within the fuselage yoke (Figure 15). The spar boom vertical web had fractured axially, with surface markings indicating fracture progression from the inboard end of the web. Cleaning and stereomicroscopic examination of the fractures found no evidence of pre-existing defects, fatigue cracking or other anomalous features. The surface morphology in all areas was typical of rapid ductile fracture under tensile or combined tensile/bending loads. Plastic deformation associated with the fractures and the bending of a fastener along the plane of separation (Figure 16) suggested failure under downward bending loads – thus correlating with the upper lug observations.

Removal of the steel sleeve from the lug bore permitted the visual and non-destructive (dye penetrant) inspection of the full lug surface. The inspection found no indications of the type of bore cracking observed within the upper lug, nor did it disclose any other significant discontinuity within the lug or adjoining sections.

**Figure 15. Right wing spar lower lug and yoke engaged (as-recovered)**



**Figure 16. Fractured flange section outboard of the spar lower lug**



**Figure 17. Right wing rear attachment yoke flanges**



### **Right wing rear connection**

Both flange sections from the fuselage yoke presented fracture features typical of ductile tensile overstress, with no evidence of pre-existing anomalies that might have predisposed the fitting to premature failure. The flanges had failed in an asymmetric fashion, with the forward flange tearing through the body to intersect the pin hole; the rear flange tearing along the reduced section immediately behind the yoke faces (see Figure 17).

## **Metallurgical characterisation**

### **Material chemistry**

Spectrographic analyses<sup>9</sup> of samples taken from the right wing upper and lower spar boom sections returned the results contained in table 1 (elemental weight percentage).

**Table 1. Chemical composition of spar boom materials**

<b>Spar</b>	<b>Al</b>	<b>Si</b>	<b>Cu</b>	<b>Fe</b>	<b>Mg</b>	<b>Zn</b>	<b>Cr</b>	<b>Ni</b>	<b>Mn</b>	<b>Ti</b>	<b>Sr</b>	<b>Zr</b>
Upper	~Bal	.74	4.02	.39	.68	.12	.02	.06	.74	.04	<.001	<.005
Lower	~Bal	.79	4.15	.38	.67	.16	.03	.04	.71	.04	<.001	<.005

As analysed, both spar boom materials conformed with the general chemistry requirements of a UNS A92014 (AA 2014) precipitation-hardenable aluminium

---

<sup>9</sup> Analytical services provided by Spectrometer Services Pty Ltd, Coburg VIC. Report 26189 refers.

alloy. The material was also closely aligned with the nominal chemical composition of a BS L65 alloy, which was the specified material of wing spar construction.

## Hardness

Vickers hardness tests conducted on suitably prepared sections through the upper and lower spar boom components returned the results as presented in table 2, with conversion to Brinell hardness values made in accordance with ASTM E140.

**Table 2. Spar boom hardness measurements**

<b>Spar Boom</b>	<b>Vickers Hardness (HV<sub>10</sub>)</b>	<b>Brinell Hardness (HB)</b>
Upper	80.5 – 83.6	70 – 73
Lower	70.5 – 74.2	62 – 65

As measured, the hardness results for both wing upper and lower spar boom fittings were considerably lower than the nominal 135 – 139 HB values prescribed for the material of manufacture in the solution treated and artificially aged condition (T6). However, consideration must be given to the thermal effects on the alloy, of the post-impact fires that destroyed much of the aircraft structure. For the alloy type in question, annealing (softening) effects commence from temperatures above 250°C and microstructural solutionising begins around 490°C. Given the evident intensity of the fires, it was probable that the spar boom alloys were both appreciably affected, and as such, no longer in a condition representative of the original material.

## Historical experience

Information made available to the ATSB during its investigation of the VH-AKY accident indicated that the potential for the development of fatigue cracking within the upper spar boom of the Strikemaster / Jet Provost type had been generally known since the mid-1980's. Maintenance records for the subject aircraft while it was being operated by the Republic of RSAF, showed that in 1984, an area of cracking within the right wing upper spar had been removed by dressing and blending. That dressing was evident from the present examination, and corresponded with the smaller region of cracking within the lug upper section. Also in 1984, a Royal Saudi Air Force (RSAF) Strikemaster was lost after it broke-up during a post-maintenance proving flight. Investigation of that accident found evidence of fatigue cracking within the wing spar upper attachment lugs, however analyses by the aircraft manufacture found that the cracking had not contributed to the accident; the break-up event being attributed to an abnormal, negative-g bunt<sup>10</sup> event stemming from a control surface rigging problem. Records of the investigation were not available to the ATSB, however, a senior investigator who had participated in the work, described the lug cracking as 'fingernail sized'.

---

<sup>10</sup> An aircraft bunt or pushover is the motion resulting from an abrupt forward pitching movement, resulting in negative-g airframe loading.

In January 1985, the aircraft manufacturer published Company Servicing Instruction CSI/Strikemaster/29, which introduced periodic inspections of the outer surfaces and bore of the wing spar upper attachment lug. In June 1995, that was superseded by CSI/Strikemaster/50, after instances of cracking were found within lugs that had satisfied the CSI/Strikemaster/29 inspection criteria. To expand the scope of the inspection and improve the probability of defect detection, CSI/Strikemaster/50 was subsequently revised in June 1995 and again in March 1996. To mandate the CSI inspections for those aircraft being operated in the United Kingdom under the permit-to-fly system, the UK Civil Aviation Authority released Mandatory Permit Directive (MPD) No. 1995-109 in 1995, with a subsequent revision (MPD 1995-109 R1) in December 1998. The requirements of MPD 1995-109 were adopted by the Australian Civil Aviation Safety Authority (CASA) and published as Airworthiness Directive AD/Strikemaster/4 in November 1996.

### ***Crack formation and growth***

Strikemaster aircraft operated by the Royal New Zealand Air Force (RNZAF) had also sustained cracking within the wing upper spar lugs. In the most significant instance, a lug removed from service as a result of upper corner cracking was found to also contain a second, much larger crack extending for the full radial thickness of the fitting. The defect, having initiated at the bore surface, extended through approximately one-third of the total lug cross-section along the plane of cracking. Despite the extensive cracking and reported demanding use of the aircraft by the RNZAF, the lug had remained intact and showed little evidence of imminent catastrophic failure. It was further noted that the aircraft had probably been exposed to moderate negative load factor manoeuvres immediately before the defect was discovered.

Investigations by the manufacturer concluded that compressive yielding around the lug bushing during high-magnitude positive load factor aircraft manoeuvres, had produced a material state whereby subsequent relaxation of the yielded material induced locally high tensile stresses at the bore surface – ideal conditions for the initiation of fatigue cracking. Consequent fatigue damage and crack propagation resulted from stress fluctuations induced during operational flight regimes.

The manufacturer's servicing instruction CSI/Strikemaster/50 provided an allowance whereby a degree of cracking within the upper-lug corner was tolerable, subject to an increased re-inspection frequency. When assessed against the dimensional criteria, the corner cracking exhibited by the right wing upper lug was marginally in excess of the maximum allowable depth of 6.1 mm (0.25"), when taking into consideration the previously blended area. The service instruction made no provision for the acceptance of lug bore cracking, with any cracking in that area rendering the wing unserviceable.

## **ANALYSIS**

### **Wing separation**

The in-flight separation of the right wing from the Strikemaster airframe occurred at the points of structural interconnection between the wing and fuselage. Fracture form and morphology at those points indicated failure occurred under predominantly downward bending loads; loads opposite in sense to the conventional upward bending loads induced by the aerodynamic lift of the wing.

With the exception of two areas of pre-existing cracking within the spar upper lug connection, all fractures were typical of ductile failure under overstress conditions. The spar material was confirmed as the design intended alloy, and while the strength could not be verified as a result of fire damage, there was no evidence to suggest the material properties were deficient in any way.

### **Spar lug cracking**

The two areas of cracking identified within the upper lug connection were confirmed as pre-existing fatigue cracks; their morphology consistent with being driven under the high-cycle dynamic stresses associated with in-flight wing loading. The presence of compressive yielding damage within the upper lug bore was indicative of one or more transient overloading events; probably associated with 'high-g' aircraft manoeuvres. As such, the aircraft manufacturer's association of compressive yielding damage with the development of upper lug bore cracking was supported by the examination findings.

The examination was unable to determine the period over which the upper lug cracks had developed, however the physical appearance and morphology of the crack surfaces suggested an extended period of comparatively slow growth.

### **Contribution of spar lug cracking to the accident**

On the basis of the evidence available to the investigation, it was concluded that the spar lug cracking, while detrimental to the strength of the wing connection, had not developed to a size where it would have been likely to produce the failure of the lug under the wing loads associated with flight within the normal certified limits of the aircraft. The principle evidence supporting this position is:

- Comparative size of the defects, versus the historical experience. The fatigue cracks found within the right wing upper spar lug of VH-AKY were appreciably smaller than the defects found within an operational RNZAF aircraft during a maintenance inspection. Utilisation of the RNZAF aircraft was reported to have been relatively demanding and it was probable that it had been exposed to moderate negative load factor manoeuvres immediately before the defects were discovered.
- Discovery of similar sized defects in an aircraft lost for other reasons. A RSAF that broke-up in flight, with the downward bending failure of both wings, was found to have similar sized fatigue crack defects within the upper spar lugs.

