



ROYAL AIR FORCE BOARD OF INQUIRY

INTO THE LOSS OF:

HERCULES XV179

(IRAQ - 30 JAN 05)

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PART 1

DETAILS OF THE BOARD

1. The Board of Inquiry (BoI) convened at 1600Z on 31 Jan 05 at HQ 2 Gp by order of the AOC 2 Gp to inquire into the loss of Hercules XV179 in Iraq on 30 Jan 05.
2. Composition of the Board.

Duty	Rank	Name	Service No	Branch	Unit
President	Wg Cdr	J P Q Reid	8141350A	GD	HQ 2 Gp
Members	Sqn Ldr	A		Eng	RAF Lyneham
	Sqn Ldr	B		Fg(P)	HQ 2 Gp

SECTION 4
— u —

3. Terms of Reference.

The BoI is to:

- a. Investigate the circumstances of the loss of the Hercules C-130 (XV179) in Iraq on 30 Jan 05.
- b. Collate and secure all available information relating to the loss of the aircraft (ac).
- c. Ascertain degree of injury, cause and time of injury suffered by persons both Service and civilian.
- d. Detail the circumstances, and determine as far as possible, the likely sequence of events that led to the loss of the ac.
- e. Report any tactical, operational, or FS matters of an urgent nature to AOC 2 Gp without delay.
- f. Investigate any operational support issues that might pertain to the loss of the ac.
- g. Ascertain if Service personnel involved were on duty.
- h. Ascertain if all relevant orders and instructions were complied with.
- i. Ascertain if aircrew escape and survival facilities were fully utilised and functioned correctly.
- j. Ascertain extent of damage to ac, public property and civilian property.
- k. Assess any human factors involved in the loss of XV179.

- l. Ascertain whether any classified material was carried on the ac and whether it has been recovered.
- m. Ensure that Op Sec is maintained at all times.
- n. Make appropriate recommendations and observations.
- o. Ensure AOC 2 Gp is regularly updated on the progress and findings of the Board.

While the BoI is to consider whether human factors contributed to the loss of XV179 it should not consider, nor make any statement about, blameworthiness. Notwithstanding that human failings are not to be assessed, individuals whose professional reputation may be affected by the BoI findings are still to be afforded the protection of QR 1269. Should any personnel be afforded the rights of QR 1269, the President is to inform AOC 2 Gp and STC CFSO.

The BoI is to be conducted and progressed in accordance with QR(RAF) Chapter 17 and Appendix 35, as amplified by JSP551 Volume 1 Section 205, and Section 205 Annex C, and is to be completed on RAF F412. QR 1272 (non disclosure of proceedings) and JSP 969 (inquests abroad) should be consulted. AOC 2 Gp is to be consulted prior to distribution of both the interim report and the findings of the Board.

PART 2

BOARD OF INQUIRY REPORT

EXECUTIVE SUMMARY

1. At 1324Z on 30 Jan 05, Hercules CMk1 XV179 took-off from Baghdad International Airport (BIAP) en-route to Balad Southeast (BSE). The ac was on a routine Op [redacted] task that included passenger and freight moves, as well as a limited period of [redacted]. At 1330Z, a radio message was received at both BSE and Op [redacted] HQ from the signaller onboard the ac saying: "no duff, no duff, we are on fire, we are on fire". At 1355Z the ac was confirmed as 'missing' and the crew of a US Apache formation found the crash site at 1415Z. The crash was not survivable.
2. XV179 appears to have been serviceable until the incident, with no history of any significant defects. The crew were on duty, properly trained, qualified, current and authorised, medically fit and well rested prior to their day's tasking. The ac was operating at low level, probably at [redacted] ft, and approximately [redacted] kts.
3. The wreckage of XV179 was found in 2 separate and distinct locations. The main site contained all human remains and ac structure less the outboard section of the right-hand wing, which was found at a second site, 1.3 miles away. The separated section of wing had become detached due to an explosive over-pressure event occurring within the number 4 fuel tank.
4. Evidence gathered from the sites ruled out the possibility of: bird strike, lightning strike, mid-air collision, controlled flight into terrain, wire or obstacle strike, control restriction, sabotage or Improvised Explosive Device (IED), cargo explosion, engine fire or fatigue. Furthermore, detailed analysis and research also concluded that the incident was very unlikely to have been caused, or influenced, by any form of technical failure.
5. The separated section of right-hand wing had been hit by [redacted] mm [redacted] rounds and there was evidence that there had been an airborne fire in the same area, which probably occurred after the wing separated. Witnesses had reported seeing rockets or "fireballs" fired at the ac and the AAIB suspected the impact of such a device at the wing separation point. However, no physical, chemical or microscopic evidence was found to suggest that any kind of rocket or missile had hit or exploded in close proximity to the ac. However, the Board deduced that [redacted] mm [redacted] rounds alone could have been responsible for the witnessed events and observed damage. Furthermore, aerodynamic analysis and expert opinion concluded that the ac would have been effectively uncontrollable after the wing's separation.
6. The Board concluded that XV179 crashed because the ac became uncontrollable after hostile action, probably [redacted] mm AAA, caused the explosive separation of the outboard 23 ft of the right-hand wing.

LIMITATIONS AND CONSTRAINTS

7. The BoI into the loss of XV179 was subject to unique limitations and constraints, which are important to understand as they defined much of the Board's modus operandi. To start, the hostile nature of the wreckage sites required BoI and support personnel to be correctly trained for the environment; consequently, the 3 Board members were not supported, in theatre, by the specialist agencies (Air Accident Investigation Branch (AAIB), Aircraft Recovery and Transportation Flt or BoI Advisor) that would normally be present. Furthermore, although 150 US Marines guarded the ac wreckage, there was strategic pressure to collapse the cordon and the Board was only afforded one day on the site.

8. The Board travelled to the crash site by the quickest possible means, arriving some 65 hrs after the incident. During this 65 hr period, the initial Search And Rescue (SAR) team, a US Interim Safety Investigation Board (ISIB) and RAF engineers (tasked with recovering sensitive material and equipment) disturbed the main crash site. However, on the Board's arrival on 2 Feb, human remains were still present as were large quantities of classified material and personal effects. Consequently, the Board prioritised the recovery of all human remains and personal effects and then proceeded to secure all classified material and examined the wreckage for evidence. With last light approaching and the collapse of the cordon imminent, the President ordered all manageable pieces of wreckage be placed in an adjacent canal with the thought that this would prevent the pieces being looted and allow for future investigation if required. The President also ordered the ac tail section to be blown up to prevent its possible use as a backdrop for propaganda videos.

9. A remote crash site, 1.3 miles from the main site, had been identified by aerial reconnaissance (recce). The Board considered this site vital to the investigation; however, the area was not secure and there was understandable reluctance to fly the Board to it. Working with a small group of [redacted] troops and [redacted], the Board did gain access to the remote site, but the risk of concealed IEDs and insurgent attack reduced the Board's freedom of movement and time at the site. However, the significance of the wreckage was immediately apparent and it was extensively photographed and swabbed by the [redacted] for forensic evidence. The President requested the wreckage be recovered at the earliest opportunity. Unfortunately, it could not be collected that day because the available helicopters were already full of personal effects, classified material, recovered ac structure and security personnel.

10. On 3 Feb 05, aerial recce of the sites, conducted prior to a planned recovery mission that night, revealed that all the wreckage from both sites had gone. An over-flight of the area by members of the Board on 4 Feb revealed that most of the wreckage had been dragged to nearby villages; however, there was no sign of the crucial wing wreckage from the remote site. A mission to recover ac structure from the villages would have carried significant risk and would have required a sizeable military force. A decision on this course of action was deferred to higher authority; however, a [redacted] operation was instigated in the form of radio broadcasts that offered a reward for returned ac components. To date, only ac instrumentation, electronic systems and very small pieces of structure have been recovered.

INVESTIGATION PHILOSOPHY

11. The lack of credible witnesses close to the crash site and the fact that the RAF C-130K is not fitted with any kind of Accident Data Recorder (ADR), coupled with the lack of recovered physical evidence led the Board to adopt a specific investigation philosophy. The approach adopted was to

examine all possible causes, eliminate those not supported by the evidence and then thoroughly analyse the remainder until the most likely cause was identified. Meanwhile, other agencies, such as the AAIB and Defence Science and Technology Laboratory (DSTL), were given all the available evidence, without the Board's analysis, allowing them to arrive at their own independent conclusions.

12. This Final Report is complete in its own right; however, it only contains the strictly relevant parts of an archive of reference material and extraneous evidence that has been collected and collated by the Board for the sake of completeness and future reference. Finally, the Board has written this report in plain English (as far as possible) to alleviate the risk of misinterpretation or misunderstanding by Service or civilian readers.

13. A full diary of the Board's activities is at Annex A.

FACTUAL EVIDENCE

14. Introduction. In this section, all recorded facts are supported by the references in the right-hand column. All times are in Zulu (Z), which equated to local Iraqi time minus 3 hrs.

15. Incident Overview. At 1324Z on 30 Jan 05, Hercules XV179 took-off from BIAP en-route to BSE. The crew were on the last sector of a routine Op [redacted] task that included passenger and freight moves, as well as a limited period of [redacted]. At 1330Z, a radio message was received at both BSE and Op [redacted] HQ from the signaller onboard the ac saying: "no duff, no duff, we are on fire, we are on fire". It was initially thought that the ac had landed on fire at BSE, which led to some understandable confusion, and it was not until 1355Z that the [redacted] Liaison Officer (LO) at BSE deduced that the ac was missing. The crew of a US Apache formation, [redacted] 13, who had seen an airborne explosion, located the crash site at 1415Z. On their arrival they found 10-15 "locals" wandering through the wreckage, but they walked away to the East when the Apaches arrived. At BSE, in-theatre post crash procedures had been implemented and coalition forces arrived on site at 1420Z. The crash was not survivable.

Exhibit I.
Exhibit D.
Witness I.
Witness H.
Witness G.
Annex M.

16. Detachment Background. Op [redacted] is a joint operation that started, under the name Op [redacted] in Jul 03 and is focussed against [redacted] operating in Iraq. The Operation's HQ is in the [redacted] and its C-130, originally based at [redacted], has been [redacted] since mid 04. The Command and Control of all Op [redacted] air assets is relatively standard, with Operational Control and Tactical Command and Control exercised through the [redacted] LO, also known as the Air Advisor, based at [redacted].

Exhibit M.

17. Hercules XV179. The detachment ac, XV179 (Lockheed Production No 4195), was a C-130K Mk 1 that was originally built in 1967 and had completed some 24 200 flying hrs. Although a mature ac, XV179 was equipped with a state-of-the-art Defensive Aids Suite (DAS). This suite included the [redacted] Directional Infra-Red Countermeasure (DIRCM) system (encompassing the [redacted] Missile Approach Warning System (MAWS)), [redacted] Chaff

Exhibit A.

& Flares dispensing system and the Joint Tactical Information Distribution System (JTIDS). As a [redacted] platform, XV179 was also equipped with [redacted] radios, [redacted] equipment and a communications 'crate' in the rear of the ac for the crew signaller. The recovered ac engineering paperwork (F700) and the results of a detailed study of the ac's computer records reveal that XV179 was serviceable for the duration of the detachment, with only minor faults reported. Furthermore, detailed analysis of the ac's engineering history revealed no serious problems or any defects that might have contributed to the incident. The crew had been flying XV179 for the duration of their detachment and were, consequently, very familiar with the ac.

Witness U.

Witness V.

18. Crew Background. The Crew of XV179 comprised:

- | | |
|--------------------|-------------------|
| Flt Lt D K Stead | - Captain |
| Flt Lt A P Smith | - Co-Pilot |
| Flt Lt P M Pardoel | - Navigator |
| MEng G Nicholson | - Air Engineer |
| FS M Gibson | - ALM |
| Chf Tech R A Brown | - Ground Engineer |
| Sgt R M O'Connor | - Ground Engineer |
| LCpl S Jones | - Signaller |

Annex C.

The operating aircrew's previous flying experience is detailed at Annex C. The Co-pilot joined 47 Sqn [redacted] in Nov 04 and this was his first operational detachment; however, the rest of the crew were very experienced, with 19 detachments to Iraq between them. The entire crew were given a thorough pre-deployment brief on 17 Jan 04, which covered intelligence, tactics and administration.

Witness P.

19. Crew Competence and Fitness. A thorough check of the crew's Log Books and F5200s (Individual Flying Records) reveal that they were all trained, qualified and current in the disciplines required for their detachment. Furthermore, with the exception of the co-pilot who was assessed as 'Average', the rest of the crew were assessed as 'Above (or Well Above) Average'. The Senior Medical Officer (SMO) also confirmed that the crew were fully fit to deploy and that none of them had any underlying medical conditions that could have contributed to the incident. Furthermore, none of the crew had reported sick during their detachment.

Annex P.

20. Supernumerary Crew and Passenger Background. There were 2 other personnel onboard XV179 at the time of the crash:

Witness M.

- | | |
|----------------------|---|
| Sqn Ldr P B Marshall | - Posted in as the [redacted] LO/Air Advisor. |
| Cpl D E Williams | - Detachment Safety Equipment Fitter. |

Exhibit F.

Sqn Ldr Marshall was travelling as a passenger en-route to BSE and Cpl Williams was serving as supernumerary crew. Both were on duty.

21. Operational Area. The C-130 was primarily used for operational and administrative moves of Op _____ personnel and equipment and for _____ tasks. The ac's most regular intra-theatre routes, shown at Fig 2.1, spanned the length and breadth of Iraq. The ac was also used for the occasional inter-theatre route. Furthermore, any spare capacity was utilised on an opportunity basis to assist with the overall air transport effort within the Iraqi theatre. The black arrows on the map at Fig 2.1 show the regular routes undertaken by the C-130 crew. It should also be noted that BSE is located within the Sunni Triangle, marked in red, a notoriously dangerous area within Iraq that has seen the majority of terrorist and insurgent activity.

Exhibit D.

