

ROYAL AIR FORCE
PROCEEDINGS OF A BOARD OF INQUIRY
INTO AN AIRCRAFT ACCIDENT

PART 1.1 DETAILS OF THE BOARD

1. The Board of Inquiry was assembled on 21 November 2007 at 1030Z at Joint Helicopter Command Headquarters (JHC HQ) by order of Commander JHC to inquire into an accident involving Puma HC1 ZA938 that occurred at approximately 1450Z on 20 November 2007 while on operation in Iraq. A complete diary of the Board's activities, from convening until submission of this report, is at Annex A.

COMPOSITION OF THE BOARD

2. The Board of Inquiry consisted of:

Duty	Rank, Name, Service No & Decoration	Branch	Unit
President	SECTION 40	GD/P	RAF Odiham
Engineer Member	SECTION 40	Eng	RAF Halton
Aircrew Member	SECTION 40	Fg (P)	RAF Benson
In Attendance (QR 1261):			
RAF BOI Advisor (BOIA)	SECTION 40	GD/P	RAF Bentley Priors
RAF Centre of Aviation Medicine (RAFCAM) Advisor	SECTION 40	Med	RAF Henlow
RAFCAM Safety Equipment (SE) Advisor	SECTION 40	SE Fit	RAF Henlow
Air Accidents Investigation Branch (AAIB) Advisor	SECTION 40	N/A	AAIB Farnborough
Behavioural Scientist	SECTION 40	N/A	N/A

TERMS OF REFERENCE

3. The Board's Terms of Reference were to:

- a. Investigate the circumstances of the accident to aircraft ZA 938 on 20 Nov 07.
- b. Determine, as far as possible, the likely sequence of events that led to the accident.

- c. Collate and secure all available information relating to the loss of the aircraft.
- d. Determine the cause or causes of the accident and examine related factors.
- e. Ascertain degree of injury suffered by persons both Service and civilian.
- f. Ascertain if Service personnel involved were on duty.
- g. Investigate any operational support issues that might pertain to the loss of the aircraft.
- h. Ascertain what orders and instructions were in issue and if all relevant orders and instructions were complied with.
- i. Ascertain if aircrew escape and survival facilities were fully utilized and, if so, functioned correctly.
- j. Ascertain the extent of damage to the aircraft, public property and civilian property.
- k. Assess any human factors.
- l. Ensure that OP SEC is maintained at all times.
- m. Make appropriate recommendations.

REPORT CLASSIFICATION

4. In order to maintain OPSEC and to keep the classification level of this report at RESTRICTED -STAFF, all references to exact locations, grid references, the callsigns of other units, the nature of the operation and details about the supported unit are excluded from Parts 1.1 and 1.2. These details have been recorded at Part 3, which is classified SECRET-UK EYES ONLY -DISCRETION. Part 2 contains the witness statements and exhibits, some of which are classified individually up to SECRET-UK EYES ONLY.

PART 1.2 - CONCLUSIONS OF THE BOARD

NARRATIVE OF EVENTS

(All times local)

1. Introduction. On the 20 Nov 07 Puma HC1 ZA 938 was on standby (as Puma 2) to support UK operations in Iraq as part of a 4 ship, mixed type formation comprising 2 Puma (Pumas 1 & 2) and 2 Lynx (Lynx 1 & 2) helicopters. The aircraft commander of Puma 1 was the designated Mission Leader (ML). A further 2 Pumas were available to task but held in a separate location. During the afternoon a target emerged and a plan was made to deliver a number of **SECTION 26** on a variety of targets during the period of darkness of 20/21 Nov 07. The aircraft were ready for lift as darkness fell, with 3 crew members and **S26** passengers on each Puma; however a last minute change in the tactical scenario necessitated a further re-plan. The ML correctly briefed the formation, giving the Lynx 2-ship the lead role **SECTION 26** with the Puma 2-ship providing the follow-up force. During the transit it became clear that the lead Lynx was unaware of his position and he could not be raised on the radio. The ML elected to turn the formation round to the last known target location, effectively splitting the formation into 2 elements, 2 Puma and a Lynx, with a separate, single Lynx. At this stage the ML believed the target to be **SECTION 26** and quickly identified **SECTION 26** in the general area. The **SECTION 26** was conducted. With the **SECTION 26** an approach was made to an adjacent field and it was during this approach that the No 2 Puma struck the ground and rolled over onto its right side. The aircraft quickly caught fire and was engulfed in flames in a matter of minutes. The 3 crewmembers and **S26** of the **S26** passengers evacuated the aircraft; however 2 passengers were trapped in the wreckage and were later found dead by follow on rescue crews. One crewmember and one passenger were classed as VSI and evacuated to a medical facility before being returned to the UK for further treatment. Several other passengers suffered minor cuts, burns and bruises. Due to the high threat, the aircraft wreckage was not recovered and was later destroyed in place by coalition forces.



Fig 1.2.1 ZA938 post crash but prior to destruction by coalition forces.

2. Crew Background. A number of crews had a role to play in the events leading up to the crash but the Board focussed its main considerations on the crew of Puma 2; full details are contained at Annex C. The Board noted that none of the operating crews had done **SECTION 26** (in theatre) prior to this incident:
- Witnesses 1, 2, 9, 10, 12, 28
- a. Puma 2 Handling Pilot (HP). The Puma 2 HP was also the aircraft commander. The accident occurred towards the end of his first detachment as a Full Mission Qualified (FMQ) aircraft commander but he had previously deployed as a Non Handling Person (NHP) as Basic Mission Qualified (BMQ) and was therefore familiar with the Op tempo and tasks. He is a relatively experienced individual with some 1700 flying hours: his early flying was with the AAC flying Lynx and he has amassed some 830 hours on the Puma since his cross-over to the RAF in 2003. He was assessed as above the average combat ready (CR) on his last Aircrew Insert Slip (AIS) with no supervisory concerns being apparent. It was not possible to ascertain his Night Vision Device (NVD) category, as it was not obvious in either his Log Book or his training records. It was clear that he had flown to NVD Cat B limits but there was no reference to any Cat B conversion course having taken place. Therefore although not theoretically qualified as NVD Cat B he had proven himself competent to fly to Cat B limits and the lack of a dedicated training course, although remiss, did not play a significant part in his handling of the events leading up to the crash.
- Witness 1
Annexe C
Exhibit 1
Exhibits 2, 3
- b. Puma 2 NHP. The Puma 2 NHP was BMQ and was on his first detachment to this Op, although he had previously deployed to the same area in a different role so was familiar with many of the local procedures. He was assessed as high average combat ready on his last AIS with some 430 hours on the Puma. His BMQ work-up was flown to a high standard where he demonstrated that he had the capability to carry out all non-handling duties: there were no supervisory concerns raised. He had only recently deployed to theatre and had not had much exposure to either this crew or this type of operation. His documents indicate that he had not completed the full NVD Cat B work up but he was sufficiently trained and experienced to be expected to carry out NHP duties as required by his aircraft commander.
- Witness 2
Annexe C
Exhibit 4, 4a
Exhibits 4, 5, 6
- c. Puma 2 Crewman. The Puma 2 crewman was FMQ and this was his second detachment to this Op. He had previously done training on Ex **SECTION 26** and was therefore familiar with the desert environment. He is a relatively experienced Puma crewman having done a previous tour on the Puma on 230 Sqn. He was posted to 33 Sqn in August 2005. He was assessed as High Average CR on his last AIS and completed his FMQ workup to a high standard, but there is no record in his training folder of FMQ
- Witness 28
Annexe C
Exhibit 7

being awarded. Neither is there a record in his training folder of his award of NVD Cat B qualification; but again he had clearly proven himself capable of operating at NVD Cat B and the record of his training did not play a part in the crash. He had been on this det for approximately 7 weeks before the crash, crewed with the Puma 2 HP for the last 2 weeks and with the Puma 2 NHP for the last week. The Board therefore concluded that the Puma 2 crewman was properly trained and sufficiently experienced to be able to carry out his duties in this role.