That aircraft was lost however, as a result of an uncommanded bunt manoeuvre that induced a gross overload of the wing connection structure.

It follows therefore, that at the time of the right wing failure, VH-AKY may have been subjected to an in-flight manoeuvre or event that resulted in the abnormal downward overloading of the wing and connecting structures. Under such circumstances, the presence of defects within the upper lug could be expected to lead to wing separation in the manner observed.

An engineering stress analysis and fracture mechanics assessment of the wing spar lug failure could have provided further evidence to assist the interpretation of the failure, however, this work was unwarranted in view of the scope of the investigation and the conclusive nature of the existing evidence.

# APPENDIX C: RNZAF SP 1137

1137-1

NZAP 6212.002-5-1.3-1

## STRIKEMASTER MK88 SERVICING PROCEDURE

TRADES		TITLE	TIME
2 ACFT	1 NDT	WING MAIN SPAR UPPER ATTACHMENT LUG EXAMINATION	

**References:**

- A. SMI STR 97G
- B. BAE Drawing K167-03-315 issue D
- C. NZAP 167, Volume 6, Part 1, Chapter 3, Table 1
- D. MMS 11043101

### Materials Required:

ITEM	PART/STOCK NO.
PD 680	

### NOTE

- Any defects/cracking are to be reported to Air Staff Attention AM2.

### BLOCK 1

### AIRCRAFT

1. Port and Starboard Wing Root Fairings Remove.
2. Port and Starboard Air Pressure Relief Valves Remove.

### NOTE

- Removal of the additional reinforcing straps (Reference B items 7 and 8) is not necessary unless required.
3. Port and Starboard Spar Upper Wing Attachment Lugs Clean using PD 680 and allow to dry.

### BLOCK 2

### NDT

1. Port and Starboard Upper Attachment Lugs Carry out Eddy Current tests iaw NDTT/STR/3.

### BLOCK 3

### AIRCRAFT

1. Port and Starboard Upper Wing Attachment Lugs (where no evidence of cracking is found)
  - a. Visually inspect top and side for any damage as far as access allows.
  - b. Rectify any damage found iaw Reference C.

108\*002.1137-1

## NOTE

- ° Remove the minimum amount of material necessary to remove defect.
- ° Blended and unblended lugs that have not already been polished over their full inspection area are to be polished iaw Reference B, as far as access will allow, and the protective finish restored.

BLOCK 4AIRCRAFT

## NOTE

- ° This Block is to be carried out only if there is evidence of cracking.

1. SIID NO 17 (Figure 1137-1) Record the following:
  - a. Aircraft tail number.
  - b. Current Aircraft hours.
  - c. Fatigue Index units.
  - d. Detail extent and location of cracks (see Figure 1137-2).
2. Upper Wing Attachment Lugs Repair cracked area and polish full inspection area iaw Reference B.
3. SIID NO 17 (Figure 1137-1) Record details of final blend measurements and outline (see example on Figure 1137-2).

## NOTE

- ° If final blending falls outside the limits imposed by Reference B, the aircraft is to be retained unserviceable pending Air Staff advice.
- ° Report any evidence of cracking to Air Staff Attention AM2.

BLOCK 5AIRCRAFT

1. Butt Strap Reinforcing Plate. Refit if removed.
2. Port and Starboard Pressure Relief Valves Refit.

## NOTE

- ° When fitting relief valves ensure 'P' clips are positioned so **DO NOT TO CAUSE damage to wing/fuselage upper attachment lugs and surrounding area, i.e. with the screw adjustment facing upwards.**

---

3. Port and Starboard Wing Root Fairings	Refit.
---	--------

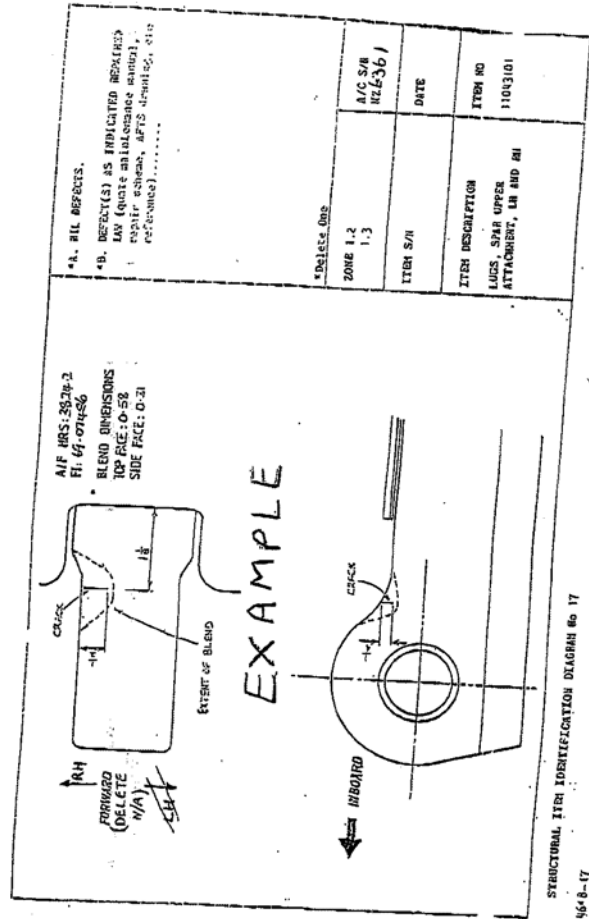
---

**BLOCK 6**

## NOTE

- Blended Lugs: Where maximum blend measurement is 0.6 inches (across top face) and 0.3 inches (down side face) or less, inspect every 50 flying hours. Inspect blends with larger dimensions every 25 flying hours.
- |                  |                                |
|------------------|--------------------------------|
| 1. Documentation | a. Annotate RNZAF 700/Records. |
|                  | b. Sign.                       |
-





NZAP 6212.002-5-1.3  
Page 5-18 AL 12 (11)

RESTRICTED

FIGURE 1137-2

END

10B\*002.1137-5

## NDTT/STR/3

## EDDY CURRENT - WING, UPPER ATTACHMENT FITTING

1. Applicability. All Strikemaster mainplanes, MMS No. 11043101
2. Purpose. To detect fatigue cracking on the upper surface and front rear faces of the wing, upper attachment fitting (Ref Fig 1), port and starboard mainplane.
3. Equipment.
  - a. Any eddy current test set as detailed in NDTT/GEN/1.
  - b. Pencil probe and knife probe.
  - c. Standard calibration block, aluminium alloy.
4. Preparation. Ensure wing root fairing access panel is removed fuel air pressure relief valve is removed and test area is clean and free of loose and cracking paint.
5. Test Procedure.
  - a. Calibrate test set iaw NDTT/GEN/1.
  - b. Scan the upper forward edge of the lugs from the upper most inboard paint to as far outboard as possible.
  - c. Repeat the above operation on the upper aft edge of the lug.
  - d. Using a spanwise zig zag pattern, scan the upper surface of the lugs between the above areas.
  - e. Scan the forward and aft face of the fitting where accessibility permits.
6. Follow Up Action. Any area displaying a defect indication will be subject to the following procedure:
  - a. Strip paint from the suspect area and retest.
  - b. Using a strong light and 10X to 20X magnification, carefully inspect the suspect area for cracks.
  - c. If cracks are seen or defect indications are still present after a. above, penetrant test iaw NDTT/GEN/PEN/1 for verification.
  - d. Report any defects iaw NZAP 6005.002-1, Chap 3.
7. Origin.
  - a. NZDEF LONDON DYD 191601Z JUL 84.
  - b. CSTI/STR/131
  - c. RNZAF.
8. Issued. September 1984. Revised January 1992.

# APPENDIX D: BAC SERVICING INSTRUCTION CSI/STRIKEMASTER/50 ISSUE 3



BRITISH AEROSPACE  
MILITARY AIRCRAFT DIVISION  
Warton Aerodrome  
Preston  
Lancashire PR4 1AX  
Telephone: 01772 633333  
Telex: 67627

## COMPANY SERVICING INSTRUCTION

SECTION AIRCRAFT SHEET 1 OF 12  
SERIAL No. 50 SF 184.  
AIRCRAFT APPLICABILITY Strikemaster All Marks and BAC 145 Mk. 55.  
(Pre Mod 7061) which have achieved 15 Fl or 1,000 Flying Hours.  
Strikemaster - All Marks and BAC 145 Mk. 55  
(Post Mod 7061) which have achieved 40 Fl.

SPARES APPLICABILITY Wings (Pre Mod 7061) which have achieved 15 Fl or 1,000 Flying  
Hours. Wings (Post Mod 7061) which have achieved 40 Fl.