22. Incident Area Topography. The red arrow on Fig 2.1 shows the general area of the incident and the picture at Fig 2.2 gives a view of the topography at the main crash site. The area is completely flat agricultural land, criss-crossed with irrigation canals. There are small clumps of trees dotted across the landscape but none of significant height, nor any electricity pylons or wires within the immediate area. The region is sparsely populated and the local infrastructure is poor.

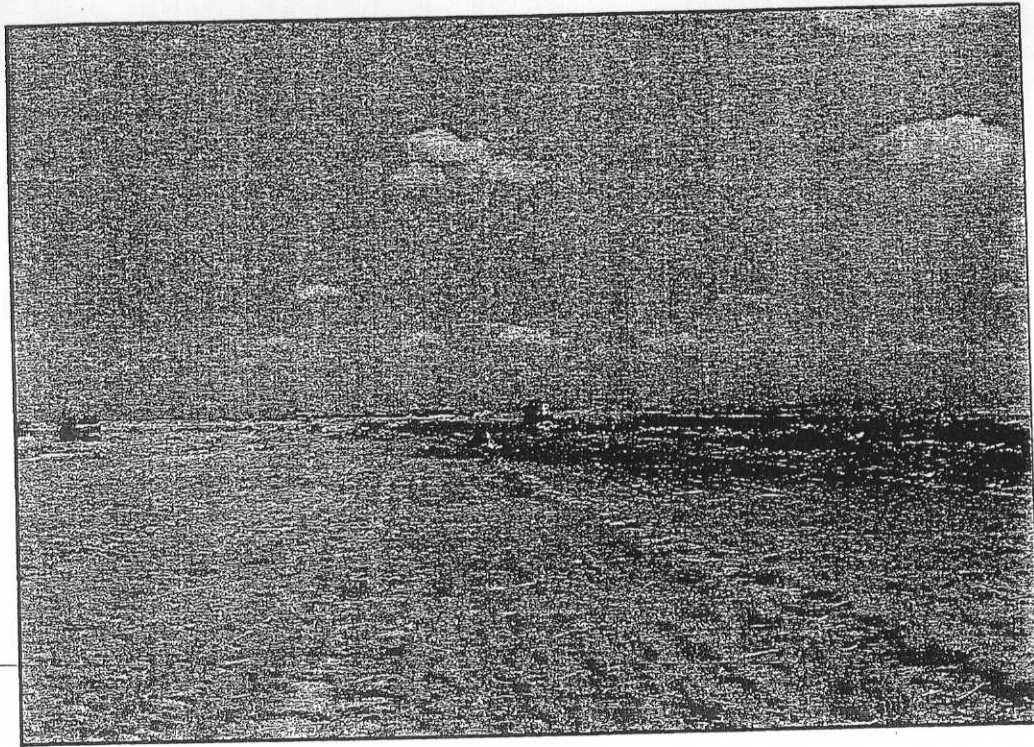


Fig 2.2

23. Weather and Visibility. The crash of XV179 occurred at approximately 1330Z, which was one hr before evening civil twilight. The official weather forecast for the time of the crash gave a visibility of 6000 m in haze and the cloud as 'few' at 200 ft and 'few' at 15 000 ft, with a temperature of +18 °C. Furthermore, the crew of 13, two US Apaches, observed the weather to be broken cloud at 8000 ft and unrestricted visibility below.

Exhibit G.

Exhibit E.

Witness G.

24. Theatre Ground to Air Threat. There is a significant threat to friendly forces across the Iraqi theatre, with several insurgent groups regularly attacking coalition and government forces. However, there is far greater insurgent activity in the North, particularly within the Sunni Triangle. Insurgents regularly use a variety of weapons systems to engage coalition ac. These include Man Portable Air Defence Systems (MANPADS), artillery rockets, light/medium Anti-Aircraft Artillery (AAA) and, the most prevalent, small calibre weapons. Indeed, between Nov 04 and Jan 05, small calibre weapons accounted for % of all surface-to-air fire (SAFIRE) as opposed to the MANPADS's %. A briefing slide that was used to illustrate the SAFIRE activity during this period, within a 15 nm radius of the crash site, is at Fig 2.3. However, although well populated, this picture does not show all the attacks that occurred within this period.

Exhibit L.

Annex X.

25. Threat Dissemination. Maintaining an up-to-date picture of the threat situation in Iraq is a continuous and complex process. The intelligence staff that the Board met were enthusiastic about their work and were obviously striving to provide the best service they could within their areas of responsibility. However, looking specifically at the ground-to-air threat, a number of factors reduced the effectiveness of the collection and dissemination process. In essence, each stage in the process appeared to work, but the links between stages were less robust. The procedure for reporting SAFIRE activity was laid down in the Special Instructions (SPINS), but units of different services and commands appeared to interpret these instructions in a manner that best served their needs. Furthermore, the different procedures used by ac flying above or below [] ft added complication to the process. Once reported, details of a SAFIRE event would progress up the reporting chain in the form of a Mission Report (MISREP), which would be interpreted and analysed before being included in the 12 hourly Mission Summary (MISSUM) and forwarded to units. As this was a human process, there were delays at every stage; furthermore, US forces frequently used communications systems that the UK only had limited access to, such as mIRC ('m' Internet Relay Chat) and Secret Internet Protocol Router Network (SIPRNET). The Air Component Headquarters (ACHQ) in Al Udeid served as the hub of the UK's air intelligence dissemination network, but was not manned on a 24 hr basis. Despite the delays in the formal dissemination process, ACHQ staff did have a procedure for passing time-critical information to airborne ac through ATC, although gaps in the radio coverage, particularly at low level, reduced the effectiveness of this process. Furthermore, because the ACHQ had no visibility of Op [] tasking, they were poorly placed to assess the true significance of intelligence to that operation. Consequently, there were no procedures in place for the ACHQ to pass real-time threat information directly to the [] C-130, which would have been possible through its excellent communications equipment ([] radio, satellite communications and JTIDS) and is a procedure regularly used in training. From the ACHQ's perspective, the

Witness L.

Witness K.

(JTIDS is a secure network, used to enhance situational awareness, that has an email facility)

Op [redacted] ac were well served by the intelligence staff at [redacted], who had the advantage of being integrated within a [redacted] Joint Operations Centre (JOC), with access to its communications systems. However, the air and ground intelligence picture generated for all Op [redacted] aircrew, fixed wing and rotary, was produced by one cpl, who obviously did not work 24 hr shifts and was, in reality, dependent on the product produced by the ACHQ. Unfortunately, the [redacted] nature of the [redacted] detachment led to limited communications between [redacted] and the ACHQ.

26. Crew Tasking – 29 Jan 05. The day before the crash, the crew flew the itinerary shown below.

Arrival (Z)	Location	Departure (Z)
	BSE	0600
0700		0710
0810	BIAP	0820
0950		1020
1150	BIAP	1200
1230	BSE	1600
1700		1800
1900	BSE	

Fig 2.4

The day's flying totalled 7½ hrs and was conducted in support of [redacted]. By returning to BSE at 1900Z on 29 Jan 05, the crew missed the daily detachment 1600Z brief, which included the daily intelligence brief. However, the brief that night did not contain any SAFIRE reports or any other 'air' related intelligence. On return to BSE, the crew was stood down and they returned to their accommodation for an uneventful night's rest.

27. Crew Tasking – 30 Jan 05. At 0930Z on the morning of the incident, the crew departed BSE having planned to fly the route shown at Fig 2.5, which also shows their actual departure and arrival times. The up-to-date information in their 47th Flight Information Folder indicates that they properly planned and briefed their sortie. The Captain also self-authorized in accordance with the powers granted to him by his Stn Cdr under 2 Gp Air Staff Order 2G301.100.2.

Arrival (Z)	Location	Departure (Z)
	BSE	0930
1000	BIAP	1008
1059	Basrah (BAS)	1211
1312	BIAP	1324
ETA 1345	BSE	

Fig 2.5

The crew's task had been revised to include an initial landing at BIAP to pick up two Op [redacted] personnel who could not wait for their delayed 'SURF' task

Exhibit D.

Witness I.

Witness K.

Witness I.

The Flight Information Folder was found at the crash site.

Witness I.

Exhibit B.

Exhibits H, I, J.

Witness H.

(SURF is the callsign of the BAS based C-130J). The SURF task was delayed because a false fire alarm at BAS had disturbed the SURF crew's rest. On arrival at BAS, the [redacted] crew off-loaded their crew Land Rover so that they could complete some routine administration whilst the ac was being loaded and refuelled. The Land Rover was reloaded and the ac departed at 1211Z. En-route to BIAP, the crew of XV179 were asked, by the crew of an in-theatre [redacted] ac, to take over their [redacted] duties. However, when the [redacted] LO discovered this re-tasking, it was cancelled and the crew were told to proceed to BIAP. They landed at 1312Z, kept their engines running, and offloaded four Op [redacted] personnel. These passengers had flown on the Hercules many times before and they all reported that their flight was normal and that the ac freight was securely strapped down. BIAP UK Mobile Air Movements Sqn (UKMAMS) accompanied Sqn Ldr Marshall to the ac and, with the engines running, hand signals were exchanged with the crew. ATC cleared XV179 to take off at 1324Z and the controller watched the ac depart at low level to the Northwest.

Witness I.

Witness M.

Witness Q.

Witness M.

Witness O.

28. Aircraft Freight. At the time of the incident, XV179 was carrying the crew's Land Rover, spare ac tyres and freight loaded at BAS by members of the UKMAMS. This cargo consisted of 125 kgs of general freight, one standard NATO pallet holding 126 kgs of flares and 12 kgs of 7.62 mm ammunition. It was noted that, in accordance with standard [redacted] procedures, no passenger manifests had been raised by the crew during their detachment.

Witness T.

Exhibit F.

29. Aircraft Fuel. XV179 was refuelled at BAS at approximately 1100Z on 30 Jan. The fuel was checked for contamination prior to the refuel and the bowser used was impounded and re-tested twice after the incident; all tests proved the fuel to be satisfactory. The documents that would have shown the quantity of fuel onboard at the time of the incident were destroyed in the crash; however, analysis of surviving records indicates that the fuel load was approximately 17 500 kgs. This comparatively high fuel load was normal for the Op [redacted] C-130, as it gave a contingency endurance in case the ac was re-tasked with [redacted] or other duties. This quantity of fuel would normally be carried in the ac's wing internal fuel tanks.

Witness T.

Annex S.

Witness W.

30. The Wreckage Sites. The ac wreckage was in 2 distinct and separate locations. The larger of these sites was located at N 33 31 53.7 E 044 02 55.5 and it contained all human remains and the majority of ac structure and systems. The second site was approximately 1.3 miles SSW of the main site and contained the outboard 23 ft of the right-hand wing from Outer Wing Station (OWS) 317 to the wing tip, including the right-hand aileron.

a. Main Site. The wreckage at the main site was largely confined to a teardrop shaped region, extending approximately 200m East from the initial impact point, as shown at Fig 2.6. The site is consistent with the ac, less the detached portion of wing, approaching the ground at a shallow angle and then disintegrating on contact. Heavier structural assemblies were projected further down the debris field and the remaining wreckage was highly fragmented. Marshall Aerospace (MA) identified all the ac's major components, from the photographic record, and the AAIB

Annex G.

Annex D.

Annex E.

stated that the wreckage was consistent with an impact of this nature.

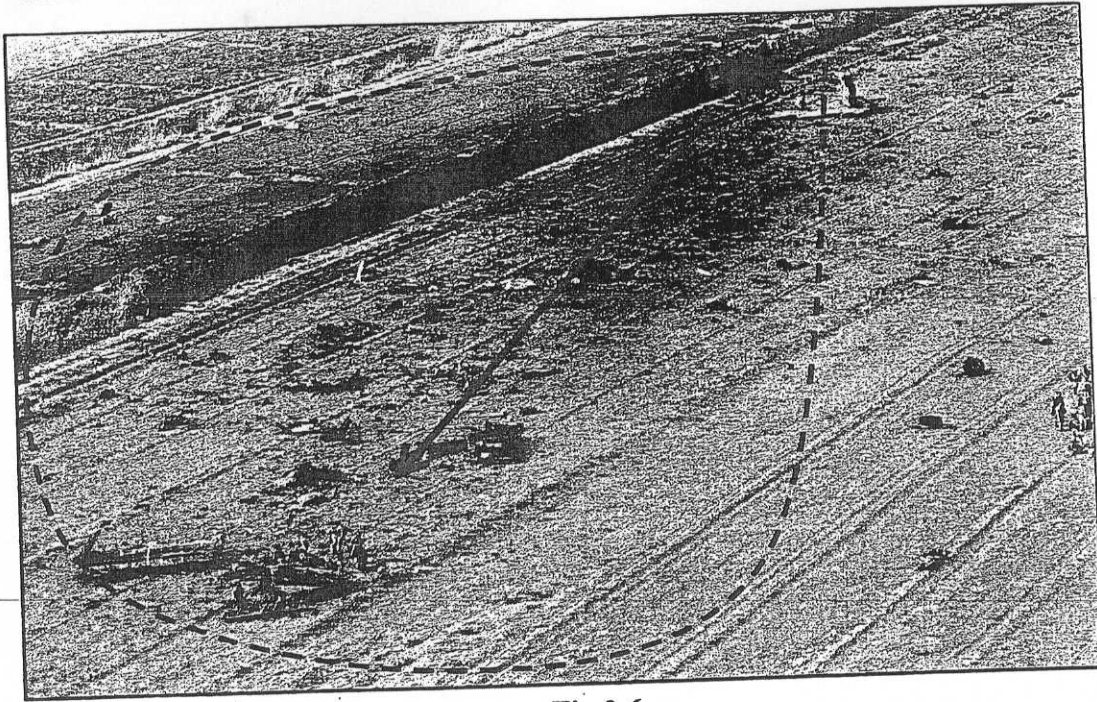


Fig 2.6

b. Remote Site. The wreckage at the remote site was contained within a 100 m radius, as shown at Fig 2.7. The distance between individual wreckage items and the lack of ground witness marks proves that the separated wing section had broken apart before impacting the ground. Suspect bullet holes were found in the structure and there was evidence of both in-flight and ground fires. From the photographs, MA and the AAIB were able to identify the vast majority of the separated section of right-hand wing.