Exhibit 8

Witnesses 1,
2, 28

3. The crews of the other formation aircraft were in the main properly constituted and competent to carry out the duties they were required to undertake at the time of the crash with the following points of note:

a. Puma 1. The crew of Puma 1 had been constituted for the 6 weeks of their deployment prior to the accident and the aircraft commander was the designated ML for the duty period. The NHP was a second tour Puma pilot on his first detachment as BMQ. He had recently joined No 33 Sqn from No 230 Sqn and had completed a day acceptance check prior to carrying out his BMQ work up training. He had not completed NVD Cat B training and his NTF qualification was not in date as it expired when he left his previous sqn. However, he had completed a BMQ work up and had flown in theatre for some 6 weeks so the Board assessed that he was suitably experienced and capable to undertake the role of NHP on this Op. His initial planning for the pre-planned Op was of a good standard. It is of note that he was too busy planning to attend some of the mission briefings and was not present for the whole of the final air mission brief, despite being the lead planner. The HP was the aircraft commander who was an experienced instructor on type who had completed 3 prior deployments; 2 as FMQ. He was chosen as ML by the previous Detachment Commander (Det Cdr) as he was one of the most experienced pilots available. However, due to the relative lack of Op experience of the NHP, they were not the most experienced crew available at the time. The crews of Pumas 3 & 4 were more experienced and were available to conduct the eventual mission that was flown as they had deployed forward prior to launch.

Witnesses 9,
10, 12
Exhibit 9

Exhibit 10

Exhibit 11

Witnesses 9,
10

Witness 10

Witness 17

Witness 9

Witness 17

b. Lynx 1 & 2. Both Lynx crews had only recently arrived in theatre but were familiar with this type of operation and the theatre, although they were not familiar with the Puma operating procedures. Both crews were correctly constituted and had a great deal of experience both on type and in the required role, although there was not much recent experience operating with the Puma. The crews had not conducted any pre-deployment training with the Puma force and there had been no in-theatre mixed-type workup package. The Lynx

Witnesses 4,
6, 7, 13, 14,
15
Exhibit 19

crews were unaware that the Puma force does very little in-theatre training as they deem the threat to be too great and the Op tempo did not allow them time to train. The Board noted that the Lynx Det had done a number of training sorties since their arrival in theatre but there had been little work done to produce joint Lynx and Puma SOPs.

Witnesses
17, 25

c. Puma 3 & 4. The crews of Puma 3 & 4 represented the greater experience levels in theatre. Puma 4 aircraft commander was a very experienced professional aviator Sqn Ldr and the Puma 3 aircraft commander was the Det Cdr, an experienced instructor. The Det Cdr had taken command some 72 hours prior to the incident and the Sqn Ldr had been given the role of acting as his mentor to ensure that he could settle in to command and not be distracted leading the formation as ML. The Det Cdr was, by his own admission, under-confident in his command role and did not believe he had the required experience levels to fully supervise the detachment. He had raised this issue on several occasions with his command chain and was told he was the right person for the job. The Det Cdr's under-confidence may have been exacerbated by the fact that he had taken over command from an extremely competent, charismatic Sqn Cdr who had demonstrated very strong leadership throughout his tenure; leading from the front whenever possible. Equally it was apparent that the previous Det Cdr was the main interface with the user unit and made the vast majority of the tactical decisions. A handover had taken place between the off-going and on-coming Det Cdrs but it was time restricted due to the high Op tempo.

Witnesses
17, 25, 29

Witness 27

4. Aircraft Background. The aircraft had accumulated a total of 9767hrs 40 mins prior to take off on 20 Nov 07. The aircraft had undergone a Minor Star maintenance package 135hrs 30 mins prior to the sortie and a Primary maintenance 3hrs 35 mins prior to the sortie. The engines and associated components were within their prescribed life as were the transmission components: confirmed by the information shown on LITS and by component log cards. The intermediate gearbox had been fitted to the airframe during the Minor Star maintenance. The Board noted the Form 737 had not been updated with the details of the new intermediate gearbox in the aircraft's F700 and that several LITS entries relating to technical instructions were out of date.

Annex B,

Annex E
Appendix 3,
Exhibit 12,

5. An engineering team conducted the AF/BF servicing on the 19 Nov 07; the aircrew completed the AF/BF on the 20 Nov 07. It is normal practice for the aircrew to conduct this routine servicing at least once a week when all engineers return to the deployed operating base to conduct the weekly maintenance on the other det aircraft and to conduct a shift changeover: restrictions on transportation mean this changeover takes an entire day to complete. The Board was made aware of a possible servicing error

Exhibit 12
Witnesses 1,
2, 12, 18, 19,
20, 23

Witness 5
Exhibit 14

during the servicing of Puma 1, resulting in a pip pin becoming loose. The incident was raised in a flight safety signal, the release of which was delayed by the events of the crash. The Board found no evidence to suggest any mistake had been made on ZA938, although it could not be completely ruled out. The Board noted that the Det EngO had offered to provide full time engineering support for the FOB, but the previous Det Cdr considered this unnecessary.

Witness 5

PRE-ACCIDENT EVENTS

6. Aircraft Preparation. The majority of Puma 1 & 2 crews were woken at around 1430, as it became clear that a target was emerging. As detailed in para 4 above it is normal practice for engineers to service the aircraft except on this day, a Tuesday, during the engineer shift changeover. The crews were fully aware of this requirement and had planned to conduct the servicing at the beginning of their duty period, at around 1600. The requirement to carry out the service earlier and carry out concurrent planning meant that the on-coming crews had less time than expected and fewer crewmembers were available to help plan and prepare for the mission.

Witnesses 1,
2, 10, 12, 25

7. Aircrew Briefing Process. Several briefings are given by both aircrew and the user prior to a particular mission being flown. It is normal practice, though not mandated, for all participating crews to attend as many of the briefs as practicable to ensure they have as much situational awareness as possible. On the day of the crash the Puma 2 crewmembers attended the initial aviation brief delivered by the ML, which covered the domestics relating to the forthcoming duty period such as the weather, light levels, intelligence, Air Tasking Orders and the Airspace Control Orders. The briefing that was given contained mainly generic information, as at this stage in the duty period there were no clear details of likely missions and tasks. Not all crewmembers attended all of the user unit briefings but some were present with the ML. However, as it later transpired the formation did not fly the pre-briefed missions so the fact many of the crews missed the briefings was, in this case, less significant. The Board was surprised to note that formation duties were detailed for Puma 3 & 4; Puma 3 was nominated as the deputy formation leader and the deputy ML, even though they did not attend the briefing and were not part of the mission planning.

