The Mull of Kintyre Review

Rt Hon Lord Philip
Rt Hon the Lord Forsyth of Drumlean
Rt Hon the Baroness Liddell of Coatdyke
Rt Hon Malcolm Bruce MP

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The Mull of Kintyre Review

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Rt Hon the Lord Forsyth of Drumlean
Rt Hon the Baroness Liddell of Coatdyke
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An Independent Review *to examine all available evidence relating to the findings of the Board of Inquiry into the fatal accident at the Mull of Kintyre on 2 June 1994*

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To the Passengers and Crew of RAF Chinook ZD576

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1.1 Introduction

1.1.1 On 16 September 2010 the Secretary of State for Defence, Dr Liam Fox, announced that he had appointed us to conduct an independent Review of the evidence relating to the tragic accident on 2 June 1994 when RAF Chinook Helicopter ZD576 crashed on the Mull of Kintyre killing all 29 people on board. He added that the Review would primarily be an examination of the written record of the Board of the Inquiry and any other related evidence which we considered might throw light on the findings of the Board. Our terms of reference were:

To examine all available evidence relating to the findings of the board of inquiry into the fatal accident at the Mull of Kintyre on 2 June 1994; and to report conclusions to the Secretary of State for Defence as soon as possible.

1.1.2 At the time of the accident the aircraft was engaged in a routine, although important, task transporting 25 members of the Northern Ireland security and intelligence community from RAF Aldergrove in Northern Ireland to Fort George near Inverness. The crash was one of the worst losses of life sustained by the RAF in a peacetime accident. The loss of each life was a personal tragedy for their families and friends but this accident was also a blow to the services and agencies of which the passengers were important members.

1.1.3 The RAF quickly established a Board of Inquiry to investigate the circumstances of the accident, to determine its cause or causes and to examine related factors. The investigating Board completed their report on 3 February 1995. They found that there were several potential causes of the accident but, despite detailed and in-depth analysis, were unable to determine a definite cause. They concluded that the most probable cause was a selection by the crew of an inappropriate rate of climb which was insufficient for them safely to overfly the high ground of the Mull of Kintyre.

1.1.4 In accordance with RAF procedure the Board's findings were reviewed by the RAF chain of command, first by the Station Commanders of RAF Aldergrove and RAF Odiham (the aircraft and crew's parent operating base), and then by the Air Officer Commanding No1 Group and finally by the Air Officer Commander-in-Chief of Strike Command. The Air Officer Commanding No1 Group, Air Vice Marshal (now Air Chief Marshal retired) Sir John Day, concluded that both pilots were "negligent to a gross degree". That finding was supported by the Air Officer Commander-in-Chief, Air Chief Marshal Sir William Wratten.

1.1.5 The finding of gross negligence has been criticised in a number of forums inside and outside Parliament and there have been calls for it to be set aside. The relevant RAF Regulations provided that, *"Only in cases in which there is absolutely no doubt whatsoever should deceased aircrew be found negligent"*. Critics of the determination have argued that the standard of proof was

not satisfied. Since 1997 Boards of Inquiry have not been permitted to attribute blame or negligence in cases involving unnatural death or serious injury.

1.1.6 The continuing debate is naturally distressing for the families involved. The relatives of the pilots feel that the finding of negligence is a stain on the characters of their loved ones, and the families of the passengers wish that the controversy surrounding the accident be brought to an end.

1.1.7 In the intervening years the accident has been examined by a number of inquiries. In January 1996 a Fatal Accident Inquiry (the Scottish equivalent on an inquest in England and Wales) was held before the Sheriff of North Strathclyde Sir Stephen Young. In May 1998 the House of Commons Defence Committee published its report on the "Lessons of the Chinook crash on the Mull of Kintyre". In November 2000 the House of Commons Public Accounts Committee's report on the "Acceptance into Service of the Chinook Mark 2 Helicopter" found the aircraft's acceptance into service to have been flawed. It also found the process for convening and conducting RAF Boards of Inquiry to be unsatisfactory and concluded that the finding of gross negligence did not satisfy the standard of proof. Finally, the House of Lords Select Committee on Chinook ZD576 considered the findings of previous inquiries and examined a number of witnesses including Air Chief Marshals Wratten and Day, Air Marshal Pulford and Mr AN Cable of the Air Accident Investigation Branch. They then considered the justification for the Air Marshal's findings of negligence against the applicable standard of proof and unanimously concluded that the Reviewing Officers were not justified in their finding that negligence on the part of the pilots caused the aircraft to crash.

1.1.8 Following our appointment we sought to write to the relatives of all those who died in the accident and to the RAF personnel involved in the Board of Inquiry process inviting them to express a view or to raise any concerns they might have. We are most grateful for the responses we received. We also received submissions from a number of individuals who have taken an interest in the accident. For these we are also grateful.

1.1.9 The Review was a non-statutory independent inquiry and was not held under the Inquiries Act 2005. As such, we did not have the power to compel witnesses to attend and provide evidence. We did, however, invite a number of individuals to meet with us or to provide written submissions. We held informal discussions with those who accepted our invitation and we are most grateful to them for the help they gave us.

1.1.10 In accordance with our Terms of Reference we have examined the report of the Board of Inquiry and the remarks of the Reviewing Officers. We have also considered the evidence given before and the conclusions arrived at by previous inquiries. In addition we have had regard to the information given to us by the families of the deceased pilots, the officers who took part in the Board of Inquiry process, Mr Cable who reported to the Board, and a number of pilots and aircrew who were flying Chinooks at the time of the accident. Finally, we considered whether the findings of the Board and the Reviewing Officers were justified having regard to the standard of proof.

1.2 Report Structure

1.2.1 In presenting our Review we have provided at Chapter 2 a background to the accident based on the evidence before us and a brief review of the Chinook HC-2's introduction into service. To assist the reader in getting to grips with the terminology we have had to use in this report we have provided a short tutorial on aeronautical terms at Annex A and a technical description of the Chinook helicopter at Annex B.

1.2.2 To put this Review in context we have summarised at Chapter 3 the Board of Inquiry and subsequent inquiries.

1.2.3 Our review of the RAF Board of Inquiry procedure is presented at Chapter 4 and the Board's consideration at Chapter 5. The panel's discussions with the Reviewing Officers are set out at Chapter 6 and those with the pilots and aircrew at Chapter 7. We provide an Executive Summary at Section 1.4

1.2.4 The Ministry of Defence's handling of this case and the action taken since the accident is reviewed at Chapter 8.

1.2.5 We have provided a summary of the Board of Inquiry report at Annex D and at Annex C the Internet links to the previous inquiries' reports.

1.3 Membership

1.3.1 The Review was chaired by the Rt Hon Lord Philip assisted by a panel of three Privy Counsellors:

- The Rt Hon the Lord Forsyth of Drumlean;
- The Rt Hon the Baroness Liddell of Coatdyke; and
- The Rt Hon Malcolm Bruce MP.

1.3.2 The Secretary to the Review was Mr Alex Passa.

1.4 Executive Summary and Conclusions

1.4.1 We were appointed by the Secretary of State for Defence, Dr Liam Fox, to examine all available evidence relating to the findings of the RAF Board of Inquiry into the fatal accident on 2 June 1994 in which RAF Chinook helicopter ZD576 crashed on the Mull of Kintyre, killing all those on board. The accident resulted in one of the worst losses of life sustained by the RAF in a peacetime accident and dealt a severe blow to the services and agencies of which the passengers were important members.

1.4.2 The investigating Board found that there were several potential causes of the accident but, despite detailed analysis, were unable to determine a definite cause. They however, concluded that the most probable cause was the selection by the pilots of an inappropriate rate of climb which was insufficient to enable them safely to overfly the high ground of the Mull of Kintyre.

1.4.3 Detailed provisions for the conduct of aircraft accident inquiries were contained in the RAF Manual of Flight Safety. The Board were required by the Regulations in force at the time to obtain evidence to show whether or not the aircrew who died in the accident were negligent. The Board concluded that pilot error was the probable cause of the accident, but made no findings of negligence in relation to any of the aircrew of ZD576.

1.4.4 The Board of Inquiry procedure was not complete until the Board's report had been reviewed by the RAF Chain of Command. The report was accordingly reviewed by the Air Officer Commanding No1 Group, Air Vice Marshal Sir John Day, who found that the evidence could only lead him to the conclusion that both pilots had been "negligent to a gross degree". The Air Officer Commander-in-Chief Strike Command, Air Chief Marshal Sir William Wratten agreed with this finding.

1.4.5 The finding has been and remains controversial and the controversy has led to the examination of the Board of Inquiry by a number of subsequent inquiries. The continuing debate is understandably distressing to the families of those who died and we hope that this review can bring the controversy to an end.

1.4.6 Our review took the form of a non-statutory independent inquiry and was not held under the Inquiries Act 2005. We did not therefore have the power to compel witnesses to attend and to give evidence. We did, however, write to the families of those who died in the accident and to a number of other individuals inviting them to meet with us or to provide written submissions. We are most grateful to those who accepted our invitation and to those who provided us with submissions.

1.4.7 We held meetings with representatives of the families of the deceased pilots, the Board's president Air Marshal Pulford and Mr AN Cable the Air Accident Investigation Branch Inspector who carried out the detailed examination of the wreckage and provided the Board with a statement of his findings. We also met with the Reviewing Officers Sir John Day and Sir William Wratten and a number of pilots and aircrew who were colleagues of the deceased

pilots at the time of the accident. In addition, at his own request, we met Sir Malcolm Rifkind who was Secretary of State for Defence at the time of the accident and the subsequent publication of the Board of Inquiry report.

1.4.8 The Regulations made detailed provision for the protection of the rights of officers or airmen whose character or professional reputation might be affected by an inquiry. These were designed to ensure that the officer or airman had adequate notice of any matter which might affect his character or reputation and that he fully understood his rights. He was entitled to be made aware of the evidence against him, to be present and represented at sittings of the Board, to examine and cross-examine witnesses, and to give evidence in his own defence. An officer or airman who was considered by a Board to have been negligent had to be shown the evidence on which that opinion was based and be given the right to ask for further evidence to be taken and any new points to be fully investigated. If negligence was finally attributed to him he was entitled to make a further statement giving reasons why he should not be held to blame. A similar right applied when the Higher Authority attributed negligence to him when a Board had not done so, or altered the reason for the finding of negligence. Disciplinary proceedings would be likely to follow a finding of negligence, and the outcome would be based on a complete re-hearing of the evidence. In such proceedings the officer or airman would be entitled to a fair trial with all the rights that would entail. In contrast, in the case of deceased aircrew there was no opportunity before the Board for representation or for defence of the deceased's reputation and the Board's decision on negligence constituted the final judgment on the deceased's character or reputation, against which there was no appeal.

1.4.9 The unfairness to deceased aircrew inherent in this procedure was recognised by an RAF working party set up in 1983 to examine the Board of Inquiry regulations. Their recommendation that accident investigation should be separated from the chain of command was rejected, but the Air Force Board accepted the introduction of a provision which created a very high standard of proof in relation to findings of negligence against deceased aircrew, "*Only in cases where there is absolutely no doubt whatsoever should deceased aircrew be found negligent*".

1.4.10 Despite the introduction of this high standard of proof we consider that the Board of Inquiry procedure into the ZD576 crash was conducted under a system which was, by generally accepted standards of justice and fairness, unfair to deceased aircrew, and which had previously been characterised as flawed by two authoritative reports commissioned by the Ministry of Defence and RAF.

1.4.11 No steps, apart from the introduction of the standard of proof, were taken to address any of the defects in the Board of Inquiry system so far as they related to deceased aircrew, until 1997. In that year, partly due to the controversy surrounding the ZD576 accident, Defence Ministers directed that Boards of Inquiry should not be permitted to attribute blame or negligence in cases of unnatural death or serious injury. Subsequently, in 2008, Boards of Inquiry were replaced by Service Inquiries under the Armed Forces Act 2006 separating accident investigation from the operational chain of command, and as recently as 2011 when an autonomous professional Military Air Accident Investigation Branch was created.

1.4.12 The standard of proof of "absolutely no doubt whatsoever" was as unfamiliar to lawyers as it was to military officers, and it is not surprising that its interpretation has given rise to differences of opinion. It was however, vital that its effect should have been properly understood and applied.

1.4.13 In our view, the provision was intended to create the highest possible standard of proof in order to offset, so far as possible, the unfairness of the Board procedure to which we have already referred. Negligence had to be proved by evidence. It could not be presumed and there could be no onus on deceased aircrew to disprove it. Missing evidence could not be assumed to support a finding of negligence. The standard of proof was higher than the standard of beyond reasonable doubt which applied in criminal cases. The words "absolutely" and "whatsoever" emphasised that the doubt was unqualified and unrestricted and could be of any kind. It was not limited to reasonable doubt. A speculative doubt could be sufficient to prevent a finding of negligence. The test was an objective one, so the subjective certainty of the decision maker was not enough to entitle him to make a finding of negligence. A hypothesis for which there was no evidence, if it created doubt as to what had happened, would also be sufficient to exclude a finding of negligence. In our unanimous opinion this case was precisely the kind of case for which the standard of proof was designed to preclude findings of negligence against deceased aircrew.

1.4.14 When the Board report came before him for review Air Chief Marshal Day sought legal advice from the RAF Directorate of Legal Services. We were told that this was the first time that someone in his position had done so. We have considered the legal advice he received and found it to be unclear and inaccurate. It failed to recognise the objective nature of the test, and placed no restriction on the power of the Reviewing Officers to make a finding different from that made by the Investigating Board. It introduced a reference to RAF policy which could be interpreted as an assertion that the standard of proof meant what the RAF wanted it to mean. The consequence was that the Reviewing Officers were given inadequate legal assistance in their interpretation of the standard of proof.

1.4.15 We are left with the impression that prior to 1994 there was no appreciation in the RAF or the Ministry of Defence of the need to examine carefully the effect of the introduction of the high standard of proof in relation to findings of negligence in cases involving deceased aircrew. It seems to us that the Ministry and the RAF simply failed to apply their minds to the restrictions which the standard of proof placed on the power of Boards and Reviewing Officers to make findings of negligence in such cases. This impression is reinforced by the fact that the Department sought counsel's advice on the interpretation of the standard of proof only when the House of Lords Select Committee had been established, several years after the requirement to consider negligence on the part of deceased aircrew had been removed.

1.4.16 For the investigating Board, the absence of a cockpit voice or flight data recorder, coupled with the multiple impact of the crash and the ground fire which damaged a major proportion of the wreckage, greatly reduced the quantity and quality of the available evidence. In his statement to the Board Mr Cable said that the pre-impact serviceability of ZD576 could not be positively

verified, but that there was no evidence of malfunction that could have contributed to the accident. He told us that his investigation would probably have uncovered evidence of a pre-impact malfunction, had there been one, but that this could not be certain. That did not mean that the absence of such evidence conclusively proved that there had been no malfunction.

1.4.17 In that situation the Board found that there was insufficient factual evidence to enable them to determine how and why the accident happened. Although they were reasonably certain that ZD576 was flying fast at low level in proximity to the southern end of the Mull of Kintyre, in the absence of a cockpit voice recorder, a flight data recorder and the evidence of the crew or any other witness, they could not know how or why the crew got into that situation or what they were intending to do. All they were able to do was to postulate three possible scenarios as to the cause of the accident and to choose the one they considered the most probable.

1.4.18 Applying the high standard of proof, the Board unanimously concluded that they were unable to make any finding of negligence or make any assessment of human failings because of the lack of evidence. After they had briefed Air Vice Marshal Day and his staff they reconsidered the question of human failings and concluded that, although it was likely that Flt Lt Tapper had made an error of judgment in the conduct of the attempted climb over the Mull of Kintyre, it would be incorrect to criticise him for human failings based on the available evidence.

1.4.19 Criticism that insufficient attention was paid by the Board to the maintenance, engineering and airworthiness aspects of the Chinook, was not in our view, justified. They investigated the problems with the engines' Full Authority Digital Electronic Control system and other technical malfunctions in the Chinook fleet, and the history of ZD576. They took these matters seriously, but did not expand on them in their report because there was no positive evidence that a malfunction had occurred before or during the accident. Their job was to determine the cause of this accident and make recommendations, not to investigate all aspects of Chinook operations. Moreover, these problems were well known and were being addressed by the Ministry of Defence.

1.4.20 Having considered the Board report along with Mr Cable's statement, and had the benefit of discussions with Air Marshal Pulford and Mr Cable, we are of the clear opinion that the Board was correct, in the light of the available evidence or the lack of it, to refrain from making a positive finding as to the cause of the accident.

1.4.21 As part of our review, we discussed with the Reviewing Officers the reasoning by which they came to their decision and raised with them a number of factors which could be said to create doubt as to the way in which the accident came about. We list a number of these factors.

1.4.22 While there was ample evidence that low cloud was present over the Mull of Kintyre at the time of the accident there could be no certainty as to its configuration or as to the visibility available to the pilots as they approached the coast.

1.4.23 Mr Cable told the Board that the serviceability of the aircraft could not be verified and he was concerned that that statement had been ignored or misrepresented. Our discussions with Sir John Day indicated to us that he had in fact disregarded Mr Cable's statement and had instead applied his own judgment to the assessment of the serviceability of the aircraft.

1.4.24 Both Reviewing Officers told us that they did not consider why the pilots had apparently acted in a way which was contrary to their instinct and training. They argued that this would have involved inappropriate speculation. We consider that it was wrong to exclude that consideration since it was capable of giving rise to doubt.

1.4.25 Sir John Day rejected a number of scenarios postulated by the Board which involved a chain of events different from that preferred by him. The existence of those scenarios in the minds of the Board indicated that there was doubt as to how the accident came about.

1.4.26 Because of the absence of a cockpit voice recorder and flight data recorder we cannot know what was going on in the cockpit in the moments before the crash. The Reviewing Officers' approach to this gap in the evidence was to apply to both pilots what in our view amounted to a presumption of negligence based upon their shared responsibility for the safety of the aircraft. That approach was inconsistent with the standard of proof.

1.4.27 For all these reasons we consider that the Reviewing Officers failed to apply correctly the standard of proof of "absolutely no doubt whatsoever" in deciding the question of negligence.

1.4.28 In fairness to them we do not consider that the application of the unfamiliar standard of proof was an easy task for professional aviators with no legal training. Legal advice was sought but the advice provided did not assist the Reviewing Officers. Instead it provided them with comfort when it should have emphasised the restriction on their power.

1.4.29 When the Board of Inquiry Report was presented to the Ministry of Defence the Department's principal concerns were the public presentation of the Board's findings, and the question of compensation for the relatives of the deceased. When the matter was first put before the Secretary of State he was not told that there had been a difference of view between the Board and the Reviewing Officers nor was he informed of the standard of proof which applied. The consequence was that Ministers were deprived of the ability to reach a properly informed view on a matter which has given rise to so much disquiet inside and outside the Service.

1.4.30 Since 1995 the Ministry of Defence has continued resolutely to defend the finding of gross negligence and to rebuff all public and private representations that the finding should be reconsidered even when the representations included cogent arguments based on a sound understanding of the effect of the relevant Regulations. We find it extremely regrettable that the Department should have taken such an intransigent stance on the basis of an inadequate understanding of the RAF's own Regulations in a matter which involved the reputation of men who died on active service.

1.4.31 After receiving the Board of Inquiry report the Ministry of Defence reviewed its policy and procedures for carrying key personnel. They concluded that the decision to carry the passengers on ZD576 was not necessarily unsound and that in future a similar decision was likely to be made. We remain concerned that that conclusion leaves open the possibility of a similar accident involving groups of personnel vital to national security happening in the future.

1.4.32 Having completed our review we are led to make the following recommendations:

(i) We recommend that the finding that Flt Lt Tapper and Flt Lt Cook were negligent to a gross degree should be set aside.

(ii) We recommend that the Ministry of Defence should consider offering an apology to the families of Flt Lt Tapper and Flt Lt Cook.

(iii) We recommend that the Ministry of Defence should reconsider its policy and procedures for the transport of personnel whose responsibilities are vital to national security.

2 Background

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2.1 Circumstances of the Crash

2.1.1 At 16:59GMT (17:59BST) on Thursday 2 June 1994 an RAF Chinook HC-2 helicopter aircraft number ZD576 on a transport task from RAF Aldergrove in Northern Ireland to Fort George near Inverness in the highlands of Scotland crashed into a hill on the west side of the Mull of Kintyre, a short distance inland of, and uphill from, the Mull of Kintyre lighthouse. The pilots, Flight Lieutenants Jonathan Tapper (the captain) and Richard Cook (the co-pilot), the two crewmen, Master Loadmaster Graham Forbes and Sergeant Kevin Hardie, and twenty five passengers were killed. The passengers were senior Royal Ulster Constabulary and Army officers and six civil servants from the Northern Ireland Office. All were members of the Northern Ireland security and intelligence community. The crash was one of the worst losses of life in a peacetime accident for the Royal Air Force.

2.1.2 The Chinook HC-2 helicopter ZD576 was delivered to the 7 Squadron detachment attached to the RAF Aldergrove based 230 Squadron on 31 May 1994 – two days before the accident. The detachment had until then operated two Chinook HC-1s. ZD576 replaced one of them which was being withdrawn as part of the continuing Chinook mid-life update programme. ZD576 had recently been updated to the new HC-2 standard and had flown only 57 hours since its return to service. All HC-2s were at that time subject to limitations on payload and icing clearance.

2.1.3 Use of RAF helicopters to transport senior personnel was normal practice in Northern Ireland as it provided the quickest, most effective and secure way of moving personnel around in the hostile circumstances prevailing in the province at the time.

2.1.4 On 1 June the Chinook detachment received a tasking from the Headquarters Northern Ireland Joint Air Tasking Operations Cell for the following day to transport a group of 26 VIP passengers from RAF Aldergrove to Fort George near Inverness. In the event only 25 passengers took the flight. This was an annual tasking to transport Northern Ireland based senior intelligence and security officers to a security conference outside the Province. Flt Lt Tapper, as captain, planned the sortie as a Visual Flight Rules flight at low level on the way out and at medium level on the return to RAF Aldergrove. The route was planned to follow a track via a number of waypoints. The first waypoint (waypoint A) was intended to be the Mull of Kintyre lighthouse. The waypoint actually programmed into the navigation system was however a point approximately 280 metres south east of the lighthouse. This first leg to the lighthouse from RAF Aldergrove was on a track of 027 degrees Magnetic covering a distance of 42 nautical miles with a safety altitude of 2,400 feet (1,000 feet above the highest land feature, Beinn na Lice, in the area of waypoint A). Flt Lt Tapper estimated this leg would take 21 minutes.

2.1.5 The decision to fly a low level Visual Flight Rules sortie was consistent with the weather forecast provided by the Belfast International Airport Meteorological Office for the area around RAF Machrihanish (some 17 kilometres to the north of the Mull of Kintyre lighthouse). The forecast for the time of the flight was, for the greater part of the route to Fort George, considered suitable for a Visual Flight Rules flight. Around the Mull of Kintyre, however, there was a forecast 30% risk of conditions below Visual Flight Rules limits which, while operationally acceptable, would have required contingency options to avoid any bad weather. The weather over the southern end of Kintyre was well known to be changeable and often foggy and affected by low cloud.