Annex J.

Annex D.

Annex E.

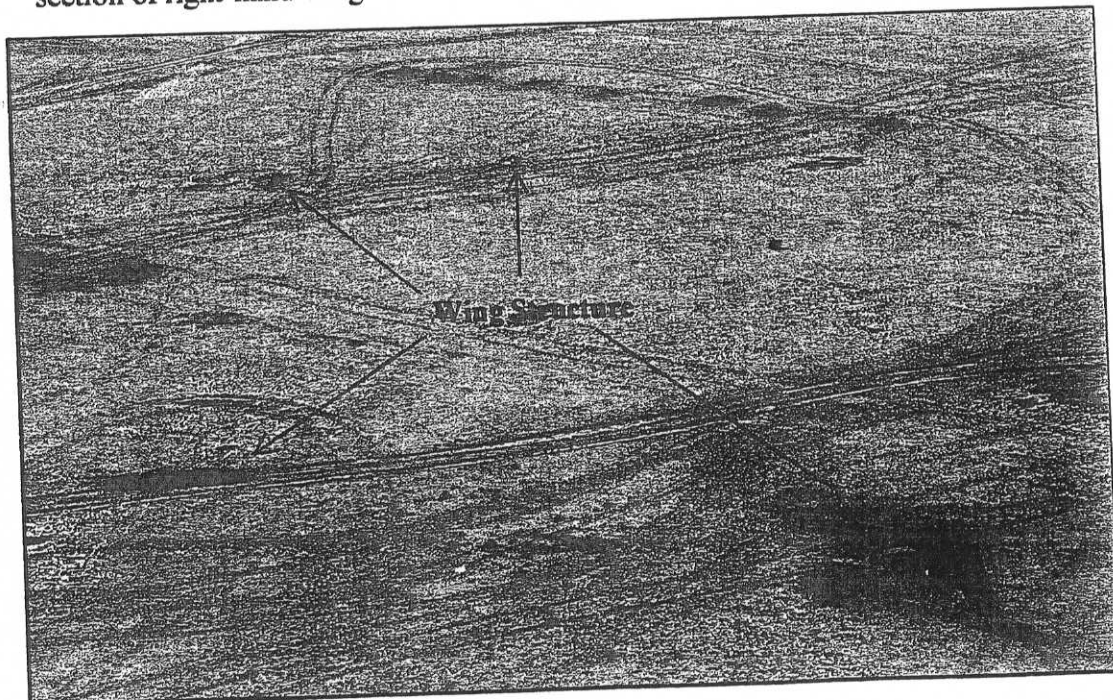


Fig 2.7

31. Positions of Crew and Passengers. The exact position of those onboard at the time of the crash is not known. However, it is reasonable to suppose that the operating crew were in their standard positions, with the ALM in the cupola and the signaller at his communications station in the freight bay. It would also be normal for the ground engineers to keep lookout at the para doors and it is probable that the passenger was on the flight deck.

32. Nature of Crew and Passenger Injuries. All those onboard XV179 died extremely rapidly, if not instantaneously, as the result of severe multiple injuries. The severity of injuries did differ between individuals; however, these differences were assessed to be the result of the ac's tumbling break-up rather than an individual's position on the ac, protective equipment or personal restraint. Post mortem examination revealed no evidence that those onboard were injured prior to the crash. Furthermore, the Post Mortem and toxicology results revealed that the occupants had not been exposed to fire or explosion whilst alive and that none had a medical condition that could have caused or contributed to the incident.

Annex O.

Annex N.

33. Survival Aspects. The crash of XV179 was not survivable and, as such, it is not possible to draw any conclusions on the performance of Aircrew Equipment Assemblies or Survival Equipment. Furthermore, no additional or alternative safety equipment would have altered the fatal outcome.

Annex O.

Annex N.

34. Damage to Aircraft, Public and Civilian Property. XV179 was destroyed by the crash and is, consequently, classified as Cat 5. Other than the aircraft and its load, no other damage was done to public property. It was not possible to ascertain who owned the fields where the ac crashed, but there was little physical damage done to the land by the impact of the crash. However, considerable quantities of hazardous pollutants were left on the sites, including ac structure, fuel, oils and live ammunition and flares. Furthermore, fuel and oils had contaminated the adjacent irrigation waterway.

35. Classified Material. A considerable amount of classified material was found at the main crash site. All classified ac systems, less 2 minor components, were accounted for and all classified paperwork found at the crash sites was recovered. However, it was not possible to ascertain what classified material had been onboard and, therefore, to fully account for it. Furthermore, the ac's safe was not found at the crash site, although it is not possible to determine what its contents were or whether it was destroyed.

Annex V.

(The IPT identified the missing components as the remote control unit for the ^A and the JTIDS low volume terminal)

Section 21

Annex Y.

36. Photographic Evidence. A large number of photographs, 'wet' and digital, were taken at both crash sites. These were used as the primary and, in many cases, the only source of evidence available to the organisations that assisted the Board. The AAIB, DSTL and MA examined all 826 images and have commented on the most significant in their reports.

(All wet film has now been digitised)

CONCLUSIONS BASED ON FACTUAL EVIDENCE

37. The Board made the following conclusions based on the factual evidence:
- a. The sortie was properly briefed.
 - b. The flight was correctly authorised.
 - c. The crew were qualified and capable of undertaking the planned task.
 - d. The crew were physically fit and well rested prior to the task.
 - e. All passengers and crew were on duty.
 - f. XV179 was serviceable for the flight.
-
- g. The weather was suitable for the planned task.
 - h. The outboard 23 ft of the right-hand wing separated from the ac in flight, approximately 1.5 miles before the main crash site.
 - h. The crash was not survivable.
-
- i. No additional or alternative safety equipment would have altered the fatal outcome.
 - j. All significant classified hardware has been recovered; however, it is not possible to ascertain what classified material was being carried on the ac and whether or not it was looted before coalition forces secured the crash site.

ANALYSIS OF CAUSE

38. Introduction. The evidence gathered from the crash sites, both photographic and physical, has been analysed by the Board and shared with a number of specialist organisations. The most significant contributions have come from the AAIB, DSTL and MA, who have all written independent reports. In addition to the photographic and limited physical evidence, the Board also had a video purporting to show the loss of XV179 and access to a number of individuals who witnessed all or part of the incident. Unfortunately, the information gleaned from these sources was contradictory and of varying credibility.

39. The Al Jazeera Video Footage. The footage purporting to be of the Hercules crash aired by the Arabic news channel 'Al Jazeera' was taken from a longer video given to the news channel by an insurgent group. The full video, reviewed by the Board, has longer scenes and shows human remains, but it is essentially the same footage. Initial analysis of the video concluded that its authenticity was questionable; however, the Board was quickly able to verify the crash site scene. Further analysis of the footage by the AAIB, DSTL and _____ revealed that earlier portions of it might also be genuine. DSTL _____ has stated that

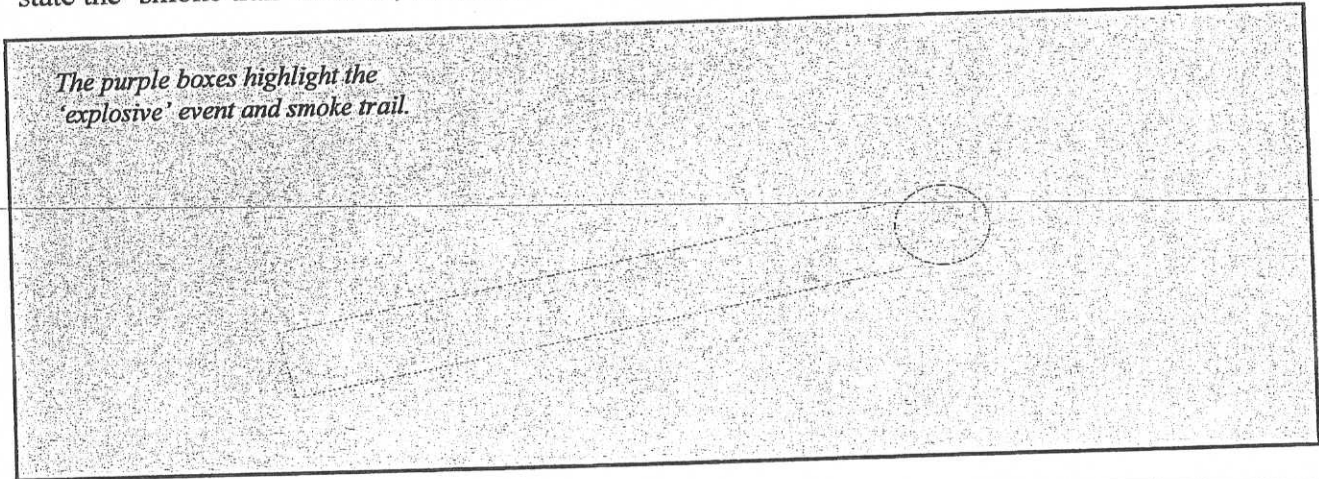
Exhibit R.

the apparent smoke trail, originally assessed as coming from a rocket, does not share the characteristics of any known rocket or missile. Indeed, they conclude that the 'smoke trail' is actually an ac on fire and that its wing subsequently separates. The AAIB also believe that the image may be of an ac, but that there is no evidence in the video to convincingly link the rockets shown to the wing separation and associated loss of XV179. Overall, the Board acknowledges that the video may contain the events described by the [redacted] and postulated by the AAIB. However, it is considered academic, as the Country's leading experts cannot enhance the video frames beyond the quality shown in Fig 2.8, which makes it impossible to positively determine the sequence of events or categorically state the 'smoke trail' is an ac, let alone XV179.

Annex J.

Annex E.

(The leading experts are considered to be the Dorset Police's Video Unit. The Board also consulted and DSTL). SECTION 26



The purple boxes highlight the 'explosive' event and smoke trail.

Fig 2.8

40. Witnessed Events. The positions of the witnesses, relative to the ac and main crash site, are shown in Fig 2.9(a) and a breakdown of their observations is shown at Fig 2.9(b). With the exception of the Iraqi, who was not formally interviewed, the Military Police assessed all witness as "credible" and their inconsistencies as "quite normal". The statements support the fact that XV179 was on fire before it hit the ground. It is tempting to accept that a rocket of some description started this fire; however, the US servicemen who reported this event were considerably further away from the ac than they perceived, which could have made them susceptible to a number of visual illusions – such as parallax. This, and the ac's direction of travel, may also account for the general perception that the ac was hit on the left-hand side, when it was actually hit on the right. Additionally, the description of rocket 'fire balls' could equally describe tracer rounds, which is discussed later in this Report. The Iraqi witness, [redacted] was close to the ac and also reported seeing rockets; however, this was during his 3rd statement and, crucially, after the Al Jazeera broadcast. The Board have not dismissed the witness statements, but do not consider them conclusive. However, it was noted that the US witnesses, who had been operating in the area for many months, had not seen a Hercules in that area before. Whilst this alone is not categorical, the Board concluded that the crew of XV179 had not been 'pattern setting'.

SECTION 40

Witnesses A-G.

WITNESS STATEMENT 'KEY FACTS' TABULATED

Time (Z)	Witness	Statement number (Taken by)	Perceived Distance from Incident	Actual Distance from Incident	Estimated Height of XV179	Number and description of projectiles	Projectile hitting the ac (Number)	Impact point on ac	Airborne explosion	Ground explosion	Small-arms fire / AAA (Type?)	Witness Statement
		1 st (US auth.)		15 km SE	~ 300 m	2 x Orange fireballs (Rocket)	✓ (x1)		✓	x	x	A
	(EOD Eng)	2 nd (UK SIB)	1500 m	15 km SE	300 m - 500 m	2 x Fireballs (Rocket)	✓ (x1)	Centre between wings	✓	x	x	A
1100-1300		1 st (US auth.)	800 m - 1 mile	15 km SE	150'	1 x dark smoke trail (RPG? - see Richard statement)	✓	Left side	✓	x	x	B
~1345	(EOD Eng)	2 nd (UK SIB)	800 m - 2 miles	15 km SE	150'	1 x grey smoke trail (Not known)	✓	Left wing	✓ (x2)	x	x	B
~1345		1 st (UK SIB)	1.5 miles	15 km SE	500'	1 x orange/yellow fast moving light with light smoke trail (RPG)	✓	Underneath right side	✓	x	x	C
~1330	(EOD Escort)	1 st (UK SIB)		15 km SE		(Rocket)	✓ (x1)			-	-	D
	(Patrol 'Def')	1 st (Debrief)		15 km SE				Left hand end of wing		✓	✓	F
1350		1 st (Soldier F)		500 m E				Centred on left hand wing	✓	✓	x	F
1300	(Local Farmer)	2 nd (US Forces)		500 m E	200'					✓	✓	E
1350		3 rd (US Forces)		500 m E		2 (Rockets)	✓ (x1)	A wing	(Fire only)	✓	✓	E
1345		1 st (Debrief)							✓	-	-	G
1350		2 nd (UK SIB)	15 km SW	15 km SW					✓	-	-	G