CSI/STRIKEMASTER/50

### PORT AND STARBOARD MAINPLANE SPAR UPPER ATTACHMENT LUGS: CRACKING

This instruction supersedes CSI/STRIKEMASTER/29

Cracking occurred in the mainplane spar upper attachment lug in the outer surface and also from the bore of the lug. CSI/Strikemaster/29 was issued to introduce periodic inspections of both of these areas.

Cases have now occurred of mainplane spar upper attachment lugs which have satisfied CSI/Strikemaster/29 being found cracked beyond acceptable limits. Investigation has determined that the ultrasonic technique called up to detect cracking emanating from the bore of the lug cannot be relied upon to detect cracks round the full circumference of the lug and attempts to develop a technique which will guarantee the detection of cracking with the wing fitted have been unsuccessful.

This instruction introduces a periodic inspection of the forward and aft faces of the mainplane spar upper attachment lug with the wing removed to check for cracking from the bore and retains the eddy current technique and recovery action detailed in CSI/Strikemaster/29 for cracking in the outer surface.

ISSUE No	1	2	3				
DATE	14/06/95	27/06/95	22/03/96				

SM8149

At the next 150 flying hour servicing and subsequently at 150 flying hour intervals and also at each heavy landing or excess 'g' loading.

1. Ensure the aircraft is safe for servicing.
2. Remove the aircraft wing(s). (ASM, Sect 3 Chap 2).
3. Examine the upper attachment lug in accordance with Appendix 1 to this instruction. Where there is no indication of cracking and the bush is secure proceed from paragraph 6.
4. Where there is a crack indication or the bush is loose remove the bush from the upper attachment lug in accordance with current Servicing Procedures.
5. Examine the bore of the upper attachment lug in accordance with Appendix 2 to this instruction and where cracking is present confirm the length and location of the crack(s). Retain the mainplane unserviceable and request advice as detailed below.
6. Thoroughly clean the port and starboard wing main spar upper attachment lugs using a br. and genlene and allow to dry. Where fretting of the boom surface has occurred, removing the minimum amount of material necessary to clear the defect, polish the surface using the technique specified in Notes 2 and 3 of drawing No. K167-03-315.
7. Examine the port and starboard spar attachment lugs in accordance with Appendix 3 to this instruction. Where there is no evidence of cracking, continue from para 11. Where there is evidence of cracks, proceed as follows.
8. Compare crack details against the graph at Fig. 1, attached. Where the cracks are within these limits the aircraft may continue to fly subject to re-evaluation i.a.w. Appendix 3, every 10 flying hours. Once repaired i.a.w. drawing No. K167-03-315, the re-examination periodicity can be relaxed to 75 flying hours. Note that the reduced re-examination periodicity's given in paragraph (8), only apply to the lug neck examination detailed in Appendix 3. Also note that re-examination of the lug neck in accordance with Appendix 3 does not require wing removal.
9. Where the cracking exceeds the limits in Fig 1, or cannot be blended out within the limits in drawing No. K167-03-315, the aircraft is to be held unserviceable and reported as below.
10. Where cracking appears in a previously blended area, repair i.a.w. drawing No. K167-03-315. If the area of new blend is within the limits of K167-03-315, the aircraft may continue to fly. Where cracking in a previously blended area has occurred it is to be reported to the address below, quoting the total flying hours and fatigue index of the wing concerned.
11. Refit the aircraft wings (ASM Sect. 3 Chap 2).

Report full details to The Engineering Manager, Product Support Department, British Aerospace, Military Aircraft Division, Warton Aerodrome, Preston, Lancashire, PR4 1AX.

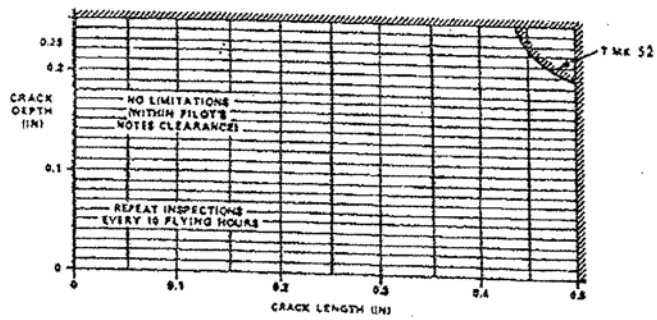
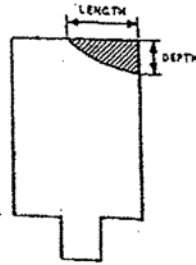
Record compliance with this instruction on the appropriate documentation.

SM8149

Where difficulty is experienced carrying out any part of this instruction, further advice should be sought from the Engineering Manager, Customer Support Dept, British Aerospace Military Aircraft Division, Warton Aerodrome, Preston, Lancashire, PR4 1AX.

SM8149

FIG. 1



VING UPPER SPAR  
BOOM CRACKING

## APPENDIX I

Safety Precautions and Servicing Notes are to be complied with throughout the work detailed in this technique.

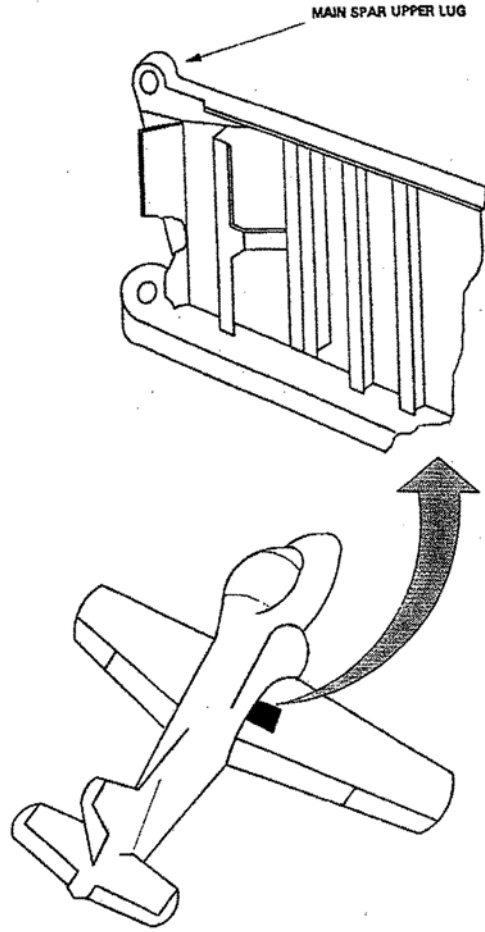
1	<u>TECHNIQUE</u>	Eddy Current
2	<u>COMPONENT TO BE EXAMINED</u>	Mainplane Upper Spar Boom (Port and Starboard)
3	<u>AREA OF EXAMINATION</u>	Attachment lug FWD and AFT faces (Fig 1)
4	<u>PURPOSE OF EXAMINATION</u>	To detect cracks in the FWD and AFT faces of the lug which have originated from the lug bores
5	<u>EQUIPMENT REQUIRED</u>	<ul style="list-style-type: none"> <li>(i) Hocking Locator Eddy current test set</li> <li>(ii) Shielded spade probe 2MHz NFe 4XE/2529661 or</li> <li>(iii) Shielded spade probe 2MHz NFe 4XE/2529651</li> <li>(iv) Standard calibration block 4XE/4657626</li> </ul>
6	<u>PREPARATION</u>	
	6.1 Aircraft	Ensure prepared in accordance with relevant servicing instructions.
	6.2 Component	Ensure the scan area is clean and free from flaking paint.
7	<u>EXAMINATION PROCEDURE</u>	
	7.1 Instrument Calibration	
	(a) Initial Setting	Set up in accordance with Equipment Manual
	(b) Operating Mode	As required.
	(c) Alarm	Set to 'Cont'
	(d) Frequency	Set to '2 MHz'
	(e) Metal Selector	Set to 'Al Mg'.
	(f) Sensitivity Setting	<ul style="list-style-type: none"> <li>(i) Set up in accordance with equipment manual.</li> <li>(ii) Calibrate to attain 80% of full scale deflection from 0,5mm slot in standard calibration block</li> </ul>
	(g) Instrument Warning	Set to operate at 70% of full scale deflection
	7.2 Procedure	<ul style="list-style-type: none"> <li>(i) Place probe on aft face of Starboard lug</li> <li>(ii) Train equipment</li> <li>(iii) Check train</li> <li>(iv) Move probe as close to bore as ferrous effect from bush will allow</li> <li>(v) Zero equipment</li> <li>(vi) Carry out a complete 360° scan of the lug face, whilst maintaining the probe at the same distance from the bush (Fig 2).</li> </ul>

8149SM

APPENDIX 1

- (vii) Repeat sub-para (ii) to (vi) on forward face of lug  
 (viii) Repeat sub-para (ii) to (vii) on Port lug
- 7.3 Fault Indications  
 Any indication which triggers the alarm that cannot be attributed to ferrous, edge, geometric or probe handling effect is to be considered a defect  
 All fault indications are to be reported
- 7.4 Examination Standard  
 In accordance with CSI/STRIKEMASTER/50
- 8 REPORTING PROCEDURE  
 1
- 9 ESTIMATED MANHOURS  
 1
- 10 ADDITIONAL INFORMATION
- (i) Mark all defect indications with a suitable marking medium  
 (ii) Re-inspect all defect indications using a zig-zag scanning pattern (Fig. 3) at 1,0mm increments  
 (iii) The extremities of the crack are to be marked where the alarm triggers