2.1.6 Following a day's routine troop movements within Northern Ireland ZD576 returned to RAF Aldergrove to collect its passengers. The day's sorties had taken five hours and forty minutes. Flt Lt Tapper as captain had sought and received approval from the 230 Squadron Duty Flight Commander to extend his crew's flying hours by one hour to eight hours. RAF aircrew were limited in the number of hours they could fly. In Northern Ireland the period was seven hours, although this could be extended by the squadron Duty Flight Commander or Senior RAF Officer in Northern Ireland. This meant that the flight to Fort George had to be completed in two hours and twenty minutes otherwise additional flying hours would have had to be sought or an overnight stay outside Northern Ireland requested. There was no tasking for the Chinook detachment until the following afternoon. Flt Lt Tapper had anticipated on his flight authorisation sheet that the round trip would take about four hours.

2.1.7 The passengers received safety briefings and were provided with the necessary safety equipment for their journey over the sea. The aircraft departed at 16:42GMT (17:42BST). Before departure Flt Lt Tapper left photocopies of the planned route with the Support Helicopter Force Northern Ireland Operations Clerk as the 230 Squadron Duty Authorising Officer was involved in another briefing. It is almost certain that as the aircraft's captain Flt Lt Tapper occupied the left hand seat in the cockpit acting as non-handling pilot, while Flt Lt Cook occupied the right hand seat as the handling pilot. Master Air Loadmaster Forbes was N°2 crewman at the front of the cabin and Sergeant Hardie was N°1 crewman at the rear.

2.1.8 The crew made a number of routine reports to air traffic control on the way out from RAF Aldergrove and the aircraft was seen at 16:50GMT flying at low level over Carnlough on the Antrim coast and out over the North Channel in the direction of the Mull of Kintyre. At 16:55GMT a member of the crew tried to contact Scottish Air Traffic Control (Military) at Prestwick. The call was not answered and the crew did not repeat the message. There was no indication that it was an emergency call. No further radio communications were heard from the aircraft.

2.1.9 A yachtsman positioned to the southwest of the Mull of Kintyre gave evidence that about the same time as the unanswered radio call to Prestwick Military he had seen the aircraft flying at a steady speed straight and level below the cloud base at an estimated height of between 200 and 400 feet on a heading to, and about two nautical miles south west of, the Mull of Kintyre

lighthouse. Cloud and hill fog was observed by the yachtsman extending over the land mass of the Mull from approximately the base of the lighthouse building at 250 feet above sea level to at least the summit of Beinn na Lice (1,404 feet) which is situated a little under two kilometres east of the lighthouse. Witnesses on the Mull itself reported visibility of 400 to 500 metres with a blustery strong wind, but close to the lighthouse it was almost calm; although they could not say what its overall extent was over the land mass or out to sea.

2.1.10 When the aircraft was about 0.81 nautical miles from waypoint A on a bearing of 018 degrees True and approximately 400 to 500 feet above sea level a member of the crew manually changed the waypoint on the SuperTANS navigation system to waypoint B (Corran near Fort William some 170 kilometres to the north of the Mull). The bearing from waypoint A to waypoint B was 012.45 degrees True and the SuperTANS navigation computer would have been expected to present the pilots with a "steer left" direction in the order of 007 degrees to port. Following the change of waypoint, however, the aircraft continued to fly towards the Mull on a track of 022 degrees True rather than the indicated bearing as would have been expected. A few seconds after the waypoint change (and about 15 to 18 seconds prior to impact) the aircraft was at a height of 468 feet above sea level plus or minus 50 feet.

2.1.11 The sortie was planned and is believed to have been flown as a low level Visual Flight Rules flight. RAF flying rules state that an aircraft operating Visual Flight Rules must be flown a specified distance from cloud and with a specific minimum visibility. These parameters are set deliberately to ensure that pilots can safely navigate, see and avoid other aircraft, and avoid terrain and other vertical obstacles. A helicopter flying below 140 knots airspeed was required to remain clear of cloud, in sight of the ground, and with a forward visibility of at least 1,000 metres. At an airspeed greater than 140 knots a forward visibility of 5.5 kilometres was required as well as greater separation from cloud. If this was not the case, the aircraft had entered Instrument Meteorological Conditions and the pilot was required to transfer to Instrument Flight Rules. A transition to Instrument Flight Rules required the aircraft to slow down and climb to at least safety altitude for the area in which it is operating (1,000 feet above the highest obstacle in the area which for the Mull of Kintyre was 2,400 feet). On entering cloud or losing sight of the surface the crew should have rapidly climbed to at least safety altitude at maximum power and best climbing speed, while also turning away from any high ground or obstruction. At low level aircrew rely on seeing the ground and other external references. Electronic navigation aids were used but as secondary aids, as the pilot had to remain in visual contact with the ground at all times.

2.1.12 The post-accident examination of the SuperTANS navigation computer revealed that 2.9 seconds before the initial impact at 16:59GMT and at a distance of about 0.95 nautical miles from the waypoint change, the aircraft was climbing at a rate of approximately 1,000 feet per minute at an airspeed of 150 knots with a tailwind of 24 knots resulting in a groundspeed of 174 knots. This was indicative of a cruise climb rather than an abort or rapid ascent. The aircraft was then believed to have executed a "cyclic flare" banking the aircraft 30 degrees nose up using maximum power some four seconds before impact. The aircraft struck a rocky

outcrop on the side of Beinn na Lice at 810 feet above mean sea level and approximately 0.28 nautical miles east of the lighthouse. Analysis of the crash indicated that at initial impact the aircraft was travelling at a groundspeed of around 150 knots on a track of approximately 012 degrees True. It then travelled almost 200 metres airborne while sustaining fuselage strikes from its rotor blades and executing violent manoeuvres. It impacted the ground inverted and broke into two major pieces which tumbled a short distance, shedding the rear rotor pylon and both engines. Fuel tanks on both sides were ruptured at initial impact resulting in extensive ground fire which severely damaged much of the wreckage.

2.1.13 The aircraft was not fitted with a cockpit voice recorder or an accident data recorder, so we will never know how or why the pilots came to fly in the manner that they did. Analysis of the crash site, wreckage and data downloaded from the SuperTANS navigation system led the Board to conclude that the accident was caused by the action of the two pilots. For reasons unknown they continued to fly towards the high ground of the Mull of Kintyre below safety altitude at high speed in potentially unsuitable weather conditions.

2.2 Introduction into Service of the Chinook HC-2

2.2.1 The RAF Chinook fleet remains the largest outside the USA. The Chinook HC-1 entered RAF service from December 1980. It was essentially the same aircraft as the CH-47C in service at the time with the US Army but with some British avionics and equipment and a number of other special provisions. A small number of aircraft with improved engines were procured in the mid-1980s. The Chinook's complexity meant that the HC-1 in RAF service was considered to have relatively poor reliability which imposed a heavy maintenance burden and adversely affected its operational availability.

2.2.2 The diversity of roles required of the Chinook HC-1 led to continuous re-configuring of the equipment installed on the aircraft, often at short notice, to meet priority tasking. This was because most operational commitments required the aircraft to be enhanced with specialised equipment and modifications of one kind or another. A major commitment had been Operation Granby, the UK contribution to the 1990-91 Gulf War, from which the fleet was still recovering. These modifications accumulated over each aircraft's service life and resulted in a nonstandard fleet with some equipment installed on all aircraft while other equipment was limited to a smaller number of aircraft. In August 1992 an internal RAF review of Chinook airworthiness identified that the Chinook HC-1 suffered from inadequate configuration control, flight and maintenance publications, and system reliability due to operational and programme management demands, aircraft and equipment shortages, and a disparate fleet. Overall management of the aircraft was proving to be increasingly difficult to control to ensure its best possible utilisation. This disparate fleet was burdensome for the fleet managers, maintenance crews and aircrew.

2.2.3 This situation prompted the Ministry of Defence to address these concerns and to prolong the aircraft's life with an upgrade programme. All surviving aircraft (some having been destroyed on operations such as the Falklands War and others through accidents) were progressively returned to Boeing Helicopters in the USA to be upgraded to a common HC-2 standard. This standard was based on the then latest US Army CH-47D but, as with the HC-1, incorporated certain RAF specific modifications. The upgrade involved the replacement of the transmission, hydraulic and electrical systems and various structural modifications. It also provided the opportunity to modify the Textron-Lycoming T-55 engines by the incorporation of a Full Authority Digital Electronic Control system (FADEC). This engine management system improved performance and reliability while reducing pilot workload making the aircraft easier to fly. (This system is described at Annex B). The HC-2 offered better reliability and supportability as well as presenting the opportunity to regain and maintain configuration control of the Chinook fleet. Update programmes such as this were standard practice during the course of a military aircraft's life in order to ensure that the aircraft kept up with emerging threats, adopted the latest technologies, and incorporated standardised modifications across the fleet.

2.2.4 When the Chinook was introduced into RAF service, Ministry of Defence policy did not provide for the routine installation of cockpit voice and flight data recorders in military aircraft. That policy was subsequently changed and all new aircraft were fitted with such equipment. Prior to the change in policy installation of recorders on existing aircraft depended on a number of factors, including the aircraft's remaining service life, flight safety record, cost and other operational considerations. A decision had already been taken before the Mull of Kintyre accident to install accident data and cockpit voice recorders in the Chinook as part of a separate programme for the installation of a helicopter health and usage monitoring system. A contract for the modification of the Chinook fleet was eventually signed in October 1996 and the programme was completed in the summer of 2002.

2.2.5 The Chinook fleet was based at RAF Odiham in Hampshire with 7 Squadron and at RAF Gütersloh in Germany with 18 Squadron. Detachments were deployed to the operational theatres of RAF Mount Pleasant in the Falkland Islands and RAF Aldergrove in Northern Ireland. The Chinook was introduced into Northern Ireland in 1988 when most troop movements were switched to helicopters following a terrorist attack on an Army transport bus en route from RAF Aldergrove. The HC-2 was entering service with 7 and 18 Squadrons at about the same time, and both Squadrons were operating a mix of Chinook HC-1s and HC-2s. Two HC-1 aircraft were based at RAF Aldergrove until 31 May 1994 when one was replaced by an HC-2 (ZD576) - two days before the accident. The transition from the HC-1 to HC-2 was fraught and to some degree chaotic. There was a reduction in the availability of the Chinook fleet as aircraft were withdrawn to undergo the upgrade. Aircraft which had been removed from service to enter the upgrade programme were not returned to service on time. The operational imperative to keep the Chinook flying meant that the RAF was still getting to know what was essentially a new aircraft.

2.2.6 While the HC-2 was entering squadron service the Aircraft and Armament Experimental Establishment was carrying out a programme of trials on behalf of the Ministry of Defence Procurement Executive. These trials were enabling the Ministry of Defence and RAF to gain an understanding of the aircraft's capabilities and potential limitations. This was necessary to enable them to define the aircraft's operational envelope and produce and update documentation for aircrew and maintenance crews. These publications were at the time incomplete and in some cases inaccurate but over time as the aircraft's performance became better understood these were rectified.

2.2.7 The Aircraft and Armament Experimental Establishment flight tested military aircraft to ensure that new aircraft, equipment or modifications were safe and effective in their intended role. These trials assessed the aircraft's performance, flying qualities, airworthiness, and mission and safety systems. The trial team reported to the Ministry of Defence Procurement Executive project team, providing trial data, advice and recommendations for contractual acceptance and entry into operational service. The project team built the safety case and made its own recommendations to the Procurement Executive's Controller Aircraft who would then issue a "Controller Aircraft Release" at which point the aircraft was handed over for use by the military. The Controller Aircraft Release was a formal document stating the aircraft performance and limitations which made it suitable for use. The aim was always to achieve the fullest release as soon as possible, but time and resource constraints meant that in many cases this was not possible. In those circumstances an "Initial" Controller Aircraft Release would be issued which imposed additional restrictions on the aircraft's operation that were gradually lifted as the trials programme progressed. Before frontline squadrons could operate the aircraft, the Assistant Chief of the Air Staff, who was the RAF sponsor for aircraft systems, was required to authorise its "Release to Service". This Release was in the form of a document which enshrined the Controller Aircraft Release and also included any additional operational requirements or restrictions. The Aircraft and Armament Experimental Establishment's Handling Squadron produced aircrew manuals and Flight Reference Cards detailing how the aircraft was to be flown and what action should be taken during its normal operation and in an emergency.

2.2.8 When in 1993 the Chinook project team were preparing the draft the HC-2 Controller Aircraft Release, the Aircraft and Armament Experimental Establishment were unable to support the release because of a number of unresolved technical concerns. These included their inability to verify the engine's Full Authority Digital Electronic Control system software and to adequately quantify its then unpredictable performance. In their opinion the "*unquantifiable risk*" would be reduced by conducting additional pre-flight checks to test the functioning of the engine overspeed protection system and by adhering to ground and flight limitations regarding Digital Electronic Control Unit fault displays and any unusual or unexplained engine behaviour. They also recommended a weight limit of 18 tonnes in order to retain an acceptable single engine landing capability should an engine fail. In relation to other systems they also recommended an icing restriction of +4°C in cloud or fog pending completion of relevant trials. If either engine automatically switched to its reversionary mode or exhibited unusual or unexplained behaviour the aircraft was to be landed as soon as possible. They warned that

the "Engine Fail" caption on the Central Warning Panel could be spurious and if illuminated was expected to extinguish after 12 seconds. They also advised caution in relation to reliance on navigational equipment and the extent to which the aircraft could be operated without the Automatic Flight Control System. Having considered all the advice available the Controller Aircraft, Sir Donald Spiers, issued an Interim Controller Aircraft Release for the HC-2 on 9 November 1993 which contained (and therefore mandated) these recommendations. This was followed shortly after by Assistant Chief of the Air Staff, Air Chief Marshal (ret) Sir Anthony Bagnall, issuing the HC-2 Release To Service. The two documents were essentially identical carrying forward the mandated restrictions of the Interim Controller Aircraft Release.

2.2.9 During the HC-2 trials programme it was considered prudent on a number of occasions to suspend test flying while certain technical matters arising from the testing were resolved by the manufacturers and once addressed testing resumed. This was not unusual as testing of an aircraft's performance envelope was expanded. Suspension of test flying did not mean that the clearances already issued were invalidated and operational aircraft could continue to operate within the limits specified by the Release to Service. The June 1994 suspension of test flying was lifted in October when the Aircraft and Armament Experimental Establishment accepted the unresolved clarifications from the aircraft and engine design authorities with no additional operating limitations.

2.2.10 As performance trials were completed, the aircraft's temperature clearances were progressively cleared and from July 1994, a few weeks after the accident, down to its target -6°C in icing conditions. The Full Authority Digital Electronic Control system manufacturer produced an updated version of its software and in September 1998 full Controller Aircraft Release was issued for the HC-2.

2.2.11 The transition from the HC-1 to HC-2, unsurprisingly, generated some concern amongst the aircraft's pilots, air and ground crews which is discussed at Chapter 7.

3 Previous Reviews and Inquiries

3 Previous Reviews and Inquiries

3.1 Introduction

3.1.1 The RAF Board of Inquiry immediately convened to investigate the accident and following extensive investigation delivered its report to the RAF Higher Authority on 3 February 1995. The findings were reviewed and signed off by the Higher Authority (the Reviewing Officers) on 3 April 1995. The report was then passed to the RAF Inspectorate of Flight Safety and the Ministry of Defence. On 15 June 1995 specialist officers from the RAF, who were able to discuss and explain the Board's findings, handed over the report to most of the next of kin. The then Secretary of State for Defence, the Rt Hon Malcolm Rifkind MP, made a statement to the House of Commons announcing the Board's findings and the placing of the Military Aircraft Accident Summary in the House of Commons Library. As an unclassified document it did not detail the comments of the chain of command.

3.1.2 A Board of Inquiry was an internal process convened for Armed Services reasons to determine how a serious incident happened and why, and to make recommendations to prevent a recurrence. The Board of Inquiry was not a substitute for a legal inquiry into the cause and circumstances of a death. So on completion of the Board the Ministry of Defence discussed with the Lord Advocate (the chief law officer in Scotland) and Solicitor General for Scotland (responsible for the Procurator Fiscal Service who were the public prosecution service and carried out functions broadly equivalent to a coroner) the need to hold a public Fatal Accident Inquiry under Section 1(1)(a)(i) of the Fatal Accident and Sudden Deaths Inquiry (Scotland) Act 1976. Shortly before publication of the Board of Inquiry report the Lord Advocate concluded that a Fatal Accident Inquiry was necessary because some of those on board at the time of the crash were engaged in the course of their employment and, while not mandatory in respect of all of the deaths, the inquiry should relate to all onboard. The Inquiry was held over 18 days in Paisley Sheriff Court from 8 January to 2 February 1996 and heard from 38 civilian and military witnesses. The Sheriff found that he could not determine the cause of the accident and did not agree with the determination of gross negligence by the Reviewing Officers.

3.1.3 Following the Sheriff's determination questions were raised about the inconsistency between the two inquiry findings and particularly the difference of opinion between the Board and the Reviewing Officers. In the intervening years the accident has been debated in and outside Parliament and a number of articles have been written and broadcast.

3.1.4 The concerns raised prompted the House of Commons Defence Committee to investigate the lessons to be learned from the accident with the Committee reporting in May 1998. The Committee was clear from the outset that it was not a further "*court of appeal*" but sought to clarify the conflicting messages about the possible cause of the accident. This investigation was followed by the Parliamentary Public Accounts Committee in November 2000, who investigated the Ministry of Defence's acceptance into service of the Chinook HC-2. The Committee specifically

looked at the engine's Full Authority Digital Electronic Control system and the Board of Inquiry process. Finally, the House of Lords set up a Select Committee in 2001 to consider specifically the justification of the Reviewing Officers' finding of gross negligence.

3.1.5 The Mull of Kintyre Group was formed representing some of the families of the deceased and others with an interest in the accident. A number of parliamentarians were members of this group. In October 2007 the Group handed the Secretary of State for Defence a legal analysis covering their analysis of the statutory requirements for Boards of Inquiry, standard of proof, evidence supporting the finding of negligence, and potential alternative causes of the accident. A number of bodies and individuals who have taken an interest have published their own reports, books and articles. In each case the Ministry of Defence has maintained its position that it would reconsider the Board of Inquiry findings if it were presented with new evidence and that no such evidence of a material nature has been brought to its attention to necessitate the reopening of the Board of Inquiry.

3.2 RAF Board of Inquiry

3.2.1 The RAF convened a Board of Inquiry immediately after the accident with the members of the Board attending the crash site on 3 June 1994. The Board of Inquiry process is discussed later at Chapter 4. This was a typical Board, comprising a President and two specialist officers, convened by the Convening Authority, No1 Group, the RAF Group owning the accident aircraft. The Board's terms of reference were also typical and are provided at Annex D. The Board members were the President, Wing Commander (now Air Marshal) Andrew Pulford, and Squadron Leader Gilday (a helicopter pilot) and Squadron Leader Cole (an aircraft engineer). All had current or recent experience of Chinook helicopters. The RAF was responsible for investigating military aviation incidents but its longstanding practice was to instruct the Department of Transport's Air Accident Investigation Branch to provide an engineering investigation, leaving the analysis of the findings, operational matters and the conclusion as to cause to the RAF Board. Mr AN Cable (a Senior Inspector of Air Accidents (Engineering) with 18 years experience as a crash investigator) and Mr R Parkinson were appointed. Mr Cable was assisted by two RAF Chief Technicians with extensive and detailed engineering knowledge of the Chinook to provide specialist technical information. The Board was also initially provided with a specialist flight safety advisor to provide guidance to assist in its establishment, procedure and operation.

3.2.2 This was the most prolonged and intensive investigation which Mr Cable had conducted. He reported his findings in the form of a factual statement to the Board on 5 January 1995. Squadron Leader Cole, the engineering member, also researched the history of the Chinook HC-2 in general and ZD576 in particular. The Board carried out a detailed diagnosis of potential causes of the accident based on the available evidence. They considered any factor which they thought could conceivably have had a bearing on the accident. Their report is summarised at Annex D.

3.2.3 The aircraft initially impacted upon a small rocky outcrop resulting in severe damage, and continued for some 200 metres manoeuvring violently while being struck by the rotor blades before impacting the ground while inverted. Ruptured fuel tanks resulted in a ground fire that appreciably damaged 80% and destroyed around 20% of the fuselage. The passengers and crew were thrown out of the aircraft during the crash. Many sources of valuable evidence commonly available to an investigation were absent because of the fire and the multi-impact nature of the crash which made it difficult to determine the state of the aircraft at the instant of initial impact. Because of the extensive damage and the lack of either cockpit voice recorder or accident data recorder the Board had very little evidence to go on with most of the evidence coming only from the examination of the crash site and remaining wreckage. Mr Cable told the House of Lords Select Committee and confirmed to us that: "… *throughout this investigation the evidence was remarkably thin, from my point of view, I must say. We spent a great deal of time trying to find evidence.*" The wreckage was transferred from the crash site to the Air Accident Investigation Branch facilities at Farnborough and a detailed investigation undertaken.

3.2.4 In compiling his Statement, Mr Cable went to considerable effort to judge the strength of the available evidence fairly and to allocate an appropriate level of confidence to it. His statement concluded that: "*A detailed investigation of possibly relevant technical aspects of the accident was made. The pre-impact serviceability of the aircraft could not be positively verified, but no evidence was found of malfunction that could have contributed to the accident, with the possible exception of a radar altimeter system fault.*" This included no evidence of explosive effects or pre-impact fire; normal operation of both engines at the time of the accident; no major pre-impact loss of electrical power; normal functioning of the navigation equipment with the exception of a radar altimeter fault; no signs of pre-impact failure or malfunction of the rotor, transmission and flight control mechanical and hydraulic systems (although the possibility of pre-impact detachment of the flight control system pallet inserts and / or a control system jam could not be positively dismissed); and some contamination of the hydraulic system. Investigations into transmitters in the vicinity of the crash site and typical mobile telephones and laptop computers on board at the time determined that they did not pose a hazard to a Chinook HC-2.

3.2.5 Data from the SuperTANS Tactical Air Navigation System was analysed showing that it was switched on and performing correctly up to loss of power at, or very shortly after, first impact. It was determined that the second waypoint B had been selected when the first waypoint A was 0.81 nautical miles distant and 0.95 nautical miles from the final recorded (crash) position. The system was commanding "steer left" which would have been indicated on the Steer meter and SuperTANS display. As the SuperTANS only retained the last measured altitude there was no information as to height or time at the waypoint change. The last measured altitude was however at approximately 15 to 18 seconds before power down and was recorded as 468 feet plus or minus 50 feet.

3.2.6 The final seconds of the flight were modelled by the Defence Research Agency Flight Dynamics and Simulation Department and by Boeing Rotorcraft. The simulations sought to determine the aircraft's final behaviour based on a range of potential pre-impact steady flight conditions derived from the crash investigation. The results of both simulations were consistent

finding a ready match where initial conditions combined an airspeed of 150 knots with a rate of climb of 1,000 feet per minute.

3.2.7 The Board considered the operational aspects of the final flight and carried out technical investigations within the RAF. In the absence of accident data or cockpit voice recorders, survivors or eyewitnesses, the Board based its findings on logical argument derived from the limited evidence. Many potential causes of the accident were dismissed or considered unlikely, and the Board concluded that there were only three likely scenarios. The least likely scenario was that the crew decided upon a suitable rate of climb, but did not achieve it. The short time interval between the waypoint change and final flare was sufficient for the crew to make some attempt to avoid hitting the ground earlier than they did, even though there were plausible reasons for their failure or inability to do so. The alternative explanation, that the crew had not made a decision by the final flare appeared to be contradicted by the rate of climb prior to it. That left the most probable explanation that the crew selected an inappropriate rate of climb to clear the high ground. The Board found that human factors (that address the human contribution to an accident, such as pilot error), spatial disorientation, visual illusion or distraction could have contributed to the accident either singly or in combination, as could have duty time, planning, radar altimeter procedures and the weather.