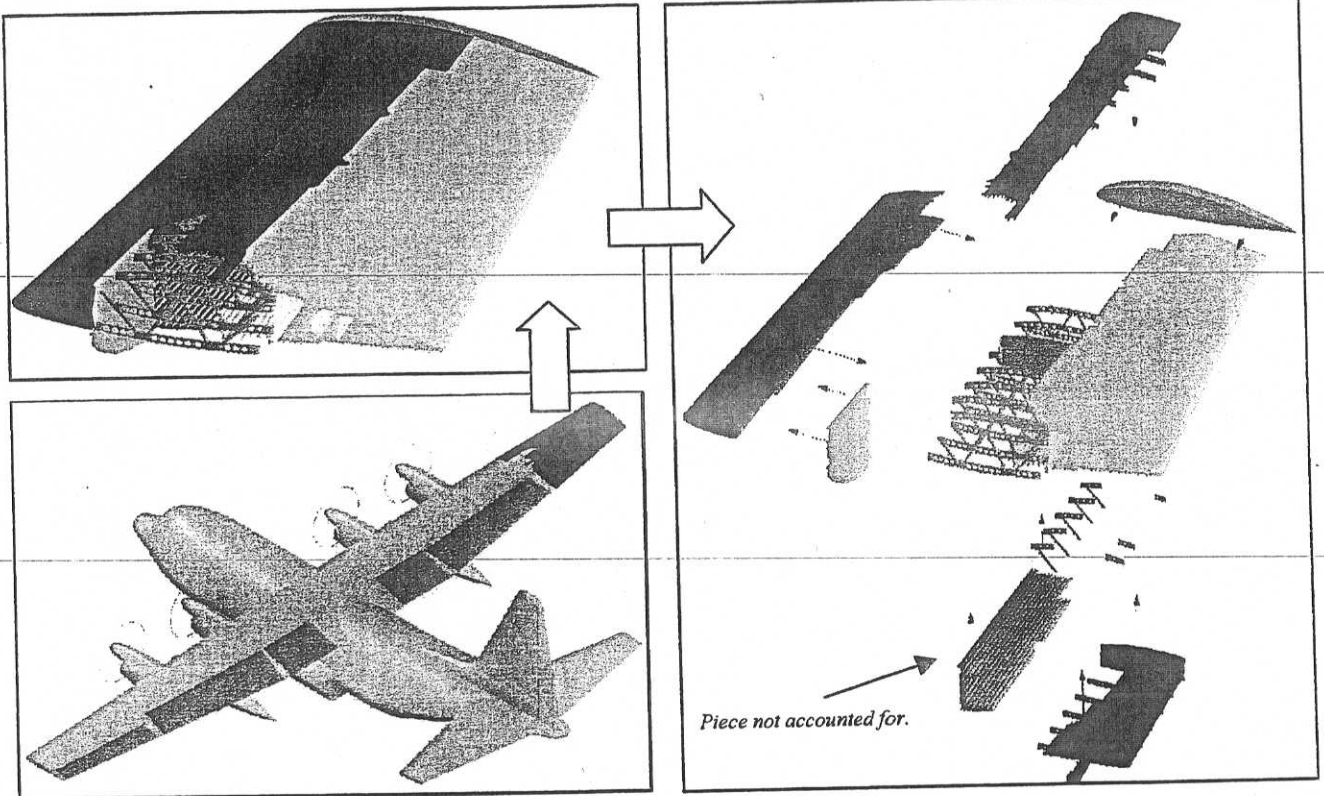
Fig 2.9(b)

2-15/44

41. The Nature of Wing Separation. The large, relatively intact, but separate sections of outboard wing prove that the wing blew apart due to an internal overpressure. This conclusion is supported by the lack of bending or yielding in the metal structure and the fact that the separated wing section had not detached in one piece, as might be expected from a fatigue failure. Break surfaces were consistent with brittle fractures and fracture lines were random and did not track. The extent of the wing damage is shown in Fig 2.10, which also depicts a computer representation of the individual pieces found at the remote crash site. The over-pressure that

Annex G.

Annex E.



Extent of separated wing section.

Representation of wreckage found at the remote site.

Fig 2.10

(Reproduced by permission of Mr Chris Protheroe, AAIB)

separated the wing must have occurred in the number 4 fuel tank, which extends from the wing tip to the right-hand outboard engine. The cause of this explosive event has been considered in detail by the AAIB Senior Investigator, who concludes that it is most likely to have been caused by an ignition of the fuel/air mix in the space above the fuel, known as the ullage. Aviation fuel as a liquid will not explode; however, the ullage contains a fuel/air mixture that can explode if ignited under the correct conditions. A number of factors, such as fuel/air ratio, temperature, pressure and agitation of the fuel, can affect the volatility of the fuel/air mix. In the case of XV179, the fuel would have been relatively warm, due to the ambient air temperature, and ac manoeuvring could have agitated the tank contents, which would have resulted in more fuel evaporation and increased the fuel vapour content in the ullage. Additionally, the agitation would result in 'misting' which increases volatility. Equally, a fuel leak caused by the

Annex K.

Annex G.

Annex D.

Annex E.

Annex I.

observed ballistic damage could have reduced the tank quantity thereby increasing the ullage volume, or a fire, caused by the ballistic damage, could have increased the ullage temperature. There is some evidence of airborne fire damage to the separated wing sections and the remaining section of right-hand wing at the main crash site. However, the AAIB conclude that there was no evidence consistent with a sustained airborne fire in the separated wing section and that the fire damage visible in this part of the wreckage occurred after separation, either as the sections fell or as a result of subsequent ground fire. There is evidence of sustained airborne fire on the remaining section of wing at the separation point, which is also likely to have occurred after separation, although evidence for this is less conclusive. This fire caused significant damage to the trailing edge of the wing, in the vicinity of OWS 300, and the observed damage is indicative of significant and sustained sideslip. After detailed inspection of the separation at OWS 317, the AAIB Senior Investigator concluded that there was some evidence of a large penetration consistent with projectile impact. Two localised areas of ragged failure contrasted strongly with the more regular pattern of failure observed elsewhere on the separated wing section. The location of this suspect damage is shown in Fig 2.11. If such a penetration existed, it would allow rapid draining of the fuel tank, provide a possible source for sustained fire and locally reduce the wing's structural strength, which would account for this area becoming the separation point. The source of ignition for the explosive over pressure is discussed later in this report; however, the Board has concluded that the explosive separation of XV179's wing was caused by the ignition of the fuel/air mix in the number 4 fuel tank ullage. Furthermore, the Board concluded that the lack of a suppression system within the fuel tank, such as foam or inert gas, was a contributory factor. The Board also concluded that the violence associated with the separation and the resulting fire, caused significant damage to the remaining section of wing. Consequently, the aerodynamic effect on the ac would have been more significant than the loss of the outer wing section in isolation.

Annex E.

Annex E.

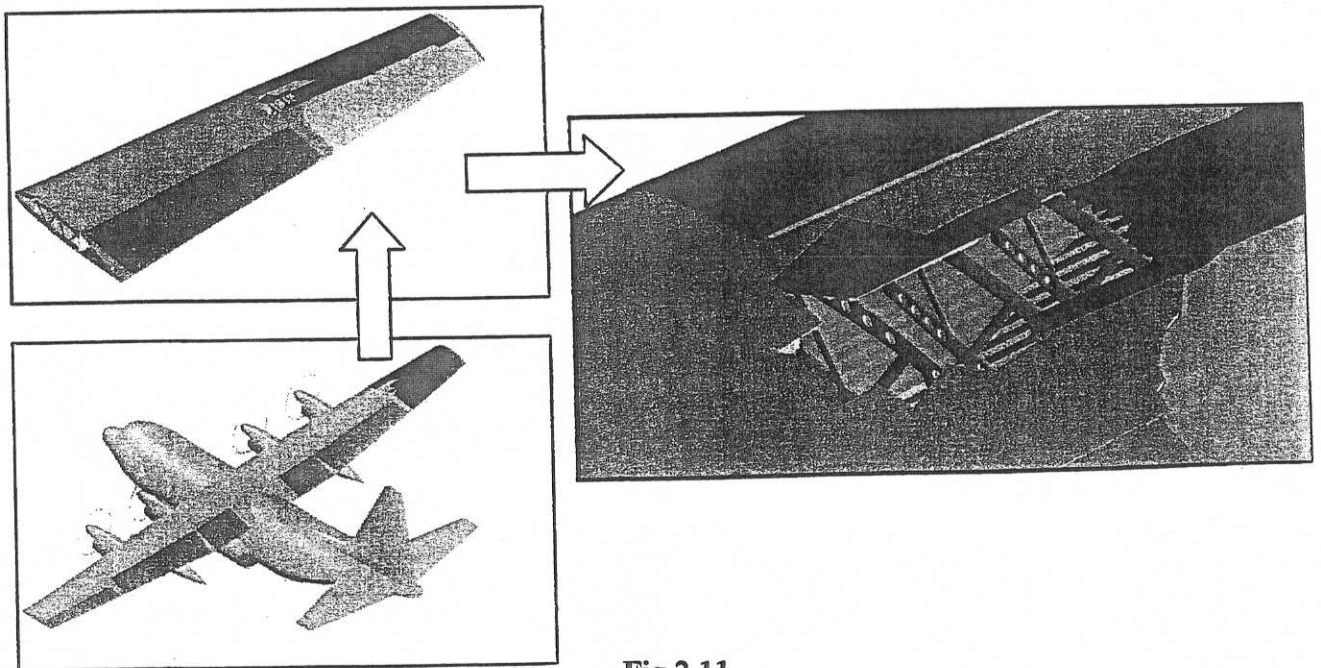


Fig 2.11

(Reproduced by permission of Mr Chris Protheroe, AAIB)

42. Flight Profile. The Board is confident that XV179 was operating at low level, probably at ___ ft, and approximately ___ kts at the time of the incident. Furthermore, analysis of the ac paperwork not destroyed in the crash, indicates that the ac weighed 59 236 kgs and had 17 500 kgs of fuel onboard. The Board cannot categorically state which pilot was flying the ac because, according to the Authorisation Sheets, the captain was allowing his co-pilot to fly at OLF heights, for which the co-pilot was not formally trained. The OLF hours awarded to the co-pilot in the Authorisation Sheets may represent an administrative error; however, if the co-pilot was operating at OLF heights, the Board conclude that it would not have been a contributory or aggravating factor in this incident. However, whilst it is safe to assume that the captain would have taken control during the incident, the Board believes that it would be prudent for ___ co-pilots to receive some level of OLF training to allow them to take control and remain operationally effective in the event of their captain becoming incapacitated at OLF heights.

Annex S. SECTION 26

43. Aircraft Configuration. Without an ADR it is not possible to fully record XV179's configuration at the time of the crash; however, photographic records, witness statements and expert analysis do help. As previously discussed, the ac hit the ground at a shallow angle; indeed, one of the witnesses believed that the ac was trying to land. However, the landing gear was up and locked with no obvious signs of pre-crash damage. Furthermore, the flaps were also up; although the in-flight fire damage and catastrophic wing failure could have prevented their operation even if selected. Most of the ac's electronic equipment was too badly damaged to assist with post-crash analysis; however, the manufacturer of DIRCM (Northrop Grumman) interrogated the surviving components of that system and stated that it was functioning correctly. This finding is further substantiated by the fact that the Board found the DIRCM turrets deployed and evidence that the system's programming card was fitted correctly. The Board concluded that the crew were not trying to land and that their DAS equipment was functioning correctly.

Witnesses E and F.

Annex G.

44. Discounted Causes. Having considered a broad range of possible causes for the observed damage and in light of the diagnosis discussed in the previous paragraphs, the Board was quickly able to discount the following:

Annex L.

a. Bird Strike. There was no sign of bird damage on the ac structure, including the leading edges, or remains of birds on the ground. Furthermore, it is not possible for bird damage to cause the separation of the outer wing in the manner observed. The Board has discounted bird strike as a factor.

Annex D.

b. Lightning Strike. The weather forecast did not predict lightning conditions; furthermore, aircrew in the vicinity of the crash sites reported that there was no lightning, or the weather conditions to generate it. The Board has discounted lightning as a factor.

Exhibits E and G.

Witness G.

Annex D.

c. Mid-Air Collision. No other ac were found to be missing or damaged and there was no other ac wreckage at either crash site. Furthermore, the observed structural damage could not have been caused by a collision with another ac. The Board has discounted mid-air collision as a factor.

(The USAF and RAF completed a 'headcount' shortly after the crash)

Annex D.

d. Controlled Flight into Terrain. The observed structural damage was not consistent with a ground strike and there were no 'ground scars' at the remote crash site to support such an event. The Board has discounted controlled flight into terrain as a factor.

Annex D.

e. Wire/Obstacle Strike. There are no obstacles, including pylons, within the immediate vicinity of the crash site that could have played any part in this incident. Furthermore, the observed structural damage could not have been caused by such an event. The Board has discounted wire/obstacle strike as a factor.

Annex D.

f. Sabotage/IED. The damage caused to XV179 would have required number 4 fuel tank to have been sabotaged or have had an IED placed within it. Given the fact that the ac was only left unguarded at very secure airfields and the extreme difficulty, in terms of height and access, that would be involved in gaining access to the number 4 fuel tank, it seems highly unlikely if indeed possible at all. Furthermore, a piece of wing recovered from the main crash site, which was known to be close to the wing separation point, proved negative for all forms of high explosive when subjected to chemical and microscopic analysis. The Board has discounted sabotage/IED as a factor.

Annex D.

Annex K.

g. Cargo Explosion. A cargo explosion would not have been capable of causing the observed damage to the outboard wing without doing considerable damage to the cargo bay. However, the cargo floor remained relatively intact and showed no evidence of fire or explosion. The ac was carrying a pallet of Dangerous Air Cargo and, whilst it is tempting to see this as a possible cause, the items carried were specifically packed for air transport. The Board has discounted cargo explosion as a factor.

Exhibit F.

Annex D.

h. Chaff/Flare Dispenser Explosion. Hercules XV179 was fitted with chaff and flare dispensing units on the nose, tail, under the wing roots and on the rear of the external fuel tank support fairings. The only dispenser unit potentially close enough to have damaged the right-hand wing was the one housed on the right-hand external fuel tank fairing. However, this unit is a chaff dispenser and whilst the chaff is expelled by a small explosive charge, it is not explosive per se. Furthermore, the dispenser unit is 'aimed' aft, so any inadvertent igniting would have been directed away from the ac. Finally, had the subject dispenser catastrophically failed, it would have damaged the wing in its vicinity, some 18 ft inboard of the observed damage. The Board has discounted chaff/flare dispenser explosion as a factor.