Witnesses 1,
2, 9, 10, 12,
17, 28

Exhibits 9, 15

8. Authorisation Process. The authorisation for the day's tasking for Puma 1 & 2 was carried out at the end of the initial aviation brief described in para 7 above. The rear based assets, Lynx 1 & 2 and Puma 3 & 4, authorised separately using a similar process. However the Lynx and Puma final authorisations are different so were carried out by the respective authorising officers. The 3 separate authorisations of effectively 3 pairs (2 Puma pairs and 1 Lynx pair) took the form of a standard authorisation that allows crews to carry out all tasks that may present themselves during the period of duty, except mixed type formation with non-UK assets;

Exhibit 9
Witnesses
10, 13, 14, 25

which requires a separate authorisation from JHC. The Board noted that this standard authorisation process catered well for an individual aircraft but less so for a formation that was dislocated. The generic, standard auth method used appeared to offer a great deal of flexibility by allowing any task to be accepted and also ensured that the paper trail was completed prior to any mission being flown within the duty period. However, the authorisation act had become more of a process and means to an end rather than the final step in the supervisory chain prior to flight. The following points were also of note:

- a. The authorisation process was completed prior to the ML having full knowledge of the task. Missions can change but the Board believes that the auth did not reflect the mission which the formation and individual crews actually flew. The aircraft commander should only sign for the authorisation when he 'understands his orders' and the authoriser should only authorise when he is confident that the crews are properly constituted and capable of the task at hand. This did not occur on this mission. Witness 10
- b. The authorisation detailed the formation Puma deputy leader as Puma 3 and not one of the participating formation members as is the normal practice. Exhibits 9, 9a
- c. The standard authorisation for the Op is different between the Lynx and Puma forces despite there being significant similarities, for example both state formation flying, however, unlike the Lynx, the Puma auth does not state which minimum span distance should be used. Exhibits 9, 16
9. Mission Planning. Final mission planning had to be undertaken quickly as the situation on the ground evolved. This was not new to the planner who appeared to be in control of the situation and the Board was impressed by the level of planning that occurred for the initial mission. The Board was surprised to note that the lead NHP did the vast majority of the planning on his own and would have expected the other operating crews to take a more active part throughout the process. However, as previously stated the other crewmembers of Puma 1 & 2 were servicing the aircraft and the remaining rear-based aircraft had not moved forward at this early stage. It would appear that the plan for the prepared mission was achievable but judging from subsequent interviews, there was much confusion as to the exact nature of the target sets and number of landing sites that were to be visited, suggesting that there was a great deal of confusion amongst all parties. Witnesses 1, 2, 9, 10, 12, 28
10. Ground Briefings and Final Preparation. A number of ground assault briefs were delivered by the troops and were attended by most of the operating crews. It has not been possible for the Board to ascertain exactly who attended each briefing as individuals' recollection of the number of briefings was less than clear and Witnesses 1, 2, 9, 10, 12, 17, 28

several mini-briefs were occurring simultaneously. These ground assault briefs were followed by a final air mission brief, which included all target sets, and the intentions for each target. This brief also contained the final formation roles and duties with Lynx 1 & 2 and Puma 3 & 4 now forward based. The Board noted that some crewmembers of Puma 3 & 4 were not present at the full mission brief as they were outside the room where it took place. The Board also noted that the lead planner was unable to attend the full mission brief as he was still engaged in the planning process. The aircrew witnesses generally agreed that the final plan was **SECTION 26** **SECTION 26** using 2 Puma (No 1 & 2) and 2 Lynx aircraft and it was agreed that, although not in the original plan, the remaining 2 Pumas would be used as on-call Quick Reaction Force (QRF).

11. The Final Task Change & Brief. As the crews moved to their aircraft to carry out their final preparation a new target emerged, **SECTION 26**, and became the focus of attention as the priority target. **SECTION 26** **SECTION 26** **SECTION 26** **SECTION 26** **SECTION 26** and moved to the aircraft to brief the ML on the latest changes to the plan. The requirement to **SECTION 26** quickly overshadowed the fact that the target had not been briefed in any detail and that it required the formation **SECTION 26**. The Board noted that although all crews had been trained to varying degrees **S26** in the UK, none of the operating crews had done **S26** on operations and the scenario had not been considered during the pre-flight briefings. With the user unit impressing the need for urgency, the ML quickly briefed a new plan to the formation over the radio. The plan was simple and workable **SECTION 26** **SECTION 26** **SECTION 26** **SECTION 26** **SECTION 26** **SECTION 26** **SECTION 26** was a much more demanding sortie profile than that previously planned and briefed. The Board noted the decision to conduct the re-plan and brief over the radio and not to move to a central location for a face to face brief with the assault force and all crews. The full complexity of the task and any contingency plans were not discussed. This in itself is not unusual, as often time sensitive tasks require rapid planning; however this was a very unusual mission profile and was to be flown in an unfamiliar formation profile.

Witnesses 1,
2, 9, 10, 12,
17, 28
Exhibits 17,
18

12. The Transit. The **S26** plan was acknowledged by the assault elements of the formation and, following a short delay whilst the Lynx refuelled and corrected a navigational equipment error, the formation departed the HLS towards the target location. At the time of lift the visibility was just over 3 km and the light levels were high as it was dusk. The transit was demanding for all crews **SECTION 26** **SECTION 26** **SECTION 26**. Obstructions such as wires were spotted late and necessitated a less than ideal flight profile at a height between **SECTION 26**. The NHP of Puma 2 reported a high workload due to chatter on the Air Traffic and tactical radios. However, it appears that he managed, with prompts, to keep up with the many grids that were passed on the tactical radio relating to the

Witnesses 1,
2, 4, 6, 9, 10,
12, 13, 14, 28
Exhibit 20,

location of the **SECTION 26**: he was fully aware of **SECTION 26** as the formation approached the target area. The Board noted that all crews had the last known grid of the **SECTION 26**, however not all crews understood **SECTION 26** **SECTION 26** The formation closed in towards the target area and with a couple of miles to run Puma 2, believing that an approach was now imminent and with no defined Initial Point (IP), carried out their IP, or kneepad, checks. These checks should have included setting the Radar Altimeters (Rad Alts) down to **S26** on the HPs and **S26** with the audio warning on the NHP Rad Alt. However, at the behest of the HP this part of the checks was not completed and the Rad Alt bugs remained at **S26** for the HP and **S26** with the audio for the NHP.

Exhibit 21

13. Missed Target. With about 1 mile to go to the target, as indicated on the Puma navigational equipment (RNS252), it became clear that the lead Lynx had overshot the target and had flown to the South of the area by approximately 1 mile. Lynx 1 was now unaware of the target's location due to an error in his navigational equipment. Despite several radio calls from Puma 1 and Lynx 2, Lynx 1 did not acknowledge that he had missed the target and continued slowly on course. The other 3 aircraft would seem to have had the correct target indication, which was now approx 3 miles behind them to the north.

Witnesses 1,
2, 4, 6, 9, 10

14. Intelligence Updates. Evidence gathered has shown that by the time the formation realised that it had missed the target area the **SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26**. It is not clear if all crews fully understood that **SECTION 26** but it is clear that they all had the same grid and they all recalled that it had been some time since an updated grid had been passed to them. The HP of Puma 2 was aware that **SECTION 26** beside a wood and became aware that **SECTION 26 SECTION 26 SECTION 26 SECTION 26**: the formation flying to the South of the target had alerted them to the aircraft's presence. The **SECTION 26** focus then changed to **SECTION 26** just to the south of the **SECTION 26** last known location. This information had been transmitted on the tactical radio and was the subject of conversations **SECTION 26 SECTION 26** but it appears that the change in focus was not made clear to the crews, not least the ML in Puma 1 who was still expecting to find **SECTION 26**.

Witnesses 1,
2, 4, 6, 9, 10

15. The Final Plan. Realising that they had missed the target, the ML elected to ask for **SECTION 26** to be illuminated **SECTION 26** Shortly after this request Puma 2 called that they were visual with the illumination in the formation's 6-7 o'clock. The ML then elected to turn round to fly directly to the target area with both Puma 2 and Lynx 2 following, effectively splitting the formation into 2 distinct packages: one of 3 aircraft and one of a single Lynx. The decision to turn and split the formation necessitated a further re-plan and reconfiguration of the now 3-ship formation to conduct **S26**. The ML briefly discussed the situation with the assault force Team

Witnesses 1,
2, 4, 6, 9, 10

Leader (TL), who was onboard his aircraft, and informed him that the **SECTION 26**; the TL elected **SECTION 26 S26**. The ML now had an unfamiliar formation configuration that was not fully pre-briefed nor previously practiced **S26**. However, a brief was delivered and was relatively simple in that Lynx 2 was to **SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26**. The Board noted that the terminology **S26** and **SECTION 26** is not used in any form in the current Lynx or Puma SOPs and yet all crews appeared to understand the general intent.