3.2.8 Even though it was difficult to do so, the Board was required to consider what human failings may have contributed to the accident. They found that neither Master Air Loadmaster Forbes or Sgt Hardie would have been in a position to affect the conduct of the flight. The Board found that, as the Chinook detachment commander and captain of the flight, Flt Lt Tapper had a duty to ensure the correct preparation and safe execution of the flight. There was, however, insufficient evidence to allow an objective assessment of any human failings to be made in respect of his crew management and flight planning and while the Board could not positively determine the sequence of events leading up to the accident it was likely that he made an error of judgment in the conduct of the attempted climb over the Mull of Kintyre. It was, however, considered incorrect to criticise him for human failings based on the available evidence. The Board concluded that Flt Lt Cook would have been fully occupied with flying the aircraft in deteriorating weather, and as it is unlikely that he would have had any reason to doubt the actions of his experienced captain, the Board concluded that he could not be criticised for failing to identify any errors.

3.2.9 The Board briefed the Convening Authority on their report in January 1995 and, following some final amendments, signed it off on 3 February 1995. The investigating Board concluded that the most probable cause of the accident was the selection of an inappropriate rate of climb over the Mull. The Board did not find that either of the pilots was negligent.

3.2.10 The Board of Inquiry procedure was a sequential process and the Board's findings were reviewed by the Higher Authority (the Reviewing Officers). These officers were expected to apply their depth and breadth of experience and to reflect the expertise of the specialist advisers in their headquarters. In this case the Higher Authority were represented by the Station Commander of RAF Odiham, the home base for ZD576, and it was also reviewed by the Station Commander of

RAF Aldergrove as the aircraft had been operating from there. On completion of their remarks the report was passed to the staffs of the Air Officer Commanding No1 Group and then the Air Officer Commander-in-Chief Strike Command. Strike Command was then the military formation which controlled the majority of the UK's combat aircraft. The Board of Inquiry proceedings were the sum of all these inputs and were not complete until the Higher Authority had commented. The understanding in the RAF at the time was that by virtue of the authority of their command the Station Commander, the Air Officer Commanding and the Air Officer Commander-in-Chief could modify the findings of the Board where they did not agree with the subordinate view.

3.2.11 Group Captain Wedge, the station commander of RAF Aldergrove, confined his comments to operations at RAF Aldergrove, the day's tasking and the supervisory aspects of the flight. He did not comment on human failings. Group Captain Crawford, the station commander of RAF Odiham, commented at length, disagreeing with the Board's inappropriate rate of climb scenario. He concluded that, in the absence of hard evidence, the reasons for the accident were open to conjecture. He was, however, drawn to the conclusion that Flt Lt Tapper failed in his overriding duty to ensure the safety of his aircraft, its crew and the passengers. While the Board had considered all the factors that could have conceivably had a bearing upon the accident, its inappropriate rate of climb over high ground theory was unrecognisable as a Chinook technique and went against all the crew's instincts and training. He believed the appropriate decision making process (to slow down or stop, turn away from high ground or turn back, or climb on a safe heading at maximum rate of climb to safety altitude) was not so complex as to be vulnerable to distraction. He proposed an alternative view where rather than electing to climb over the Mull the crew saw the coast prompting the waypoint change and decided to continue Visual Flight Rules to the West of the Mull peninsula. As identified by the Board there were a number of factors which could have sufficiently distracted the crew from turning away from the Mull and caused them inadvertently to enter cloud and then fail to carry out the correct procedure for an emergency climb in a timely manner.

3.2.12 On review by the Air Officer Commanding No1 Group, Air Vice Marshal Sir John Day (now Air Chief Marshal retired) concluded that the Board had conducted a very thorough inquiry, but he found it incomprehensible why two trusted, experienced and skilled pilots should have flown a serviceable aircraft into cloud covered high ground. In his judgment, the actions of the crew were the direct cause of the crash and on the evidence both pilots were negligent to a gross degree. Flt Lt Tapper, as the non-handling pilot and captain, was responsible for the safe navigation of the aircraft and had the overriding duty to ensure its safety, in which duty he had clearly failed. This was not an error of judgment as he did not exercise appropriate care and judgment and contravened the strict rules for flight. He allowed his aircraft to proceed at high speed and low level directly towards the Mull, notwithstanding the obvious dangers. Flt Lt Cook as the Handling Pilot and an experienced Chinook captain had the skill and experience to recognise an unsound and potentially dangerous course of action. The pilots should have been ready to take decisive action to ensure the safety of their aircraft and its occupants. They had two choices: maintaining Visual Flight Rules by slowing down, turning away or turning back; or continuing under Instrument Flight Rules by climbing to above safety altitude. On entering cloud or losing sight of the surface the crew failed to climb to the Safety Altitude and until that height was

achieved the aircraft should not have continued approaching the Mull of Kintyre. He accepted that Master Air Loadmaster Forbes and Sergeant Hardie were not in a position to offer much useful navigational input to the pilots; the responsibility for navigation lay with the captain.

3.2.13 The Air Officer Commander-in-Chief Strike Command, Air Chief Marshal (now retired) Sir William Wratten, agreed with this finding.

3.3 Fatal Accident Inquiry

3.3.1 A Fatal Accident Inquiry under the Fatal Accidents and Sudden Deaths Inquiry (Scotland) Act 1976 was held between 8 January and 2 February 1996 in the Sheriff Court Paisley. The decision to hold a Fatal Accident Inquiry is made independently by the Lord Advocate in the public interest. Investigation into the circumstances of deaths covered by the Act is carried out by the Procurator Fiscal for the district with which the circumstances of the death appear to be most closely connected. The Procurator Fiscal is responsible only to the Lord Advocate. At the conclusion of his investigation he makes an application to the Sheriff for the holding of an inquiry into the circumstances of the death. The Sheriff fixes a time and place for the holding of the inquiry and grants a warrant which is used to compel the attendance of witnesses. At the inquiry it is the Procurator Fiscal who leads evidence on behalf of the Lord Advocate as to the circumstances of the death. In this case Crown Counsel was instructed. The Act also provides for other parties having an interest, including the relatives of those who died, to appear and to lead evidence.

3.3.2 At the conclusion of the evidence and any submissions the Sheriff is required to make a determination setting out the circumstances of the death so far as they have been established to his satisfaction. In particular he must deal with:

(a) the time and place of the death and the accident which resulted in the death;
(b) the cause or causes of the death and the accident;
(c) the reasonable precautions, if any, whereby the death and the accident might have been avoided;
(d) the defects if any in any system of working which contributed to the death or the accident; and
(e) any other facts which are relevant to the circumstance of the death.

3.3.3 The Sheriff does not pronounce any verdict such as accidental death, open verdict or unlawful killing. His determination is made on the basis of the evidence led before him. If evidence is led of any other inquiry into the accident he may take that evidence into account but is not bound by it.

3.3.4 In this case the Sheriff heard evidence and submissions over a period of 18 days. A total of 36 witnesses were called by the Crown. The Ministry of Defence, the families of the pilots and the deceased passengers, and the manufacturers of the Chinook, Boeing, were legally represented. Counsel for the relatives of Flt Lt Tapper called two witnesses. None of the other parties led any evidence. A significant number of the witnesses were RAF personnel.

3.3.5 The Sheriff issued his determination on 21 March 1996.

3.3.6 The determination contained 50 numbered paragraphs which set out the facts which the Sheriff found established. In accordance with the normal practice, he appended a Note in which he set out the legal framework governing the conduct of the inquiry, and made detailed reference to the evidence relating to the background to the accident, the crew's qualifications, experience and working relationships, the final flight, and the Air Accident Investigation Branch investigation.

3.3.7 The Sheriff found himself unable to make a finding as to the cause of the accident. More particularly, he was unable to find it established on a balance of probabilities that the cause of the accident was the decision of the crew to overfly the Mull of Kintyre at cruising speed and their selection of an inappropriate rate of climb. In his opinion, to reach that conclusion on the basis of the available evidence, as the Board of Inquiry had done, involved a speculative leap.

3.3.8 It should be emphasised that, in terms of section 4(7) of the 1976 Act, the Sheriff applied the standard of proof applicable in ordinary civil litigation, namely, on a balance of probabilities.

HM Government's Response to the Fatal Accident Inquiry

3.3.9 The Government made no formal response to the Sheriff's findings. However, when questioned, the Ministry of Defence stated that the Fatal Accident Inquiry did not uncover any evidence that was not known to the RAF at the time of the Board of Inquiry and that neither the Sheriff's determination nor the views which he expressed altered the Board's findings. The Department maintained its position that the Board of Inquiry had been scrupulous and had carried out its work in accordance with agreed procedures. The Board comprised experts with firsthand experience of Chinook helicopters and no new evidence had emerged to cause it to doubt the accuracy of the Board's conclusion. If new evidence emerged it was open to the RAF to reopen the Board of Inquiry.

3.4 House of Commons Defence Committee

3.4.1 The House of Commons Defence Committee examines the Ministry of Defence and its associated public bodies. The Committee of eleven members was in 1997-8 chaired by Mr Bruce George MP.

3.4.2 In light of the apparent inconsistency in the findings of the Board of Inquiry and the Fatal Accident Inquiry and in response to perceived issues of due process which had been raised in relation to the Board of Inquiry, the Committee sought and received a briefing on the accident from the Ministry of Defence in November 1997. They concluded that it would be helpful to clarify in a public forum some of the conflicting messages about the possible causes of the

crash and put them into the wider context of concerns about the safety of the Chinook fleet. The Committee was careful to limit its investigation so as not to be "a further court of appeal". They did not seek to re-open questions relating to the accident which had been the subject of other inquiries by military and civil authorities, nor did they seek to either challenge or endorse those findings.

3.4.3 The Committee held one hearing with the then Minister of State for the Armed Forces, the Rt Hon Dr John Reid MP, and officials as well as receiving written evidence from the Ministry of Defence and interested parties. The Committee's investigation was published in its Fourth Report for the 1997-98 Parliamentary Session published on 13 May 1998 (Lessons of the Chinook Crash on the Mull of Kintyre (HC 611)). The Committee did not offer its own view as to the cause of the accident or the ZD576 Board of Inquiry process, but considered some of the wider implications of the accident including the general performance and reliability of the Chinook HC-2, Board of Inquiry procedure and the attribution of blame, training in movement between visual and instrument flight, cockpit voice and flight data recorders, and the transport of "VIP passengers".

3.4.4 The Committee's consideration of the overall reliability of the HC-2 was based on unscheduled maintenance events and aircraft accidents and they were informed by the Ministry of Defence that these were broadly in line with other aircraft types. They concluded that the HC-2 fleet appeared to be operating reasonably safely and reliably. While the Full Authority Digital Electronic Control's performance had improved since its introduction into service they were concerned that its software had still to receive final approval and while this did not raise safety-critical questions it resulted in the related 18 tonne weight limit that needed prompt resolution. The Committee also noted that the Ministry of Defence had told them that the risk to flight safety of a de-bonding failure in the "broom closet" was assessed by Boeing to be minimal. They also welcomed the revised training for transition between Visual and Instrument Flight Rules. They strongly endorsed the programme to fit flight recorders on aircraft and welcomed a reappraisal of the policy on transporting key personnel. They also recommended the introduction of procedures to allow the families of deceased service personnel to be represented in the appropriate part of Board proceedings.

3.4.5 At the hearing Dr Reid told the Committee that "*If information came forward of a substantially material nature that suggested that the original Board of Inquiry, in all integrity and in all sincerity had reached the wrong decision, yes, we would have that power [to withdraw the finding of gross negligence]. Not only would we have the power if such information came forward, we would be, in all conscience, obliged to address that.*" He also assured the Committee that he had reviewed and scrutinised the circumstances of the crash with a sceptical and compassionate eye, and that he had found no grounds for overruling the Board's findings. The Committee welcomed the Ministry of Defence's decision that Boards of Inquiry would no longer allocate blame or attribute negligence.

3.4.6 The Committee hoped that lessons from this accident would help to avoid such controversies in the future.

HM Government's Response to the Defence Committee

3.4.7 The Ministry of Defence responded to the Committee's report in July 1998. The memorandum noted that the Full Authority Digital Electronic Control system warranty arrangement ensured that the contractor provided, at its own expense, replacement components for any part that failed to meet the warranted performance. It stated that the Ministry of Defence had been working with Boscombe Down and other acknowledged experts to provide advice on the validation of its software. A programme to install accident data recorders and cockpit voice recorders was underway as part of the helicopter's Health and Usage Monitoring System. The procedure for transferring from Visual Flight Rules to Instrument Flight Rules had been formalised and was practised at every stage of helicopter training. Following consultation with other government departments, it had been decided there was little scope to develop common guidance for the transport of key personnel and that the risk should be judged on a case by case basis. The Ministry of Defence did, however, issue guidance for transporting key personnel. The 18 tonne limitation had had a modest effect on operations and the RAF had been progressively permitting flying in excess of the limit and in October 1998 the Minister of State for Armed Forces wrote informing the committee that through the application of statistical analysis of operating the HC-2 the Controller Aircraft Release had been amended so that the maximum weight was increased to the 24.5 tonne design limit.

3.5 Public Accounts Committee

3.5.1 The Committee of Public Accounts examines and oversees government expenditure on behalf of the House of Commons.

3.5.2 At an evidence session held on 8 March 2000 the Committee examined the Comptroller and Auditor General's report on the Ministry of Defence's acceptance of equipment off-contract and into service (HC204). In particular they examined in detail one of six case studies, which related to the Chinook HC-2. The case study focused on the introduction of the HC-2 engine's Full Authority Digital Electronic Control system. The Comptroller and Auditor-General found, notwithstanding the internal differences of opinion over the controller, that there were no significant impacts on acceptance into service and the Chinook mid-life update had been delivered on time, below budget and provided a significant increase in payload capability compared to the Staff Requirement. The Committee decided to investigate the acceptance of the HC-2 helicopter in more detail.

3.5.3 The Committee held one hearing with the then Ministry of Defence Permanent Under-Secretary of State, Mr Kevin Tebbit, and officials, and received written evidence from the Ministry of Defence and interested parties. The Committee's investigation went wider than the acceptance of the HC-2 and considered also the ZD576 accident Board of Inquiry, the burden of proof in finding deceased pilots negligent and the Ministry of Defence's reliance on equipment manufacturers. Most of the report addressed concerns with the HC-2 engine's Full

Authority Digital Electronic Control system. The Committee's investigation was published in its Forty Fifth report for the 1999-2000 Parliamentary Session on 30 November 2000 (Forty Fifth Report - Ministry of Defence: Acceptance of the Chinook HC-2 helicopter (HC975)).

3.5.4 The Committee was concerned that problems with the Full Authority Digital Electronic Control system software were only identified at a late stage resulting in flight restrictions (on payload weight) for four and a half years and that the software had not been independently verified. The Committee criticised the Ministry of Defence's specification, procurement and testing of the system's software and found its assurances that the software was safe unconvincing.

3.5.5 The Committee also found that given the burden of proof the Board of Inquiry's finding of gross negligence was not justified by the available evidence. They believed that areas of doubt related to the condition of the HC-2 fleet at entry to service and the incomplete nature of the technical crash evidence, and that negligence was found in the absence of any other explanation rather than being positively identified as the cause. Their rejection of the finding was based on a technical malfunction being a "potential" or "contributory" cause of the crash and that they noted the Reviewing Officers were also responsible for keeping the HC-2 operational, questioning their "perceived objectivity" (although the Committee did not impugn their integrity). They strongly recommended that the Board of Inquiry process should be revised to ensure that those officers with management and command responsibilities for the aircraft and personnel did not influence the Board's findings.

HM Government's Response to the Public Accounts Committee

3.5.6 The Government responded to the Committee's report in March 2001 by means of a Treasury Minute responding to both the Committee's 44th (Ministry of Defence: Accepting equipment off contract and into service) and 45th (Ministry of Defence: Accepting of the Chinook (HC-2) helicopter) reports. The Ministry of Defence noted the Committee's conclusions but did not accept its view that the HC-2 acceptance process was flawed and noted that the HC-2 was in fact delivered on time and below budget and exceeded the RAF's original requirement. They set out the reasoning for releasing the aircraft to squadron service with limitations and the Full Authority Digital Electronic Control system software verification process. The Ministry of Defence rehearsed its position on the evidence that supported the finding of gross negligence, maintaining that the burden of proof had been met and that no new evidence had come to light to justify setting aside the Board of Inquiry's finding. In respect of the Fatal Accident Inquiry the Ministry of Defence noted that its purpose and that of the Board of Inquiry were different, the former determining the cause of the deaths and the latter the cause of the accident and action needed to prevent a recurrence. The Department rejected the suggestion that there was a conflict of interest for Reviewing Officers of Board of Inquiries.

3.5.7 The Committee responded to the Government's Treasury Minute stating that in their view it was inadequate, unbalanced and partial in its response. The Committee's memorandum was later sent to the House of Lords Select Committee on the ZD576 crash.

3.6 House of Lords Select Committee

3.6.1 After the Ministry of Defence published the findings of the Board of Inquiry there were a number of debates in both Houses of Parliament. On 5 March 2001 Lord Chalfont moved in the House of Lords that the Liaison Committee should consider the appointment of a Select Committee to consider all the circumstances surrounding the crash and this was agreed without a division. The Liaison Committee recommended against the appointment of a Select Committee on the grounds that it would effectively have to carry out a quasi-judicial function and substitute its own decision for that of the Board of Inquiry. On 30 April 2001 their Lordships rejected the Liaison Committee's recommendation and established a Select Committee "*to consider the justification for the finding of those reviewing the conclusions of the RAF Board of Inquiry that both pilots of the Chinook helicopter ZD576 which crashed on the Mull of Kintyre on 2 June 1994 were negligent*". The Committee was set up on 2 July 2001 under the chairmanship of Lord Jauncey of Tullichettle sitting with four members: Lord Brennan, Lord Bowness, Lord Hooson and Lord Tombs.

3.6.2 The Committee considered both oral and written evidence from members of, and contributors to, the RAF Board of Inquiry, families of the pilots, the Ministry of Defence, and groups and individuals with a technical, professional or personal interest in the accident. The Committee also received a memorandum from the Public Accounts Committee dealing with their 1998 inquiry into the introduction into service of the Chinook HC-2. The Committee considered not only the evidence that was before the Board but additional evidence that had come to light since. While they heard in their own words "*a good deal of evidence about mechanical problems*" their role was not to determine the likely cause of the accident and that concluded on the evidence that it would not have been possible to do so.

3.6.3 The Committee published its report on 31 January 2002 presenting a background to the HC-2 introduction into service (focusing heavily on the HC-2 engine's Full Authority Digital Electronic Control system) and the circumstances of the crash and subsequent investigation detailing the technical findings. The evidence of a number of the witnesses was discussed in some detail. The analysis of the Board's findings focused on the weather (and in particular the yachtsman's evidence to the committee), potential technical malfunctions (engine control, flight control restrictions and undemanded flight control manoeuvres) and the Reviewing Officers' findings. Having reviewed pertinent evidence before it, the committee unanimously concluded that the Air Marshals were not justified in concluding that the pilots were in control of their aircraft before the crash and that it had not been established to the required standard of proof that the crash was caused by a voluntary action by the pilots. The Reviewing Officers were, therefore, not justified in finding negligence on the part of either pilots. They also identified matters which they had had regard to but were not before the Air Marshals, namely more detailed weather evidence and evidence from a digital engine control expert, a Special Forces Chinook pilot and the then RAF Odiham unit test pilot. The Committee also raised concerns regarding perceived deficiencies in the Boeing simulation and possible effects of hydraulic fluid contamination. They also questioned why a very experienced crew would have would have done what the Reviewing Officers determined they had and flown a serviceable aircraft into the ground on the Mull of Kintyre.

HM Government's Response to the Select Committee

3.6.4 The Ministry of Defence responded to the House of Lords Select Committee report on 22 July 2002, reiterating their view that, having examined all the alternative hypotheses put to the Committee, they remained of the view that they were implausible given the known facts. If the evidence left the Reviewing Officers with no honest or genuine doubt that the aircrew had been negligent, it was their duty to find accordingly. The pilots' conscious change of waypoint showed they were "*undoubtedly in control of the aircraft*" and that it was not possible for a catastrophic technical failure to remain unnoticed in flight. The negligence finding was not dependent upon whether or not the crew could see the Mull at the time of waypoint change. As they approached land they should have been aware that their visibility was about to reduce significantly and have taken appropriate action. The response noted the difficulty in making reliable estimates of distance and time based on relatively fleeting observation. The paper also provided further analysis by Boeing which benefited from additional information not originally made available. The Ministry of Defence reiterated that the Boeing simulation was an analysis tool and not a factual reconstruction. It was not essential to the determination that the pilots were negligent. On the contrary the "*factual evidence pointed compellingly to a controlled flight into terrain*".

4 Board of Inquiry Procedure and Standard of Proof

4 Board of Inquiry Procedure and Standard of Proof

4.1 Board of Inquiry Procedure

4.1.1 At the time of the ZD576 accident the constitution and conduct of RAF Boards of Inquiry were governed by Chapter 17 of The Queen's Regulations for the RAF, which had statutory force.

4.1.2 Board procedure was covered by paragraphs 1264 – 1292 of Chapter 17, paragraph 1269 of which made detailed provision for the steps to be taken when it appeared that an inquiry might affect the character or professional reputation of an officer or airman. These provisions were designed to ensure that the officer or airman was given adequate notice of any matter which might affect his character or professional reputation, and fully understood his rights under the Board of Inquiry rules. He was entitled to be made aware of the evidence against him, to be present and represented at sittings of the Board, and to examine and cross examine witnesses. He was to be encouraged to exercise his right and to question witnesses. When he was unable to be present or represented for any reason he had to be informed of any evidence or statements which appeared to require a report or explanation from him, and given the opportunity to make statements in denial, exculpation or explanation.

4.1.3 When a Board considered that an officer or airman had been negligent he had to be informed and shown the evidence on which the Board's opinion was based. He might then ask for further evidence to be taken and make a further statement, and any new points brought to light as a result required to be fully investigated. If the Board finally attributed negligence to him he was to be invited to make a further statement giving reasons why he should not be held to blame. He was to be given a similar invitation in cases where the convening officer or Higher Authority attributed negligence to him when the Board had not done so, or where a finding of negligence was endorsed by the convening officer or Higher Authority but for different or additional reasons.

4.1.4 Paragraph 1270 dealt with the Board's findings. Boards were directed to be careful to ensure that their findings were supported by evidence and to consult the Manual of Flight Safety for guidance in respect of inquiries into aircraft accidents. They were to endeavour to differentiate between incidents caused by accident (including error of judgment) and those caused by negligence. Findings of error of judgment were to be confined to cases where a person, through no fault of his own, had been presented with alternative courses of action, and had made a bona fide mistake whilst trying to do his best in the circumstances thrust upon him. Accidents caused by errors of judgment were to be classed as having been caused accidentally.