Annex E.

i. Engine Fire/Failure. There was no physical evidence of engine fire in any of the 4 engines found at the main crash site and the 2 fire extinguisher bottles were fully charged. Furthermore, for an engine to have caused the observed damage, it would have had to explosively fail and there was no evidence of this. Indeed, the fragmentation of the ac's propellers at the main crash site suggests that they were all rotating when the ac hit the ground and the damage to the compressor and turbine blades indicates that the engines were operating. The Board has discounted engine fire/failure as a factor.

Annex R.

j. Over-Stress. Ultimate design loads for the C-130 consist of a combination of manoeuvre and environment forces. A pilot induced manoeuvre sufficient to cause catastrophic structural failure would need to be exceptionally violent, unless the residual strength of the ac had already been reduced below ultimate design strength; for example, due to fatigue or ballistic damage. In previous residual strength tests, up-bending failures, associated with normal in-flight 'G', have resulted in failure at known structural stress points in the centre, not outer wing. Additionally, the outermost section of wing was designed on a stiffness basis and has greater strength safety margins than the inner wing. A pilot induced overstress is highly likely to result in the yielding of material before its failure and tell-tail signs such as pulled rivets and the bending and buckling of structure would be apparent. Whilst some over-stress probably occurred during, or immediately prior to impact, there is no evidence that it played a principal or even significant role as a cause factor. The Board has discounted over-stress as a factor.

Annex D.

Annex G.

Annex R.

Annex D.

k. Fatigue. The distribution and fragmentation of wreckage was not consistent with a fatigue failure. There was no evidence of fracture patterns typical of fatigue found at either site. Extensive in-service and fatigue test experience indicates no known fatigue initiation points that would cause the wing of XV179 to fail where it did. Fatigue is a complicated and technical issue that cannot easily be summarised in this part of the Final Report; however, a more detailed explanation of C-130 fatigue issues and information relevant to XV179 has been recorded in the Board's Engineering Report. The Board has discounted fatigue as a factor.

Annex G.

Annex D.

Annex E.

Annex R.

Furthermore, the Board concluded that the following 3 scenarios either played no primary role or were highly unlikely to have been the cause of the catastrophic wing failure:

l. Control Restriction. Control restriction alone could not have caused the damage observed. However, aileron control could have been lost or restricted after the wing separated. In essence, the ailerons are controlled by a metal tube that connects the left and right control surfaces to a hydraulic booster pack at the mid-point. There are no weak links in this system; therefore, if the right-hand aileron control run became jammed after the wing separated, the left-hand

Annex G.

aileron would also be jammed, rendering the ac uncontrollable in roll. The Board has discounted control restriction as a primary cause but concludes that it may have been a contributory factor after the wing separated.

Annex D.

m. Bleed Air. Hot engine bleed air is ducted into the outer wings for de-icing purposes and XV179's ducts were made from a corrosion resistant material called 'Inconel'. The only known issue with this material is cracking of the attached steel couplings, but there have been no instances of this causing significant leaks or failures. A section of forward spar web from OWS 300 found at the remote site showed no evidence of heat damage and the temperature sensor was intact. Additionally, as the ac was not in icing conditions it is unlikely that the de-icing system was selected on at the time of the crash. An explosive rupture of a bleed air duct could have caused structural damage and subsequent fire, but there was no evidence of this in the wreckage. The Board has concluded that Bleed Air was highly unlikely to be a factor.

Annex G.

Annex R.

Annex H.

n. Electrical Arcing. Electrical arcing could result in the explosion of a flammable fuel/air mixture within the number 4 fuel tank. Indeed, when a Boeing 747 crashed on departure from New York in 1996, the US National Transportation Safety Board concluded that the most likely cause was a fuel/air explosion in the centre wing fuel tank resulting from a short circuit in the fuel quantity indication system. The Federal Aviation Authority acted upon these findings with the release of Special Federal Aviation Regulation 88, which was subsequently incorporated into Lockheed Martin Service Bulletins (SBs). These SBs were in turn incorporated into an RAF Special Technical Instruction, STI/Hercules/630, which had not been completed on XV179. However, this was not an oversight, but rather a conscious decision by the Hercules Integrated Project Team (IPT) to extend the usual SB compliance period of 90-days, to 12 months. This was justified by the IPT because the Hercules was found to meet or exceed existing Air Publication requirements and the risk of a high resistance causing a spark was not significant. Nevertheless, the STI was to be completed at the earliest maintenance opportunity, as directed by the IPT, and XV179 was one of the last 7 C-130Ks (out of a Fleet of 26) yet to be completed. In another incident, the cause of a wing fire on a USAF C-130 was traced to the incorrect installation of a fuel pump (an external fuel tank pump had been 'locally modified' for use in a main tank). In this case, the resultant fire was probably retarded by fuel tank foam, allowing the ac to land safely. However, in the case of XV179, a thorough review of the maintenance records revealed that no maintenance had been carried out inside the number 4 fuel tank since the last Minor maintenance in Jul 04. At the time of the incident, XV179's wing fuel tanks would have been virtually full and the Board noted that keeping fuel pumps submerged in fuel is a common engineering solution used, as an interim measure, to alleviate the danger associated with suspect fuel pumps arcing in a

Annex G.

Annex R.

Annex H.

fuel/air mix. Consequently, the Board concluded that even if a fuel pump had malfunctioned it would have been covered in fuel and, therefore, an extremely unlikely source of ignition. The Board has concluded that while electrical arcing could have initiated the observed damage, when considered in conjunction with the ac's maintenance history, the Fleet's technical record and the ac's fuel load, it is highly unlikely to be a factor.

The AAIB Senior Investigator, having discounted technical and structural causes in his Preliminary Report, states that the additional analysis he carried out whilst preparing his Final Report, "confirmed and reinforced this conclusion".

Annex E.

45. Ground to Air Threat. The elimination of the factors discussed above focussed the Board's attention onto the threat posed by hostile action. As has already been made clear, the crew of XV179 were operating in an extremely hostile environment, with daily SAFIREs. Documents recovered from the main crash site prove that the crew had the most up-to-date information available at BSE when they took off; however, the intelligence picture changed whilst they were airborne. At 1015Z on 30 Jan, two UH60 helicopters ([redacted] 35) were engaged from a prepared ambush site by small arms (possibly large calibre) and an IED. These SAFIREs occurred one and 3 kms respectively from XV179's eventual crash site. According to previous MISSUMs, this was the first SAFIRE event within a 15 nm radius of the crash site since Nov 04 when 2 helicopters were engaged with RPGs, AAA and small arms. However, there may have been attacks in the area that did not make the MISSUMs. Indeed, the SAFIRE at 1015Z on 30 Jan did not appear on the next MISSUM or any subsequent ones, although the MISREP did arrive at the ACHQ by email 80 mins before the C-130 crash. Unfortunately, as the ACHQ staff had no visibility of XV179's tasking or routing, the significance of this earlier attack was not apparent to them and the [redacted] Intelligence Cpl did not have visibility of the SAFIRE until the 31 Jan. As the [redacted] crew had good communication equipment onboard and a dedicated signaller, it is reasonable to suppose that they were confident that any time-sensitive threat information would be passed directly to them. However, the crew of XV179 remained unaware of the earlier attack and, once airborne, flew close to the SAFIRE sites and crashed shortly afterwards (see Fig 2.12). Joint Surveillance Targeting Attack Radar System (JSTARS) Moving Target Indicator (MTI) imagery shows vehicles merging in the vicinity of this SAFIRE site and then, after the crash, transiting to the main crash site. This intelligence does suggest that insurgents had prepared an ambush site, probably for helicopter traffic, and that XV179 flew close to it. This fact ties in with the AAIB's assertion that the aircraft was engaged by multiple sites, in close proximity, to the right of the ac's track. Ultimately, it is not possible to prove that the earlier SAFIRE and the loss of XV179 were linked; however, the fact that the ac took-off on a routine sortie without an accurate threat picture, proves that the intelligence collation and dissemination system needs urgent review. The Board concluded that the SAFIRE collation and dissemination process was a contributory factor in this incident.

Exhibits N, O and P.

Exhibit O and P.

Exhibit N.

Annex E.

Annex W.

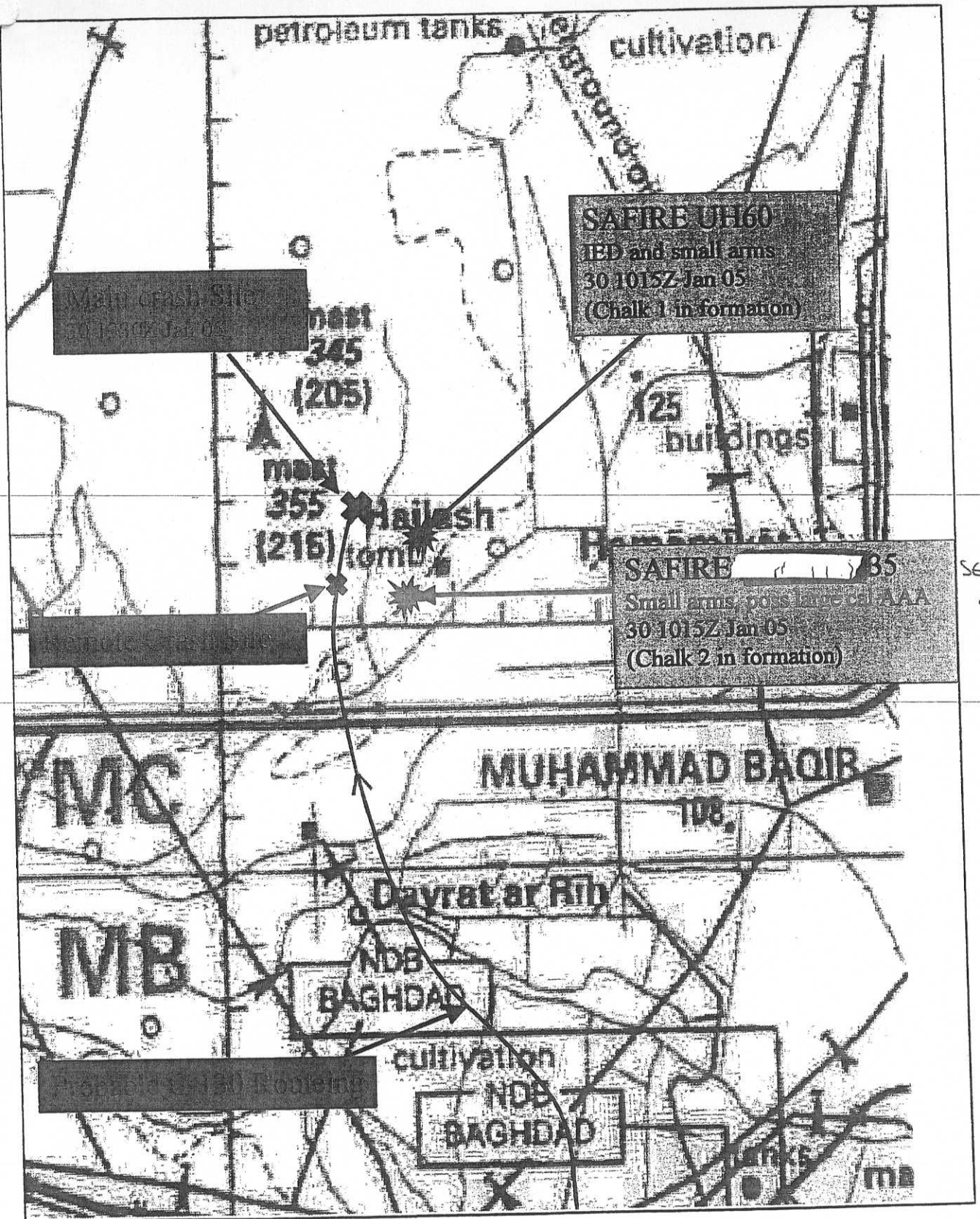


Fig 2-12

46. Tactics. The decision on the routeing and tactics employed by the C-130 for a particular task, rested with the crew of that ac. In making their decision they would have drawn on 47 Sqn's Standard Operating Procedures (SOPs), advice from the Air Warfare Centre (in the form of Tactical Memos), procedures laid down by the Air Commander (AC) and their own experience. Factors such as day or night, ac weight and route destination were dictated by the operational requirement, but would also have influenced the crew's choice of tactic. The leg from BIAP to BSE is approximately 40nm and, on all previous occasions, the crew chose to fly this leg at _____ ft by day and _____ ft by night. Published advice states that ac are only completely clear of the insurgent's Weapons Engagement Zone (WEZ) above _____ ft. However, the vulnerability associated with climbing and descending to this altitude on such a short sector in a heavy ac would have reduced the advantage. The crew could have flown above _____ ft, thereby significantly reducing the risk of small arms fire, but this would have increased their vulnerability to MANPADS, which were perceived as a greater threat. Flying at low level was a recognised tactic that reduced the crew's reliance on the ac's DAS, although the AWC did highlight the reduced benefit of low level flying over a flat and featureless landscape in an area of known insurgent activity. However, the use of Operational Low Flying (OLF) as a tactic to evade MANPADS was supported by the AC in his letter of 2 Jun 04, in which he also identifies MANPADS as the most significant, if not prevalent, threat. Flt Cdr Trg & Plans also supported this stance, as OLF was a tactic that had served well in Iraq. The Board concluded that the crew of XV179 were operating in accordance with relevant orders and instructions and in-line with 47 Sqn's Flt's perceived best practice. However, the Board concluded that flying at low level, in daylight, was a contributory factor in this incident.

Exhibit D.

Exhibit S.

Exhibit J.

Exhibit K.

Witness W.