Witnesses 9, 10, 12

Exhibit 22

ACCIDENT EVENTS

16. The Target Selection. On arriving overhead the illuminated target area the ML could not see **SECTION 26** as he had expected; indicating that he had not registered the latest intelligence updates regarding **SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26**. The ML also saw Lynx 2 ahead of him making an approach. The Lynx had made an assessment of the situation and made the assumption that, despite not being visual **SECTION 26 SECTION 26** must be ahead of them to the far side of **SECTION 26**. Lynx 2 then made an approach to a likely area but conducted an early overshoot **SECTION 26** could be seen. During this period the ML asked for clarification **SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26** and received an answer relating to **S26** that he could see. The ML still believed that the target **SECTION 26** even though he had heard the reference to **SECTION 26**, he understood **SECTION 26 SECTION 26**. During the approach to the area the ML had seen a **SECTION 26** to the south of **SECTION 26** and, with the lack of a **SECTION 26 SECTION 26** he assumed that the **SECTION 26 SECTION 26**

Witness 10

Witnesses 4, 6

17. **SECTION 26**. The ML elected to follow **SECTION 26 SECTION 26 SECTION 26**. This transit was flown between **SECTION 26 SECTION 26** in the latter stages. As stated in Para 12, Puma 2's Rad Alt setting had not been altered below the transit settings, therefore the aircraft was at times flying below the height of the audio warning. Puma 1 flew parallel with a track and Puma 2 remained with his leader, slowing down and descending as required to maintain his formation position, but the Puma 2 HP was unsure as to his leader's intent at this stage. Lynx 2 had overshoot from his approach and was rapidly closing with the formation but remained at a safe distance to assess where they were going; he was also unsure as to the ML's intent. Despite the close proximity of the **SECTION 26** and the speed now **SECTION 26** Puma 2 and Lynx 2 remained unsighted on the target **S26** throughout this final transit.

Witness 10

Witness 1, 2

Witnesses 4, 6

Witnesses 1, 2, 4, 6
Witness 1

18. The Turn On To Finals. As Puma 1's speed reduced further, Puma 2 believed that he was in the process of making an approach to an area ahead, but he did not know why. He elected to set up for

an approach on a southerly direction and assessed the surface wind throughout as calm. The formation speed was now in the region of **SECTION 26** and the height was an estimated **S26**. Puma 1 then carried out a sharp right hand turn through approximately 110 degrees. This was immediately followed by a radio transmission to the effect that Puma 1 was **SECTION 26**. Shortly after the radio call Puma 2 and Lynx 2 witnessed Puma 1 opening fire **SECTION 26** **SECTION 26** **SECTION 26** : this was the first time either Puma 2 or Lynx 2 had seen **SECTION 26**. Puma 1 then manoeuvred in such a manner that it was clear he was making an approach to the field adjacent to the **SECTION 26**. Believing that a contact situation existed, the Puma 2 HP elected to make an approach to the same field, which he quickly assessed to be relatively flat and suitable for an approach and landing.

Witnesses 1,
2, 4, 6, 7, 10,
12, 28

19. The Approach. At this relatively early stage of the approach the Puma 2 HP called committed because he assessed there was an immediate requirement to support his leader and the ground force; this committed call was not based on aircraft performance, as is normal. It was clear from the dust cloud that had been created by Puma 1 that the field was very dusty; however this did not initiate a change in Rad Alt settings. The late turn on by Puma 1 left Puma 2 with restricted options for his landing area. He chose an area that would remain a safe distance from the leader but it meant that the final approach path was on a heading of approximately 300 deg and required a near vertical descent from around 75ft. Despite this not being a recognised profile the HP believed he had the necessary handling skills to undertake this demanding approach and it was not questioned by the NHP or by the crewman. However, unknown to the HP there was a 5-10kts surface wind from a southerly direction. This gave him a significant downwind component throughout the approach which undoubtedly increased the difficulty of the manoeuvre. The evidence suggests that the HP was now working to capacity, as he did not notice that one of the troops in his aircraft fired his personal weapon in the direction of **S26** from the right hand door. This action did not appear to distract the HP but both the crewman and the NHP reported it as a distraction. It is not possible to ascertain the rate of descent or ground speed at any time during the approach as the NHP did not give any prompts relating to these parameters, however he did brief an escape/overshoot path.

Witness 1

Exhibit 21

Exhibit 17a

Witnesses 1,
2, 30, 32, 35,
37

Witness 2

20. The Initial Impact. As far as can be established Puma 2 continued its approach vertically from about 50ft with a significant dust cloud forming around the aircraft at around 30ft, with references becoming increasingly difficult to maintain as height was reduced. Although the HP initially stated that he lost references at about 15ft he later stated that he maintained references throughout the approach, however they were of varying quality and mainly consisted of moving dust and straw. As he approached the ground he failed to arrest his rate of descent in sufficient time and impacted the ground earlier than he expected in what has been described by a number of witnesses as a 'very heavy landing' and by the NHP as the heaviest

Witnesses 1,
2, 27, 30, 31,
32, 33, 34,
35, 36, 37

landing he had been involved in. That said, there is no evidence to support that the landing caused any structural damage and all aircraft systems appear to have operated normally afterwards. As far as can be ascertained the aircraft impacted the ground at less than 3G, as the Helicopter Emergency Egress Lighting System (HEELS) did not operate, and with some forward speed, thought to be in the region of 5 kts. The collective was not lowered fully at this stage with an estimated 9-10 deg of pitch being maintained. As the aircraft moved forward it was felt to decelerate and it began to oscillate in roll with the initial movement to the right. As the speed reduced the aircraft rolled to the left then back to the right but to a much greater extent than previously experienced. The HP believed that the aircraft was in danger of rolling over so he elected to 'overshoot' with the intention of getting airborne. He had no visual references at this stage.

Witnesses 1,
2

Witness 1

21. Cabin Security. The crewman was the only rear cabin occupant who was restrained, although he was not secured to the recommended securing point but to a point underneath the right hand front seats and his harness was not properly adjusted for length. It had been previously agreed by the Det that the passengers would not strap in. This decision was based on a number of factors ranging from the straps being too short to get around the equipment worn by the user to them simply not wanting to impede a quick exit after landing. The JHC HQ Flying Order Book directs that a letter of dispensation must be issued to allow passengers to be unrestrained during flight and no such letter was in place for this flight; therefore all passengers should have been secured to the aircraft. However, the Board noted that had a letter of dispensation been granted it is likely that this would have allowed for the passengers to unstrap just before landing, therefore the passengers would, in all likelihood, have been unstrapped for the final landing and subsequent rollover.

Witnesses
27, 28, 30,
31, 32, 33,
34, 35, 36, 37

Exhibits 23,
24

22. The Final Impact. The HP believes he selected a level attitude for the take-off, but he does not believe that he used the aircraft instruments to do this. Nevertheless, he then raised the collective and felt the aircraft leave the ground and start to climb. Neither cockpit occupant remembers looking at any flight instrument throughout this manoeuvre so it is not possible to ascertain the following:

Witness 1

Witness 1, 2

- a. The aircraft's attitude.
- b. Discernable drift.
- c. The rate of climb achieved.
- d. The maximum height reached.
- e. Engine performance or pitch settings.