4.1.5 Negligence, on the other hand, was defined in paragraph 4 of Annex G to the Manual, headed "Guide to the Consideration of Human Failings", one of a number of annexes or supplements to the Manual intended to be read along with it. It defined negligence as:

"*a. The omission to do something which, in the circumstances, a reasonable person would do, or*

b. The doing of something which, in the circumstances, a reasonable person would not do or would do differently."

4.1.6 Paragraph 5 of Annex G added the explanation: "*When related to flying an aircraft or to aircraft maintenance, neglect means a breach of duty to take care or, in other words, carelessness in a matter where care is demanded. The duty to take care varies according to the operation being performed and a duty to take a very high degree of care is rightly imposed upon a person flying an aircraft or responsible for its maintenance or its control.*" Paragraph 1270 of the Regulations also provided that if a Board decided that an incident was caused by negligence they were to consider what degree of negligence should be attributable and whether it was to be classed as excusable or meriting further action by superior authorities.

4.1.7 Paragraph 1277 dealt with the investigation of deaths sustained in aircraft accidents. In such investigations Boards of Inquiry were required to obtain evidence to show, and to record an opinion on, whether or not the deceased person died in the course of his official duties, and whether or not he was negligent. If the Board found that he was negligent, their report had to give details of the circumstances and assess the degree of negligence, together with any mitigating circumstances.

4.1.8 Paragraph 1278 provided: "*Aircraft Accidents. The provisions specifically relating to inquiries into aircraft accidents are contained AP3207 (Manual of Flight Safety).*" As we understand it, it has been accepted on all sides throughout the debate and controversy which has followed the ZD576 accident that the terms of the Manual of Flight Safety in relation to aircraft accidents were binding on the Board of Inquiry and subsequent review by the Higher Authority. Included among those terms was Paragraph 9 of Annex G to the Manual, which contained the provision which lies at the heart of the controversy in this case, "*Only in cases in which there is absolutely no doubt whatsoever should deceased aircrew be found negligent.*" We have conducted this review on the basis that this paragraph set out the standard of proof which the Board of Inquiry and the Reviewing Officers were obliged to apply. We will return to this topic to consider how the standard of proof should have been interpreted, after we have concluded our consideration of Board procedure.

4.1.9 As part of the guidance to the conduct of inquiries into aircraft accidents, paragraph 141 of Chapter 8 of the Manual of Flight Safety dealt with situations in which disciplinary action against *surviving* aircrew arising from the findings of a Board was being considered by superior officers. That paragraph concluded with the words "*Judgement should not be passed upon an officer or airman who has had no opportunity of giving evidence at the board of inquiry or of making a statement*".

4.1.10 When a Board had completed the gathering of evidence they recorded their findings on the points raised by their terms of reference. The record of the proceedings was then sent to the Commanding Officer of the appropriate unit and then to the Higher Authority. The Commanding Officer, the appropriate Air Officer Commanding and the Air Officer Commander-in-Chief then examined the record of the proceedings and recorded their opinions on the matters investigated. These additional opinions, whilst not part of the actual Board of Inquiry procedure, were regarded as forming part of the wider administrative Board process.

4.1.11 For many years it was Ministry of Defence policy that Board of Inquiry reports should not be released outside the department unless there was an overwhelming requirement, such as a legal obligation, to do so. Summaries of reports were provided on request to those involved in the incident and, in the case of fatal accidents or serious injury, copies of reports were made available to the next of kin on request, subject to redaction of security information and/or third party personal data. In addition, a duty to assist other investigative bodies such as Coroners and Fatal Accident Inquiries resulted in appropriately redacted Board reports being released on a confidential basis.

4.1.12 When the report of the ZD576 Board was completed a Military Aircraft Accident Summary was published on 15 June 1995, in accordance with the normal practice at the time. At the same time a redacted version of the full report was made available in confidence to those next of kin of the deceased who wished to see it and the full report was sent on 8 June 1995 to the Procurator Fiscal at Campbeltown in connection with the Fatal Accident Inquiry. The report of the Board of Inquiry, along with the statement to the Board by the Air Accident Investigation Branch, was placed in the public domain on 10 August 2001 in connection with the House of Lords Select Committee Inquiry.

4.1.13 Following full implementation of the Freedom of Information Act on 1 January 2005 the Ministry of Defence policy in relation to the release of Board of Inquiry reports changed to reflect the underlying principle of that Act, which is that information held by public authorities should be made available to members of the public on request unless an exemption applies.

4.2 Standard of Proof

4.2.1 One of the most important aspects of our task in this review is to determine how paragraph 9 of Annex G, which sets out the standard of proof to be applied in the assessment of negligence in the case of deceased aircrew, is to be interpreted. We were provided with information as to the background to the adoption of this provision by Air Commodore DJ Hine, RAF retired, to whom we are indebted. Air Commodore Hine was, in 1982, appointed chair of an RAF working party tasked by the Air Force to examine RAF Boards of Inquiry regulations. The working party was established by the late Air Marshal Sir Kenneth Hayr (then an Air Vice Marshal and Assistant Chief of the Air Staff (Operations)). During his tenure as the

first Inspector of Flight Safety (1976 to 1979) Air Marshal Hayr became concerned that in Boards of Inquiry into flying accidents findings of negligence were being made too readily, based on sparse evidence with insufficient consideration being given to doubt. The working party comprised flight safety officers from the commands and senior officers from aircrew, operations, engineering, legal and medical branches of the RAF and were assisted by a member of the Air Accident Investigation Branch. Among their terms of reference was a requirement to make recommendations in relation to findings of blame and negligence against aircrew. They gathered evidence and consulted RAF personnel at all levels at home and abroad and reported in the spring of 1983, by which time Sir Kenneth had moved on.

4.2.2 Air Commodore Hine told us that his working party found dissatisfaction among aircrew based on a feeling that they were being unfairly blamed for accidents where the true causes were not obvious. An officer of air rank (Air Commodore or above) wrote to the working party asserting that the stage had been reached when aircrew, faced with terminal emergencies in the air, were staying too long in the cockpit in the vain hope of sorting out the problem. They were delaying ejection to safety where they felt they would face an almost inevitable finding of negligence. We were told that opinion throughout the RAF at the time found it repugnant that deceased aircrew might be found negligent without overwhelming positive evidence to support such a finding. There was also criticism of the fact that Boards were convened and controlled by the officers who had command and control of the flying operations under investigation, and Air Commodore Hine reported that several cases came to light of interference in Boards of Inquiry by Commanders and senior officers "so serious that details of them could not be included in the working party's unclassified report".

4.2.3 The rules governing Boards of Inquiry at the time made no distinction between the approach to assessing negligence in relation to surviving aircrew and that relating to deceased aircrew despite the fact that surviving aircrew had extensive rights to legal representation, and to lead evidence and make representations on their own behalf at all stages of the Board process, rights which were self evidently denied to deceased aircrew.

4.2.4 The working party initially sought to recommend that accident investigation should be separated from the chain of command but this was opposed by various RAF Commands. A compromise recommendation in the working party's final report that there should be a standing pool of Board of Inquiry presidents isolated from the command chain was, according to Air Commodore Hine, ultimately vetoed by Strike Command. Nevertheless the working party secured acceptance by the Air Force Board of amendments to the Manual of Flight Safety which included Paragraph 9 of Annex G, "*Only in cases in which there is absolutely no doubt whatsoever should deceased aircrew be found negligent.*" At the same time the Manual was further amended to include an aid to the assessment of responsibility for aircraft accidents which now appears as Appendix 1 to Annex G. These amendments were made in 1983.

4.2.5 Three years later, in May 1986, Mr WH Tench the former head of the Air Accident Investigation Branch was appointed by the Minister of State for Defence Support to examine Board of Inquiry reports and investigate the methods of conducting inquiries into military

aircraft accidents in all three services and the Ministry of Defence Procurement Executive, in order to establish whether alternative procedures, or any other features, would be more efficient or effective in determining the cause of accidents. In his report he said that of all the features of the Board of Inquiry system, the identification of the person responsible for the accident, and the assessment of whether he was guilty of culpable or mitigated negligence, was the subject of more adverse criticism than any other in the representations made to him.

4.2.6 Drawing upon his extensive experience in the civil accident investigation field his clearly stated view was that the assessment of blame, and in particular negligence, made no contribution to the establishment of the cause of an accident or the remedial measures necessary to prevent it. The sole aim of a Board of Inquiry was to determine what had happened and how it could be prevented in future. He recommended re-examination of Air Commodore Hine's working party's report, which he described as "searching" and more comprehensive than his own on the subject of negligence, in order to convey a true appreciation of all the factors involved. There was evidence, according to Mr Tench, that Boards had a better chance of getting to the truth when they were interested only in establishing the cause of the accident and not in apportioning blame, as the risk of being found negligent could adversely affect the openness of witnesses. To associate aircraft accidents with breaches of discipline as had been traditionally done in the Services was in his view a mistaken notion. The threat of punishment for the breach of a rule which was assumed to have resulted in an accident was far less of a deterrent than the very real threat of a sudden and violent death. The loss of esteem in the eyes of colleagues resulting from an accident could be more important to most pilots than condemnation by a system seen to be obsessed with attributing blame. Quoting the working party's comment that one bad decision on negligence could do much harm to a unit's morale and undermine its trust in "the system" and authority, he went so far as to conclude that the assessment of negligence was totally futile. Disciplinary considerations could properly be taken account of by requiring any investigating body to notify the appropriate authorities when it appeared to them that a breach of discipline might have taken place. He recommended that aircraft accident inquiries' terms of reference should include the statement that it was *not* the purpose to apportion blame or responsibility.

4.2.7 As a separate point, Mr Tench emphasised that the independence of an investigative body from outside influence was fundamental. There should be no question of anyone with the responsibility for the manner in which the flight was conducted being able to prevent its investigation. This would ensure that recommendations for the correction of shortcomings in administration or procedures would not be suppressed by reason of the superior rank of the authority receiving the report over that of the investigating authority. The authority to whom the accident report was submitted should be senior to any interested party or command which had responsibility for the manner in which the accident flight was carried out.

4.2.8 He was concerned that an excessive preoccupation with the assessment of negligence was apparent throughout most of the inquiries he had studied. A disturbing feature for him was the influence which senior officers sought to exert on the investigation process, particularly in the RAF. He described the pervasive nature of the involvement of some Station Commanders,

Air Officers Commanding, Senior Staff Officers and even Commanders-in-Chief as an unwelcome intrusion upon what should be the complete independence of the Board of Inquiry. "*In some cases*", he wrote, *"Station Commanders or [Air Officers Commanding] have changed the findings made by Boards of Inquiry when the report is submitted to them. Not unusually this is in connection with the degree of negligence involved, but occasionally different conclusions have been drawn on technical matters on a basis of the evidence recorded by the Board and the advice of staff officers. It must, of course, always be possible to have reservations about the findings of an inquiry, but to assume superior insight on a basis of rank must be more doubtful. Furthermore, since it is frequently the [Air Officer Commanding] who convenes the Board and decides on the terms of reference, it should not be the [Air Officer Commanding] who provides the answers to the terms of reference. The claim that collectively the officers on the [Air Officers Commanding] staff have a wider diversity of expertise than the members of the Board of Inquiry and are thereby better able to draw conclusions in a basis of the evidence on the report, is an indication of the inadequacy of the Board of Inquiry system".*

4.2.9 Mr Tench also highlighted the problem that in the Board of Inquiry system the investigation was commonly conducted by complete novices. There was no opportunity to accumulate knowledge in the techniques of accident investigation nor was there any continuity of effort. The general theme of the representations he received from service personnel on the existing system of accident investigation was to compare unfavourably the amateur nature of Boards of Inquiry with the painstaking professionalism of the Air Accident Investigation Branch. Accordingly, he recommended that a unit comprising a number of trained professional investigators experienced and qualified in the operation of current service aircraft should take over the duty of investigating all serious aircraft accidents in the three services. As we have said, Mr Tench was writing in 1986.

4.2.10 These were powerful criticisms of the system as it existed at the time of the crash. No steps (apart from the introduction of paragraph 9 of Annex G) were taken to address any of the concerns raised in, or to implement any of the recommendations of, the two reports until 1997, more than ten years later, when a Ministerial Directive by the then Armed Forces Minister directed that Boards of Inquiry should not be permitted to attribute blame or negligence in cases involving unnatural death or serious injury. As we understand it, the controversy surrounding the findings of negligence in relation to the ZD576 crash was a significant factor in the decision to issue that directive.

4.2.11 Subsequently, in 2008, the Armed Forces (Service Inquiries) Regulations (SI 2008/1651), made under Section 343 of the Armed Forces Act 2006, were introduced which met all of the criticisms to which we have referred. As recently as 1 April 2011 the Military Air Accident Investigation Branch was set up bringing together previously established Royal Naval and Army air accident investigation teams with a newly formed RAF element.

4.2.12 Against that background, we are forced to the conclusion that the Board of Inquiry into the ZD576 crash was conducted under a system which was, by generally accepted standards of justice and fairness, manifestly unfair to deceased aircrew, and which had been characterised as flawed by two authoritative reports. It is said by the Ministry of Defence that Boards of Inquiry were intended to be internal investigations to establish what happened in any incident

and to recommend action to prevent recurrence. That ignores the fact that, in cases where deceased aircrew were involved, boards were also empowered, and indeed directed, to carry out a form of post mortem disciplinary function in assessing whether deceased aircrew had been guilty of negligence. That function might, and in this case did, affect the rights of the deceased aircrew's families in relation to compensation. But deceased aircrew had no rights of representation or appeal. In this connection, we should record that members of the pilots' families told us that they were not motivated by questions of compensation.

4.2.13 In the case of surviving aircrew on the other hand, not only were they entitled to full legal representation at every stage of the Board process, but in the event of their being found negligent would be likely to be subject to disciplinary proceedings ultimately in the form of Court Martial, throughout which they would again be entitled to legal representation. In terms of Section 135(5) of the Air Force Act 1955, evidence given before a Board of Inquiry was not admissible against any person in disciplinary proceedings. So in disciplinary proceedings the evidence had to be led all over again and the decision of the Court Martial, or Commanding Officer, or appropriate Superior Authority, had to be based on the evidence led before it or him and not on the evidence led before the Board of Inquiry. Deceased aircrew could not of course be the subject of disciplinary proceedings in the normal sense, so the verdict of the Board constituted the final judgment on their conduct against which, as we have said, there was no appeal. The system has now changed. That change we think can be seen as a belated acknowledgement of the defects of the system in force at the time of the accident.

4.3 Interpretation of Standard of Proof

4.3.1 We turn now to consider the interpretation of the standard of proof applicable to the assessment of negligence by deceased aircrew. We begin by setting out the arguments advanced on this question, firstly, by the Ministry of Defence and, secondly, on behalf of the Mull of Kintyre Group.

4.3.2 The Ministry of Defence's position is perhaps best summarised in their response dated 22 July 2002 to the report of the House of Lords Select Committee. They submitted that the provision was drafted by and intended to be comprehensible to non lawyers. Its effect was that, if a consideration of all the evidence left the Board or a Reviewing Officer with no honest or genuine doubt that aircrew had been negligent, it was their duty to find accordingly. The words "absolutely no doubt whatsoever" were intended to be capable of practical application. They required a distinction to be drawn between honest or genuine doubt and implausible conjecture. Thus it was not permissible to avoid a finding of negligence by recourse to a hypothesis for which there was no evidence and which was revealed as wholly implausible when tested against the known facts. Any accident investigation would inevitably be unable to answer every possible question posed by investigators with absolute certainty. That did not mean that the established facts when taken together could not compel a particular conclusion. A sufficiently detailed picture of the circumstances of any particular accident, pointing

conclusively towards aircrew responsibility, was necessary before a finding of negligence could properly be made. The Department contended that such a detailed picture was available in relation to the ZD576 crash.

4.3.3 Reviewing Officers, argued the Ministry, were able to call on their professional knowledge and experience and could also draw upon the expertise within their headquarters. Having examined various factors and scenarios the professional judgment of the Reviewing Officers in the present case was that none of these could have prevented such an experienced crew from maintaining safe flight. The pilots could and would have avoided the accident had they followed a different course of action to the one they did. Negligence was causative of damage if it operated either alone or in conjunction with other factors. Negligence need not be the sole cause. The hypothesis that the pilots subsequently were not in control of the aircraft as a result of a technical failure such as a control jam, uncommanded flying control manoeuvre or other technical difficulty did not mean that their negligence ceased to be a contributory cause of the crash.

4.3.4 We were advised that the foregoing arguments were based upon advice obtained by the Attorney General on behalf of the Ministry of Defence from leading aviation counsel in 2001 and 2002. In 2001, the advice was sought in anticipation of the House of Lords Select Committee hearings when Counsel was asked inter alia whether it was possible to justify the case put forward by the Air Marshals and the Ministry of Defence both then and in 1995, bearing in mind the very high standard of proof required. In 2002, advice was sought following the publication of the House of Lords Select Committee's report. At that stage Counsel was asked to advise further in relation to the standard of proof applicable to the decisions of the Air Marshals.

4.3.5 The argument presented on behalf of the Mull of Kintyre Group was set out in their 2008 submission to the Defence Secretary prepared by Michael Powers QC and Arnold and Porter, Solicitors, and can be summarised as follows. The standard of proof was higher than the criminal standard of beyond reasonable doubt, and was different from the standard required to establish negligence against surviving aircrew. That was so for good reason: (a) deceased aircrew were unable to defend themselves or be represented before the Board of Inquiry, (b) as a result of their death important evidence was likely to be missing, and (c) the assessment of negligence in the case of deceased aircrew served no disciplinary purpose. Neither the Board of Inquiry nor the Reviewing Officers were under any duty to find that negligence had been established. The suggestion that any alternative explanation for the crash had to be plausible before it could create doubt was wrong. Plausibility was relevant only to likelihood. Any reference to likelihood or probability was inconsistent with the standard of proof imposed by paragraph 9. The distinction drawn in that context by the Ministry of Defence between honest and genuine doubt on the one hand and implausible conjecture on the other was irrelevant.

4.3.6 The suggestion that the determination of negligence was a rough and ready exercise based on the experience of the members of the Board of Inquiry and the Reviewing Officers ignored, it was argued, the terms of paragraph 9 of Annex G. The "absolutely no doubt whatsoever"

test was not subjective. If it were, it would override due process and the requirements of justice. The assessment of negligence was a quasi judicial function which potentially affected the rights of the aircrew under investigation. The test was an objective one. Any finding of negligence required to be supported by sufficient evidence. The Board of Inquiry were unable positively to determine the sequence of events leading up to the accident, and were therefore unable to determine that the pilots had been negligent. Negligence could not be inferred from missing or incomplete evidence. The Reviewing Officers ignored the doubts of the Board of Inquiry. Those doubts were not implausible. They were reasonable doubts held by reasonable people who were fully apprised of the evidence. The possibility that the accident was caused by another factor or factors could not be ruled out. That was sufficient to prevent a finding of negligence.

4.4 Conclusion on Standard of Proof

4.4.1 The test of "absolutely no doubt whatsoever" is an unfamiliar one and it is perhaps not surprising that its interpretation should have given rise to differences of opinion. It is however vital that its meaning should have been properly understood and applied. Otherwise any decision attributing negligence to deceased aircrew which was based on an erroneous interpretation of the test would be contrary to the terms of Manual of Flight Safety which were binding on the Board and Reviewing Officers. The RAF had introduced the rule and it was the RAF's responsibility to ensure that it was properly understood and applied.

4.4.2 In his submission to the House of Lords Select Committee Air Commodore Hine, the author of the test, explained the thinking behind its introduction. He said, "*The regulation – 'only where there is absolutely no doubt whatsoever should deceased aircrew be found negligent' demands a high degree of proof.* ***That was the intention****. Deceased aircrew cannot give witness; they do not have the luxury of civilian law, nor any form of defence or appeal. The [Board of Inquiry] is not a court of law, it is a tribunal of officers who are experts in their own field but not in law.*" He gave examples of circumstances in which gross negligence might be found against deceased aircrew and continued, "*However, without this sort of* ***overwhelming*** *positive evidence [Boards of Inquiry] are very wrong* ***to fill in the gaps to support the most probable cause****.*" [his emphasis]

4.4.3 In 2001 and 2002 two retired Lords of Appeal in Ordinary, the late Lord Ackner and Lord Lloyd of Berwick, made a number of speeches in various debates in the House of Lords relating to the ZD576 crash. On 5 March 2001, quoting the words of paragraph 9 of Annex G to the Manual of Flight Safety, Lord Ackner said "*On that test, there must therefore be absolute certainty. Only in such very limited circumstances is there jurisdiction to find negligence. Here is the very limited power which the Air Marshals had. Only where there was absolute certainty could they make that finding... Clearly, it is being said [by Air Marshal Day] that none of the factors or scenarios [postulated by the Board] is of sufficient strength to provide a likely explanation. That does two things: first, it puts the onus upon the deceased, which is wrong; and, secondly, it deals in probabilities. It does not deal with reasonable doubt and it does not deal with the certainty which the words of the manual require.*"

4.4.4 In a later debate on 30 April 2001, Lord Lloyd of Berwick said "*To sustain its conclusion, the Board of Inquiry has to be left with absolutely no doubt that the crash was the result of pilot error or of negligence on the part of the pilot. That test is an objective one. It means that the Board of Inquiry must have excluded with certainty – that is the critical expression – every other possible cause; otherwise it could not be driven to the conclusion of pilot error. What were the other possible causes? Taking the matter purely hypothetically and knowing nothing about the facts, one possible cause could be engine failure. It does not follow that engine failure did not occur merely because there was no evidence to support such a finding. That is a great mistake and one that is often made. Absence of evidence means what it says: that there is no evidence one way or the other. It is not the equivalent of what is referred to by the noble Lord, Lord Craig, … as negative evidence. …In the end, that raises a legal question rather than a factual one.*" These arguments were repeated in later speeches but, so far as we have been able to ascertain, where never properly addressed by the Ministry of Defence.

4.4.5 In our opinion these speeches contain the correct analysis of the effect of paragraph 9 of Annex G. The paragraph was intended to create the highest possible standard of proof, in order to offset, so far as possible, the unfairness, to which we have already drawn attention, of the Board procedure in relation to deceased aircrew. Negligence had to be proved by evidence. There was no presumption of negligence and no onus on the deceased to disprove it. The standard of proof was self evidently higher than the standard of proof in criminal cases – beyond reasonable doubt. The words "*absolutely*" and "*whatsoever*" emphasised that the doubt was unqualified and unrestricted and could be of any kind. It was not limited to reasonable doubt. A speculative doubt could be sufficient to prevent a finding of negligence.

4.4.6 The test was certainty. But the subjective certainty of the decision maker was not enough to entitle him to make a finding of negligence. If that were so, such findings would not be capable of challenge. The test was an objective one, "*only in cases in which* ***there is*** *absolutely no doubt whatsoever…..*". So the doubt did not require to be one which was shared by the decision maker. He was obliged to consider whether any doubt whatsoever existed, and if one came to his attention, he was prevented from making a finding of negligence. The only kind of doubt which would not prevent a finding of negligence against deceased aircrew was one which, to adapt Lord Diplock's words in the Tameside case (Secretary of State for Education and Science vs Tameside Metropolitan Borough Council [1977] AC 1014, 1064), no sensible decision maker acting with due appreciation of his responsibilities would have decided to entertain. There was no room for drawing a distinction between honest and genuine doubt on the one hand, and implausible conjecture on the other. One man's honest and genuine doubt may be another's implausible conjecture without either acting unreasonably or irrationally. A hypothesis for which there was no evidence, if it created doubt as to what had happened, would also be sufficient to exclude a finding of negligence. In our unanimous opinion, for reasons relating to the quantity and quality of the evidence which we explain later, this case was precisely the kind of case for which paragraph 9 of Annex G was designed to preclude findings of negligence against deceased aircrew.