47. C-130K Vulnerability. The C-130 has a long history of operating in hostile environments and is generally perceived to be a robust ac. Indeed, with the duplication of powered flying controls, 'combat' electrical wiring, the ability to retain control with a total loss of electrical and hydraulic power and the ability to fly on 2 engines, this stance is justifiable. RAF Hercules ac have been hit by small calibre rounds in the past; however, they have caused little damage. Indeed, in the past year two C-130s have been hit in the wing by small calibre rounds. In one incident a 14.5 mm round went through a 'dry' area of wing and in the other a Kalashnikov 7.62 mm round entered the number one fuel tank from below, causing a fuel leak. However, other than slight structural damage, there were no significant consequences in either case. The ac's apparent resilience to small arms led to a perception that the ac was not vulnerable to this type of weapon. On the other hand, the effect of MANPADS or modified 'dumb' rockets was perceived as a far greater threat and hence the ac were extensively modified, with the incorporation of a DAS, in order to mitigate an element of this risk. However, the ac fuel tanks have remained vulnerable. As previously discussed, the fuel itself may not be explosive, but it is combustible and the fuel/air mix in the ullage is explosive when appropriately mixed. Consequently, the heat generated by a bullet passing

Annex T.

Annex U.

through ac structure could either start a fuel fire or cause catastrophic damage by igniting an explosive fuel/air mix. These results are even more likely if the [redacted] and/or [redacted] as they are designed to [redacted]. Indeed, a trial completed in 1979 (entitled: *Some Factors Influencing The Probability That Sustained AVTUR Fuel Fire Will Result From Incendiary Bullet Impact*) concluded that incendiary bullets, fired at wing fuel tanks, cause ignition in 94% of impacts and a sustained fire on 49% of these occasions. Foam and inert gas systems, intended to prevent an explosive mix developing within a fuel tank, are available and have been fitted to ac, including some US C-130s. However, whilst effective in this regard, these systems would not prevent a fuel fed fire, they are expensive and can have significant maintenance and performance penalties. The Board concluded that the vulnerability of C-130 fuel tanks to relatively small calibre weapons was a contributory factor in this incident.

Annex U.

48. Hostile Action. In light of the threat, tactics and ac's vulnerability to weapons systems, the Board considered the effect of hostile action directed against XV179.

a. Ground IEDs. Insurgent groups have designed ground IEDs to blast upwards, into passing ac.

Witnesses A and B.

Exhibit P.

MANPADS. A wide variety of MANPADS are held and used by insurgent groups in Iraq, but the most prevalent are the [redacted]. These weapons have a variety of operational parameters, but they share some similarities: they leave a 'corkscrew' smoke trail.

Annex I and J.

Witnesses A-G.

Annex K.

c. Unguided Rockets. A large selection of unguided rockets are available to insurgent groups and some of these, such as the S5, have been ingeniously modified from their designed air-to-ground role to an improvised ground-to-air role. These weapons are dumb insofar as they are fired at their target, but have no way of independently homing onto it.

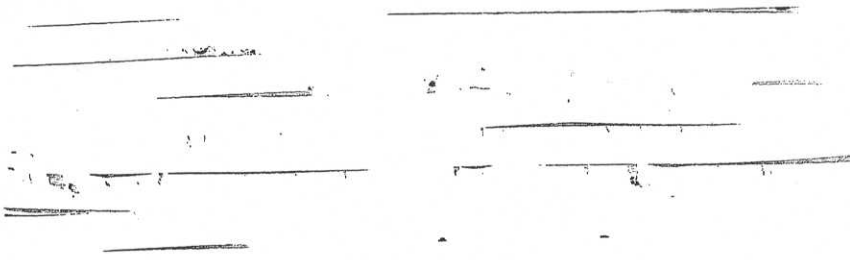
Annex J.

With the exception of a Chinese 107 mm rocket, all candidate weapons detonate on impact and some self-destruct if they do not hit their target within a specific period. Furthermore, all candidate rockets produce high velocity fragments on detonation. In the case of XV179, all 5 witnesses who saw the ac engaged, reported seeing what could have been one or more unguided rockets fly towards the ac. The insurgent video aired on Al Jazeera also showed 2 rockets, identified as probable 120mm class artillery rockets, fired at the ac. However, analysis of the film by the Board, AAIB and DSTL concluded that these rockets almost certainly missed their target. Furthermore, as with MANPADS, the observed and analysed wreckage revealed no fragmentation damage, chemical residues or micro-pitting synonymous with high explosive. As previously mentioned, the AAIB Senior Investigator has concluded that there is evidence in the separated pieces of outer wing to suggest that a large projectile, or a projectile with a small high explosive warhead, penetrated the wing, from below, in the vicinity of the separation boundary.

Annex K.

Exhibit R.

Annex E.



d. Small Arms/Light Anti-Aircraft Artillery. The Board found evidence of bullet damage on the right-hand wing at the remote crash site. Analysis by DSTL has confirmed that this damage was caused by mm rounds. The calibre of munition was ascertained from the dimensions of the bullet holes and the assertion that they were is based on the fact that all known mm ammunition in the Iraqi theatre is either or (with). The similarity between one of the bullet entry holes made by a mm round during the Board's live-fire trial, shown at Fig 2.13, and one of the entry holes found on XV179's wing, shown at Fig 2.14, is clear. It was possible to prove

Annex I and J.

Annex E.

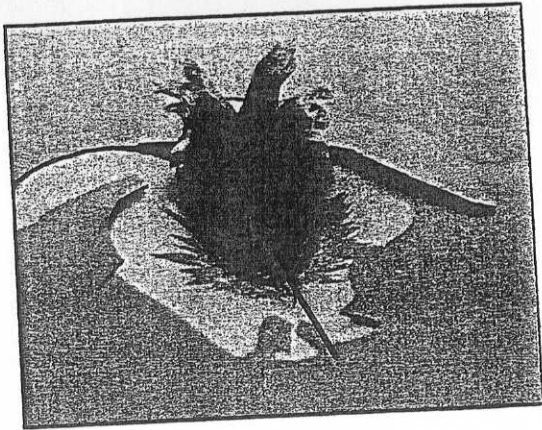


Fig 2.13

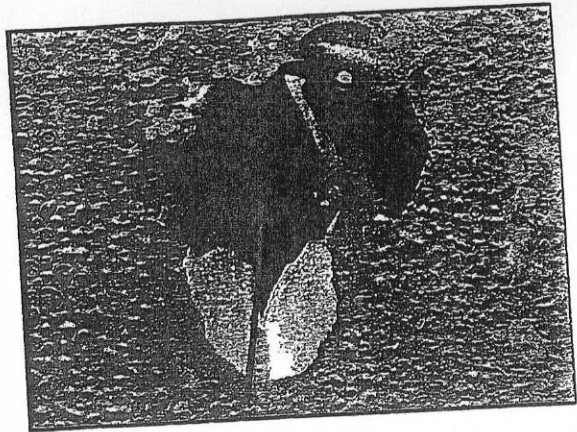


Fig 2.14

that XV179's wing had been shot whilst still intact (ie the wreckage was not shot on the ground) by using photographs from the remote crash site to reconstruct the wing physically, as a model, and digitally through a Computer Aided Design (CAD) programme, which proved the alignment of bullet holes. One of the CAD drawings from the AAIB's Final Report showing the bullet hole alignment can be see at Fig 2.15. Additionally, ballistic and fracture damage was marked onto an intact Hercules wing, which further substantiated this conclusion.

Annex E.

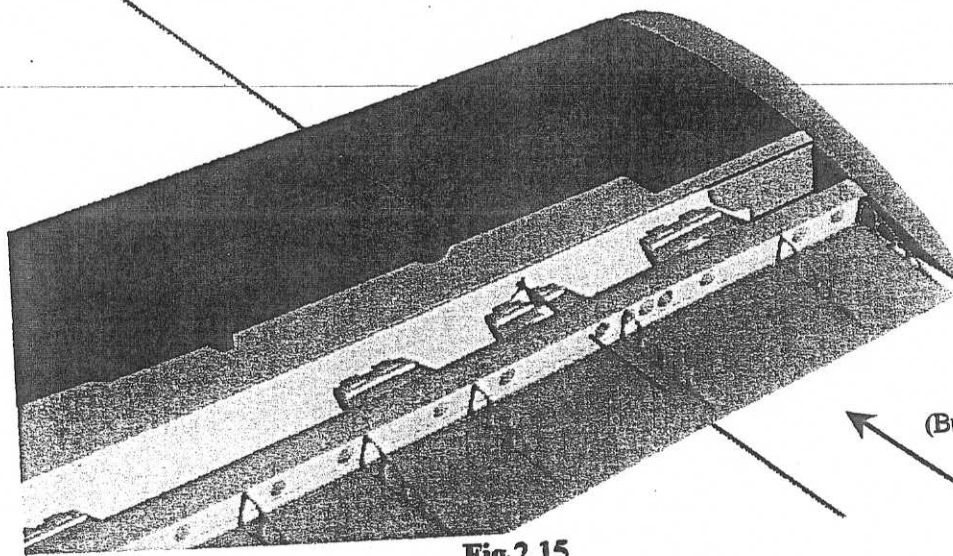


Fig 2.15

(Reproduced by permission of Mr Chris Protheroe, AAIB)

49. Analysis of [redacted] mm [redacted] Rounds Hitting the Number 4 Fuel Tank. As previously discussed, the impact of any round into aluminium ac structure could provide an ignition source, especially [redacted] or [redacted] rounds. Indeed, when the Board fired [redacted] mm [redacted] rounds from a [redacted] into a section of Hercules tailplane at a range of 600m, a fire was observed on the 'dry' aluminium structure. The sooting from this fire can be clearly seen in Fig 2.16. In the case of XV179, such an event may have caused an

Annex I and J.

instantaneous explosion of the fuel/air mix in the ullage, or a fuel fire (either internal or external) that led to an explosion once the conditions were correct. Furthermore, the effect of a [redacted] mm bullet impacting the fuel tank could have been increased by the affect of hydrodynamic ram. (In this instance, hydrodynamic ram refers to the overpressure produced by the motion of a bullet, and any accompanying fragments, inside a body of fuel within a fuel tank) This force could potentially result in a fuel tank rupturing from the penetration of one round. Such an affect can be seen in Fig 2.17, which shows the result of a water-filled oil drum having been hit by a single [redacted] mm [redacted] round.

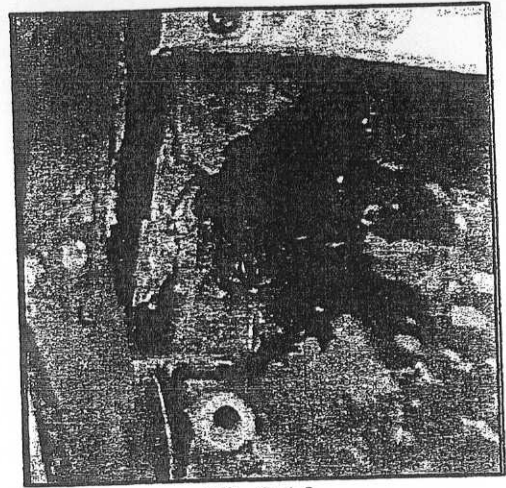
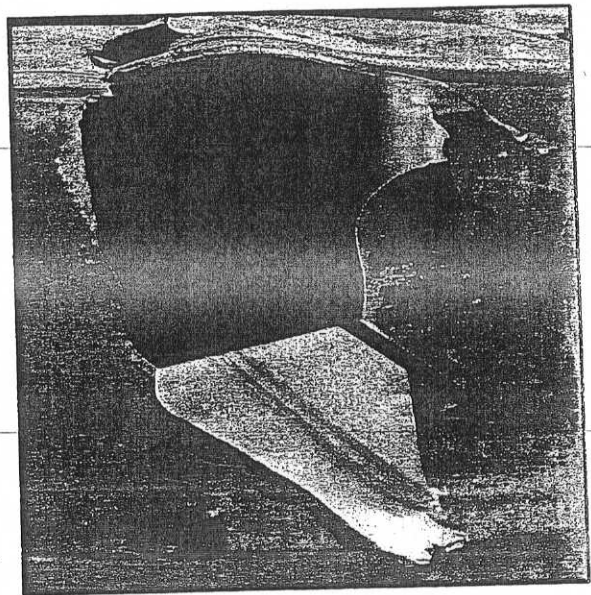
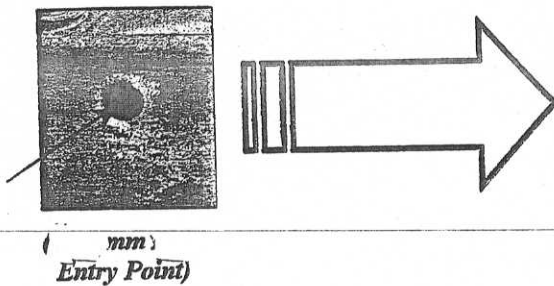


Fig 2.16



([redacted] mm) Exit Point)

Fig 2.17

A further effect of hydrodynamic ram would be to agitate the fuel, thus increasing the chance of creating an explosive mix. During the firing trial, the Board noted the similarity between the appearance and trajectory of [redacted] mm tracer rounds and the "orange fireballs" with "light grey smoke trails" described by some of the witnesses. Examples of [redacted] and [redacted] mm tracer rounds at a range of approximately 1000 m are shown on the left and right, respectively, of Figs 2.18 and 2.19. The Board has concluded that the

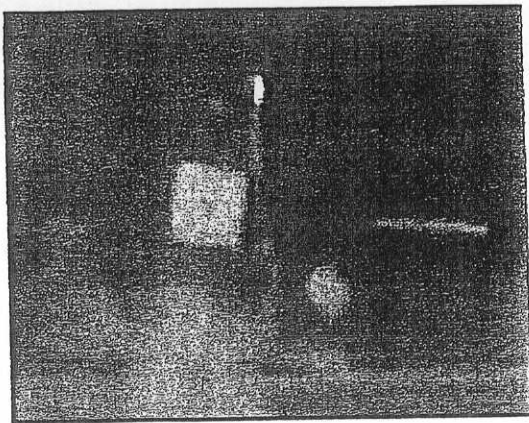


Fig 2.18

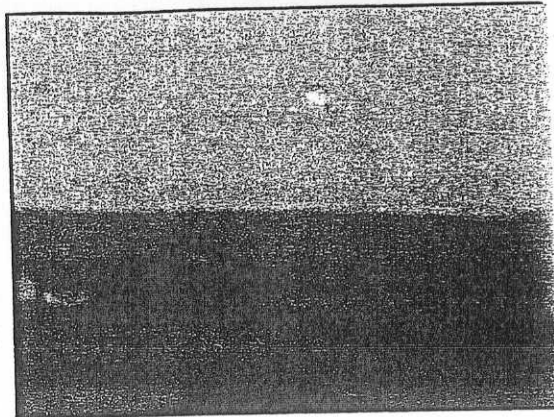


Fig 2.19

outboard section of the right-hand wing was definitely hit by two $\frac{f}{mm}$ rounds and the $\frac{f}{mm}$ associated with these rounds could be the observed 'fireballs'. The path of one of the rounds carried it through the right-hand aileron dry-bay into the number 4 fuel tank ullage, making it an ideal trajectory to cause the loss of fuel, an external fuel fire and/or an instantaneous fuel/air explosion. Whilst the AAIB assert that an RPG, or similar weapon, struck the wing, it has not been possible to corroborate this hypothesis, by any of the scientific methods used to verify such an event. Indeed, photographed structure in very close proximity to this suspect area is undamaged by explosion or fire. However, the penetration of $\frac{f}{mm}$ rounds and the possible catastrophic consequences of such an impact can be proved; furthermore, the AAIB confirms that multiple hits from such a weapon system could have caused the observed damage at the separation point. On balance, therefore, the Board concluded that $\frac{f}{mm}$ rounds are highly likely to have initiated the catastrophic wing over-pressure.