As the aircraft continued to 'climb' the low main rotor RPM (Nr) audio warning sounded twice, indicating that the Nr had decayed to less than 255rpm (but above 220rpm). This was probably due to the rapid raising of the collective lever. On hearing the audio warning the HP recalls 'checking' on the collective lever and does not remember hearing the tone again. This would suggest that he had taken corrective action to prevent further Nr decay and that the Nr had recovered to within normal operating limits: it is not clear if the HP lowered the lever to achieve this.

Witnesses 1,
2

23. Lynx Sighting. Simultaneously with the low Nr warning sounding the NHP called tally on a Lynx which was high in the 10 o'clock flying away. The NHP assessed that there was no chance of impact but did not declare this at the time. The HP recalls seeing the Lynx as he was 'checking' on the collective lever and also remembers seeing stars and the dust cloud outside the bottom of his front window screen. At this stage both front crew believed they were clearing the dust cloud but do not recall what height they had achieved or what attitude the aircraft was in. The HP believed that he had cleared the dust cloud and took attitude reference on the Lynx as there was still no clear horizon. He quickly became worried that he was in danger of climbing up into the second Lynx (Lynx 1 had been left behind when the formation split) so he immediately elected to stop his climb and carryout a level transition.

Witnesses 1,
2

24. The Transition. At this stage the HP elected to carry out a level transition to gain forward airspeed and to leave the dust cloud. He did not check for a visual horizon and elected to carry out this manoeuvre without reference to his instruments. As he rotated the aircraft nose forward to initiate the forward transition, the aircraft immediately re-entered the dust cloud with no visible references available to the crew. The HP quickly lost the sensation of climbing and became disorientated, as he no longer felt the aircraft doing what he expected. At some point he remembers looking in at his instruments to see a 5-10 deg right wing low with 5-10 deg nose down attitude and as he began to level the wings he felt an acceleration of roll to the right accompanied by the noise and control feedback associated with the blades striking the ground on the right as the aircraft rolled onto its right side.

Witness 1

Witnesses 1,
2

POST ACCIDENT EVENTS

25. Post Impact. The aircraft continued to move across the ground on its right side but the exact direction of movement is unclear. There were no visual references due to the amount of dust in the air but the crew could hear and feel the blades striking the ground and the aircraft scraping across the ground with the most likely movement being forward and nose rotation to the left from an initial northerly heading to a south westerly heading. The aircraft finally came to rest after about 5 sec heading approximately 240 deg lying on its right side and relatively intact. Both cockpit occupants' NVD had been dislodged in the impact and the HEELS had

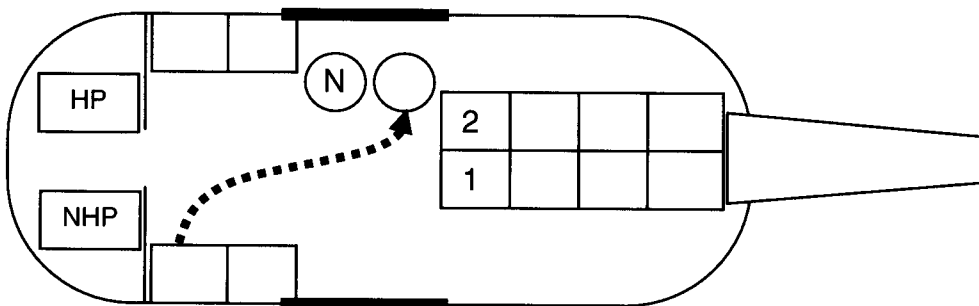
Witnesses 1,
2, 27, 28, 30,
31, 32, 33,
34, 35, 36, 37

Exhibit 25

illuminated. The NHP operated both of the fuel shut off levers, before jettisoning his escape hatch and evacuating the aircraft. He then moved to the front of the aircraft to a pre-briefed evacuation assembly area. The HP picked up his personal weapon and also departed the aircraft through the left hand cockpit hatch before proceeding to the front of the aircraft. On departing the aircraft the HP noticed a fire had taken hold to the rear of the main gearbox cowling, but he could not be sure of the exact location. Other occupants were then seen to emerge from the aircraft main cabin and both cockpit crew moved to assist with the evacuation and egress of the remainder of the occupants.

26. Cabin Egress. The details of who was where in the cabin post the final impact is not clear as the many witness statements taken do not agree and therefore make it impossible to locate individuals clearly at any point in time. The diagram below indicates the seating positions immediately prior to the final impact and rollover:

Witnesses 1,
2, 27, 28, 30,
31, 32, 33,
34, 35, 36, 37



Key

HP: Handling Pilot; NHP: Non-Handling Pilot; N: Crewman **SECTION 26.**
1 & 2 : Troops (deceased)

SECTION 26

Fig 1.2.2 – Seating positions prior to final impact and rollover

As the aircraft fell onto its right side 3 passengers, **S40**, 1 & 2 and the crewman were thrown towards the open right hand door. From the evidence gathered, it is likely that soldier 1 was thrown out of the door and ended under the rear fuselage of the aircraft, as he was not seen in the cabin. Soldier 2 remained mainly in the area of the open door, unconscious with his arm trapped between the upper door structure and the ground: it is believed that the injuries to soldiers 1 & 2 rendered them unconscious. The crewman remained within the cabin as he was snagged around the GPMG mount. **S40** was thrown through the open door and recalls feeling the aircraft moving over his body: it is likely he was thrown slightly forward and ended forward of the doorframe. He remembers being unable to move as his helmet was trapped between the aircraft and the ground.

27. Rescue Attempts. The remainder of the cabin occupants required no further medical treatment as they were relatively uninjured and able to egress unassisted. **SECTION 40** played a pivotal role in ensuring that those that could escape were assisted both in the cabin and later from the under-belly of the aircraft.

Witnesses 1,
2, 27, 28, 30,
31, 32, 33,
34, 35, 36, 37

Passengers from Puma 1 also played a crucial role in assisting the egress from the cabin, including pulling the crewman out of the aircraft from below. Every effort was made to release the trapped soldiers but rescue attempts had to be abandoned as the fire took hold and explosions could be seen and felt.

Exhibit 17a

28. Post Crash Fire. Almost immediately after the aircraft had come to rest the cabin occupants and the cockpit crew saw and smelt a fire. The fire appeared to be coming from the area of the rear cabin bulkhead aft and below the engine cowling in the area of the aft fuel vent outlet aperture. A detailed report into the likely cause of this post-crash fire is attached at Appendices 4 and 5 of Annex D; these indicate the likelihood of a fire involving aircraft fuel in this area. The fire quickly took hold and despite being tackled with one of the aircraft cabin handheld fire extinguishers it soon became intense, igniting flares and ammunition initially followed later by a variety of passenger carried **SECTION 26** and grenades. Evidence indicates that the aircraft was completely ablaze and therefore unreachable within 4 minutes of coming to rest with no further rescue attempts being possible after this relatively short time. The post crash fire and subsequent explosions all but destroyed the aircraft.

Witnesses 1,
2, 27, 28, 30,
31, 32, 33,
34, 35, 36, 37

Exhibit 17a

29. Casualty Handling. The most seriously injured personnel, **SECTION 40** and the crewman, received an initial assessment and treatment by the medic **SECTION 40** on the scene. Both seriously wounded casualties were evacuated from the crash scene, along with the HP and NHP, by Puma 1 and evacuated to a coalition medical facility within 15 min of the crash. The Board noted that despite several attempts to pre-warn the medical facility no one was there to meet the arriving aircraft. That said, the arrival of the helicopter soon resulted in assistance and the casualties were very well handled. Following surgery and initial stabilisation the seriously wounded casualties were returned to the UK where they received follow up medical treatment at Selly Oak Hospital. The HP and NHP also attended the medical facility but were not given any further medical checks or assistance and were released to return to unit. They both received blood tests for drugs and alcohol the following day but were not checked by a doctor for injuries sustained in the crash until they were seen by the Board's own attending medical expert.