4.4.7 It follows that if, as was the case here, the original Board took the view that they were unable to make a finding of negligence because of the existence of doubt resulting from insufficiency of information, and so long as they had not misdirected themselves in law and the doubts

which prevented them making a finding of negligence could not be said to be irrational, it was not open to the Reviewing Officers to make such a finding. The existence of doubt in the mind of the Board was sufficient to prevent their doing so.

4.4.8 Air Chief Marshal Day informed us that when the Board Report came before him for consideration he was concerned enough to seek legal advice from the RAF Directorate of Legal Services. This was, we were told, the first time that an Air Officer Commanding reviewing a Board decision had sought such advice.

4.4.9 The circumstances in which the legal advice was provided were as follows. The Board of Inquiry report was delivered to the Group Flight Safety Officer of No1 Group on Friday 3 February 1995. Air Chief Marshal Day's staff approached the Directorate of Legal Services for assurance that the Regulations had been complied with. In response a lawyer of Squadron Leader rank, from the General Advisory Section of the Directorate, went on the instructions of the Director to Air Chief Marshal Day's headquarters on 7 February 1995. He had not previously seen the Board of Inquiry report nor had any detailed information relating to the crash or to the Inquiry's findings. He was unaware of the background to the adoption of paragraph 9 of Annex G and despite attempts to clarify the background no information was available within Directorate of Legal Services. On arrival at headquarters he read the Board proceedings for the first time and spent the rest of the day meeting with Air Chief Marshal Day and his staff, during which the staff gave the strong indication that they could not accept the Board of Inquiry's conclusion. The officer did not provide advice at the time but submitted written advice in a letter dated 10 February 1995, the terms of which he cleared with the Director of Legal Services.

4.4.10 The legal advice contained the following passage dealing with the standard of proof:

"*9. I appreciate that paragraph 9 of Annex G to Chapter 8 of Reference B appears to produce special problems in relation to a finding of negligence. The normal civil standard of proof is "on the balance of probabilities" or "more than likely than not". In criminal proceedings in the United Kingdom the standard for a jury to reach is "satisfied beyond reasonable doubt" or "sure beyond reasonable doubt". The test is* ***not*** *absolute certainty.*

10. "The implication in paragraph 9, the origins of which I have been unable to ascertain, is that ***certainty*** *is required. Whilst it is entirely a matter of internal RAF policy what standard of proof is to be reached, and clearly a high standard is intended, at the end of the day it must be one which is potentially achievable. Absolute and complete certainty about any fact is, as a matter of commonsense, something that humans have some difficulty in achieving save perhaps death. Therefore, the standard outlined in paragraph 9 must be achievable in certain circumstances. A finding will always be an expression of subjective opinion by the person making that judgment, as indeed a jury's finding is merely an expression of opinion by a group of 12 individuals. Thus, if a Board of Inquiry on all the evidence before it, cannot find negligence given that standard, it is still open for a subsequent higher authority to make a different finding on that evidence, if it deems it appropriate. Further there is clear precedent in at least two previous [Board of Inquiry] where a superior authority has found negligence where the Board itself did not […] Such findings are entirely to do with internal RAF management policy, which is why, as I express above, the standard of proof can be whatever the RAF considers that it requires.*" [his emphasis]

As we understand it, this passage contained the only formal legal advice regarding the standard of proof applicable in determining negligence on the part of deceased aircrew which was obtained by any officer at any stage of the Board of Inquiry procedure.

4.4.11 In our view the legal advice afforded to Air Chief Marshal Day was unclear and inaccurate insofar as it failed to recognise the objective nature of the test, placed no restriction on the power of the higher authority to make a finding different from that made by the Board, and introduced reference to RAF policy. The reference to policy can be interpreted as an assertion that the standard of proof meant what the RAF wanted it to mean. That is manifestly incorrect and in conflict with the intention of paragraph 9. The consequence is that Air Chief Marshal Day and Air Chief Marshal Wratten misdirected themselves in relation to the standard of proof.

4.4.12 We have come to this interpretation of the standard of proof on a consideration of the terms of paragraph 9 of Annex G, the report of the Board and the remarks of the Reviewing Officers. Having concluded that the Reviewing Officers did not apply the correct standard of proof, we wish to record our opinion that they considered it to be their duty to make the finding they did. As we shall explain later, a consideration of the factual evidence, or the lack of it, leads us to the view that the Reviewing Officers were precluded from making a finding of negligence.

4.4.13 Having regard to the significance of the Chinook crash in terms of loss of life and the inevitable public interest which it attracted, and in the light of the controversy as to the legality of the Air Marshals' subsequent findings which has developed over the years, it is clear that there was no appreciation in the RAF of the need to examine carefully the effect of the terms of the Manual of Flight Safety in relation to findings of negligence in cases involving the death of aircrew. In that situation the legal advice provided at the time could be described as somewhat perfunctory.

4.4.14 We think it appropriate to emphasise that our opinion on the interpretation of the standard of proof is unanimous. Although the interpretation of paragraph 9 of Annex G is a question of law, the paragraph was framed by a non lawyer for the use of non lawyers. In these circumstances we consider it important that the non legal members of our panel, bringing their experience as legislators to bear, and having considered all the arguments and the material with which we have been provided, have independently come to the same view as the reviewer as to the way in which paragraph 9 of Annex G should be interpreted.

4.4.15 In his discussions with us Air Chief Marshal Day indicated that he considered, in accordance with the legal advice he had received, that he was following precedent. By that, we understood him to mean that there had been previous cases involving deceased aircrew in which Higher Authority had found negligence where the original Board had not. In the light of this explanation we have thought it appropriate to give some consideration to the background against which the Reviewing Officers made their decision in the hope of providing some insight into their approach.

4.4.16 It will be recalled that in the 1980s Air Commodore Hine experienced resistance from senior officers to his proposals to separate Boards of Inquiry from the chain of command. Senior officers were reluctant to relinquish the capacity to review Board decisions even where they might have had command and control of the flying operations under investigation, and could therefore be perceived to have a potential conflict of interest, as they saw this as part of the authority they required for complete command of their operation. These views prevailed and, despite the concerns of aircrew, the provisions of The Queen's Regulations and the Manual of Flight Safety in relation to Boards of Inquiry remained unchanged, apart from the insertion of paragraph 9 of Annex G.

4.4.17 It is our impression that despite the recommendations of Air Commodore Hine's working party and the Tench Report there was a perception among some senior officers that little had changed, and this led to a failure to apply minds carefully to the restrictions which paragraph 9 placed on their power to make findings of negligence, or to consider whether the approach to the review of Board decisions in relation to deceased aircrew should in any way be modified. It also seems clear to us that the RAF Directorate of Legal Services had not prior to 1994 given any consideration to the consequences of the introduction of the standard of proof imposed by paragraph 9.

5 Board of Inquiry Findings

5 Board of Inquiry Findings

5.1 Consideration of the Board of Inquiry Findings

5.1.1 We make no criticism of the composition of the Board of Inquiry. We have no reason to believe that the appointment of more senior officers would have produced a more thorough or accurate report. In the context of the RAF Board of Inquiry system at the time, and with the benefit of hindsight, we are satisfied that the members of the Board had the necessary competence and experience, and in the light of subsequent events, the requisite independence of mind. Wing Commander Pulford was a Chinook Pilot with 2,000 flying hours in the Chinook HC-1. His present rank of Air Marshal gives some indication of his ability. Squadron Leader Gilday was a HC-2 qualified pilot and Squadron Leader Cole was a HC-2 engineer. They had the services of a Board of Inquiry advisor who gave them guidance on procedure and the method without influencing their decision making. Mr Cable, the Air Accident Investigation Branch inspector, told us that he was entirely satisfied that the Board understood what he was presenting to them. He told us, "I was quite impressed with the Board, ….. they seemed quite a sharp bunch".

5.1.2 We met and interviewed Air Marshal Pulford. He told us that he and his colleagues were well aware of the significance of the accident and anticipated that public interest in it would be great. They were aware that their report would be made public and would be the subject of scrutiny, although he recognised with hindsight that they had not fully appreciated the need to make the report more accessible to the general reader. He believed that they had done a thorough job, an assessment which was endorsed by Air Chief Marshal Day and Air Chief Marshal Wratten, at least so far as the gathering of evidence was concerned.

5.1.3 Air Marshal Pulford and his fellow Board members knew both deceased pilots. Both were capable, highly trained, professional officers and he refuted emphatically any suggestion that they were likely to take risks or to act irresponsibly or recklessly. By the nature of their job and according to their confidential reports, the two crewmen were also known to be of high calibre.

5.1.4 Air Marshal Pulford told us that now, as a senior officer, he remained firmly of the view that there was insufficient factual evidence to enable the Board to determine how and why the accident happened. As a result the Board unanimously found themselves unable to make any finding of negligence. He considered that paragraph 9 of Annex G had been wisely incorporated into the Manual of Flight Safety. Although they were reasonably certain that ZD576 was flying fast at low level in proximity to the southern end of the Mull of Kintyre, in the absence of a cockpit voice recorder, a flight data recorder or the evidence of the crew or any other witness, they could not know how or why the crew got into that situation or what they were intending to do. All the Board were able to do was to postulate three possible scenarios as to the cause of the accident. They considered that their terms of reference obliged

them to choose one of them, and they chose the one they considered to be the most probable. Air Marshal Pulford regretted that it had been possible for the Reviewing Officers to make a finding of gross negligence on the basis of the evidence his Board had gathered. Perhaps the report had not made the paucity of evidence clear enough. The Reviewing Officers' finding of negligence was, he considered, based on only one of a number of possible theories as to what happened.

5.1.5 The Board dealt with human failings at paragraphs 66, 67 and 68 of their report. Air Marshal Pulford explained that they had done so because they considered they were required to satisfy the Convening Authority (No1 Group) that they had met their terms of reference. In their initial draft the Board had made no reference to human failings because they felt unable to do so due to the scarcity of evidence. When they briefed the Air Officer Commanding and his staff it became apparent that they were not satisfied that the terms of reference had been met. The Board then reconsidered the question and included the following sentence in their report. "*The Board was unable to positively determine the sequence of events leading up to the accident, and therefore concluded that although it is likely that Flt Lt Tapper had made an Error of Judgement in the conduct of the attempted climb over the Mull of Kintyre, it would be incorrect to criticise him for human failings based on the available evidence.*" Air Marshal Pulford told us that he now regretted including that reference to error of judgment and that it should not have been made. He maintained, and we agree, that the degree of doubt as to what happened was such that it was unsafe to go into the question of human failings at all, or to try to quantify the degree of error.

5.1.6 In relation to the evidence of the weather, Air Marshal Pulford's view was that nobody was in a position to give a precise description of the cloud situation over the south end of the Mull of Kintyre at the time of the accident, and the Board had not attempted to do so. Piecing together all of the various witnesses' evidence, his impression was that the cloud situation was fragmented. "There were elements where they were in fog. There were elements where they were in holes." It was likely (but not certain) that the pilots were in a "goldfish bowl" while flying over the sea. Goldfish bowl conditions are where deteriorating visibility and flying close to the cloud base mean the pilot can look down and see the surface and look ahead and see clouds but no visibly discernable horizon. In this scenario the pilot would use his aircraft instruments in consultation with the outside world. It is not unusual for the aircraft to enter a quickly reducing cloud base. Without a discernable horizon to look at the pilot's situational awareness might become compromised, creating the possibility of disorientation. When this occurred the crew's training was clear and they would have been expected to slow down, but in the absence of a record of what the pilots were saying to each other, the Board did not know why that did not happen. There might have been a disagreement or a lack of communication between them and so no one could be certain that both were negligent.

5.1.7 Views have been expressed that insufficient attention was paid by the Board to maintenance, engineering and airworthiness aspects, including the problems with engines' Full Authority Digital Electronic Control system which were recognised at Boscombe Down during the ongoing trials and experienced by flight crews in 7 and 18 Squadrons after the HC-2 had been released for operational duties. We do not consider that this criticism is justified. The problems

with the Full Authority Digital Electronic Control system (and other technical malfunctions) on the Chinook fleet and the history of ZD576 were investigated by Squadron Leader Cole and the Board were aware, as was Mr Cable, that intermittent engine failure captions, engine run-ups and run-downs, as well as undemanded flight control movements, had been experienced in operational HC-2 aircraft at RAF Odiham and also at RAF Gütersloh. They knew that the load restriction had been placed on the HC-2 to minimise the potential risk of an engine failure on the recommendation of Boscombe Down because the Full Authority Digital Electronic Control system software could not be verified. They took these matters seriously but did not expand on them in their report because there was no positive evidence that a technical malfunction having occurred before or during the accident. Moreover, as these problems were well known in the RAF there was no requirement to include them in their report. In any event, their job was not to investigate all aspects of Chinook operations but to determine the cause of the accident and to make recommendations. The Board did however say that an unforeseen technical malfunction of the type being experienced on the Chinook HC-2, which would not necessarily have left any physical evidence, remained a possibility, and could not be discounted.

5.1.8 The principal source of evidence on which the Board based its findings was the Air Accident Investigation Branch report prepared by Mr Cable. He wrote to this review at his own instigation and we subsequently met and interviewed him. His purpose in writing to us was to correct misrepresentation of his published findings and verbal statements relating to his investigation. He reiterated to us that although the engineering investigation was the most prolonged and intensive of his Air Accident Investigation Branch career the amount of quality evidence uncovered was limited. The absence of cockpit voice and flight data recorders, the multiple impact, and the ground fire which damaged the major proportion of the wreckage greatly reduced the quantity and quality of the available evidence.

5.1.9 The multiple impact nature of the crash meant that it was impossible to determine whether systems settings and instrument indications found in the wreckage represented the setting at initial impact or reflected the subsequent crash manoeuvres. While Mr Cable found no evidence of pre-impact malfunction of the aircraft which could plausibly have contributed to or caused the accident (with the one possible exception of a radar altimeter system fault) he could not dismiss the possibility that such a malfunction had occurred, but had left no evidence in the wreckage. He considered it self evident that it was impossible to prove beyond all doubt that no malfunction had occurred. A number of malfunctions could conceivably have caused ZD576 to impact the ground in spite of the best efforts of the crew to prevent it. He singled out malfunctions in the flight control system, but his experience suggested that, given the relative paucity of evidence, there might well have been other malfunctions affecting other aspects of the aircraft. His own conclusion was that the available evidence was insufficient to determine the immediate serviceability of the aircraft or the causes of the accident with a high degree of confidence.

5.1.10 Mr Cable was at pains to convey his judgment of the strength of the evidence in order to assist the Board of Inquiry. He made considerable efforts to do so fairly and to allocate an

appropriate level of confidence to it. He did not believe that any of his evidence weighting or conclusions had been disputed, but he was concerned that both had been misconstrued. In particular, in the summary of his statement he wrote "*the pre-impact serviceability of the aircraft could not be positively verified, but no evidence was found of malfunction that could have contributed to the accident, with the possible exception of a radar altimeter system fault*". That sentence appropriately represented his judgment that his detailed investigation would *probably* have uncovered evidence of relevant pre-impact malfunction, had there been one, but that this could not be certain. He did not intend the sentence to mean that the absence of findings of pre-impact malfunction conclusively proved that there had been no malfunction. In his experience it was never possible to prove that no pre-impact malfunction had occurred. So it was not possible to prove the pre-impact serviceability of ZD576.

5.1.11 One area in which a malfunction might have caused the aircraft to crash, in spite of the best efforts of the crew to prevent it, without leaving any evidence of its occurrence, was the flight control system. Large fixed wing public transport aircraft were designed with system and structural redundancy which was intended to provide a high level of reliability, so that they could continue to function adequately despite double or triple unconnected failures. This had not yet been possible for manufacturers of helicopters, including the Chinook, a sophisticated helicopter with a complex flight control system. The Chinook had several systems where a single fault could almost inevitably result in a catastrophic failure. These systems included parts of the flight control system where events such as a mechanical linkage jam, disconnection or actuator runaway could render the helicopter uncontrollable.

5.1.12 There were a number of conceivable faults which could have rendered ZD576, either permanently or temporarily, uncontrollable but which would not necessarily have been evident from the wreckage investigation. The reliability of the inserts fitted into the aircraft's flight control pallets and used for mounting multiple flight control components was questionable in that a uniform high standard of bonding of the inserts to the pallets might be difficult to achieve. Insert detachment had previously occurred on ZD576 after only relatively few flight hours following its midlife update. If the mounting for a flight component were to detach, there would be a distinct possibility of an uncommanded flight control manoeuvre or control jam. Mr Cable's investigation of the wreckage showed that most of the inserts had detached from both pallets but it was not possible to establish with confidence whether the detachments had been the result of the crash or had occurred before the accident.

5.1.13 Mr Cable's main concern was that the Reviewing Officers had based their findings of gross negligence on the assertion that ZD576 was serviceable at the time of the accident. For the reasons we have explained, to do so was to misrepresent his statement to the Board. Indeed the Board themselves, although they were unable to determine the cause of the accident with the necessary certainty, ran the risk of making the same mistake. At paragraph 5 of their report, they raised the question of technical malfunction as a possible cause of the accident, but they confined themselves to considering such a malfunction as a possible distraction, rather than a direct cause.

5.1.14 Having considered the Board report along with Mr Cable's statement, and had the benefit of the discussions with Air Marshal Pulford and Mr Cable, we are of the clear opinion that the Board was correct, in the light of the available evidence or the lack of it, to refrain from making a positive finding in fact as to the cause of the accident. As we have already recorded, they limited themselves to postulating three possible "scenarios" which could have been the cause of the accident, and concluding that one of them was the most probable. The evidence did not allow them to attain the certainty as to what happened that was necessary to enable them to make a finding of negligence. In our view they then correctly applied the standard of proof of "*absolutely no doubt whatsoever*", and rightly concluded that it was impossible on the evidence to find that the pilots had been guilty of negligence to any degree.

5.1.15 While we agree with the Board's ultimate conclusion, there were two conclusions which they reached on their way to that ultimate conclusion which we are unable to accept. In part two of their report they came to five conclusions, the final two of which were:

"(d) the aircraft was serviceable to undertake the flight; and

(e) the weather was suitable for the flight but would have required flight in accordance with [Instrument Flight Rules] in the vicinity of the Mull of Kintyre."

So far as conclusion (d) is concerned, in the light of the results of Mr Cable's investigation as he explained them to us, and applying the test of "absolutely no doubt whatsoever", there can be no certainty as the aircraft's serviceability at the time of the accident. It may well be very likely or probable that the aircraft was serviceable at the time, but that is not the same as certainty, which is what was required. Similarly, as we explain in paragraph 6.2.2, there can be no certainty as to the configuration of the cloud or the visibility over the south end of the Kintyre as they appeared to the crew of ZD576 as they approached from the south west.

6 Reviewing Officers

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6.1 The Reviewing Officers' Approach

6.1.1 We had separate meetings with the Reviewing Officers, Sir John Day and Sir William Wratten. In Sir John's case we had three meetings extending over a total of 6 hours. We had two meetings with Sir William, the second at his own request. Both officers gave us a full explanation of the reasoning which led to the finding of gross negligence and repeated and reinforced the arguments they presented at the hearings before the House of Lords Select Committee.

6.1.2 Neither of them had been in the chain of command at the time of the accident, but when the Board delivered their report Sir John Day was Air Officer Commanding No1 Group and Sir William Wratten was Air Officer Commander-in-Chief Strike Command. Both were assisted by their staffs in the review of the Board's report.

Sir John Day

6.1.3 Sir John Day was Air Commodore Operations at Strike Command at the time of the crash and took up appointment as Air Officer Commanding No1 Group in July 1994. He was an experienced helicopter pilot with experience of both Northern Ireland and Chinook operations. He told us that the decision to make the finding of gross negligence in this case was the hardest decision he had had to make in his RAF career and he made every effort not to find the pilots negligent by considering all plausible alternative scenarios.

6.1.4 Sir John said that he had based his decision on the propositions that the aircrew were in control of a serviceable aircraft at and after the waypoint change and at the time of the final cyclic flare, and, in his words, "consciously and on purpose" flew into cloud. In his view the pilots had contravened the most fundamental rules of flight at the waypoint change. They had a choice. They chose not to change course or to reduce speed when the appropriate action would have been to slow down and turn away from the high ground or to climb at the maximum rate of climb to safety altitude. He was absolutely certain that at the point of impact the aircrew were in instrument flying conditions with very limited visibility. In discussion, Sir John accepted that these propositions had been arrived at by applying his professional judgment to the factual evidence provided by the Board report. In other words, they were inferences which he drew from what he believed to be the established facts.

6.1.5 He was unable to say what the precise configuration of cloud at the south end of Kintyre was at the time of impact, but he could not accept Air Marshal Pulford's view that between 299 feet, the level of the lighthouse, and 810 feet, the level at which the crash took place, the cloud may have been broken or fragmented. Whatever the situation was, visibility was not sufficient to maintain Visual Flight Rules.

6.1.6 He could not explain the crew's actions. What they did was "just incredible". But he did not give any consideration in his review as to why they had acted in the way they did. That, he said, would be to engage in speculation. There was no alternative but to find both pilots negligent since both were competent and experienced captains and were both responsible for the safety of the aircraft. Had it been proved that one or other of the crewmen had been between the pilots in the cockpit at the time of the crash he too would have been blameworthy.

6.1.7 When Sir John and his staff considered the Board's report, uniquely in his experience, they were unanimous that a finding of gross negligence was inevitable. By contrast, Sir John said the Board had failed to carry out a robust non-emotional analysis of human failings based on the facts. He went on to say that Air Marshal Pulford was inexperienced at the time and unfamiliar with the standard of proof which required to be met. His conclusion that it was likely that Flt Lt Tapper had made an error of judgment (as opposed to having been negligent) indicated that he did not understand the rules.

6.1.8 In the course of our discussion Sir John conceded that it was possible that the crew had flown into cloud inadvertently. They might have found themselves in goldfish bowl conditions over the sea and flown into cloud without realising they had done so. But if that had happened, they were required to take immediate decisive action by turning away or climbing.

6.1.9 In his view the ultimate cause of the crash was probably the mis-plotting of the waypoint. Had it been correctly plotted the aircraft would probably have cleared the terrain. But in his view the plotting error did not amount to negligence. In visual flying conditions a waypoint was merely a navigational guide used in conjunction with the pilots' observations from the cockpit. Given the weather conditions, they still would have been negligent even if they had cleared the terrain because they were flying so fast and low, but they would have "got away with it".

6.1.10 Sir John was unaware that there was any anxiety among aircrew prior to the accident arising from the difficulties experienced during the introduction of the HC-2 to operational service. Shortly after taking command of N°1 Group he was assured that, on the contrary, 7 Squadron aircrew were desperately keen to fly the HC-2.