Annex E.

50. Reason for the Loss of Control. Having established the most probable cause of the catastrophic failure of the right-hand wing, the Board investigated why the ac crashed. The 1.3 mile separation between the 2 crash sites proves that the 23 ft of right-hand wing detached in flight. Aerodynamic modelling has proved that the loss of this amount of wing would render the ac uncontrollable in roll below 215 kts. Additionally, it is reasonable to suppose that the violence associated with the wing separation would have caused damage to the remaining section of wing, which was on fire, and would have had a destabilising effect on the ac. The Board endeavoured to recreate the scenario in the simulator and, on all occasions, the ac crashed approximately 1.5 miles after the incident, which is similar to the distance between the 2 crash sites. There have been other incidents of Hercules ac losing outboard sections of wing and, as in cases such as XV206 in the Falkland Islands, landing successfully. However, once again, the nature of separation is highly significant. In the instances that are similar to this case, the ac that had their outer-wing severed off without subsequent fire survived, but those that exploded and caught fire did not. The crew of XV179 were in an invidious position; their ac was highly

Annex E.

Annex G.

(It should be noted that there is no way to simulate the loss of a portion of wing in the simulator so the effect was reproduced using control inputs)

(When trialled in the simulator, the Board found that they had no time to intellectually deal with the situation even

unstable, if controllable at all, and on fire. If they were able to keep it flying, the fire could have spread and destroyed the rest of the wing; however, if they slowed down to attempt a landing, the ac would have become even less controllable. In either event, a crash was inevitable. Furthermore, the Board concluded that the ac only flew for 12-15 secs after the explosion, which strongly implies that the crew had little, if any, control of the ac and no time for anything other than an instinctive piloting reaction. Indeed, the aerodynamicist's assertion that the best landing scenario would have been wheels up, at an airspeed of 250 kts, is so far removed from any training or 'common sense' solution that the crew were highly unlikely to have considered it in the time available. The Board concluded that the explosive loss of the outboard section of right-hand wing made the ac uncontrollable and was, therefore, the cause of the crash. This conclusion is supported by the AAIB.

though they knew what was happening)

(At the ac's weight the normal land speed would have been 125 kts with gear and flaps fully down and the maximum speed for lowering the undercarriage is 165 kt).

Annex E.

51. Responsibility for Ground-to-Air Fire. Having concluded that XV179 crashed as the result of being hit by ground-to-air fire, the Board examined who was responsible for this action: hostile or friendly forces. The calibre of weapon identified is in the insurgent's arsenal, but friendly forces have similar calibre weapons. However, all other evidence conclusively points to an insurgent attack. Firstly, the C-130 is a well-known US ac that the eyewitnesses were able to clearly identify at considerable range. There are no enemy ac operating in Iraq, so coalition forces confidently consider all ac activity as 'friendly'. Due to the nature of the ground threat, all coalition troops working in the area were in formed units; therefore, if an individual had accidentally shot the ac the event would have been witnessed by his unit and impossible to cover up. None of these units were close to the engagement, although some actually reported that they were much closer to it than they really were. Furthermore, units that had no direct contact with each other reported the attack over the radio and internet as it happened and all accounts described the same event. The Al Jazeera video, which certainly records elements of the incident if not all of it, was clearly made by an enemy that have been responsible for many such attacks in the past. The Board unequivocally concluded that hostile forces were responsible for the ground-to-air fire directed at XV179. Identifying those specifically responsible for the attack has not been possible; however, there is an on-going operation aimed at catching the perpetrators.

SUMMARY OF ANALYSIS

CAUSE OF THE CRASH

52. The Board concluded that XV179 crashed because the ac became uncontrollable after hostile action caused the explosive separation of the outboard 23 ft of the right-hand wing. Furthermore, the Board conclude that the explosive separation could have been caused solely by mm rounds, or a combination of these and another unidentified projectile impacting the wing in the vicinity of the separation boundary.

CONTRIBUTORY FACTORS

53. The Board concluded that the following factors contributed to the loss of XV179:

- a. Flying at low level and in daylight made the ac vulnerable to _____
- b. The lack of any fire retarding technology, either foam or inert gas, in the fuel tanks allowed an explosive fuel/air mix to develop in the ullage.
- c. The ACHQ did not have sight of Op' _____ tasking and this reduced their ability to provide relevant intelligence support.
- d. The SAFIRE reporting, collating and dissemination chain was not efficient enough to provide aircrew with the time-sensitive intelligence they need.
- e. The lack of a procedure to pass up-to-the-minute and relevant threat information to the C-130 left the crew unaware of the recent SAFIRE site between BIAP and BSE.

AGGRAVATING FACTORS

54. The Board concluded that there were no aggravating factors.

OTHER FACTORS

55. The Board concluded that there were no other factors.

OBSERVATIONS

56. The Board made the following observations:

- a. The lack of a passenger manifest caused a delay in ascertaining who was onboard XV179.
- b. The lack of an ADR significantly reduced the evidence available and, consequently, the ability to learn fully from this incident. However, the Board observed that MA have an ADR that they use when operating the RAF's C-130Ks.

c. The co-pilot was apportioned OLF flying hrs in the authorisation sheets when he was not qualified or trained to operate at this height.

d. DSTL is researching ac vulnerability to the most prevalent forms of _____, and this work is producing valuable results. The study includes looking at the possibility of modifying the acf _____

SECTION 26

e. A number of factors combined to complicate, and possibly delay, the identification of the deceased once they were repatriated to the UK. The Board recommends that all the issues surrounding repatriation (including in-theatre pathology, repatriation location and communication between the different agencies involved) be reviewed¹. Furthermore, considerable distress was caused to the families that were asked to provide reference DNA samples for comparative purposes. This distress could have been prevented had the deceased voluntarily donated a DNA reference sample to the archive held by the RAF Department of Aviation Pathology.

f. The Board has consulted, through DSTL, a number of US organisations with expertise relevant to this inquiry; primarily the Survivability/Vulnerability Information Analysis Center (SURVIAC) and the Missile and Space Intelligence Center (MSIC). SURVIAC has a wealth of transport ac vulnerability data and, whilst it will not effect the conclusions of this inquiry, the Board believe that the RAF would benefit from a bi-lateral agreement that allowed routine access to this information and SURVIAC's expertise.

g. During the early part of this inquiry, the Board had to work closely with the Military Police (MP), whose report is at Annex Z. The MP had primacy over the investigation because it was a murder inquiry; however, the lack of a 'SOP' and differing chains of command led to periods of friction between the Board and the MP. These difficulties were overcome when Sgt _____ 70 Section SIB (a) RMP, took over the Police investigation - for which he deserves specific recognition.

SECTION 40

h. The Board would like to acknowledge the excellent level of support they received at all stages of their investigation. Wg Cdr _____, the _____ Det Cdr, quickly took charge of the incident prior to the Board's arrival and the Board do not believe he could have done a better job. The Stn Cdrs at BAS and Lyneham also worked exceptionally hard to facilitate the Board's needs. Furthermore, the AAIB's Senior Investigator (Mr Chris Protheroe) provided the Board with an outstanding level of support, much of which he gave in his own time. The Board were also given excellent scientific and practical assistance by DSTL and MA.

SECTION 40

¹ It is understood that a review of repatriation procedures has been instigated by VCDS.

RECOMMENDATIONS

57. The Board recommend that:

- a. In light of the damage that can be done by relatively small calibre munitions, HQ 2 Gp should review C-130 tactics.
- b. The fitting of a fuel tank fire suppression system for the C-130 should be considered.
- c. The ACHQ should have an overview of the Op[redacted] C-130's tasking.
- d. A more reliable and timely system should be developed to ensure aircrew are kept up-dated with relevant time-sensitive intelligence.
- e. Communications:
 - (1) With immediate effect, better use should be made of ac communications equipment to ensure the timely passage of air intelligence information.
 - (2) ATC radio communications in Iraq should be improved to ensure that there is coverage at low level, especially in hostile operational areas, so that the ATC network can be used to pass threat warnings more effectively, in accordance with SPINS.
- f. A method of allowing[redacted] crews to raise passenger manifests without compromising security should be developed.
- g. The C-130K should be fitted with a basic ADR.
- h. [redacted] co-pilots should be given formal OLF training in case they need to take control at OLF heights.
- i. The Board recommend that AWC and/or 2 Gp liaise closely with DSTL on their[redacted] project to ensure that results benefit those at risk.
- j. The Board recommend that STC make aircrew aware of the potentially distressing consequences of not providing CAM with a DNA sample.
- k. The Board recommend that HQ 2 Gp develop a Memorandum of Understanding with the US in order to allow the routine sharing of transport ac vulnerability data with SURVIAC.
- l. The Board recommend that a SOP be developed between Flight Safety and the MP in order to facilitate efficient working practices.

President:

Wg Cdr J P Q Reid

3 August 2005

Engineering Member:

'A'

} August 2005

Operations Member:

3 August 2005

B'

SECTION 40

REMARKS BY STATION COMMANDER**Cause of the Crash**

1. I believe that the Board of Inquiry Team has carried out a very thorough and detailed investigation into the tragic loss of Hercules XV 179 with all crew and passengers, particularly considering their very limited access to the crash site and the wreckage. I agree with the Board's finding that this well-trained, well constituted and highly professional crew, were subject to a ground-based insurgent ambush on the 30 Jan 05. The aircraft was hit in the starboard wing by one or more _____ millimetre _____ Rounds and possibly other unidentified systems. As a result, the aircraft became uncontrollable and crashed, instantly killing Flt Lt STEAD, his crew and the passengers.

Contributory Factors

2. I agree with the Board's analysis of contributory factors.
3. Flying at low level in daylight does increase the aircraft's vulnerability to _____. Just as importantly, those tasking _____ assets must always try to balance the operational need for a mission with the risk involved. The Board has correctly concluded that Flt Lt STEAD and his crew were operating in accordance with all relevant orders, instructions and perceived best practice. Operational Low Flying (OLF), as a tactic against Man Portable Air Defence Systems (MANPADS), had recently been considered and approved by the Air Warfare Centre and the _____ Air Commander (_____ AC). The _____ AC had also recently identified MANPADS as the most significant, if not prevalent, threat. When one also considers the relatively minor damage caused by previous incidents of AAA hits against Hercules aircraft, it is not difficult to understand the crews decision to choose OLF as a tactic on this short transit back to their home base. Sadly, on the day in question, the tactic was not successful.
4. The use and fitting of fire-retarding technology in the fuel tanks of Tactical Air Transport aircraft flying in hostile territory needs to be urgently considered by HQ 2 Group and the Hercules Integrated Project Team. Although our Hercules aircraft had suffered hits in the fuel tank area by small calibre rounds in recent months, it is clear that there is a vulnerability when a fuel/air mix forms in the ullage. Foam and inert gas systems can prevent this explosive mix from developing and may have reduced the damage to XV 179's wing.
5. I believe that the 3 factors relating to ACHQ sight of tasking, collation and dissemination of intelligence, and timely Surface to Air Fire (SAFIRE) reporting, have been addressed within theatre and by amendment to UK National procedures. The timely provision of information relating to the recent SAFIRE event between Baghdad International Airport (BIAP) and Ballad South East (BSE) may have altered the crew's choice of routing and the tactics that they utilised. That said, many insurgent groups employ the tactic

of 'shoot and scoot'; this could have led the crew to surmise that the location of the previous SAFIRE was actually a less dangerous place to fly over, their deduction being that the likelihood of insurgents remaining in the same area, from where they had just fired at an aircraft, was low. Furthermore, the diagram at Figure 2.3, which illustrates the SAFIRE activity between November 2004 and January 2005, clearly shows how difficult it would be for any crew to have picked a route between BIAP and BSE that avoided recent SAFIRE sites. That said, the evidence shows that Flt Lt STEAD and his crew had not been pattern setting in terms of their low-level routing during the previous days and they had chosen a random track for their mission on the 30 Jan 05.