Witnesses 1,
2, 9, 10, 12,
27, 36
Annex E

30. CSAR. The CSAR team initially had difficulty in recovering the sensitive equipment from the aircraft and took some time to recover the aircraft cockpit voice recorder (CVR), which sustained significant fire damage. The CSAR teams were responsible for the recovery of the 2 bodies from the wreckage prior to the remains of the aircraft being denied to the enemy by several coalition air attacks. Pumas 3 & 4 and Lynx 1 & 2 took part in the recovery of the remainder of the passengers once the mission was complete.

Witness 22

DEGREE OF INJURY

31. The Board finds the degree of injury to personnel as follows: Annex F
- a. Service Personnel. The injuries sustained by service personnel are detailed as follows:
 - i. Puma 2 HP. SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40
 - ii. Puma 2 NHP. SECTION 40 SECTION 40 SECTION 40 SECTION 40.
 - iii. Puma 2 Crewman. SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 Witness 39
 - iv. Soldier H. SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 Witness 40
 - v. Soldier E. SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 Witness 41
 - vi. Soldier 1. Multiple fatal injuries.
 - vii. Soldier 2. Multiple fatal injuries.
 - b. Civilian Personnel. Not applicable.

WHETHER SERVICE PERSONNEL WERE ON DUTY

32. Duty Status of Personnel. The Board found that the operating crew of Puma 2 were on duty at the time of the incident. The Board further found that all other aircraft crews and all passengers involved in the operation were on duty at the time of the incident. The Board noted that the off-going, more experienced, Air Advisor had attended the ops room during the Op despite being 'off' duty prior to his departure from theatre. Witness 17
Exhibit 9

AIRCRAFT ESCAPE FACILITIES & SURVIVAL ASPECTS

33. Personal Aircrew Equipment Assembly (AEA). The aircrew were flying in fire retardant Combat Soldier 95 (desert pattern). No faults were reported, although none of their clothing was tested, as it was not recovered. The crewman did not have a second layer of clothing SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 SECTION 40 Witnesses 1,
2, 28
Annex F

aircraft through the open starboard door to evacuate **S40** and the crewman.

36. Passenger Clothing. There were several cases of the passenger clothing coming into contact with fire and all witness statements suggest that the clothing provided significant fire resistance. The Board was also informed that it was common practice for the passengers to secure to the aircraft via a 'helibelt', which is a 'riggers' belt with a loop of rope attached to the aircraft via a clip: as was the case with **S40** until he released himself prior to the first impact. The current aircrew cutter is not capable of cutting the width of rope used and work is underway with the Force HQ to identify a suitable J-type knife to be used as an aid to escape should the Helibelt system be cleared for use on future Ops.

Witnesses
12, 28, 37

37. Cockpit Seats, Restraint and Escape Exits. Both pilots were restrained in their seats by their 5-point harness and the inertia-reel system unlocked. The seats and cockpit area integrity appear to have been maintained during the crash. The port cockpit escape hatch was jettisoned correctly and both pilots eventually left via this exit. The NHP had stored his personal weapon in the map pocket of the port cockpit escape hatch, and it was jettisoned along with the hatch. The NHP closed both engine fuel shut-off cocks before leaving the aircraft but does not remember doing any other checks. The Board noted that there is currently no procedure or actions set out in the event of an aircraft crash. The NHP prevented himself from falling on the HP after releasing his harness, and stood on his own seat back to exit the hatch. The HP used the escape drill taught in the Underwater Escape Trainer and orientated himself before trying to jettison his nearest exit, the stbd escape hatch, despite the aircraft lying on its right side. This was unsuccessful due to the close proximity of the ground and he subsequently made his way out via the port escape hatch with his personal weapon.

Witnesses 1,
2

Exhibit 26

Witness 2

Witness 1

38. Passenger Seats, Restraint and Escape Exits. The recollections of the people in the cabin are somewhat incomplete and contradictory, however the Board could conclude that there was no significant deformation of the cabin structure or dislodgement of the seating. None of the passengers were restrained at the time of the crash therefore the Board could not report on the suitability of the passengers' restraint systems. Although not clear it appears that 3 soldiers were thrown around and were either fully or partially ejected from the cabin, suffering varying degrees of injury some of which may have been fatal before the fire took hold. The open cabin doors allowed the quick evacuation of the cabin from both above and below and it is likely that escape would have been slower had the doors been closed. However it is also likely that no one would have been ejected from the cabin had the doors been closed as the aircraft rolled. The rest of the passengers either made their own escape through the port cabin door or were helped through it. The Board noted that the Puma crew were unfamiliar with the quick release mechanism of the passengers' body armour and could not

Witnesses 1,
2, 27, 28, 30,
31, 32, 33,
34, 35, 36, 37

release it.

39. Post Crash Fire. The severity of the post crash fire was a cause for concern for the Board and significantly reduced the survivability aspects of this crash. Witnesses have consistently described the flames as initially being a yellow/orange colour, with a lapping or licking action rather than a constant, fierce jet of flame. These flames are described as being located initially in the area of the top rear of the stbd cabin door and were visible almost immediately after the crash. This was accompanied by a smell and visible smoke described as acrid, catching in the throat and similar to a downwind engine 'wet start' indicating the likely presence of burning aviation fuel. Within 2-3 minutes, the flames are described as being more intense with a white to light yellow centre. It was then some 1-2 further minutes before the entire cabin area was engulfed in flames following a significant explosion. The Board agreed with the combustion specialists from QinetiQ that a significant quantity of liquid fuel would have been necessary to cause such an intense fire so quickly.

Witnesses 1,
2, 6, 7, 9, 10,
27, 30

Witnesses
10, 27

Appendix 5 to
Annex D

40. Fire Extinguishers. Very soon after the crash **S40** was working in the cabin to free survivors and called for a fire extinguisher as he could see flames in the area of the top rear of the stbd door. The crewman was still trapped at this stage but heard the call and explained to **S40** that there was a fire extinguisher on the stbd forward bulkhead of the cabin. **SECTION 40** retrieved the extinguisher and attempted to fight the fire, but it had no noticeable effect. The only other hand held extinguisher is in the cockpit and was not used. The crew did not activate the engine fire extinguisher on leaving the aircraft as at this stage they were not aware of any fire and it is not clear if this would have had any benefit in this instance.

Witnesses
27, 28

Witnesses 1,
2

DAMAGE TO AIRCRAFT, PUBLIC AND CIVILIAN PROPERTY

41. Aircraft. ZA 938 seems to have survived the initial impact. The main rotor blades struck the ground during the second impact and it is likely that the tail rotor also struck the ground as the aircraft rolled onto its right hand side. The cabin and cockpit integrity would appear to have been maintained throughout both impacts but some structural damage cannot be ruled out. At some stage during either the first or second impact the nose undercarriage oleo detached from its housing. The aircraft was largely destroyed by the post crash fire, as was the data card of the CVR that was recovered but was damaged beyond use. The aircraft was then completely destroyed by coalition forces to deny the enemy any propaganda material. A fuller report is at Appendix 1, Annex D.

Annex D,

Annex D
Appendix 1

42. Public Property. Numerous miscellaneous items of public property were believed destroyed in the wreckage. The following list is not comprehensive and concentrates on significant items:

a. Role Equipment. The aircraft was in the Op standard

Exhibit 12a

strong working relationship with the deployed SIB team, which ensured that the maximum amount of evidence was gathered in a very short period of time. Unfortunately the CVR was denied to the Board as it would have filled in the many 'can't remembers', covering the final minutes. It was also unfortunate that **SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26** The Board believes that the CVRs from the other formation aircraft would have been very useful and, had there been no survivors, may well have been the only evidence of quality available. However, some excellent work by the AAIB has provided some additional evidence to support the Board's view of the cause of the post-crash fire.