8149SM



8149SM

FIG. 1

APPENDIX 3

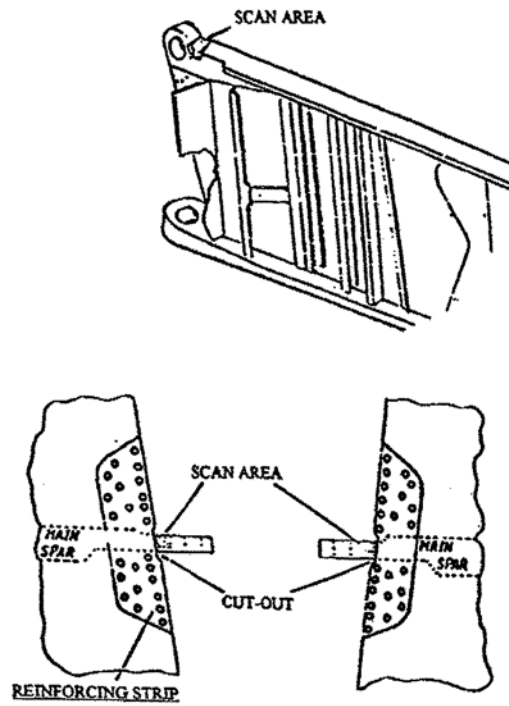


Figure 2

8149SM

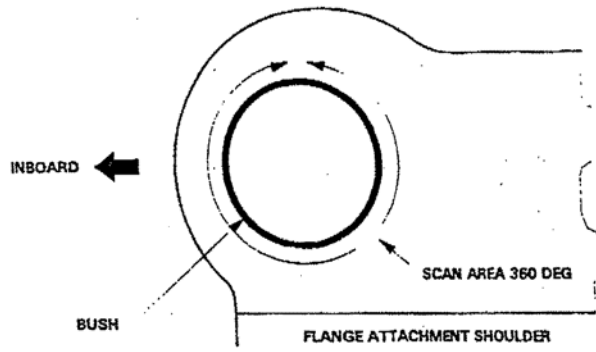


FIG. 2 AFT FACE OF STARBOARD LUG

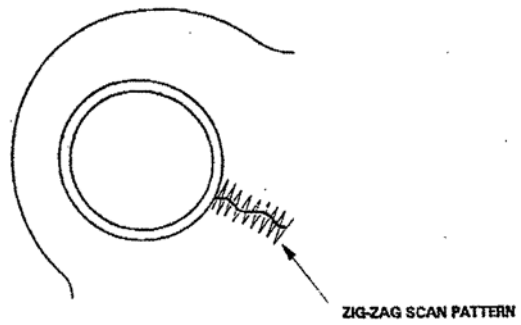


FIG. 3 METHOD OF SIZING CRACKS

0140CM

## PROCEDURE

### 7.1 Instrument Calibration

- (a) Initial Setting Set up in accordance with manufacturers instructions
- (b) Alarm Setting Set to "OFF"
- (c) Bandpass Adjust to equalise lobes on "Line Scan"
- (d) Reject Set to "OFF"
- (e) Filter Set to obtain optimum signal from 1/16 inch dia hole in calibration block

### 7.2 Sensitivity Setting

- (i) Select spot display
- (ii) Adjust signal from 1/16 inch hole in calibration block to vertical
- (iii) Select timebase display
- (iv) Set signal to 100% full screen height
- (v) Select spot display
- (vi) Set signal to 30 degrees, Figure 1
- (vii) Increase signal amplitude by 2 dB

### 7.3 Procedure

- (i) Ensure spot display is selected
- (ii) Insert probe into bore to be examined
- (iii) Switch on rotor gun and allow RPM to stabilize

8149SM

APPENDIX 2

1	<u>TECHNIQUE</u>	Eddy Current
2	<u>COMPONENT TO BE EXAMINED</u>	Mainplane Upper Spar Boom
3	<u>AREA OF EXAMINATION</u>	Attachment lug bores
4	<u>PURPOSE OF EXAMINATION</u>	To detect cracking
5	<u>EQUIPMENT REQUIRED</u>	(i) Rototest (ii) Probe (Diameter as to suit hole Ø) (iii) Calibration Block (BAe supplied) (iv) Rototest rotor and lead (v) Rototest rotor, reduction gearbox N.B The Eliotest B1 may be used as an alternative to the Rototest
6	<u>PREPARATION</u>	
	6.1 <u>Aircraft</u>	Ensure prepared in accordance with relevant servicing instructions
	6.2 <u>Component</u>	Ensure bores clean
7	<u>EXAMINATION PROCEDURE</u>	
	7.1 <u>Instrument Calibration</u>	
	(a) <u>Initial Setting</u>	Set up in accordance with manufacturers instructions
	(b) <u>Alarm Setting</u>	Set to "OFF"
	(c) <u>Bandpass</u>	Adjust to equalise lobes on "Line Scan"
	(d) <u>Reject</u>	Set to "OFF"
	(e) <u>Filter</u>	Set to obtain optimum signal from 1/16 inch dia hole i calibration block
	7.2 <u>Sensitivity Setting</u>	(i) Select spot display (ii) Adjust signal from 1/16 inch hole in calibration block to vertical (iii) Select timebase display (iv) Set signal to 100% full screen height (v) Select spot display (vi) Set signal to 30 degrees, Figure 1 (vii) Increase signal amplitude by 2 dB
	7.3 <u>Procedure</u>	(i) Ensure spot display is selected (ii) Insert probe into bore to be examined (iii) Switch on rotor gun and allow RPM to stabilize

81495M

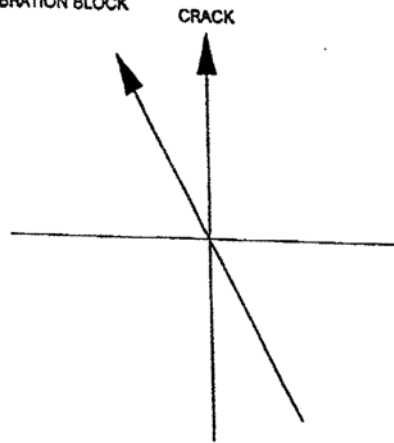
APPENDIX 2

- |     |                               |  |
|-----|-------------------------------|--|
| 7.4 | <u>Signal translation</u>     | (iv) Withdraw probe through bore   |
|     |                               | (v) Repeat operations (i) to (iv) on remaining bores   |
|     |                               | (i) Select timebase display to ascertain amplitude and direction of defect signal              |
|     |                               | (ii) Diagnose indications, Figure 1  |
| 7.5 | <u>Examination Standard</u>   | (i) All defects to be reported   |
|     |                               | (ii) Defect length in mm to be measured  |
|     |                               | (iii) Clock position of defect to be reported with 12 o'clock as vertically up looking forward |
| 8   | <u>Reporting Procedure</u>    | As detailed in CSI/STRIKEMASTER/50   |
| 9   | <u>Additional Information</u> | This technique is to be used to evaluate bores reported as suspect by ultrasonic technique     |

8149SM

**APPENDIX 2**

PHASE ANGLE 30°  
ANTI-CLOCKWISE  
FOR 1/16 IN HOLE  
IN CALIBRATION BLOCK



NOTE: NOISE, 1/8 SCORES, SAW CUTS, SPARK  
ERODED SLOTS AND CORROSION ETC  
WILL RESULT IN VARYING PHASE  
ANGLES OTHER THAN VERTICAL

SPOT DISPLAY SHOWING PHASE ANGLE

Figure 1

8149SM

## APPENDIX 3

1	<u>TECHNIQUE</u>	
2	<u>COMPONENT TO BE EXAMINED</u>	Appendix to CSI/STRIKEMASTER/50 Mainplane Main Spar (Port & Starboard Fig.1)
3	<u>AREA OF EXAMINATION</u>	Outboard of front upper attachment lug, upper surface, forward and aft faces. (Figs 2 & 3)
4	<u>PURPOSE OF EXAMINATION</u>	(i) To detect and establish the extent of cracking  (ii) To monitor defect growth
5	<u>EQUIPMENT REQUIRED</u>	(i) Hocking Locator Eddy Current test set (ii) Shielded Probe, NFe 4XE/196 (iii) Right angled shielded probe, 4XE/197 (iv) Standard calibration block, 4XE/4657626
<b>Note:</b> The technique has been written for Hocking equipment, however, any Eddy Current equipment that will meet this Technique standard may be used		
6	<u>PREPARATION</u>	
6.1	<u>Aircraft</u>	(i) Ensure upper wing root panels removed (ii) <u>Starboard side only</u> ; Ensure pipe and associated clips and bonding lead removed from spar
6.2	<u>Component</u>	(i) <u>Part 'A'</u> Ensure free from flaking paint (ii) <u>Part 'B'</u> Ensure scan area blended as required
7	<u>EXAMINATION PROCEDURE</u>	
7.1	<u>Instrument Calibration</u>	
(a)	Frequency	2 MHz
(b)	Metal Selector	A1. Mag
(c)	Operating Mode	Normal
(d)	Alarm	Continuous
(e)	Initial Setting	In accordance with manufacturers Instructions or Servicing Notes
(f)	Sensitivity setting	(i) Train equipment on calibration block (ii) Calibrate to attain 80% of full scale deflection from 0.5mm slot in standard calibration block Set to 'OFF'
(g)	Instrument warning setting	
7.2	<u>Procedure Part 'A'</u>	(i) With appropriate probe connected, train equipment on upper forward edge of spar attachment lug. (Fig 3 refers) (ii) Scan upper boom scan area in tight zig-zag pattern including upper 8,0mm of the forward vertical face. (Fig 3 refers) (iii) Repeat Sub-paragraph 7.2 (i) and (ii) on rear face and other wing