Observations

6. I believe that the lack of a passenger manifest on this 'routine' flight was an administrative error on the part of the crew. However, and in mitigation, it is common practice during [redacted] operations to rely on the [redacted] TGHQ to take responsibility for the tracking and 'manifesting' of passengers. Indeed, JSP 550 outlines the procedures and responsibilities of the user unit during [redacted] operations. However, these rules apply only to aircraft operated by the Joint Helicopter Command and I would recommend that an amendment is made to include Strike Command aircraft when in support of [redacted] operations. That said, all crews have been reminded of the need to correctly manifest passengers on routine administrative flights.
7. I note that the Board of Inquiry for the 2 previous Hercules crashes (1993 and 1998) both commented that the lack of an ADR fitted to the Hercules aircraft had hindered their investigations. The C-130J has an ADR fitted. I recommend that HQ 2 Group investigates the procurement of suitable ADR equipment, perhaps portable and interchangeable in nature, which could be fitted to those C-130K aircraft employed in high-risk areas.
8. Whilst co-pilots are trained to fly the aircraft at 250 feet, they are not trained or qualified to operate the Hercules at OLF heights ([redacted] feet). I note that Flt Lt SMITH had been apportioned OLF flying hours in the authorisation sheets on previous flights and, whilst perhaps an administrative error by the Captain, it is possible that the Co-pilot may have incorrectly flown the aircraft at OLF heights prior to, or even during, this sortie. Without the benefit of an ADR we will probably never know. However, it is my opinion that the Captain would more than likely have been in control of the aircraft, particularly after they had been engaged by enemy ground forces. Indeed, I would expect both pilots to have been handling the flying controls, whilst trying to maintain directional control of the aircraft after the loss of the outboard portion of the starboard wing. All of my [redacted] crews have been reminded of the rules pertaining to crew roles and responsibilities during OLF.

Recommendations

9. I am content to endorse all of the Board's recommendations apart from the suggestion that all co-pilots should be given OLF training in case they need to take control at OLF heights. This would require over 300 flying hours per year to achieve and would provide very little benefit in my view. The primary task of the co-pilot within the OLF environment is to navigate the aircraft visually and to manage the communications systems. I am confident that all co-pilots could, in an emergency, fly the aircraft at OLF heights if necessary, particularly as they are already trained to fly at 250 feet. Furthermore, if the captain were to become incapacitated whilst flying at OLF heights, the co-pilot may have the option to climb the aircraft to a safe altitude. In any case, I consider that the disadvantages in terms of the cost of flying hours, aircraft fatigue, and pressure on the UK Tactical Training Areas outweigh the small benefits gained by training co-pilots to fly at OLF heights.

Conclusion

10. I believe that the Board's findings and recommendations to be accurate and constructive. In particular, the evidence provided by the Air Accident Investigation Branch's Senior Investigator has been pivotal and has provided a higher degree of confidence in the certainty of the cause than may otherwise have been available, given the limitations and constraints that the Board of Inquiry were working under.

11. Flt Lt STEAD and his crew were all well trained and they had a good spread of experience between them. They were properly equipped and well prepared for the mission that they were flying. Indeed, I would find it hard to constitute again such a thoroughly professional and experienced team as this one - they were the best. They were flying an operational mission in hostile territory doing the best that they could to reduce the risk to themselves and their passengers. Tragically for them, their friends, colleagues and family members, they were targeted by insurgents, and shot down.



P N OBORN
Gp Capt
Officer Commanding
Royal Air Force Lyneham

5 September 2005

22 SEP 2005

Keyword 260/41AOC
Disk No.
F102 Ser No. # 241
MI/MO/GO/PA/FAXREMARKS BY AIR OFFICER COMMANDING

1. I commend the President of the Board and his Board Members for their thorough investigation into the loss of Hercules XV179 in Iraq on 30 January 2005. I accept their findings on the cause, their analysis of contributory factors and their observations. I also accept the comments made by the Station Commander of Royal Air Force Lyneham. I agree with his endorsement of all except one of the recommendations of the Board; I agree with his rejection of the Board's recommendation at paragraph 57h on formal OLF training for [redacted] co-pilots. I have discussed the Report with the [redacted] Air Commander and with the Commander of Joint Operations, and I make the following additional remarks on the cause and on the complex interaction of the three principal contributory factors: the intelligence picture, the aircraft vulnerability and the tactics employed.

The Cause

2. There is no doubt that Hercules XV179 was shot down by hostile action. There is doubt about the exact sequence of events and whether the loss of the aircraft was solely due to medium-calibre anti-aircraft fire, most probably [redacted] mm [redacted] ammunition, or due to two separate types of weapon, namely [redacted] mm rounds and some unidentified projectile, possibly a rocket-propelled grenade. Given the impossibility of gaining the physical evidence, the Board have correctly left this debate open. However, the final report by Mr Chris Protheroe of the Air Accident Investigations Branch states that "The evidence points very strongly to the aircraft having been caught in some form of coordinated attack involving multiple weapons sites". Acknowledging the lack of hard evidence, but based on his *expert opinion*, he concludes that the two scenarios involving different weapon systems are much more viable as hypotheses than the scenarios involving a single agency. It is my view, therefore, that the loss was more probably caused by the coincident action of two weapon systems than by one.

The Intelligence Picture

3. The Board has drawn out the factors relating to the intelligence picture, and particularly the deficiencies that existed in procedures for passing time-critical intelligence to Operation [redacted] crews. These deficiencies were a major contributing factor, although it is clear from the prevalence of surface-to-air firings that avoiding all recent threat sites would not have been possible. Nor could intelligence have predicted where future threat sites could arise. Nevertheless, the intelligence flow was not well organised and in-theatre procedures have been amended since the loss of XV179, fulfilling the specific recommendations of the Board at paragraph 57c and d.

4. There is also a broader point. The need for operational security for some operations is well understood but, in air operations particularly (given their reach and the consequent number of potential interactions with other friendly and hostile force elements), there is a need to ensure that compartmentalisation of information does not lead to elements of the force operating in ignorance of vital information. I therefore recommend that the Commander-in-Chief of Strike Command, in conjunction with the [redacted] operational command chain, initiates a wider review of the

potential penalties of operational security in _____ air operations. The review findings should enable operational commanders to make better judgements on the risk-benefit balance of their operational security measures in relation to air operations.

The Aircraft Vulnerability

5. The vulnerability of the Hercules at low level (below 2000ft) to anti-aircraft artillery fire was judged by all involved to be lower than the vulnerability to man-portable surface-to-air missiles at medium altitudes (between 2000ft and _____). This perception was reasonable, especially given the history of damage sustained by aircraft in theatre before 30 January 2005. In the case of UK Hercules aircraft, two incidents in the previous year of small calibre ammunition hitting the wing had not caused substantial damage. And, as stated above, the more probable cause of the loss was not simply anti-aircraft artillery, but the coincident use of two weapons systems.

6. However, now that the vulnerability of the Hercules to _____ has been so tragically brought home, it is clearly necessary to consider what more might be done to make the aircraft less vulnerable. Following early direction by the Commander-in-Chief of Strike Command, the Board's recommendation to consider the fitting of a fuel tank fire-suppression system has begun with the Hercules Integrated Project Team. Future aircraft procurement should also take account of this urgent requirement. This applies particularly to the A400M.

Tactics

7. The intelligence picture and the aircraft vulnerability are the principal factors leading to an assessment of risk and subsequent decisions on tactics. As a result of the loss of XV179, the views on both factors have been changed. First, the mixed weapons probably used and the relatively sophisticated tactics employed in this attack suggest that the balance of risk in day low-level tactics in Iraq is less favourable than previously supposed. Secondly, the vulnerability of the Hercules (and other aircraft) to unguided ground-to-air fire is greater than was previously understood. Nevertheless, these two factors are still not well quantified and the risk from man-portable surface-to-air missiles remains high (although defensive aids suites and tactics against these missiles are well-developed). And it must be recognised that no tactic guarantees safety; operational flying will always carry risks. However, there is an urgent need to refine the quantification of the risks, in order to make the best information and guidance available to crews. The Air Warfare Centre is already engaged in this work.

8. One other aspect may be relevant in crews' selection of tactics. The tactics of the Royal Air Force for many years of the Cold War were conditioned by the very significant threat posed by Warsaw Pact surface-to-air guided missile systems. Low level flying, despite its hazards from terrain and from unguided weapons, was the only counter available to the UK, and our personnel became very good at it. Since the Gulf conflict of 1991, it has been appreciated that against many adversaries the balance of risk/benefit has mainly changed in favour of medium-level and high-level operations. Yet some bias towards low-level tactics may still persist (although it should be noted that in this case the option did not exist for a C130K to climb above

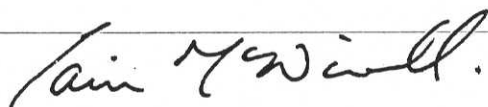
the missile threat on the short leg from Baghdad to Balad). I recommend to Commander-in-Chief Strike Command that he directs a review of low-level operations to determine whether RAF training and culture is skewing the selection of operational tactics.

Conclusion

9. On 30 January 2005, XV179 was shot down by hostile action, with the loss of all ten of our colleagues who were aboard. The crew were very well constituted to meet the increased risks of the demanding operational flying that they were undertaking. Although these risks can never be completely removed, there are lessons that we can take from this loss to reduce the risks in future. The most pressing lessons relate to: improving intelligence flow and reducing compartmentalisation of information; decreasing the vulnerability of our large aircraft; and reviewing tactics to ensure the best possible guidance is provided to our crews. Action that produces results quickly in these areas will be a lasting and fitting memorial to those who were killed in action.

10. Finally, there is much information in this Board of Inquiry that could be useful to enemies of the UK and its allies. Such information must be removed from this Report before it is released publicly. Yet much of the Report can be released and it is important to be as open as possible. This may require new judgements to be made on releasing information in connection with,

SECTION 26



I W McNICOLL
Air Vice-Marshal
Air Officer Commanding No 2 Group

20 September 2005

HERCULES - XV179

PART 5

REMARKS BY COMMANDER-IN-CHIEF STRIKE COMMAND

1. I commend the Board for a thorough investigation into the loss of XV179, especially given the hostile location of the crash site and the limited time available at the site to obtain meaningful data from the aircraft wreckage. These limitations presented the Board with an extremely difficult task. Nevertheless, I am satisfied that the Board has done all that it can to identify those factors that directly attributed to the loss of XV179. I am also grateful to the AAIB for the detailed investigation carried out and the assistance given to the Board allowing a greater degree of certainty than would otherwise have been possible. I firmly believe the Board is correct in its analysis that XV179 was shot down by hostile fire. I also concur with the AOC's comments and recommendations. He has rightly highlighted the complex interaction of the three main contributory factors involved: the intelligence picture; the aircraft vulnerability; and the tactics employed.

2. The intelligence information available to the crew of XV179 was not ideal. We will never know if the availability of time sensitive Surface to Air Fire (SAFIRE) data would have changed the crew's chosen route or flight profile. However, I am clear that a real-time intelligence picture would have given the crew more relevant information on which to base their risk assessment. That said, there is always a significant element of risk with all operational flying and no amount of routing or flight profile planning can be guaranteed to produce a risk free mission, particularly in a theatre such as Iraq. Nonetheless, I note that in-theatre procedures have been amended and the recommendations of the Board in this area have already been actioned. On the broader issue of information compartmentalisation, raised by AOC 2 Gp, there is of course a need for operational security. However, this must be balanced against the potential increased risk to other forces as a result of their operating with an incomplete tactical picture. I therefore intend to address with my CinC colleagues, through the forum of the Joint Command Group, the issue of compartmentalisation of information.

3. The issue of the Hercules' vulnerability to _____ was, at the time SECTION 26 of the accident, not fully appreciated. A perception had developed over many years, based on previous attacks on Hercules aircraft, that such weapon systems did not represent a major threat to aircraft integrity. Clearly that perception was incorrect and therefore methods to further reduce that risk should be investigated. One method could be the fitting of a fuel tank fire-suppression system and I have already directed the Hercules Integrated Project Team (IPT) to investigate this as a matter of urgency. However, there is no guarantee that, had XV179 been fitted with such a system, the outcome would have been different. Nonetheless, I anticipate that the IPT investigation will identify whether such a system is viable for the Hercules (and similar aircraft).

4. Given that the Hercules is more vulnerable than was first thought to _____ the tactics SECTION 26 used to defeat this threat also need to be reviewed. As the AOC has stated, there is a balance between flying low to defeat the Man Portable Aid Defence (MANPAD) threat (but at greater risk to AAA) or climbing to avoid the AAA threat (but at an increased risk to MANPADs). Also, the significant effect of defensive aids to reduce the MANPAD threat

must be given due consideration when developing robust and relevant tactics. The development of tactics for a dynamic threat environment is an ongoing process and remains a key task for the Air Warfare Centre (AWC). Notwithstanding the results of the AWC's work, it is possible that our selection of tactics has become inappropriately skewed towards using the low level environment. This aspect is not only applicable to the Hercules force but is equally relevant to other fleets. I have therefore directed that AOCs 1, 2 and 3 Gps review the applicability of their low flying tactics against the background of the prevailing threat environment. This could be equally applicable to the rotary fleets and, therefore, I invite Comd JHC to review the applicability of their extant low flying tactics.

5. Turning to the recommendations of the Board, I endorse them all except the suggestion that co-pilots should be given OLF training. Instead, I concur with the Stn Cdr that this SECTION 26 is not necessary as co-pilots are already capable of flying the Hercules at 250ft and that, should a situation arise where they were required to take control at ft, they would be SECTION 26 able to do so safely.

6. In summary, the loss of XV179 with all on board was caused by hostile enemy action in a dynamic threat environment. I am satisfied that the crew did all they reasonably could to reduce the risks posed by that environment and conducted the mission in a fully professional manner. However, as with all operational flying, there is an element of risk and, while we must take every possible opportunity to mitigate that risk (both in terms of equipment and tactics), it will not possible to remove it completely. Thus we can never guarantee that we would not lose an aircraft and crew in this way in the future – but I will ensure that everything possible is done to make it less likely. Indeed, we have learned some tragic but valuable lessons from the loss of XV179, and we owe it to that gallant crew to ensure that every possible action is taken to reduce in-theatre risk to those who continue to shoulder the RAF's operational burden.



Sir Brian Burridge
Air Chief Marshal
Commander-in-Chief Strike Command

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