Sir William Wratten

6.1.11 Sir William Wratten told us that he took command in September 1994. He had previously been Air Commander and Deputy British Forces Commander Middle East during the Gulf conflict and prior to taking up his post at Strike Command was Director General of the Saudi Armed Forces Project. His first contact with the Board of Inquiry was a telephone call from Sir John Day warning him that he was unable to avoid finding the ZD576 pilots negligent. After it had been signed off by Sir John, the Board report was delivered to Strike Command and circulated to his staff officers. A meeting of his Command headquarters staff was convened and attended by some 20 officers including each of the Command Heads of Branch, the Command Chief of Staff and other officers whose expertise could contribute to

the deliberations. At that meeting it was accepted that the Board's investigation had been comprehensive and there was no need for it to be reconvened, but the unanimous conclusion was that a finding of gross negligence was unavoidable.

6.1.12 Sir William informed us that three elements in the evidence made the conclusion of gross negligence inevitable. Firstly, the pilots were flying in cloud with visibility well below the 1,000 metres demanded by Visual Flight Rules. The Mull of Kintyre was completely covered in cloud from a height of about 300 feet upwards. This assertion was derived from the evidence of witnesses on the Mull of Kintyre at the time of the crash, including experienced lighthouse keepers, none of whom actually saw the aircraft because they were in fog. In those conditions, Sir William contended, the pilots' clear duty was either to divert away from the bad weather or to climb to safety altitude. Such action was instinctive to every pilot. They failed to do this and so put their aircraft in danger. Had they been at safety altitude the accident would not have happened. The pilots' failure to take decisive action constituted gross negligence. That would have been the appropriate finding even if the aircraft had not crashed.

6.1.13 Secondly, the aircraft was travelling at an airspeed of around 150 knots at the time of impact. It was entirely contrary to the pilots' instincts and training to be flying so fast so close to high ground in the prevailing weather conditions.

6.1.14 Thirdly, the aircraft was under the control of the pilots at the waypoint change (1.75 kilometres from impact) and also in the final seconds when it was able to execute the final cyclic flare. This was the inevitable inference from the fact that the pilots changed the waypoint when they did. There was no doubt that at the waypoint change visibility was less than 1,000 metres and the aircraft was therefore in Instrument Meteorological Conditions.

6.1.15 Sir William told us that he and his staff looked "solely and objectively" at what the pilots did. They could not put themselves in their minds. There was no place in accident analysis for claiming that experienced pilots would not behave as these pilots did. That was not relevant. It would never be possible to find a conclusive answer to why they acted as they did. A pilot with a record of recklessness would not have been allowed to continue flying, but in Sir William's experience it was often more experienced pilots who were tempted to carry out risky manoeuvres.

6.1.16 The yachtsman Mr Holbrook's evidence was irrelevant and potentially misleading. Surface visibility could be very different from cockpit visibility in flight. So it was not known whether ZD576 was flying visually over the sea. That could only be an assumption. The possibility that the pilots were experiencing a false horizon could be dismissed.

6.1.17 Sir William was unaware of any anxiety among aircrew in relation to the introduction of the HC-2, and he questioned whether any such anxiety existed. In any event, a pilot had total authority, and indeed a duty, to refuse to fly an aircraft if he had concerns about its safety. Even if the authorities had decided that a particular type of aircraft should be put into service it was the pilot's prerogative to refuse to fly it.

6.1.18 Although there was no certainty as to which of the two pilots was actually flying the aircraft at the time of the accident, Sir William had absolute certainty that both pilots were working together, and that both had the training, experience, ability and the authority to have avoided the accident. It was inevitable therefore that they should both be found negligent. The Board was wrong to exonerate Flt Lt Cook. If he and Sir John Day had concluded that neither pilot could be found negligent because, for example, it was not known whether there had been a disagreement between them, that would have been seen as a "*whitewash*".

6.1.19 Sir William maintained that his conclusion in relation to negligence was based solely on fact and there were no assumptions involved in coming to that conclusion.

6.2 Consideration of Reviewing Officers' Approach

6.2.1 There were a number of aspects of the Reviewing Officers' approach to the consideration of human failings which gave us difficulty. A number of the propositions upon which they based their decision and which they described as established facts were in our view actually assumptions or inferences which, it was argued, were arrived at by exercise of their professional judgment. Part of the Reviewing Officers' responsibility was to exercise their professional judgment to determine whether the pilots had been negligent. But they could only do that on the basis of established facts in cases where there was absolutely no doubt whatsoever. That involved there being absolutely no doubt whatsoever as to how the accident came about. As we explain, that was not the case in the this accident. The Reviewing Officers told us that they exercised their professional judgment to determine how the accident came about. Having regard to the applicable standard of proof, that was not something which they were entitled to do.

6.2.2 For example, on the basis of the weather forecast, the aftercast and the evidence of the witnesses on the Mull at the time of the crash, Sir William took as his starting point the proposition that the visibility over the Mull above 300 feet was between 20 and 400 metres. Sir John Day was certain that visibility at the point of impact was very limited. In his discussions with us Sir William maintained that the perspective of the witnesses who were on the Mull at the time of the crash was exactly the same as the perspective from the aircraft, and dismissed the possibility that the pilots had been deceived by a false horizon. Sir John Day, on the other hand, was prepared to concede the possibility that they were in goldfish bowl conditions over the sea, while Air Marshal Pulford spoke about the possibility of a "fragmented" cloud situation over the Mull and considered it likely that the crew had been in goldfish bowl conditions over the sea. Each one of these views was as valid as the next, but they were expressions of opinion, not facts. In the absence of any evidence as to the view of the south end of Kintyre from the perspective of the pilots, there can be no certainty as to the configuration of cloud over the Mull or the visibility as it appeared to the pilots as they approached from the south west.

6.2.3 We put to Sir John Day the final sentence of Mr Cable's letter to us, "*The possibility that a malfunction of the aircraft, undetected by the investigation, caused ZD576 to crash in spite of appropriate action by the crew cannot be dismissed*". The Air Accident Investigation Branch report was the sole source of evidence of the examination and interpretation of the wreckage. Applying his expertise, Mr Cable did his best to, as he put it, put a level of confidence on the evidence he found. The sentence we have quoted represented the effect that he intended to convey in the summary of his report to the Board when he said, "*…thorough assessment of most control system components was possible and revealed no signs of pre-impact failure or malfunction, although the possibilities of pre-impact system jam or detachment of control pallet inserts were not positively dismissible*", and "*The pre-impact serviceability of the aircraft could not positively be verified*". Mr Cable was at pains to point out that the multiple impact nature of this crash denied his investigation much of the evidence commonly obtained from a crash site and wreckage examination. A single impact accident tended to provide much more information.

6.2.4 Sir John's response was "*……that is not unusual in Air Accident Investigation Branch reports because that's the way they write them. If you're going to go down that line then no deceased aircrew could ever be found negligent … every single Air Accident Investigation Branch report will have those kinds of caveats in them because the wreckage is always such that there is going to be something missing*". When it was suggested to him that he had dismissed the possibility of a malfunction of the kind envisaged by Mr Cable, he said "*Fair enough if you look at it like that, but what I am saying is that any Air Accident Investigation Branch report into an accident would have said the same thing and my judgment was that …. they were negligent at the waypoint change*".

6.2.5 This exchange indicated to us that Sir John did in fact dismiss the possibility of a malfunction of the aircraft of the kind that Mr Cable said could not be dismissed. It was clear to us that Sir John disregarded the passages in Mr Cable's summary, preferring to apply his own judgment. That in our view was something he was not entitled to do given the standard of proof. Mr Cable's expert report raised the possibility of the unserviceability of the aircraft. That created a doubt about the cause of the accident. In the absence of expert evidence to the contrary, and applying the test of absolutely no doubt whatsoever, Sir John was therefore wrong to make the assumption that the aircraft was serviceable and wrong to base his findings of negligence upon it. Sir William Wratten asserted that it was a fact that the aircraft was under the control of the pilots. For the same reasons, we do not consider that this assertion was justified.

6.2.6 The doubts created by the terms of Mr Cable's report were reinforced by the history of the HC-2 and in particular the catalogue of engine control and other malfunctions experienced both at Boscombe Down and by the Squadrons to which the HC-2 had been released. A great deal has been written and said, and continues to be written and said, about the difficulties experienced during the introduction of the HC-2. We do not consider it appropriate in this review to examine and compare the various technical arguments and theories which have been advanced. What is important and relevant to our consideration is that, prior to the crash, the aircraft was experiencing a number of malfunctions the causes of which were not fully understood. We were told that, at the same time, and to some extent as a result, the flight manuals available to pilots were incomplete and in some respects misleading. Against that background, the possibility of the occurrence of a malfunction or malfunctions with which the crew were not fully equipped to cope could not be eliminated.

6.2.7 Flt Lts Tapper and Cook were both Special Forces pilots selected on the basis of their aptitude and competence, and neither had a record of recklessness. Nevertheless, Sir William Wratten considered it irrelevant to consider how likely it was that such pilots would act in a way which was contrary to their instinct and training. Sir John Day excluded consideration of why the crew of ZD576 acted as they did, on the view that to do so would be to engage in speculation. On the other hand, Air Marshal Pulford in his discussion with us was much more reluctant to disregard the training and reputation of the pilots and indicated that these were factors which his Board had taken into account.

6.2.8 While we accept Sir John's contention that expert pilots are on occasions responsible for crashes, we consider that Air Marshal Pulford's approach, given the state of the evidence, was the correct one. When the standard of proof was absolutely no doubt whatsoever, the likelihood of experienced pilots behaving in a way which was so contrary to their instinct and training was something which required to be considered as a factor which could give rise to a doubt. In applying the test the decision maker was required to exclude all explanations for deceased aircrews' actions which were inconsistent with negligence. If he declined to consider why the crew acted as they did he was excluding consideration of factors which could potentially create doubt.

6.2.9 In his remarks and in discussion with us Sir John Day said that in his judgment none of the possible factors and scenarios postulated by the Board and the Officer Commanding RAF Odiham, including possible distraction and disorientation, were so strong that they would have been likely to prevent such an experienced crew from maintaining safe flight. As Lord Ackner said in the House of Lords on 5 March 2001, that approach is at odds with the application of a standard of proof which requires the existence of absolutely no doubt whatsoever. The fact that other informed and experienced officers postulated other "factors and scenarios" which involved a chain of events different from that preferred by Sir John Day means that, objectively, there can be no certainty that the accident happened as a result of a deliberate action on the part of the crew, the basis on which Sir John reached his conclusion. Basing his rejection on the likelihood of this happening involves a mis-direction, since in the application of the test, there is no place for consideration of which scenario is more likely than the other. The existence of a possibility is enough to create doubt. In addition to that, Sir John's approach places the onus of disproving negligence on the deceased, which as we discussed in paragraph 4.4.5 is also wrong.

6.2.10 We cannot know what was going on in the cockpit in the moments before the crash. We do not know why after the waypoint change the handling pilot did not turn the aircraft to head for waypoint B as the SuperTANS would have indicated. We do not know what communication was taking place between the pilots and the crewmen, or what part, if any, each pilot played in causing the aircraft to crash. The Reviewing Officers' approach to these gaps in the evidence was to apply to both pilots what in our view amounted to a presumption of negligence based upon their shared responsibility for the safety of the aircraft. That was not a valid approach when the standard of proof was as it was. Negligence had to be proved beyond all doubt by the evidence. The standard of proof excluded the application of any presumption of negligence

when there were gaps in the evidence. The benefit of any lack of evidence could not accrue to the party seeking to establish negligence, it had to go to the deceased aircrew. To do otherwise was to reverse the onus of proof. The intention of paragraph 9 of Annex G was to prevent that happening. As Air Commodore Hine said to the House of Lords Select Committee "*[Boards of Inquiry] are very wrong to fill in the gaps to support the most probable cause*". What he meant by that, in our opinion, was that while a Board assessing human failings of deceased aircrew might legitimately decide, on the basis of incomplete evidence, what the most likely or probable cause of an accident was, they were not entitled to assume that the missing evidence supported that conclusion, and by that means convert what they considered to be the most probable cause into the certain cause of the accident. The Board of Inquiry selected what they considered to be the most probable cause but refrained from concluding that there was absolutely no doubt whatsoever that that was the cause of the accident. The Reviewing Officers on the other hand did not shrink from that conclusion. In doing so they were, in our opinion, to adopt Air Commodore Hine's words, filling the gaps to convert their view of the most probable cause into the certain cause of the accident.

6.2.11 The Board of Inquiry completed their report on 3 February 1995. About 16 February Sir William Wratten sent a letter to his five Group Commanders expressing concern about aircraft accidents brought about by carelessness and indiscipline and making it clear that he would not tolerate shortcomings in concentration or personal indiscipline in aircrew. He also made certain further points directed at ensuring consistency throughout the command in relation to disciplinary procedure and concluded, "This will of course in no way undermine the certainty for those affected of a fair and unbiased hearing with all the safeguards entailed in the legal process." Sir John Day signed off the Board of Inquiry Report on 30 March 1995.

6.2.12 Sir William was asked about this letter by the House of Lords Select Committee and we also raised it with him. He told us that the letter was not relevant to deceased aircrew and that it was nonsense and insulting to suggest that it created pressure on Sir John Day to reach the conclusion he did. We also raised the matter with Sir John Day. He told us that he did not share Sir William's view about the level of discipline and had verbally told him that he thought the letter was unnecessary. It had certainly not placed any pressure on him in the decision making process. Because of the timing of this letter it is understandable that it might have been seen as having influenced Sir John Day in coming to his decision on negligence. As we have indicated both officers vigorously denied that suggestion.

6.2.13 Sir John Day expressed great concern that, if he and Sir William had not made the affirmative decision they did, the RAF would have been accused of "ducking the issue". He had to get the decision 100% right. He could not be too lenient or too harsh. He believed that his decision was the only honest one. Sir William Wratten said that if they had not found both pilots negligent because it was not known what part each had played in the final few minutes it would have been seen as "the original whitewash". It might appear therefore that consideration as to how their decision would be received outside the RAF was in the Reviewing Officers' minds during the decision making process. If that was so, it would, in our opinion, constitute a potential further misdirection. The officers were making a quasi judicial decision on the

basis of the evidence and the evidence alone. A judge's duty is to make findings based on the evidence and to apply the law. He must not be influenced by concerns as to how his decision will be received. Again both officers strenuously denied that they had been influenced in this way.

6.2.14 For the reasons set out in paragraphs 6.2.1 to 6.2.10 we consider that the Reviewing Officers misdirected themselves in the approach they took to the review of the Board of Inquiry. In our discussions with the Reviewing Officers we were disappointed by their unwillingness to engage in constructive discussion in relation to the assessment of negligence in cases involving deceased aircrew by methods other than that adopted by them. It is a matter of continuing sadness, and, we are sure, of distress to the relatives of those who died, that the debate surrounding the finding of gross negligence in this case has become so polarised and so protracted.

6.2.15 Both Reviewing Officers agreed that there was little point in making findings of negligence against deceased aircrew but, standing the Regulations in force at the time, considered that they had no alternative but to do so. In fairness to them, we do not consider that the application of the unfamiliar standard of proof was an easy task for professional aviators with no legal training. Sir John Day very properly sought legal advice, something which we were told had not previously been done in connection with a Board of Inquiry. Regrettably, the effect of the introduction of paragraph 9 of Annex G had not previously been the subject of careful consideration by the RAF Directorate of Legal Services. The result was that the legal advice provided to the Reviewing Officers did not for the reasons we have already explained assist them in their task. It provided them with comfort when it should have emphasised the restriction on their powers.

7 The Pilots and Aircrew

7 The Pilots and Aircrew

7.1 Concerns Amongst Aircrew

7.1.1 We met a number of serving and retired pilots and aircrew who were flying Chinooks in 1994, most of whom were members of 7 Squadron at the time of the accident. One had in 1994 been recently posted to 18 Squadron, the only other operational Chinook HC-2 Squadron. Our purpose in meeting these gentlemen was to gain some impression as to how the introduction of the upgraded HC-2 was viewed by serving aircrew at the time. Some of those we met have now reached senior rank in the RAF and some have been highly decorated for bravery. We were impressed by the professionalism, commitment to the service and candour of many of them.

7.1.2 We were told that the HC-1 was viewed as an unreliable aircraft and that individual aircraft were frequently unserviceable. On the other hand crews were very familiar with it and, unlike the HC-2 at that time**,** it could be operated free of any restrictions.

7.1.3 The introduction of the upgraded HC-2 was variously described as rushed, fraught and chaotic. The staged withdrawal of HC-1s for upgrade created a running shortage of aircraft. There were difficulties in manning the two types of aircraft as crews had to maintain currency on one or both of them and qualified crew members had to be matched to the appropriate aircraft. The shortage of aircraft meant that flying hours were limited. As a result available hours for training were reduced, which in turn had an effect on the maintenance of crew currency. The conversion course was short but the pilots were familiar with the HC-1s. The phased introduction of the HC-2 meant however that some pilots, including Flt Lt Tapper, were required to go back to flying the HC-1 for a period after undergoing the HC-2 conversion course.

7.1.4 While HC-2s were being introduced to operational service the aircraft was still being tested at Boscombe Down. During this period, both at Boscombe Down and in service with operational squadrons the aircraft experienced unpredictable malfunctions. These mostly affected, but were not limited to, the engines and more particularly their Full Authority Digital Electronic Control system and led to undemanded shutdowns and surges in power, which could cause overheating to the point of self-destruction. Torque mismatching between engines and false captions were also experienced. It was sometimes difficult to identify which of the two engines was faulty and the application of remedial measures to the wrong engine could lead to catastrophic consequences. Most but not all of these malfunctions occurred when aircraft were on the ground.

7.1.5 Boscombe Down did not have the tools to read the engine's Full Authority Digital Electronic Control system software and there was at the time a limit to their understanding of its malfunctions. Nevertheless, on the basis of their testing of the aircraft, they issued procedures and instructions as to how malfunctions should be dealt with by aircrew. Some of these

procedures were however flawed or wrong or created further problems. The flight manual for which Boscombe Down were responsible was incomplete and inadequate, as were the flight reference cards which required frequent amendment and updating. The result of all this was that the response by aircrew to some emergencies, particularly those relating to the engines on the HC-2, could not be instinctive. This was productive of distraction and possible delay in dealing with problems in flight.

7.1.6 As a consequence of these difficulties Boscombe Down imposed restrictions on the operation of the HC-2 in the form of a load limitation of 18 tonnes. Also, until icing trials were completed, an icing clearance of +4°C was imposed, as compared with the HC-1's icing clearance of -6°C. Many sorties in Northern Ireland were still best undertaken by HC-1s not because of airworthiness concerns, but because of the limitations on the use of the HC-2 imposed by its operating clearances and the lack of aircrew familiarity.

7.1.7 18 Squadron were operating in Germany and deployed to the Falkland Islands and were not subject to the same operational imperative as 7 Squadron in general, and the Special Forces flight in particular. 18 Squadron were able to insist on 40 hours flying on the HC-2 before pilots were cleared to fly it operationally. The Squadron briefed operations staff that, as the HC-2 was a new aircraft being brought into service, up to 50% of tasking might be turned down for various reasons, such as weather conditions and availability, while they became accustomed to flying it. 7 Squadron, who were the lead squadron for the introduction to operational service of the HC-2, did not have that luxury in the hostile operational environment of Northern Ireland. In the aftermath of attacks on ground troop movements it became necessary to transport troops in the Province by air. Chinook helicopters were introduced to provide greater passenger capacity than other aircraft. The Chinook had therefore become indispensable to Northern Ireland operations.

7.1.8 At the same time the mid-life upgrade of the Chinook was marred by the malfunctions we have described. A lack of understanding of the cause of these malfunctions led shortly before the accident to a decision by Boscombe Down to cease flying the HC-2. In that situation those in command required to balance the risk to service personnel created by ground troop movements against the risk of flying an aircraft with a history of malfunctions which was comparatively unfamiliar to aircrew. The introduction of the HC-2 could not be halted and on 30 May 1994 it was deployed to Northern Ireland. That decision was taken on the basis of the operational imperative existing at the time and we are not in a position to criticise it. Subsequently, the difficulties with the HC-2 were largely eliminated and it is now regarded as a highly successful aircraft.

7.1.9 The information provided to us satisfies us that there were concerns among aircrew which were caused by the untidy and unpredictable form which the introduction of the HC-2 was taking. Meetings and conversations took place among groups and between individuals, including more than one mass briefing, to discuss the problems which were being experienced with the HC-2. The situation presented a challenge of leadership and the men's loyalty to the service and their concern to maintain the "can do" reputation of 7 Squadron was relied upon.

7.2 ZD576 Crew Concerns

7.2.1 The fact that Flt Lts Tapper and Cook were Special Forces made them particularly suitable for selection for the Northern Ireland posting. They were also considered suitable to see the new HC-2 aircraft into service there. All four members of the crew were regarded by their commanders as very capable and having a close mutual understanding. The pilots were stable, thinking officers and any suggestion that they were reckless or irresponsible was vigorously refuted by all aircrew who knew them. On the basis of their personnel files and psychological assessments, which we have seen, we have no difficulty in accepting this assessment.

7.2.2 We were told that Flt Lt Tapper telephoned his Deputy Flight Commander on the evening before the delivery of ZD576 to Northern Ireland expressing concern that some time had passed since his conversion training. He felt unprepared to fly the aircraft. He had attempted to persuade the tasking authority to spread the load between more than one aircraft, but his request had been refused. Flt Lt Tapper had hoped that Flt Lt Cook would have had more HC-2 experience than he had had and was disappointed that he had not. He asked that delivery of the HC-2 be delayed. His request was passed on to the Deputy Squadron Executive but it was refused. Flt Lt Tapper was told that Sqn Leader Prowse who was delivering the aircraft to Northern Ireland would offer the crew an opportunity to refresh their understanding of HC-2 procedures. The remaining Chinook HC-1 in Northern Ireland was unserviceable on the day of the accident. Following the refusal of his requests Flt Lt Tapper had no alternative but to undertake the tasking to fly the HC-2 to Inverness.

8 Ministry of Defence Response to the ZD576 Accident

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8.1 Ministry of Defence Response Following Board of Inquiry

8.1.1 The Ministry of Defence's principal concerns, apart from the conclusions of the report itself, when presented with the Board of Inquiry report were firstly, the public presentation of the Board's findings, and secondly the question of compensation for relatives of the deceased given that the pilots had been found negligent. This latter point arose primarily from the different status of the passengers and crew; a mix of military and civilian personnel. There was potential that the next of kin of the flight crew, including the pilots who had been found to be grossly negligent, would receive greater compensation than the passengers due to the differing death in service provisions. Expert legal advice was sought and discussions between departments and next of kin representatives ensued. Finally, the Defence Secretary decided that compensation in this case should not be limited to the civil aviation limit and the matter of compensation was settled.

8.1.2 We have seen the correspondence between Ministry of Defence officials and ministerial private offices and also with the Lord Advocate and Solicitor General for Scotland. In these documents, we have seen no evidence to suggest that the Ministry of Defence actively sought to impede the holding of a Fatal Accident Inquiry into the accident. In retrospect, however, the Department could have adopted a more urgent approach in assisting the Scottish authorities.

8.1.3 At his own request we met with Sir Malcolm Rifkind who was Secretary of State for Defence at the time of the accident and at the time of the release to the next of kin and the Procurator Fiscal of the Board of Inquiry report. Before meeting us he was able to review Ministerial papers relating to the accident in order to refresh his memory.