8149SM

APPENDIX 3

7.3 Procedure Part 'B'

Measurement

- (i) Where cracks have been confirmed measure crack length as follows:
  - (a) Zero probe at edge of boom
  - (b) Using a tight zig-zag pattern, scan across the crack in direction of propagation and carefully note the point where no discernible meter movement occurs
  - (c) Mark this point with a finely sharpened pencil
- (2) Using straight edges for locally manufactured jig positioned as shown in Fig.4, and suitable calipers, measure crack length in both horizontal and vertical plains

The zero datum for all measurements is shown in Fig.4

Monitoring

- (iii) Where cracks are present and acceptable within the terms of the CSI, they are monitored as follows:
  - (a) Using measuring jig and calipers, re-establish end of defects on both faces
  - (b) Using a finely sharpened pencil, mark the surfaces at the crack termination
  - (c) Using appropriate probe, zero on surface clear of defect
  - (d) Using a tight zig-zag pattern, scan in line with and toward end of marked-up end of defect
  - (e) Note point where defect causes perceptible meter deflection, mark the surface at this point
  - (f) Any defect growth is to be reported as directed in this CSI

Note: This procedure when carried out will record growth better than 2mm

7.4 Defect Standard

Any indication which cannot be attributed to edge effect, geometry, ferrous effect or probe handling, is considered to be a defect, and shall be reported giving all relevant details, i.e. A/C No. - Port or Starboard - Fwd or Aft boom Vertical and Horizontal length

7.5 Additional Information

- (i) All defects originate from the edges of the booms
- (ii) The amount of skin cut away varies according to mark

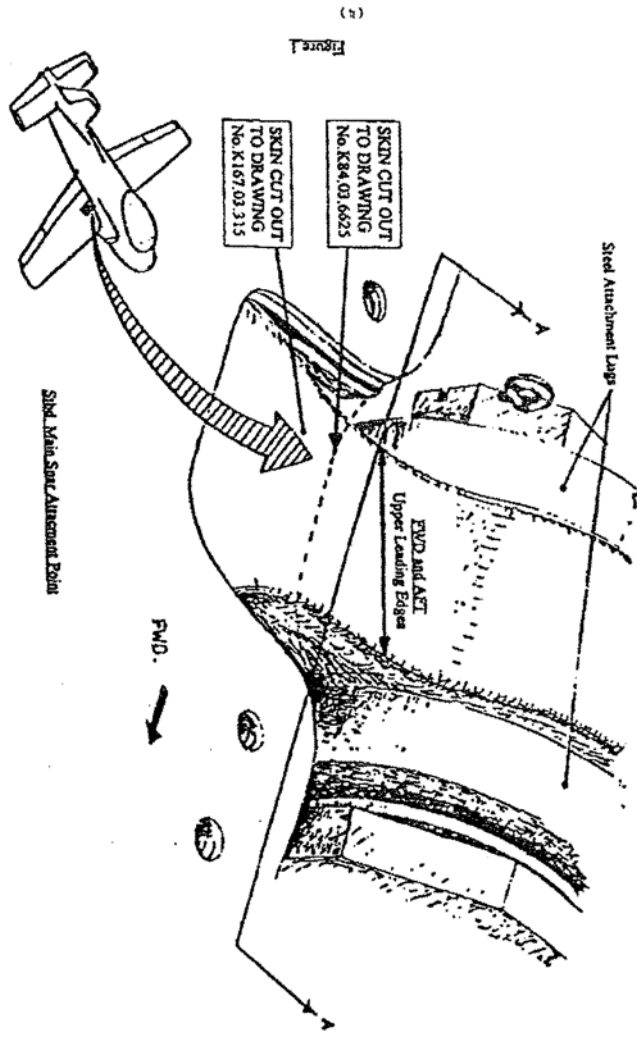


Figure 1

(2)

APPENDIX 3

CSVSTRKEMASTER/50.

APPENDIX 3

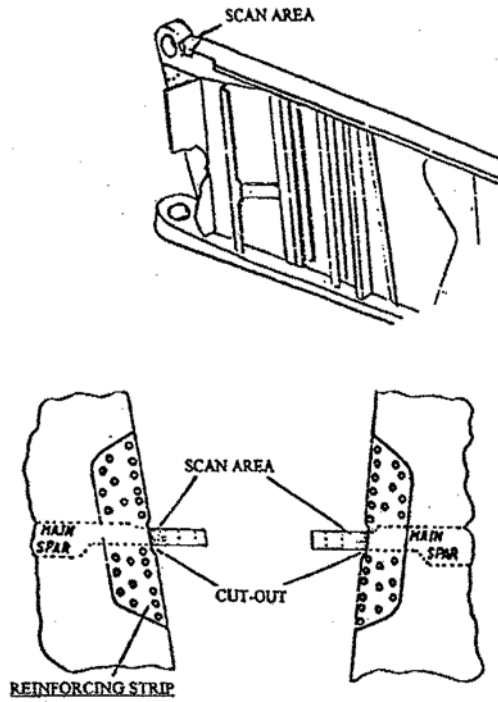
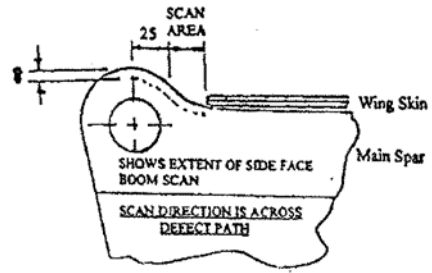


Figure 2

6149SM

APPENDIX 3



Dimensions:- mm

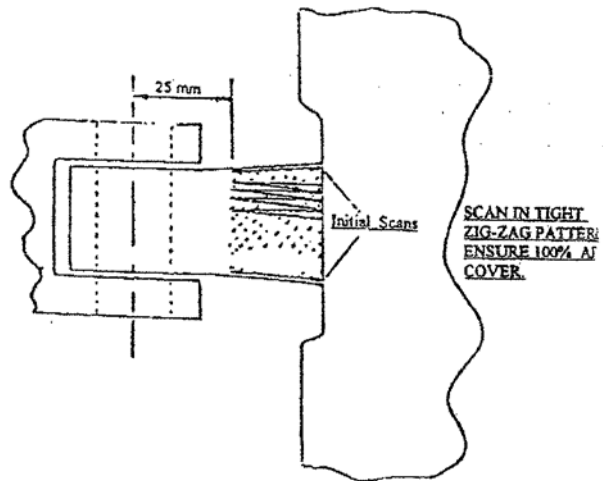
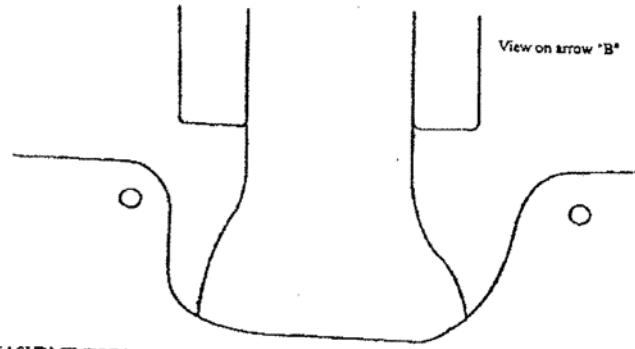
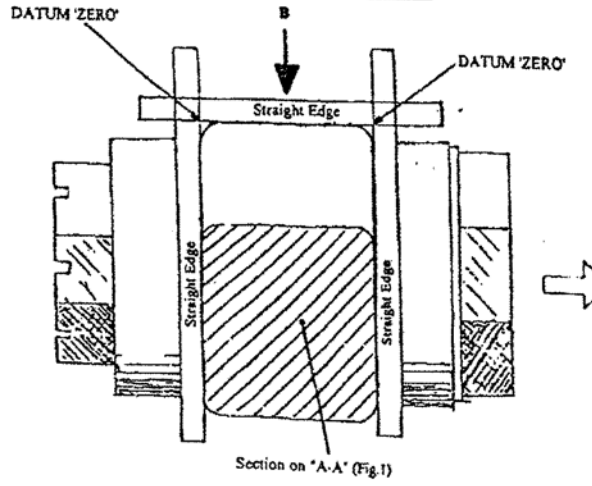


Figure 3

(6)

APPENDIX 2

DATUM ZERO IS USED IN BOTH  
HORIZONTAL AND VERTICAL DEFECTS



ALL MEASUREMENTS IN mm's

FIGURE 4

(7)



UNITED KINGDOM  
CIVIL AVIATION AUTHORITY

| MPD No: 1995-109 R1

## MANDATORY PERMIT DIRECTIVE

The following action required by this Mandatory Permit Directive (MPD) is mandatory for applicable aircraft registered in the United Kingdom operating on a UK CAA Permit to Fly.