47. Available Evidence. To assist the Board in their deliberations, the following evidence was available:

- a. The statements of the crew of Puma 2.
- b. The statements of the crews from the other formation aircraft.
- c. The statements of the surviving passengers.
- d. The statements of the Ops room staffs from 3 locations.
- e. 8 post crash photographs of the wreckage.
- f. Access to SIB evidence and statements.
- g. Copies of all planning data used, including several sources of meteorological reports and satellite imagery.
- h. **SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26**
- i. Analysis of the post-crash site by JARIC **SECTION 26 SECTION 26**. The imagery is of a poor quality.
- j. A report on Human Factors by **SECTION 40**, aviation psychologist.
- k. All in-theatre flying related documentation including orders and procedures from the Puma and Lynx detachments.
- l. Subject matter expert testimonies from QHIs, QHCIs and experienced Puma operators.
- m. A report by RAFCAM including a report on AEA.
- n. Aircrew flying records and training documentation for

the crews of Puma 1 and Puma 2 including Log Books and F5000.

- o. Aircraft engineering documentation, including the F700 and LITS.
- p. Technical assistance from the AAIB, QinetiQ, PGIPT, aircraft and aircraft systems manufacturers.
- q. Access to the fuel vent system anti-spill valves removed from Pumas XW222 and XW231.
- r. Date on previous Puma accidents.
- s. Access to sensitive items removed by the CSAR team.

48. The Board did not have the following:

- a. Access to the crash site or aircraft wreckage.
- b. Access to the Puma 2 crewman until some time after the crash due to the severity of his injuries.
- c. Cockpit voice recordings from any of the aircraft in the formation because they were either rendered unusable by fire or were not quarantined for the Board.
- d. ADR data, as this is not fitted to the Puma.
- e. Access to any imagery of the crash occurring.
- f. Access to any of the NVD being used by the Puma 2 crew at the time of the crash.
- g. Access to any of the flying clothing worn by the Puma 2 crewman.
- h. Access to accurate Defence Met Centre (DMC) light levels.

CONSIDERATION OF FACTORS

49. Factors Considered. During deliberations the Board considered several factors, human and otherwise. A deep analysis of the Human Factors aspects of the incident by **SECTION 40** is at Annex G and these aspects have been incorporated within the Boards considerations below. The following were considered:

- a. Aircraft technical failure.
- b. Weather.

- c. Light levels and NVD capabilities.
- d. Aircraft performance.
- e. Terrain.
- f. Other hazards including dust.
- g. Supervision.
 - i. Command and control
 - ii. Crew selection and training.
 - iii. Crew composition.
 - iv. Operational pressures.
 - v. Authorisation process.
- h. Briefing process.
- i. The formation.
- j. The **SECTION 26** profile.
- k. Approach profile
- l. Enemy action, sabotage or friendly fire.
- m. Rotor RPM (Nr) decay and seeing the Lynx.
- n. Adherence to SOPs, including Rad Alt settings.
- o. Cockpit gradient.
- p. Disorientation.

50. Aircraft Technical Failure. There is no evidence to suggest any problem with the integrity of the aircraft prior to the first impact. Following the first impact, the aircraft appears to have responded normally and there is no indication that the aircraft's structural or mechanical integrity was compromised even at this point. **Therefore, the Board does not consider Aircraft Technical Failure to be a factor.**

Witnesses 1,
2

51. Weather. Witness reports and meteorological data were considered by the Board and indicated that the weather was suitable for the sortie with some low cloud, less than ideal visibility and a slack surface wind from the South East. Witnesses had formed the impression that the wind was so light as to be virtually negligible, but imagery of the site taken shortly after the crash indicates a

Exhibit 20

Witnesses 1,
2, 10

southeasterly wind of between 5 and 10 knots. This would have given Puma 2's HP a significant downwind component during his approach that he had not anticipated. This is important for a number of reasons:

a. The HP would have anticipated a loss of translational lift at some stage late on the approach. A downwind component would result in this lift being lost at a much earlier stage and, if left unchecked, would result in a higher than anticipated rate of descent (RoD). At no time did any crewmember confirm the RoD on the Rate of Climb or Descent Indicator (RCDI). The initial very heavy landing was caused by an uncorrected RoD.

Witnesses 1,
2

b. The crew would have been anticipating a dust cloud to form behind the aircraft. However the downwind component meant the dust cloud formed below the aircraft and much earlier than expected. The wind would also have blown some dust ahead thereby reducing the references available to the HP and crewman and making the judgement of RoD or aircraft attitude very difficult.

c. The downwind component is likely to have contributed to a larger than normal nose down attitude during the final level transition because of the Puma's tendency to over rotate forward during a downwind forward transition: the wind acts on the horizontal stabiliser and tends to increase the nose down attitude. This is likely to have resulted in an unanticipated RoD as the aircraft was transitioned forward.

Therefore the Board concluded that the un-anticipated downwind component experienced on the final approach and landing was a contributory factor.

52. Light Levels and NVD Performance. The Board noted that the DMC forecasts for light levels were different by approximately 90 minutes from the forecasts provided by the coalition forces met office. Both forecasts were available to the crews, with the coalition forecast being the one normally used due to its simpler presentation. The DMC forecasts were incorrect due to an incorrect grid reference being used (Camp Bastion, Afghanistan) which has now been rectified. The Board considered the sun had set approximately 1 hour before the crash and the crews reported the ambient light levels to be workable, with no reported problems with the NVD picture. The sun's afterglow would have been in Puma 2's 9 or 10 o'clock, however this afterglow was not reported by any of the crews as **SECTION 26 SECTION 26** and most witnesses report it as being fully dark by the time of the crash. **Therefore, the Board concluded that light levels were not a contributory factor.**

Exhibit 20

Witnesses 1,
2, 4, 6, 9, 10,
12, 13, 14

53. Dust Cloud. The approach was carried out into a significant dust cloud and it is probable that the HP had very few visual

Witnesses 1,
2, 28

references in the latter stages of the first approach, during his short time on the ground and during the subsequent take off and crash. Despite the crew's utilisation of the latest UK NVD technology they ended up being close to the ground but unable to see the surface due to dust. **Consequently, the Board concluded that the inability to see usable references through the dust was a contributory factor.**

54. Aircraft Performance. The performance figures indicate that the aircraft would have had 1.2deg of pitch in hand above that required for a hover outside ground effect (OGE). This is sufficient for the aircraft to manoeuvre easily whilst OGE and to transition vertically upwards from an OGE hover if necessary. It is also more than sufficient to carry out a pre-meditated downwind approach and take-off. This would indicate that aircraft performance was not a factor. However no member of the crew was monitoring the engine instruments during the approach or the subsequent attempted take-off, so if there had been a power limitation for some reason, it would not have been noticed. The HP did not report any lack of aircraft response to the power demands he consciously made, and the theoretical power available figures were sufficient for what he was trying to do. **Therefore the Board concluded that aircraft performance was not a contributory factor.**

55. Terrain. The field was flat, at an altitude of approximately 100ft above mean sea level (AMSL). There was a large rounded mound, approximately 30ft above the level of the field, which formed the eastern boundary of the field. The field itself was heavily furrowed with a rectangular grid of irrigation ditches and smaller furrows and was very dusty (see fig1.2.3).