8.1.4 Sir Malcolm was first informed that the Board of Inquiry had made a finding of negligence by a minute from the Air Staff Secretariat to his Private Secretary on 13 April 1995. He was saddened but understood that RAF Board of Inquiry procedure had been correctly followed. He was briefed orally by the Chief of the Air Staff and the Air Officer Commanding, No1 Group, Air Marshal Day. That briefing focused on the consequences of the finding of negligence, and in particular on the question of compensation for the relatives of the passengers, rather than on the findings themselves.

8.1.5 On 9 May 1995 his private office informed him that closer examination of the later paragraphs of the RAF Aircraft Accident Report had revealed that there had been a difference of opinion between the Board and the Reviewing Officers. The Reviewing Officers had made a finding of gross negligence, but the Board had not. He was surprised and concerned that he had not been informed of this at the initial briefing as he considered he should have been, and sought

an explanation of the grounds on which the Air Officer Commanding had overturned the Board's view. He also asked whether the Air Officer Commanding had received legal advice before making his findings. He did not recall having been briefed on the relevant standard of proof. In retrospect he saw this as a relevant consideration which should also have been brought to his attention.

8.1.6 In response to his requests he received an explanation of the respective responsibilities of the Board of Inquiry and the Higher Authority. It was explained to him that the authority of the Reviewing Officers to modify the findings of the Board existed by virtue of their powers of command. The advice also contained the statement that the Reviewing Officers and their staff were much better placed in terms of professional knowledge and experience to take a view on the cause of the crash based on the evidence available.

8.1.7 At that stage Sir Malcolm took the view that it was not appropriate for him to second guess the professional judgment of the Reviewing Officers and that the correct course was for him to assume that the matter had been dealt with according to the rules.

8.1.8 There was no immediate controversy following the publication of the decision but as time went on views began to be expressed by individuals with relevant expertise that the decision was wrong. Subsequent inquiries criticised the finding of negligence on the test of absolutely no doubt whatsoever, and the rules were later changed to eliminate findings of negligence against deceased aircrew.

8.1.9 Sir Malcolm now considered that the finding of negligence was unsafe and unfair. The standard of proof was high for good reason. He considered that it had not been met in this case. The Reviewing Officers had failed to take account of the high calibre of the two Special Forces pilots who had no reputation for recklessness, and he found it difficult to understand how they could conclude with certainty that there was negligence on the part of both of them. While he did not question the integrity of the Reviewing Officers he considered that their position was one of judgment and not of fact. The possibility that there had been gross negligence could not be ruled out, but there were many grounds for doubt and the pilots were entitled to the benefit of it. Sir Malcolm was sufficiently concerned subsequently to seek a meeting with his successor the Rt Hon Geoff Hoon but was unable to persuade him to reopen the matter.

8.1.10 We share Sir Malcolm's concern that he was not initially informed of the difference of opinion between the Board and the Reviewing Officers, or of the standard of proof which applied to findings of negligence against deceased aircrew. As a result he was deprived of the ability to reach a properly informed view on a matter which has given rise to much disquiet inside and outside the service. Since 1995 the Ministry of Defence has continued resolutely to defend the finding of gross negligence and to rebuff all public and private representations that the finding should be reconsidered. Those representations have included cogent arguments based on a sound understanding of the effect of the relevant Regulations. It is our impression that the Ministry of Defence simply turned a deaf ear to those arguments, failing to recognise that

the power of review vested in the chain of command had been very considerably restricted as a result of the adoption of Paragraph 9 of Annex G to the Manual of Flight Safety, and also failing to give adequate regard to considerations of fairness to deceased aircrew. We find it regrettable that a Government department should have taken such an intransigent stance on the basis of an inadequate understanding of the RAF's own Regulations in a matter which involved the reputation of men who died on active service.

8.2 Action Taken Relating to Military Aviation Accidents

8.2.1 As previously noted, in 1997 the then Armed Forces Minister directed that Boards of Inquiry should no longer be permitted to attribute blame or negligence in cases involving death or serious injury.

8.2.2 In response to the Haddon-Cave Inquiry into the crash of RAF Nimrod MR2 XV230 during a reconnaissance flight over Afghanistan on 2 September 2006, the Ministry of Defence created the Military Aviation Authority on 1 April 2010. While part of the Ministry of Defence, the Authority is independent and autonomous. On 1 April 2011 the Military Air Accident Investigation Branch was established as part of the Authority, bringing together the established Royal Navy and Army accident investigation teams with a newly formed RAF team and now undertakes investigations in support of aviation Service Inquiries. The Branch now provides air accident investigation expertise and support to Inquiries building on existing formal and informal working relations with the Department of Transport's Air Accident Investigation Branch. To this end they are co-located at Farnborough to ensure that best practice and training opportunities are built upon.

8.2.3 The Armed Forces Act 2006 had already established Service Inquiries, unifying the disparate processes for the RAF, Royal Navy and Army and placing them on a firm statutory basis. Service Inquiries remained an internal process convened for Armed Services reasons to determine how a serious incident happened and why, and to make recommendations to prevent a recurrence. Extensive guidance in the form of Joint Service Publication 832 "Guide to Service Inquiries" was issued in October 2008 to support the Service Inquiry process. Since its establishment, military aviation accident Service Inquiries have been convened by the Military Aviation Authority's Director General. Suitable panel members are identified by the Service Manning Authorities and appointed by the Director General (or his staff). The Military Air Accident Investigation Branch provide a team of dedicated accident investigators to support the panel and facilitate access to specialist capabilities and experts, including legal support. The Inquiry president submits his draft reports to the Director General who may disclose it to other senior officers for comment or clarification of potential errors of fact or to enable implementation of recommendations. The final report with the Convening Authority's comments is signed off by the Director General and circulated within Ministry of Defence and an executive summary circulated more widely to ensure awareness of flight safety. Implementation of any recommendations is monitored by the Military Air Accident Investigation Branch and assured by the Director General of the Military Aviation Authority.

8.3 Action Taken Relating to Board of Inquiry Recommendations

8.3.1 The Board of Inquiry recommended that all Chinook aircraft be fitted with cockpit voice and flight data recorders at the earliest opportunity and that instrument flight abort procedures be developed. The Board observed that the Flight Reference Cards were confusing and that some orders, procedures and instructions were ambiguous or confusing or were not followed in this case. They also observed that some aircraft components and systems (such as the Digital Electronic Control Unit) could be better tested and monitored. There was also an observation that at a certain frequency some of the avionics systems interfered with the VHF radio.

8.3.2 From the information we have seen the Board of Inquiry's observations and recommendations were addressed and implemented, although we remain concerned about the transport of key personnel.

Movement of Key Personnel

8.3.3 The tasking to transport the ZD576 passengers came from Headquarters Northern Ireland and it is unlikely that they would have been aware of the HC-2 limitations or have considered it an inappropriate aircraft for such a "bus run".

8.3.4 On receiving the Board of Inquiry report, the Ministry of Defence reviewed, in consultation with other government departments, its policy and procedures for carrying "VIP passengers". The Department reached the conclusion that the decision to carry the passengers on ZD576 was not necessarily unsound and that in the future a similar decision would likely be taken. It was decided there was little scope to develop common guidance for the transport of key personnel (except for the Royal family) and that any risk was best judged on a case by case basis. Guidance setting out the considerations to be borne in mind when transporting key personnel was promulgated.

8.3.5 Although we have no reason to doubt the thoroughness of the Ministry of Defence's review, we remain concerned that its conclusions leave open the possibility of a similar accident involving groups of key personnel vital to national security happening in the future. We would therefore encourage the Department to look again at its policy and procedures in this area.

Accident Data and Cockpit Voice Recorders

8.3.6 A programme to install Accident Data Recorders and Cockpit Voice Recorders was in its early stages at the time of the accident as part of the Chinook Health and Usage Monitoring System. The final aircraft installation was completed in mid 2002.

Action Taken Relating to IMC Aborts

8.3.7 The Board of Inquiry recommended the development of formal procedures for the en-route transition from Visual Flight Rules to Instrument Flight Rules and an abort technique for inadvertent entry into Instrument Meteorological Conditions at low level. Formalised Instrument Meteorological Conditions climb procedures were introduced throughout the RAF (not just the support helicopter force) and formed part of pilot training and were regularly refreshed.

8.4 Action Taken Relating to Limitations on the HC-2 Aircraft

8.4.1 The HC-2 was progressively cleared to operate in icing conditions and down to design limit of -6°C from July 1994.

8.4.2 The Full Authority Digital Electronic Control system manufacturer produced an updated version of its software and in September 1998 and through statistical analysis of operating the HC-2 the weight restriction was lifted and the Controller Aircraft Release was amended so that the maximum weight was increased to the 24.5 tonne design limit.

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- Rear Admiral Ian Tibbett (ret) for providing technical advice to the panel; and
- The Review Secretariat staff.

Annex A
Terminology

Annex A – Terminology

A1. The aviation sector uses a mix of units. For ease of reference we have used in this report the units of measurement stated in the relevant evidence. Accordingly, as the aviation sector has not fully adopted the metric system and uses a mix of imperial and metric units we have also had to follow suit. In this annex we introduce the terminology we have used.

Distance, Altitude and Speed

A2. For most navigational purposes pilots use the nautical mile (nm) to measure distance. Although sometimes statute miles or metres are used when, for instance, describing meteorological conditions. The nautical mile is a measurement of latitude where 1° of latitude = 60 nautical miles. While the metric system is generally replacing imperial measurements, the nautical mile relationship to the measurement of latitude is likely to keep it in use for navigation. Consequently, it is practical to keep nautical miles per hour (i.e. knots or kt) for measuring speed.

A3. Altitude is measured in feet (ft) although meters are also commonly used. It is usually measured as the aircraft's height above mean sea level (amsl). Mean sea level being the average height of the surface of the sea for all stages of tide. This height will usually be indicated in the cockpit by a barometric altimeter. Altitude can also be measured as an absolute height Above Ground Level (AGL) and measured by a radar altimeter.

A4. Safety altitude is a specified height that is usually 1,000 feet above the highest terrain feature or obstacle in a defined area. For instance, in the area around the Mull of Kintyre it was 2,400 feet; the highest feature being Beinn na Lice whose peak was at 1,404 feet above mean sea level.

A5. The speed of an aircraft can be measured relative to either the ground it is flying over (ground speed) or to the air it is flying through (airspeed). When the air is moving, as it often is, these two speeds will not be the same. For the same airspeed, a tailwind will increase its absolute speed giving the aircraft a greater ground speed while a headwind will result in a slower ground speed.

Navigation

A6. Aeronautical navigation uses fixed datums, such as those found on maps (and now derived from global navigation systems such as the Global Positioning System (GPS)), and more traditional ones such as magnetic compass bearings. The key datum used for navigation is the North or South Pole. The earth rotates on its geographic Polar Axis which, in the northern hemisphere, is represented by the North Geographic Pole or True North. When navigating

the direction is expressed with reference to the geographic pole and is said to be the True Direction, and symbolised by "T" e.g. 020°T. A compass, however, does not indicate True North but points to Magnetic North, symbolised by "M" e.g. 027°M. The Geographic and Magnetic Poles do not coincide and consequently there is a small but significant difference between the True geographic direction as shown on a navigation chart and the Magnetic direction indicated by a compass. This variation at the Mull of Kintyre was recorded on Ordinance Survey charts as 007° West of True North and was measured at the crash site during the investigation as 012.5° West.

A7. Port and starboard are nautical / aeronautical terms referring to the respective left and right sides of the aircraft as perceived by a person on board facing the front.

A8. An aircraft's course is its direction of travel, called a "track". This is the path followed over the ground and specified as the angle from a fixed reference, usually its angle from True North e.g. 058°T. The aircraft's heading is the direction the aircraft is pointing, again referenced to a fixed (e.g. true north) datum. As an aircraft is flying through the air which is also moving its track and heading will not necessarily be the same but be a combination of its heading and any crosswind. The aircraft will be continuously drifting sideways requiring the pilot to point away from the intended course to counteract these effects.

A9. A flight plan is a document filed by the captain or pilot prior to departure so that operations personnel and air traffic controllers know where the pilot is going and how he intends to get there. The plan includes information such as departure and arrival points, estimated journey time, diversion options in case of bad weather, type of flight (whether instrument flight rules or visual flight rules), the pilot's information, number of people on board, information about the aircraft itself and any other relevant information. The flight plan would be used, where required, by air traffic control to initiate tracking and routing services (where the aircraft enters controlled airspace). In describing the intended route the flight plan may set out a number of navigation or geographical locations or features which mark out the turning points along the route the captain intends to fly. These points are known as waypoints and would be marked on his route map and programmed into the flight navigation system. RAF regulations required that the flight plan be authorised by an authorising officer. In the case of the Chinook detachment in Northern Ireland the pilots were self authorising as the resident unit did not have Chinook experience – however, normally, the captain would seek the squadron duty officer's approval.

Pilots

A10. The Chinook two pilot cockpit had the pilots sitting side by side with the flight controls and most of the instruments duplicated so either pilot could fly the aircraft. One pilot would be designated the "handling pilot" usually sitting in the right hand seat and would fly the aircraft. The other pilot, usually the captain, would be the "non-handling pilot" and occupy the left hand seat responsible for the navigation, supervision and other activities.

Flight Manoeuvres

A11. An aircraft manoeuvres about three axes intersecting its centre of gravity. Moving the nose up or down is known as "pitch" and moving it from side to side is "yaw". Tilting the wings up or down is known as "roll". By combining these manoeuvres the pilot increases or decreases altitude or turns the aircraft. To change heading (i.e. turning) an aircraft must roll into a bank to develop a component of its lift force in the direction of the desired turn.

A12. Aircraft need to generate lift to fly and a helicopter's rotor blades achieve this. Unlike fixed wing aircraft which manoeuvre using aerodynamic control surfaces (e.g. ailerons and rudder), a helicopter only has its rotors to produce lift to manoeuvre it through the air. This is achieved by altering the angle of attack (the angle at which the blade moves through the air) of its rotor blades, which varies the lift forces generated thereby controlling its flight path. To pitch or roll the helicopter, the rotor blades' angle of attack are altered cyclically around the rotation circle, creating different amounts of lift around the rotation. This causes the overall lift force produced to tilt relative to the fuselage. A left or right tilt is known as "lateral cyclic" variation and a fore or aft tilt a "longitudinal cyclic" variation. To increase or decrease overall lift, the angle of attack for all blades is collectively altered by equal amounts at the same time achieving ascents, descents, acceleration and deceleration.

A13. A helicopter is "flared" by pitching its nose up. This is achieved by pulling back on the cyclic (see paragraph B2) to flare the helicopter which is why it is also known as a "cyclic flare". When combined with reducing power, speed and rate of descent will be reduced and would be executed just prior to touchdown. Not reducing power would reduce forward speed but increase altitude achieving a rapid ascent. A flare is also part of a "quick stop" or rapid deceleration manoeuvre often used to abort takeoffs or stop a helicopter in flight. How quickly a helicopter will decelerate can be adjusted by how aggressively the aircraft is flared. The more aggressive the faster the helicopter will stop. Increasing the flare as the helicopter decelerates maintains altitude and causes the helicopter to decelerate faster.

Flight Rules

A14. RAF flying rules state that an aircraft operating Visual Flight Rules must be flown a specified distance from cloud and with a specific minimum visibility. These parameters are set deliberately to ensure that pilots can safely navigate, see and avoid other aircraft, and avoid terrain and other vertical obstacles. A helicopter flying below 140 knots airspeed was required to remain clear of cloud, in sight of the ground, and with a forward visibility of at least 1,000 metres. At an airspeed greater than 140 knots a forward visibility of 5.5 kilometres was required as well as greater separation from cloud. If this was not the case, the aircraft had entered Instrument Meteorological Conditions and the pilot was required to transfer to Instrument Flight Rules. A transition to Instrument Flight Rules required the aircraft to slow down and climb to at least safety altitude for the area in which it is operating. On entering cloud or losing sight of the surface the pilots would have to rapidly climb to at least safety

altitude at maximum power and best climbing speed, while also turning away from any high ground or obstruction.

Military Aviation Accident Reports

A15. Apart from the Board of Inquiry report the RAF also produced two summary reports. The Military Aircraft Accident Summary (MAAS) was a statement intended for public release summarising the Board of Inquiry findings and designed to increase awareness of flight safety in the civil aviation world. As an unclassified document it did not detail the comments of the chain of command. The Aircraft Accident Report (AAR) was a classified document recording the findings of the Board of Inquiry, the subsequent comments of the chain of command and the subsequent action. This allowed the reader some insight into the workings of the system, thereby generating confidence in it. By virtue of its classification, the Aircraft Accident Report was not intended to be released to the public.

Annex B
Chinook Flight Controls

Annex B – Chinook Flight Controls

B1. The Chinook is one of the heaviest lifting helicopters in military service. It is used primarily for transporting troops and carrying loads (both internally or under slung). It can carry up to 54 troops or 10 tonnes of cargo and the cabin is large enough to accommodate two Land Rovers. It is crewed by either two pilots, or a pilot and navigator, and two Air Loadmasters in the cabin. The Chinook's twin-engine tandem rotor design makes it a complex aircraft with a flight control system that differs significantly from conventional single main rotor helicopters.

B2. The pilot controls the helicopter with three flight controls: the cyclic stick, the collective lever, and the anti-torque pedals. These produce four flight control channels: collective (also known as thrust), pitch, roll and yaw. The four channels are translated into control movements for the two rotor heads through a complex linkage system of mechanical, hydraulic and electrical actuators, and various sensors, springs, dampers and brakes. The force required to move the rotor head controls mean they cannot be moved without hydraulic assistance. Unlike a typical single main rotor helicopter, the Chinook, with its tandem rotors, the pilot only controls the collective and lateral cyclic settings of the rotors while the longitudinal cyclic is varied by an Automatic Flight Control System in response to airspeed changes.

B3. The mechanical linkages from the cockpit flight controls are combined with other flight controllers, such as the Automatic Flight Control System (AFCS) and Differential Airspeed Hold (DASH) system within mixing units to produce integrated outputs for the aircraft's four control components (collective, pitch, roll and yaw). These mixing units are attached to mounting pallets and tightly packed in a compartment behind the left-hand pilot seat (known as the control closet or "broom closet"). The Automatic Flight Control System automatically maintains the desired airspeed, altitude, bank angle, and Heading. The Differential Airspeed Hold, also controlled by the Automatic Flight Control System, modifies the pilots' control systems to improve the helicopter's flight characteristics, its stability, provide autopilot functions and maintains the desired airspeed. The four control components drive Integrated Lower Control Actuators which convert mechanical commands into two hydraulic commands that feed the Upper Boost Actuators located below the rotor head swash plate. Because the main rotor blades are spinning, the swash plate is used to transmit commands from the non-rotating aircraft to the rotating rotor hub to alter the rotor blade angle. Raising or lowering the entire swash plate assembly changes the pitch of all blades simultaneously and pushing one side up or down changes the blade pitch cyclically.

B4. Redundancy in the flight control systems are sought wherever possible to minimise the risk of a system failure and provide high reliability. However, the complexity of helicopters means that there are points in the system where a single failure could result in a flight control system failure. An example in the Chinook was the "broom closet" housing a large amount of mechanical linkages in a very tight space. A loose article or a detached mounting pallet could interfere with or restrict a control linkage leading to a single critical failure.

B5. The Chinook was powered by Lycoming Model T55 gas turbine engines with one mounted on either side of the aft pylon. Each engine had two main sections: a gas producer similar to a jet engine producing hot pressurised gases and a power turbine driven by the pressurised gas delivering mechanical power to an output shaft located at the front of the engine. The output shaft in turn drove the engine transmission. The power plant included fuel, cooling, control and starting systems. The fuel system was a hydro-mechanical device that pumped fuel into the engine at a rate that maintained a desired turbine speed. On the HC-1 model the engines were controlled by a hydro-mechanical fuel / power regulator system. The HC-2 was one of the first military helicopters to be fitted with a Full Authority Digital Electronic Control (FADEC) system which utilised many of the existing HC-1 engine and aircraft sensors and controls but delivered improved engine performance, reliability and reduced flight and maintenance crew workloads.

B6. The primary components of the Full Authority Digital Electronic Control system were the Digital Electronic Control Unit and Hydro-Mechanical Assembly. The Hydro-Mechanical Assembly, controlled by a Digital Electronic Control Unit, was mounted on the engine and housed the primary and reversionary fuel control components and monitored and controlled fuel flow to the gas producer. The microcomputer-based Digital Electronic Control Unit was a dual channel digital controller with primary and reversionary channels controlling fuel to the engine to slow down or speed up the gas producer rotor so that the power turbine speed remained nearly constant as the load varied. The reversionary system served as the back-up fuel metering system. Each engine was controlled by an engine condition lever which selected the appropriate fuel flow rates for STOP (engine shutdown), GROUND and FLIGHT. Maximum engine speed (the engines were rated for emergency power) for a limited cumulative amount of time was demanded by raising the collective control into the emergency power range.

B7. On the HC-1, pilots had to continuously manage load share (as indicated by dual torque-meters) between the engines by monitoring and adjusting engine speeds to keep them matched through a process called engine "beep trim". The Full Authority Digital Electronic Control system did this automatically. If the system failed it was designed to default to the reversionary mode and a predetermined setting and the pilot would revert to manual engine trim.

B8. It was important to ensure that the engine temperature remained within safe limits and so was monitored by the Power Turbine Inlet Temperature (PTIT) system which monitored the temperature of the air passing through the power turbine. Any temperature change could provide the pilot with a primary indication of an impending engine emergency situation such as a "flame out" or a developing fault in the engine.

B9. Power from the engines was transferred to the rotor heads by the transmission system. The engine shaft assembly transmitted torque from each engine transmission to a combining transmission which in turn distributed the combined torque to the forward and aft transmissions. The speed was then reduced before driving the forward and aft rotary-wing heads. These were mechanically connected to keep the forward and aft rotors in phase.

B10. The flight control hydraulic system powered the four Upper Boost Actuators and four Integrated Lower Control Actuators. It comprised two identical systems operating in parallel to provide redundancy should one fail. The utility hydraulic system supplied hydraulic power for non-flight essential hydraulic systems such as wheel brakes, power steering, ramp and cargo door and engine starters.

B11. The Chinook cockpit provided the pilots with a range of instruments to assist in flying the aircraft and monitoring its operation. The flight and navigation instruments included a compass, Air Speed Indicator, barometric and radar altimeters, vertical velocity and attitude indicators, an artificial horizon and Ground Speed and Drift Indicator. Aircraft monitoring instruments included engine and rotor tachometers and torquemeters, temperature and pressure gauges, other control indicators and a Central Warning Panel (which included engine fail captions). There were also control panels for the various aircraft systems.

B12. The navigation system comprised the RNS252 SuperTANS Tactical Area Navigation System which was a single-unit panel-mounted navigation computer. It used an input from the doppler system, which used a downward looking radar to bounce a signal off the earth's surface to determine the aircraft's motion and hence calculate the aircraft's position by dead reckoning, and the aircraft's compass heading plus an additional sensor, usually the Global Positioning System receiver. The Global Positioning System (GPS) used a number of navigation satellites to provide position and altitude (depending on the number of satellites in view). While now considered very accurate and reliable, in 1994 GPS was a new technology having only become fully operational during that year. Operational guidance was that GPS accuracy could not be guaranteed and should not be used as a sole navigation aid. The SuperTANS assisted pilots in determining their position, bearing, distance and their time-to-go to a selected waypoint. Steering guidance was presented via the system's display and the Attitude Indicator / Steer Meter on the instrument panel. The navigation advice presented depended on the steer function selected which could be Search and Rescue, Tactical, or Route. When Tactical Steer was selected the SuperTANS provided steering guidance to fly directly to the selected waypoint. Navigation was also supported by the Tactical Air Navigation System (TACAN) which was used by military aircraft to provide a bearing and distance to a navigation beacon and the civilian VHF Omnidirectional Radio Range (VOR) system that also provided the bearing to a fixed navigation beacon. An Automatic Direction Finder (ADF) was used to provide the bearing to a radio transmitter such as a beacon.