### | MPD: 1995-109 R1 BRITISH AEROSPACE

Subject: Port and Starboard mainplane spar upper attachment lugs cracking.

Applicability: British Aerospace BAC 167 Strikemaster all Mks and BAC 145 Mk 55 aeroplanes (Pre Mod 7061) which have achieved 15 Fl or 1,000 flying hours. BAC 167 Strikemaster all Mks and BAC 145 Mk 55 aeroplanes (Post Mod 7061) which have achieved 40 Fl.

Reason: Cracking has occurred in the mainplane spar upper attachment lug in the outer surface and also from the bore of the lug. BAe CSI/STRIKEMASTER/29 was issued to introduce period inspections of both of these areas.

Cases have now occurred of mainplane spar upper attachment lugs which have satisfied BAe CSI/STRIKEMASTER/29 being found cracked beyond acceptable limits. Investigation has determined that the ultrasonic technique called up to detect cracking emanating from the bore of the lug cannot be relied upon to detect cracks round the full circumference of the lug and attempts to develop a technique which will guarantee the detection of cracking with the wing fitted have been unsuccessful.

BAe CSI/STRIKEMASTER/50 introduces a periodic inspection of the forward and aft faces of the mainplane spar upper attachment lug with the wing removed to check for cracking from the bore and retains the eddy current technique and recovery action detailed in BAe CSI/STRIKEMASTER/29 for cracking in the outer surface.

Compliance: At the next 150 flying hour servicing from the effective date of this MPD and subsequently at 150 flying hour intervals and also at each heavy landing or excess 'g' loading. Inspect the port and starboard mainplane spar upper attachment lugs for cracking in accordance with BAe CSI/STRIKEMASTER/50 Issue 3.

| A copy of the CSI can be obtained from Mr A C Love, Aircraft Certification Section 2E, Aircraft Projects Department, United Kingdom Civil Aviation Authority, Safety Regulation Group, Aviation House, Gatwick Airport South, West Sussex, RH6 0YR Telephone +44(0)1293 573726.

| This MPD becomes effective on 13 November 1995. Revision 1 becomes effective on 1 December 1998.

Enquiries regarding this MPD should be made to the United Kingdom Civil Aviation Authority, Aircraft Maintenance Approvals Section, Safety Regulation Group, Aviation House, Gatwick Airport South, West Sussex RH6 0YR. Telephone: +44 (0)1293 573149 Telefax: +44 (0)1293 573993.

# APPENDIX F: CASA AD/STRIKEMASTER/4

COMMONWEALTH OF AUSTRALIA  
CIVIL AVIATION SAFETY AUTHORITY  
SCHEDULE OF AIRWORTHINESS DIRECTIVES

(Civil Aviation Regulations 1998), PART 39 - 105

B Ae (BAC 167) Strikemaster Series Aeroplanes

---

<b>AD/STRIKEMASTER/4</b>	<b>Port and Starboard Mainplane Spar Upper Attachment Lugs</b>	<b>13/96</b>
--------------------------	--	--------------

- Applicability: BAC 167 all Mks:  
pre mod 7061, which have achieved 15 F.I. or 1000 hours time in service, or  
post mod 7061, which have achieved 40 F.I.
- Requirement: Inspect the port and starboard mainplane spar upper attachment lugs for cracking in accordance with B Ae CSI/STRIKEMASTER/50.  
*Note: UK CAA MPD 1995-109 refers.*
- Compliance: At the next 150 flying hour Service after 5 December 1996, thereafter at intervals not exceeding 150 hours time in service, and at each heavy landing or excess "g" loading after 07 November 1996.
- Background: Cracking has occurred in the lugs which cannot be reliably detected in-situ using the existing ultrasonic techniques. It is therefore necessary to remove the wings and use the technique specified in the Requirement Document.



## Advisory Circular

AC 21-25(2)

MARCH 2002

### LIMITED CATEGORY AIRCRAFT — PERMIT INDEX

#### CONTENTS

1. References	1
2. Purpose	1
3. Status of this AC	1
4. Background	2
5. Permit Index (categorisation of risk)	2
6. Categorisation of aircraft	3
7. Categorisation by design philosophy	4
8. Categorisation by maintenance philosophy	4
Attachments:	
1. Risk assessment chart (single engine stall speed)	5
2. Risk assessment chart (design philosophy)	6
3. Aircraft safety index assessment (maintenance)	7

#### 1. REFERENCES

- Civil Aviation Safety Regulations (CASR) Parts 21 to 35; and
  - Regulation 262AM of the *Civil Aviation Regulations 1988* (CAR 1988).
- Note: CASRs referred to above are currently enacted as CAR 1998.*

#### 2. PURPOSE

This Advisory Circular (AC) provides information on the method used by CASA's Maintenance Review Board (MRB) for determining the Permit Index number applicable to limited category aircraft for the purpose of applying appropriate safety conditions to the operation of the aircraft.

#### 3. STATUS OF THIS AC

This is the third AC to be issued on this subject and supersedes AC 21.25(1) and removes section 9 dealing with categorisation of Permit Index.

*Advisory Circulars are intended to provide recommendations and guidance to illustrate a means but not necessarily the only means of complying with the Regulations, or to explain certain regulatory requirements by providing interpretative and explanatory material.*

*Where an AC is referred to in a 'Note' below the regulation, the AC remains as guidance material.*

*ACs should always be read in conjunction with the referenced regulations*

March 2002

#### 4. BACKGROUND

**4.1** This AC sets out how manufactured aircraft that are not of type certificated civil design, or are no longer supported by a current manufacturer i.e. historical aircraft, replica aircraft and special purpose aircraft, may be flown as a limited category aircraft by the application of appropriate safety conditions. These safety conditions were previously included in the now repealed CAR 134 Permit to Fly for Historical and Ex-Military aircraft.

**4.2** An in-depth review of historical and ex-military aircraft in Australia was carried out between 1993 and 1996, in conjunction with industry, in which a rationale was agreed by the review team for determining a Permit Index for specific types of aircraft so as to minimise the risk to third parties.

**4.3** The philosophy agreed to by the Authority/Industry review team, and accepted by the Board of the CAA, CASA's predecessor, endorsed by the Program Advisory Panel in February 1997, for determining the Permit Index is based on the aeroplane's stalling speed, design philosophy and maintenance complexity.

#### 5. PERMIT INDEX (CATEGORISATION OF RISK)

**5.1** The system of risk assessment (Permit Index) has been developed to provide a series of benchmarks against which each aircraft may be assessed in relation to the associated risk incurred in operating it. This index is used by CASA to set appropriate operational restrictions to minimise this risk to third parties.

**5.2** The Permit Index is equally applicable to all limited category aircraft irrespective of the aircraft origin. It provides, for a given aeroplane, a basis on which to judge the perceived risk of an accident occurring and the potential damage that such an accident could cause.

**5.3** Safety is not absolute and it can only be quantified by acceptance, in the worst case scenario, of the possible accident. The rationale used for the Permit Index philosophy requires control of the exposure to risk for third parties to a possible accident. It follows that the number and type of occupants i.e. crew and passengers, and the third party risk associated by flight over people and property, become factors that need to be taken into account in the categorisation of risk.

**5.4** The risk assessment is based on similar risk management principles used with civil certificated aircraft in the various categories:

- (a) single-engine aeroplanes are initially categorised by stall speed, which is the main parameter that determines the energy consideration in the event of a forced landing;
- (b) for multi-engine aeroplanes the main parameters are the degree to which an engine failure can be accommodated as well as size/weight; and
- (c) The design and maintenance philosophy and complexity is also considered to ensure an adequate weighting of the risk assessment.

**5.5** As many of the applicable aircraft will be operating in a more conservative role as compared to their original intent, the level of maintenance may be able to be tailored to suit the new role. Additionally, it is desirable in some applications where utilisation is

March 2002

likely to be very low, to trade additional limitations for a very basic level of maintenance, particularly in respect of arbitrary overhaul lives of major components.

**5.6** The Permit Index assessment charts (see Attachments 1 and 2) that have been developed take account of the design code philosophies and the level of reliability achieved through maintenance.

**5.7** A summary of the aircraft types with CASA Permit Index and associated safety conditions are shown in Attachment 3.

**5.8** The Permit Index for an additional type/model of aircraft is assessed in consultation with the appropriate industry specialist group by the CASA chaired MRB (Limited Category aircraft) augmented by at least one CASA Flying Operations Inspector (FOI) who specialises in the aircraft type or similar type.

*Note: Rotorcraft are independently assessed by the above MRB.*

## **6. CATEGORISATION OF AIRCRAFT**

**6.1** The categorisation of aircraft has been specified differently for single engine and multi-engine aeroplanes.

**6.2** Single engine aeroplanes constitute:

- (a) aeroplanes with direct civil equivalents;
- (b) aeroplanes with a  $V_{SO}$  less than 61 knots CAS;
- (c) aeroplanes with a  $V_{SO}$  equal to or greater than 61 knots CAS but less than 81 knots CAS; and
- (d) aeroplanes with a  $V_{SO}$  equal to or greater than 81 knots CAS and/or  $M_{MO}$  not greater than Mach 1;

where  $V_{SO}$  is the stalling speed in the landing configuration, and  $M_{MO}$  is the maximum operating mach number. If  $V_{SO}$  cannot be established then CASA Certification Section should be contacted for further advice.

**6.3** Multi-engine aeroplanes constitute:

- (a) aeroplanes with a direct civil equivalent;
- (b) aeroplanes with both take-off and en-route engine failure accountability:
  - (i) up to 5700 kg MOW;
  - (ii) greater than 5700 kg MOW;
- (c) aeroplanes with en-route engine failure capability only:
  - (i) up to 5700 kg MOW;
  - (ii) greater than 5700 kg MOW;
- (d) aeroplanes that weigh less than 5700 kg MOW with no en-route engine failure accountability are treated as single engine aeroplanes.

*Note: The maximum operating weight (MOW) is the MTOW except for ex-military aircraft where the MOW is the MTOW without military specific equipment, e.g. armament not permanently fitted.*

March 2002

## 7. CATEGORISATION BY DESIGN PHILOSOPHY

**7.1 Design philosophy 1.** An aircraft with a civil equivalent or a basic military trainer, transport or observation aircraft which incorporates a non-complex, civil design philosophy in respect to structural integrity, system integrity, flight control integrity, engine complexity and fire protection.

**7.2 Design philosophy 2.** An aircraft which has been designed for special missions, resulting in some reduction in the structural capability, system reliability and/or criticality or fire safety, as compared to civil aircraft of a similar class (for which the use of complex systems has been used).

**7.3 Design philosophy 3.** An aircraft which has been designed primarily for special missions having limited consideration for the traditional safety values of civil aircraft in relation to failure analyses, fire protection or severely restricted design life considerations.

## 8. CATEGORISATION BY MAINTENANCE PHILOSOPHY

**8.1 Maintenance level 1.** An aircraft whose maintenance is conducted in an equivalent manner as an equivalent civil aircraft; or in accordance with the standard applied by the military user or manufacturer amended only as required to account for role change; or specifically developed and approved for the least restrictive role.

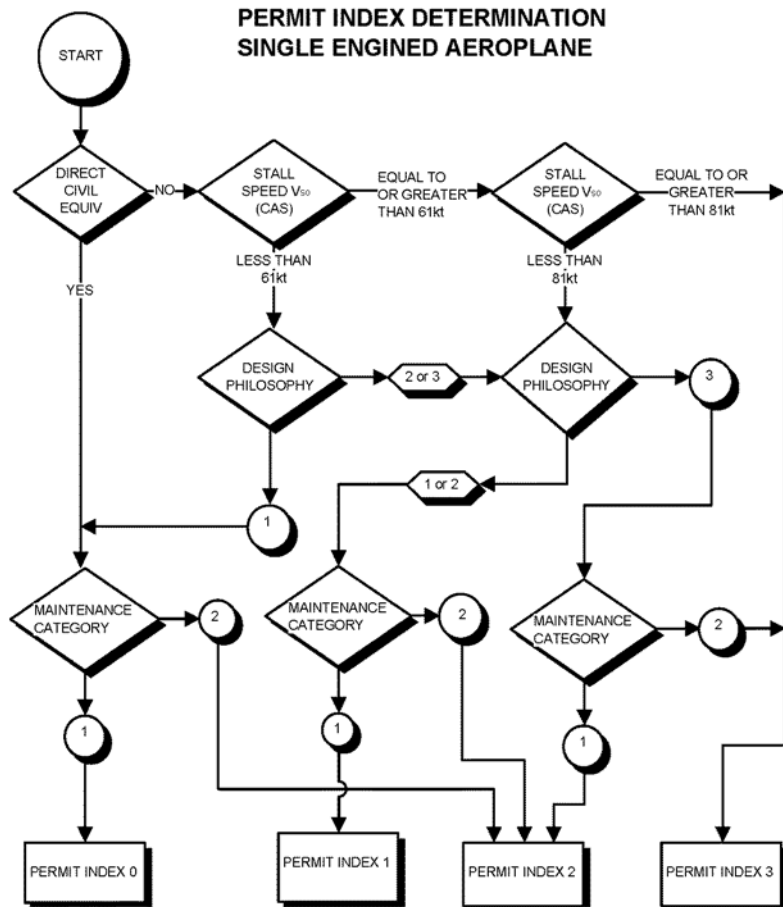
**8.2 Maintenance level 2.** An aircraft whose maintenance is limited to levels consistent with the acceptance of a higher risk of failure based on reduced exposure to other parties.

---

Bill McIntyre  
Aviation Safety Standards Division

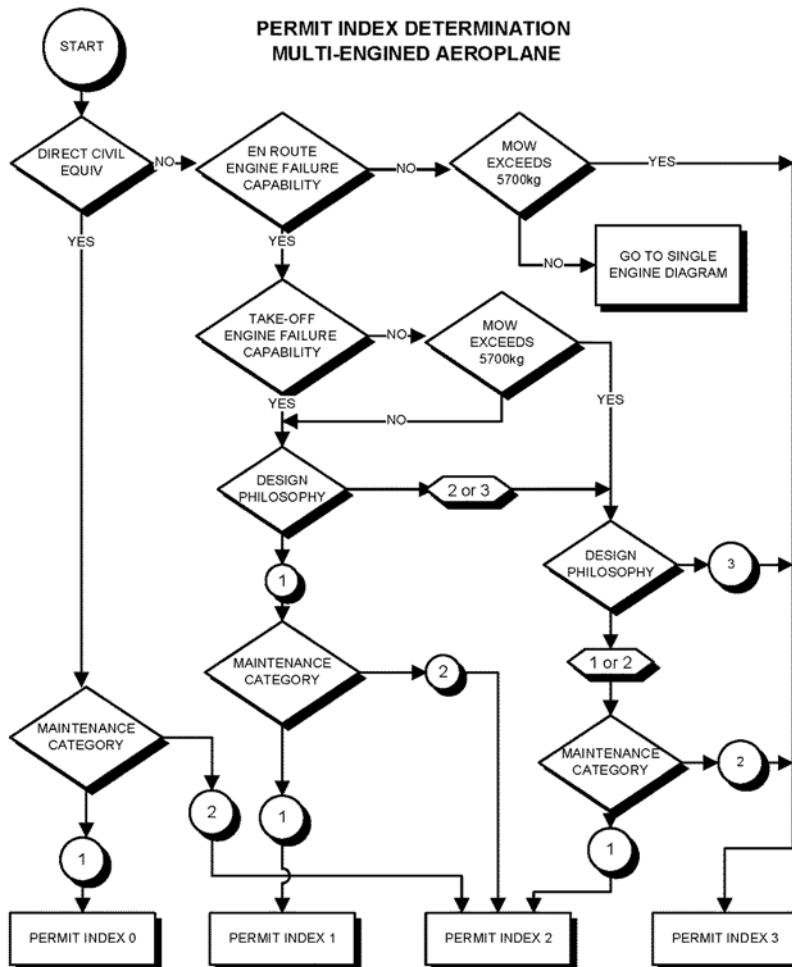
March 2002

ATTACHMENT 1



March 2002

ATTACHMENT 2



March 2002

## Attachment 3

## AIRCRAFT SAFETY INDEX ASSESSMENT

These aircraft have been assessed by the CASA Maintenance Review Board (Limited Category Aircraft). The approved schedules and/or maintenance programs for the aircraft types as listed have been approved for the listed organisation. Industry may obtain a copy of these maintenance programs from the organisation and submit to a CASA or an authorised person for specific aircraft approval.