B13. The aircraft was fitted with an Identification Friend or Foe / Secondary Surveillance Radar (IFF/SSR) system. This was an aircraft transponder that replied to an interrogation signal (for instance sent by air traffic control) by transmitting its identity, altitude and a four digit status code set by the pilot such as 7700 for a general emergency or 7001 for a sudden military climb out from low-level operations.

B14. Accident Data and Cockpit Voice Recorders were principally for the purpose of post accident investigation. An Accident Data Recorder, also known as a Flight Data Recorder, was a device that recorded instructions sent to electronic systems on an aircraft and certain aircraft

performance parameters. A Cockpit Voice Recorder was a flight recorder used to record the audio environment on the flight deck. In the case of the Chinook these recorders were incorporated in its Health and Usage Monitoring System which monitored the performance of an aircraft which seeks to signal the need for maintenance action if the monitored data (from engines, transmission, rotors, etc.) did not lie within a normal or healthy range. These were on fitted to the HC-2 in 1994.

B15. The Chinook would also be fitted with mission specific equipment such as a defensive aids suite to protect from ground based missile attack.

Annex C
Previous Reports

Annex C – Previous Reports

Given their length we have not annexed copies of previous reports. These can, however, be accessed on the parliamentary and departmental websites.

The RAF Board of Inquiry report and Air Accident Investigation Branch statement to the Board was published by the House of Lords Select Committee and can be found here:
http://www.publications.parliament.uk/pa/ld200102/ldselect/ldchin/25/25we.pdf

The Military Aircraft Accident Summary for RAF Chinook ZD576 can be found here:
http://www.mod.uk/DefenceInternet/AboutDefence/CorporatePublications/AirSafetyandAviationPublications/MAAS/1990s/19940602RafChinookHcMk2Zd576.htm

The Fatal Accident Inquiry determination and note was published by the House of Lords Select Committee and can be found here:
http://www.parliament.the-stationery-office.co.uk/pa/ld200102/ldselect/ldchin/25/25we21.htm

The House of Commons Defence Committee's Fourth Report for the 1997-98 Parliamentary Session on "Lessons of the Chinook Crash on the Mull of Kintyre" (HC611) published on 13 May 1998 can be found here:
http://www.parliament.the-stationery-office.co.uk/pa/cm199798/cmselect/cmdfence/611/df0402.htm

The Government's response to the House of Commons Defence Committee's Fourth Report for the 1997-98 Parliamentary Session on "Lessons of the Chinook Crash on the Mull of Kintyre" dated July 1998 can be found here:
http://www.parliament.the-stationery-office.co.uk/pa/cm199798/cmselect/cmdfence/1109/110904.htm

The Public Accounts Committee's Forty Fifth report for the 1999-2000 Parliamentary Session on "Ministry of Defence: Acceptance of the Chinook HC-2 helicopter" (HC975) published on 30 November 2000 can be found here:
http://www.publications.parliament.uk/pa/cm199900/cmselect/cmpubacc/975/97502.htm

The House of Lords Select Committee report on "Chinook ZD 576" (HL paper 25(iii)) published on 31 January 2002 can be found here:
http://www.parliament.the-stationery-office.co.uk/pa/ld200102/ldselect/ldchin/25/2501.htm

The Government's response to the House of Lords Select Committee report on "Chinook ZD 576" dated 22 July 2002 can be found here:
http://www.mod.uk/NR/rdonlyres/AE81D0D3-8025-4567-A658-47B561CC6F83/0/chinook_response.pdf

The 2008 Legal analysis commissioned by the Mull Of Kintyre Group can be found here:
http://www.medneg.co.uk/Campaign_Legal_Review.pdf

The Ministry of Defence's response to the Mull Of Kintyre Group Legal analysis can be found here:
http://www.mod.uk/NR/rdonlyres/B4E7598B-4F43-4ACD-BAB0-79943C867AAF/0/mullofkintyre_report_response.pdf

Annex D
Summary of Board of Inquiry

Annex D – Summary of Board of Inquiry

D1. The RAF convened a Board of Inquiry immediately after the accident with the members of the Board assembling on 3 June 1994 at RAF Benson and attending the crash site later that day. The Board was convened by the Convening Authority, No1 Group, the RAF Group owning the accident aircraft, and comprised a president and two specialist officers. These Board members were Wing Commander (now Air Marshal) Andrew Pulford, the president, Squadron Leader Gilday (a helicopter pilot) and Squadron Leader Cole (an aircraft engineer). All had current or recent experience of Chinook helicopters. At the same time the Air Accident Investigation Branch was requested by the RAF to carry out a technical investigation of the crash and to assist the Board in its work. Mr AN Cable and Mr R Parkinson from the Branch were appointed to conduct that investigation and to provide technical assistance to the Board. Mr Cable also advised the Board on the analysis and survey of the crash site and on recovery, layout and detailed analysis of the wreckage. The Board was initially provided with a flight safety specialist advisor to provide guidance on Board of Inquiries and to assist in its establishment and operation.

D2. The Air Accident Investigation Branch was part of the Department for Transport and responsible for the investigation of civil aircraft accidents and serious incidents within the UK. The Chief Inspector of Air Accidents reported directly to the Secretary of State for Transport. The RAF was responsible for investigating military aviation incidents but its longstanding practice was to instruct the Air Accident Investigation Branch to provide the technical investigation while the Board's RAF officers assessed the operational aspects. In their civil aviation work Air Accident Investigation Branch inspectors investigated the accident to arrive at a conclusion as to its cause or causes. When advising RAF Boards of Inquiry their practice was to confine themselves to carrying out an engineering investigation, leaving the analysis of the findings and the conclusion as to cause to the Board.

D3. Mr Cable is now retired but was then a Senior Inspector of Air Accidents (Engineering) with 18 years' experience as a crash investigator involving a wide range of civil and military fixed wing and rotary wing aircraft. These included three previous Chinook accidents: an RAF Chinook HC-1 and two civil variants (known as the BV-234). He was assisted by two RAF Chief Technicians with extensive and detailed engineering knowledge of the Chinook who provided specialist technical information. This was the most prolonged and intensive investigation that Mr Cable conducted during his time with the Air Accident Investigation Branch, working virtually full-time for some six months. At the end of his investigation on 5 January 1995 he reported his findings in the form of a factual statement to the Board. The Board used this and other evidence in their analysis of the potential causes of the accident reporting to the Convening Authority on 3 February 1995.

D4. The Board's terms of reference specified by the Convening Authority were typical of a RAF Board of Inquiry at the time; these were:

(a) Investigate the circumstances of the accident to Chinook HC-2 ZD576 at Mull of Kintyre on 2 June 1994;
(b) Determine the cause or causes of the accident and examine related factors;
(c) Ascertain degree of injury suffered by persons both service and civilian;
(d) Ascertain if service personnel involved were on duty;
(e) Ascertain if all relevant orders and instructions were complied with;
(f) Ascertain if aircrew escape and survival facilities were fully utilised and functioned correctly;
(g) Ascertain extent of damage to aircraft, public property and civilian property;
(h) Assess any human failings;
(i) Investigate the loss of all classified material carried on or in the aircraft at the time of the accident; and
(j) Make appropriate recommendations.

D5. The Board of Inquiry received oral and written evidence both formally and informally from a range of witnesses and technical experts. Having completed a technical investigation, the Board carried out a detailed diagnosis of potential causes of the accident based on the available evidence. They considered the following factors, any of which they thought could conceivably have had a bearing on the accident:

(a) Crew's mental and physical state;
(b) Crew's Currency;
(c) Human Factors;
(d) Operational Procedures;
(e) Birdstrike;
(f) Mid-Air Collision;
(g) Hostile Action;
(h) Structural Failure;
(i) Technical Failure;
(j) Loose Article/Control Restriction;
(k) Electromagnetic Interference;
(l) Crew Incapacitation;
(m) Spatial Disorientation;
(n) Visual Illusion;
(o) Task Factors;
(p) Weather;
(q) Navigation Error;
(r) Instrument Flight Climb Procedures;
(s) Altimeter Procedures; and
(t) Crew Distraction.

D6. Following onsite examination, the wreckage was transported to the Air Accident Investigation Branch facilities at Farnborough and a detailed investigation undertaken. The aircraft systems are described at Annex B. Crash investigators are not necessarily specialised in any particular type of aircraft or system. It was, and is, therefore normal practice to obtain specialist assistance from manufacturers and operators to provide the detailed information or analysis of a particular system. The accident investigator ensured that any investigation or analysis remained independent and unbiased. In this case the aircraft, engine and avionics manufacturers assisted the investigation under the supervision of the Air Accident Investigation Branch and RAF investigation teams. Squadron Leader Cole, the Board's engineering member, also researched the history of the Chinook HC-2 in general and ZD576 in particular.

D7. Examination of the crash site and wreckage determined that the aircraft initially impacted on a small rocky outcrop at 810 feet, 594 feet below and 0.56 nautical miles west of the summit of Beinn na Lice resulting in severe damage to the lower and rear portions of the fuselage and sponsons. The secondary impact very shortly afterwards caused severe damage including the rupture of the fuel tanks which caused a ground fire. Around 20% of the fuselage structure was destroyed and 80% appreciably damaged. Many sources of valuable evidence commonly available to an investigation (such as cockpit and cabin instrument indications, actuator positions, etc) were absent because of the fire and the multi-impact nature of the crash (giving time for instrumentation to change from their settings at initial impact). This made it difficult to determine the state of the aircraft at the instant of initial impact. Because of the extensive damage and the lack of either cockpit voice recorder or accident data recorder the Board had very little evidence to go on with most of the evidence coming only from the examination of the crash site and remaining wreckage. Mr Cable told the House of Lords Select Committee and confirmed to us that: "… *throughout this investigation the evidence was remarkably thin, from my point of view, I must say. We spent a great deal of time trying to find evidence.*"

D8. The Air Accident Investigation Branch investigation concluded from examination of the crash site and the wreckage that the aircraft initially impacted climbing at approximately 20 degrees above the horizontal with a 5 to 10 degree left roll and approximate groundspeed of 147 knots on a 012 degree True track. The aircraft was erect, rolled slightly left and pitched approximately 30 degrees nose-up. The aircraft continued almost 200 metres from the initial impact point before impacting the ground while inverted. The aircraft manoeuvred violently while being struck by the rotor blades breaking into two with substantial parts breaking off during the crash. The passengers and crew were thrown out of the aircraft during the crash. The investigators also determined that:

(a) The completeness of the aircraft at impact could not be positively verified but there was no evidence of explosive effects, pre-impact fire or separation of any part.

(b) Examination of the rotor, transmission and flight control mechanical and hydraulic systems showed no signs of pre-impact failure or malfunction. Most primary flight control system actuators and parts of the Differential Airspeed Hold and Longitudinal Cyclic Trim Actuators remained functional and available evidence indicated normal Automatic Flight Control System operation. The possibility of pre-impact detachment

of the flight control system pallet inserts and / or a control system jam could not be positively dismissed. It was noted that on 10 May 1994 ZD576 suffered a failure of the bonding on the thrust control balance spring and the bracket had detached from the pallet assembly. This had been repaired and there was no evidence that it had failed again prior to impact. The Board was of the view that most of the attachment brackets for the control pallets probably became detached during the post-impact breakup of the aircraft.

(c) While there was no evidence of pre-impact failure or malfunction of the flight control hydraulic system, there was some contamination of the lower control actuator hydraulic system which formed part of this system and possible utility hydraulic system abnormalities were suggested by some indications, but the evidence was not positive and not confirmed by component examination.

(d) The engine condition and available evidence of instrument indications and control settings suggested normal operation of both engines at the time of the accident. Fire had destroyed the N°1 Digital Electronic Control Unit memory so its status was unknown but the N°2 unit remained partially functioning consistent with crash damage. Data downloaded from the unit showed that the operating program and constants had not altered since its delivery, no abnormal exceedances or faults had been detected over its life and no faults had been detected on the last flight. Post-crash testing found both engine fuel control hydro-mechanical assemblies functioning correctly.

(e) The available evidence indicated that there was no major pre-impact loss of electrical power and that all electrical systems had probably de-energised almost immediately on initial impact.

(f) A radar altimeter transmitter fault was unlikely to have affected system performance. Post-crash analysis of the Global Positioning System determined that the anomaly identified earlier in the day of the crash where the system was tracking more satellites than it could see was not present at power-down. The SuperTANS Tactical Air Navigation System was found to be switched off in the wreckage, but analysis by the manufacturer, showed that it was switched on and performing correctly at the time of loss of power (at or very shortly after first impact).

(g) The status of the cockpit warning captions was unknown and few reliable instrument indications were found.

D9. The SuperTANS Tactical Air Navigation System was analysed by the manufacturer, RACAL. The company was able to download the system's memory and the data showed that the system was switched on and performing correctly up to loss of power at, or very shortly after, first impact. It indicated that the second waypoint B had been selected when the first waypoint A was 0.81 nautical miles distant and 0.95 nautical miles from the final recorded (crash) position. The system was commanding "steer left". The SuperTANS only retained the last measured altitude so gave no information as to height or time at the waypoint change. The last measured altitude at approximately 15 to 18 seconds before power down was 468 feet plus or minus 50 feet.

D10. The final seconds of the flight were modelled by the Defence Research Agency Flight Dynamics and Simulation Department and by Boeing Rotorcraft. The simulations sought to determine the aircraft's final behaviour based on a range of potential pre-impact steady flight conditions derived from the crash investigation. As a model is a mathematical approximation of a complex real world problem and only as accurate as the data input and fidelity of the simulation, this work sought to provide confirmatory data and not a definitive description of ZD576's final moments. The Defence Research Agency found a ready match for the most probable final flight trajectory where initial conditions combined an airspeed of 150 knots with a rate of climb of 1,000 feet per minute. To achieve a maximum rate of climb, far exceeding 1,000 feet per minute, the airspeed would have had to reduce to 80 knots or less. The Boeing simulation indicated that a sharp up-collective and back-cyclic pull-up manoeuvre (flare) combined with initial conditions of approximately 150 knot airspeed and 1,000 feet per minute climb rate was required to produce the assessed combination of aircraft pitch attitude, flight path, speed and Differential Airspeed Hold and Integrated Lower Control Actuators extensions at impact.

D11. In response to the House of Lords Select Committee questioning of the simulation's accuracy, the Ministry of Defence directed Boeing to undertake additional analysis which was presented in the Department's response to the Committee's report. The simulation included a gross representation of a Full Authority Digital Electronic Control and used additional data not previously made available. This analysis concluded that the aircraft was following its intended flight path up to the waypoint change but did not follow the navigation system's directed flight path, rather it made a small course change towards the Mull. It flew at an airspeed towards the higher end of the normal cruise range. As it approached the Mull it slowed to a speed more consistent with the initiation of a cruise climb but was insufficient to clear the high ground. While there were inconsistencies between the modelling and the evidence from the wreckage, this gross assessment was considered valid.

D12. Electromagnetic compatibility and interference analysis of transmitters in the vicinity of the crash site and typical mobile telephones and laptop computers on board at the time were undertaken by the Aircraft and Armament Evaluation Establishment Aircraft Systems Engineering Unit. They concluded that these systems did not pose a hazard to a Chinook HC-2.

D13. In compiling his Statement, Mr Cable went to considerable effort to judge the strength of the available evidence fairly and to allocate an appropriate level of confidence to it. His statement concluded that: "*A detailed investigation of possibly relevant technical aspects of the accident was made. The pre-impact serviceability of the aircraft could not be positively verified, but no evidence was found of malfunction that could have contributed to the accident, with the possible exception of a radar altimeter system fault.*"

D14. In addition to the technical investigation the Board investigated the operational aspects of the final flight and the HC-2 aircraft in general drawing upon a range of experts. The Board concluded that:

(a) The crew were properly authorised, competent and fit to fly the sortie and did not become incapacitated during the flight but may have become spatially disorientated

contributing to the accident. Also, while unlikely, visual illusion could not be discounted as a contributory factor. Human factors could have been a factor in the accident.

(b) The flight was well planned and the chosen route was logical and sound for a Visual Flight Rules sortie. However, waypoint A, the Mull of Kintyre lighthouse was misplotted by 280 metres.

(c) There was no evidence of a collision, hostile action or structural failure.

(d) A technical failure was unlikely to have been the direct cause of the accident but given the number of unforeseen malfunctions the HC-2 had experienced, mainly associated with the engine control system, a malfunction or warning may have distracted the pilots and contributed to the accident. Radio operation or a passenger would not have distracted the crew.

(e) As the weather in the vicinity of the Mull was very poor with low cloud bases and visibility, weather was a contributory factor in the accident.

(f) While there were no formal instrument flight climb procedures, the crew were experienced in undertaking the expected manoeuvres.

(g) It was likely that the radar altimeter settings and their audio warnings would not have alerted the pilots to their proximity to the ground and would have contributed to the accident.

D15. The Board then sought to reconstruct the events immediately prior to the crash and came to postulate three possible scenarios which, in their opinion, could have been the cause of the accident:

(a) Suitable rate of climb to clear the high ground was determined by the pilots but not flown;

(b) No decision was taken by the pilots; and

(c) Inappropriate rate of climb to clear the high ground selected and flown.

D16. The Board then attempted to establish which one of these scenarios were the most probable. The Board concluded at paragraph 60 of their report that the least likely was the crew having decided upon a suitable rate of climb but not achieving it. The short time interval between the waypoint change and final flare was sufficient for the crew to make some attempt to avoid hitting the ground earlier than they did even though there were plausible reasons for their failure or inability to do so, making this scenario unlikely. The alternative that the crew had not made a decision by the final flare appeared to be contradicted by a rate of climb prior to it. That left the crew having selected an inappropriate rate of climb to clear the high ground.

D17. The Board found that human factors (that address the human contribution i.e. pilot error), spatial disorientation, visual illusion or distraction could have contributed to the accident either singly or in combination as could have duty time, planning or radar altimeter and the weather.

D18. The Board went on to consider what human failings may have contributed to the accident. Given the paucity of evidence the Board found it particularly difficult to determine what part human failings had played in the accident. The Board found no evidence that either Master Air Loadmaster Forbes or Sergeant Hardie would have been in a position to affect the conduct of the flight.

D19. The Board found that as the Chinook Detachment Commander and captain of the flight, Flt Lt Tapper had a duty to ensure the correct preparation and safe execution of the flight. There was insufficient evidence to allow an objective assessment of any human failings to be made in respect of his crew management and flight planning and while they could not positively determine the sequence of events leading up to the accident, it was likely that he made an error of judgment in the conduct of the attempted climb over the Mull of Kintyre. It was, however, considered incorrect to criticise him for human failings based on the available evidence.

D20. The Board concluded that Flt Lt Cook would have been fully occupied with flying the aircraft in deteriorating weather, and as it is unlikely that he would have had any reason to doubt the actions of his experienced captain, they concluded that he could not be criticised for failing to identify any errors.

D21. The Board briefed their report to the Convening Authority in January 1995 and following some final amendments signed it off on 3 February 1995. The Board concluded that the most probable cause of the accident was the selection of an inappropriate rate of climb over the Mull. The investigating board did not find either of the pilots negligent.

Reviewing Officers

D22. The Board of Inquiry procedure was a sequential process. By their authority of command the Board's findings were reviewed successively by the Higher Authority (the Reviewing Officers). These officers were expected to apply their depth and breadth of experience and reflect the expertise of the specialist advisers in their headquarters and could modify the findings of the Board where they did not agree with the subordinate view. In this case the Higher Authority were represented by the Station Commander of RAF Odiham, the home base for ZD576, and on this occasion it was also reviewed by the Station Commander of RAF Aldergrove as the aircraft had been operating from there. On completion of their remarks it was passed to the staffs of the Air Officer Commanding No1 Group and then the Air Officer Commander-in-Chief Strike Command. Strike Command was then the military formation which controlled the majority of the UK's combat aircraft. The Board of Inquiry proceedings were the sum of all these inputs and was not complete until the Higher Authority had commented.

D23. Group Captain Wedge, the station commander of RAF Aldergrove, confined his comments to operations at RAF Aldergrove, the day's tasking and the supervisory aspects of the flight. He did not consider or comment on human failings. Group Captain Crawford, the station commander of RAF Odiham, commented at length, disagreeing with the Board's inappropriate rate of climb scenario and concluded that, in the absence of hard evidence, the reasons for the accident were open to conjecture. He was, however, drawn to the conclusion that Flt Lt Tapper failed in his overriding duty to ensure the safety of his aircraft, its crew and the passengers. While the Board had considered all the factors that could have conceivably had a bearing upon the accident, its inappropriate rate of climb over high ground theory was unrecognisable as a Chinook technique and went against all the crew's instincts and training.

He discounted any suggestion that they placed undue reliance on GPS or that they were flying at an unusually high speed. He also believed the crew's decision making process (to slow down or stop; turn away from high ground or turn back; or climb on a safe heading at maximum rate of climb to safety altitude) was not so complex as to be vulnerable to distraction. He proposed an alternative view where rather than electing to climb over the Mull the crew saw the coast prompting the waypoint change and decided to continue Visual Flight Rules to the West of the Mull peninsular. As identified by the Board there were a number of factors that could have sufficiently distracted the crew from turning away from the Mull to cause them both to inadvertently enter cloud and then fail to take the correct procedure for an emergency climb in a timely manner.

D24. On review the Air Officer Commanding No1 Group, Air Vice Marshal Sir John Day (now Air Chief Marshal retired) concluded that the Board had conducted a very thorough inquiry, but he found it incomprehensible why two trusted, experienced and skilled pilots should have flown a serviceable aircraft into cloud covered high ground. In Day's judgment, the actions of the crew were the direct cause of the crash and on the evidence both pilots were negligent to a gross degree. Flt Lt Tapper, as the non-handling pilot and captain, was responsible for the safe navigation of the aircraft and had the overriding duty to ensure the safety of his aircraft in which duty he had clearly failed. This was not an error of judgment as he did not exercise appropriate care and judgment; contravening the strict rules for flight. Flt Lt Cook as the Handling Pilot and an experienced Chinook captain, was well placed to recognise an unsound and potentially dangerous course of action. The pilots should have been ready to take decisive action to ensure the safety of their aircraft and its occupants. They had two choices: maintaining Visual Flight Rules by slowing down, turning away or turning back; or continuing under Instrument Flight Rules by climbing to above safety altitude. On entering cloud or losing sight of the surface the crew failed to climb to the Safety Altitude and until that height was achieved, the aircraft should not have continued approaching the Mull of Kintyre. He accepted that Master Air Loadmaster Forbes and Sergeant Hardie were not in a position to offer much useful navigational input to the pilots; the responsibility for navigation lay with the captain.

D25. The Air Officer Commander-in-Chief Strike Command, Air Chief Marshal (now retired) Sir William Wratten, agreed with this finding.

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