AIRCRAFT	WEIGHT MOW (Kg)	MRB PERMIT INDEX	MRB APPROVAL DATE
AUSTER AOP9	802	0	18/3/99
BAE 167 STRIKEMASTER	4147	2	27/09/95
BELL UH-1B	4309		TBA
BOEING A75NI	1138		TBA
BOEING E75	1338		TBA
C47/DC3	11884	2	TBA
CA16 WIRRAWAY	2528	0	30/05/96
CA19 BOOMERANG	3492		TBA
CA25 WINJEEL	1935	0	27/09/95
CA27 SABRE	8450	3	TBA
CESSNA 140	658		TBA
CESSNA A-37B	5300	1	13/09/95
CESSNA OE-1A	953		TBA
CT4-A	1111	0	TBA
DH-115 VAMPIRE	5380	3	TBA
DHC-1 CHIPMUNK	953		TBA
DH-T11 VAMPIRE	4490	3	TBA
FIAT G59-43	3265		TBA
FIREFLY AS-6	6342	2	TBA
GRUMMAN S-2	13222	2	TBA
ISKRA TS-11	3243	3	20/09/95
JET PROVOST	2810	3	TBA

(Continued)

March 2002

AIRCRAFT	WEIGHT MOW (kg)	MRB PERMIT INDEX	MRB APPROVAL DATE
L-39	5670	3	TBA
LOCKHEED C-121C	60327.7	2	TBA
LOCKHEED HUDSON 414	8391	2	TBA
LOCKHEED NEPTUNE	36287	2	TBA
LOCKHEED VENTURA	14061	2	TBA
LUSCOMBE 8A	544		TBA
MIG 15	5400	3	18/10/95
MiG 15		3	
MiG 17	5454	3	TBA
MiG 21	9090	3	TBA
MUSTANG	3401.9	1	TBA
NANCHANG CJ-6	1400		TBA
NTH AMER B25	11998		TBA
NTH AMER SNJ-5	2040	0	TBA
NTH AMER T-28	3900	1	30/05/96
NTH AMER T6	2040	0	27/09/95
P-40N KITTYHAWK	3510		TBA
PROVOST T MK1	4400	3	TBA
RYAN ST3-KR	771		TBA
SEA FURY	5700	2	TBA
SPITFIRE	3629		TBA
STAMPE SV-4A	770		TBA
STINSON 108	1048		TBA
VULTEE BT-13A	2091	0	27/09/95
YAK 50	965		TBA
YAK 52	1290		TBA

March 2002

---

# APPENDIX H: CASA AWB 02-018 ISSUE 4

---



## AIRWORTHINESS BULLETIN

BAC 167 Strikemaster Accident

AWB 02-018 Issue : 4  
Date : 02 November 2007

### 1. Applicability

All BAC 167 Strikemaster and Jet Provost Aircraft

### 2. Purpose

Issue 4 of this AWB supersedes all previous issues. It provides owners and operators with important airworthiness information arising from an accident involving a Strikemaster on 5 October 2006. Issue 4 provides an important update based on new information emerging from the ATSB investigation into the accident involving VH-AKY

### 3. Background

On 5 October 2006, BAC Strikemaster VH-AKY crashed near Bathurst. While ATSB investigators have not yet completed their investigations, it is obvious that the aircraft broke up in flight. Initially, the investigation concentrated on the separation of the right wing. ATSB has confirmed that the upper attachment lug of the right wing failed, and examination of the fractured lug has confirmed the presence of fatigue cracks in the lug, which reduced its load capacity.

However, further investigation has now shown that there is a possibility that the failure of the right wing may have occurred later in the break up sequence than previously believed. The investigation has raised the possibility that a failure involving the horizontal or vertical stabilisers may have preceded the wing failure.

As either failure is likely to be catastrophic, CASA believes that operators should check both the wing attachments and the horizontal and vertical stabilisers and control surfaces for problems.

### 4. Recommendation

Operators should inspect the horizontal and vertical stabilisers, rudder, elevators, trim tabs, hinges and the entire flight control system for security, correct installation, control cable tensions, locking and excessive play in any direction. Particular attention should be paid to the security of mass balance weights, and a special check should be made of the rudder hinges and torque tube. The elevator bellcrank pivots about the rudder torque tube and any failure in this area could be catastrophic.

While the focus of the ATSB investigation now includes the possibility of an empennage failure, operators should continue to ensure that any cracks in the wing attachment lugs are detected and addressed.

In particular, CSI/STRIKEMASTER/50 Issue 3 only prescribes inspection of the lug bore for fatigue cracks where cracking has extended to the fore or aft faces of the lug or where the bush is loose in the bore of the lug.

This procedure will not detect a fatigue crack in the bore which does not extend to a lug face if the bush is not loose in the bore. Consequently, CASA still strongly recommends inspection of the bore of the lug for fatigue cracks irrespective of whether cracking extends to the lug faces or whether the bush is loose in the bore. Currently, this will require the removal of the bush.

However, if a method of inspection which can reliably detect lug bore fatigue cracks without removal of the bore bush is available, the bush need not be removed.

Similarly, for all Jet Provost aircraft it is strongly recommended that the bores of upper attachment lugs be inspected for fatigue cracks irrespective of other inspection instructions.

Operators and maintainers are reminded that any blending of lug surface cracks must comply with the manufacturer's instructions for blending.

The UK CAA has published several Mandatory Permit Directives pertaining to the BAC 167 Strikemaster and Jet Provost. Some of these pertain to cracking in wing structures and attachment fittings. These Mandatory Permit Directives are published by the UK CAA, and are available at <http://www.caa.co.uk/docs/33/CAP661.PDF>. Two of the UK Directives have been mandated by AD AD/STRIKEMASTER/3 and AD/STRIKEMASTER/4 mandate compliance with MPD 1995-101 and MPD 1995-109 respectively. The latest revisions of the MPDs and associated CSIs should be used, subject to the strong recommendation that the lug bore be inspected irrespective of any other instructions.

Further advice will be provided when more information becomes available. Unless the bore of the upper attachment lugs have been inspected and found free of cracks, CASA strongly recommends that operators not subject their aircraft to negative g, and limit as far as possible the application of positive g. UK CAA MPD 2007-002 R1 specifies the limitations which the UK CAA has imposed upon UK operators, and CASA strongly recommends that Australian operators consider these limitations.

#### **5. Enquiries**

Enquiries with regard to the content of this Airworthiness Bulletin should be made via the direct link e-mail address:

[AirworthinessBulletin@casa.gov.au](mailto:AirworthinessBulletin@casa.gov.au)

Or in writing, to:

Airworthiness Engineering Branch,  
Civil Aviation Safety Authority  
GPO Box 2005, Canberra, ACT, 2601



United Kingdom  
Civil Aviation Authority

MPD No: 2007-002 R1

Issue Date: 3 August 2007

## MANDATORY PERMIT DIRECTIVE

In accordance with Article 11(6)(a) of the Air Navigation Order 2005 as amended, the following action required by this Mandatory Permit Directive (MPD) is mandatory for applicable aircraft registered in the United Kingdom operating on a UK CAA Permit to Fly.

**MPD: 2007-002 R1      BRITISH AEROSPACE**

**Subject:** Port and Starboard mainplane spar upper attachment lugs cracking.

**Applicability:** All British Aerospace Jet Provost and Strikemaster aeroplanes.

**Reason:** The CAA is awaiting the Final Report on the accident to Strikemaster VH-AKY in Australia in October 2006, in order to ascertain the full details of the cause of the accident. Until that report becomes available, the CAA has issued this interim measure to ensure safety in the fleet. Revision 1 of this MPD has been raised due to new information received by the CAA regarding the nature of the lug bore cracking and the way the aircraft can be operated even when subject to 'non-aerobatic' operations.

The wing upper lug cracking has occurred before in military service, prior to aircraft achieving their limiting Fatigue Index (FI). There are some distinguishing features that may indicate whether an aircraft has been subject to the loading necessary to cause this cracking. These features are not foolproof but if present will indicate a high probability of cracking in the bore of the lug requiring lug bore inspection before further flight. Where these features are not present, historical evidence indicates that lug bore cracking may still be present. As such, operational restrictions will still need to be maintained until the bore of the affected lug can be clearly shown to be free from cracking.

The CAA also understands that high 'G' manoeuvres can still be flown in normal 'non-aerobatic' operations, so negating the purpose of the original MPD, leaving open the possibility of lug bore crack propagation. The CAA has therefore determined that a limit on 'G' would be a better means of controlling the situation. The limits have been chosen to slow down the growth of any incipient crack.

**Compliance:** (1) Jet Provosts and Strikemasters are restricted to manoeuvres that do not exceed the range +3.0g to -0.25g. Before further flight, insert a placard within plain view of the pilots stating :

**"Manoeuvres are restricted to between +3.0G to -0.25G".**

Insert a similar page in the Aircraft Manual, referring also to this MPD

(2) Within the next 5 flying hours carry out the following inspection: -  
visually inspect the upper neck of the wing attachment lug fitting to see if a repair has been carried resulting from crack detection following CSI 50 Appendix 3 inspection. If a repair has been carried out, the lug bush should be removed and the lug bore inspected in accordance with the eddy current inspection of CSI 50 Appendix 2, before further flight. Any cracking in the lug must be rectified before further flight.

(3) Confirmation that the lug is free from cracking by inspection in accordance with the eddy current inspection of CSI 50 Appendix 2 with the bush removed or another method agreed with the Authority, removes the operational limitation noted in this MPD.

(4) Record compliance with this MPD in the aircraft log book.

This MPD becomes effective on 6 August 2007

Enquiries regarding this MPD should be referred to Mr Tony Love, Aircraft Certification Department, Civil Aviation Authority, Safety Regulation Group, Aviation House, Gatwick Airport South, West Sussex, RH6 0YR. Phone: 01293 573726 E-mail: [tony.love@srg.caa.co.uk](mailto:tony.love@srg.caa.co.uk)