Exhibit 30

Witnesses 1, 2

Exhibit 25

Witnesses 1, 2, 9, 10, 12, 28

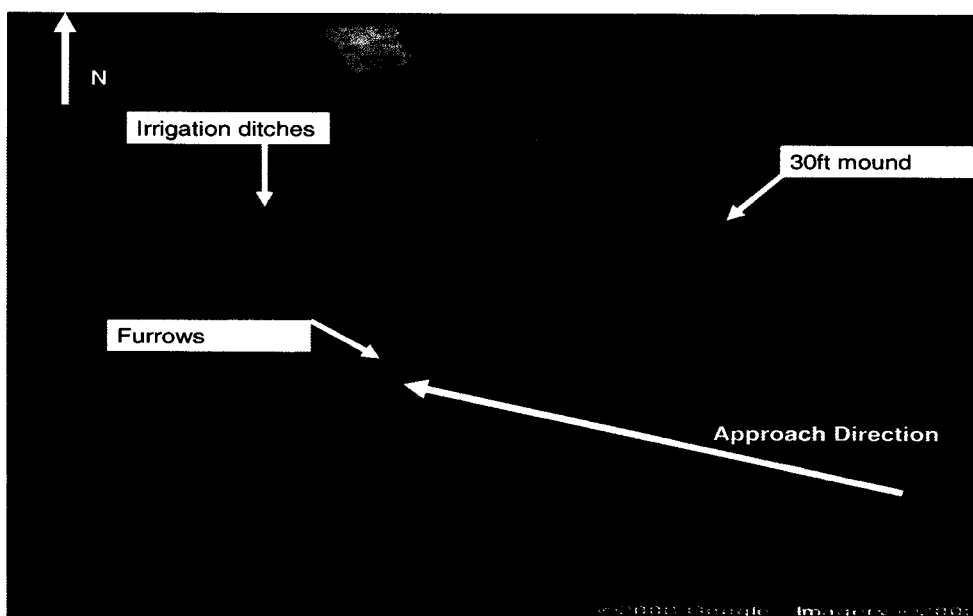


Fig 1.2.3 – Landing zone terrain.

The approach heading of Puma 2 meant that these ditches were crossed at about 20deg off the parallel. Some of the ditches were

approximately 2ft deep, the furrows being about 1ft high. It has not been possible to ascertain the strength of the surface of the field, but it seems to have been firm enough to support Puma 1 where it landed, and some of the imagery indicates that, in places, the ditches were not unduly deformed when they were struck by debris. The Board formed the opinion that if a Puma were to carry out a running landing and strike one of these ditches or furrows it could contribute to aircraft oscillations depending on the groundspeed at the time. Furthermore, the Board believed that if a thorough recce of the field had been carried out, these features would have been noticed and an appropriate landing would have been chosen to avoid any run on, making oscillations unlikely. **The Board concluded that the lack of a detailed recce was a contributory factor.**

56. Other Hazards. No wires were reported in the area of the field. There were no reports of loose objects around the area from prior to the crash, nor were any objects subsequently observed on the ground. There were no reports of bird activity at any time before or after the crash. None of the passengers or crew can recall anything being lost overboard from either aircraft during the approach or after Puma 2's first heavy impact. None of the rounds fired from Puma 1 **SECTION 26** were seen to ricochet backwards towards Puma 2 and the rounds fired by **S40** from Puma 2 were seen to go **SECTION 26** and clear of Puma 2's rotor disc. Furthermore, Puma 2's HP reported no handling or performance problems that could have been caused by other hazards at any stage. **The Board concluded that no other hazards contributed to this accident.**

Witnesses 1,
2, 9, 10, 12,
28

57. Supervision. The Board considered the complex nature of the flying supervision for the detachment and measured this against the experience of the deployed crews, their work-up training and the demands of the task. The in-place command and supervisory chain should have been sufficient to ensure adequate supervision of the task from inception to it being flown, however the following points were of note:

Exhibits 31,
32

a. Command and Control. All deployed **SECTION 26** come under the Tactical Command (TACOM) of the Air Detachment Commander (ADC). The Air Advisor (AA), who was new in post, exercised tactical Control (TACON) on behalf of the ADC and both Puma and Lynx detachments had a Det Cdr. The ADC and AA posts were filled by experienced aviators but neither had previously worked with helicopters. Neither the ADC nor the AA, therefore, believed they had the knowledge to get involved in the detailed supervision of the flying and left this very much to their Det Cdrs. **The Board concluded that the ADC's and the AA's lack of knowledge of helicopter ops reduced the level of supervision available to the detachment and was a contributory factor.**

Witnesses 3,
24, 25

b. Crew Composition. There were **S26** Puma crews and **S26** Lynx crews available at the time of the incident. The Lynx crews were correctly constituted and all of a similar experience level. The Puma crews had recently been changed round to ensure that a balance was struck to give the MLs the best NHPs available. The Puma 3 & 4 crews were well constituted with a good spread of experience, including the Det Cdr. The crews of Puma 1 & 2 on the face of it were less experienced but were trained and capable of conducting a dust landing into a field as part of a formation. The Board found a number of anomalies in their flying records and were able to ascertain the following:

Witnesses
17, 25

Exhibits: 2, 3,
4, 5, 11, 10

i. Puma 2 HP. The HP was FMQ having passed his final check prior to deployment. His check report highlights that he flew a steep approach and warns against the dangers of such a manoeuvre. Further investigation into the report suggests it was one approach and the HP appeared to learn from his mistake. However, a pre-requisite for the award of FMQ is to be NVD Cat B qualified and the HP had not completed an NVD Cat B syllabus nor had he been awarded the qualification. Significantly, he had held a higher grade NVD Cat during his previous time on the Lynx so he had flown down to and below the limits of Cat B. **The fact that Puma 2 HP had not completed a recognised NVD Cat B course was not a contributory factor in itself.**

Exhibits 2, 3

ii. Puma 2 NHP. The NHP was less experienced and newly qualified as BMQ. His BMQ workup training was completed satisfactorily but his Logbook was incorrectly signed as qualified NVD Cat B when he had not done any handling aspects of this qualification. He had also not completed a desert environmental qualification. Significantly the HP felt the need to reduce the NHPs workload by undertaking several tasks, such as the tactical radio net, as he did not want to overload his inexperienced NHP. **The Board concluded that the fact the Puma 2 NHP was not properly NVD Cat B qualified was not a contributory factor, but the fact that the Puma 2 HP felt he needed to reduce his NHP's work load, thereby increasing his own, was a contributory factor.**

Exhibits 4, 5

iii. Puma 1 Crew. The Puma 1 HP was an experienced, fully qualified CR pilot and QHI. He had done several previous deployments and was well suited to the role of ML. His NHP however was much less experienced as he had just completed his first tour. He had shown some poor captaincy on his

Exhibits 10,
11

previous unit but appeared to have overcome these issues. Prior to deployment he was day accepted on to the Sqn and was signed up as CR (Day), which is not a recognised flying qualification. He then underwent BMQ training despite not being NVD Cat B trained. His Night Tactical Formation (NTF) qualification was also out of date but he had been correctly trained, be it at a different NVD Cat, on his previous Sqn. Therefore, he deployed to theatre without being night accepted onto the Sqn and without a NVD Cat B qualification. **The Board concluded that the fact that the Puma 1 NHP was incorrectly qualified was not a contributory factor in itself.**

The above issues relating to the individuals within the crew constructs should not have contributed to this accident. However, both Puma 1 & 2 HPs were working to capacity to overcome the inexperience of their NHPs on this unfamiliar task: none of the operating crews had conducted a **S26**. The fact that all 4 crewmembers were working very hard meant no one took stock of the situation and no was balancing the risks that were being taken. The NHP on Puma 2 stopped providing a service during the crucial late stages of the approach as he witnessed tracer for the first time and his HP had asked him to do the checks silently. Therefore, **the Board concluded that the crew composition of Puma 1 & 2 for this particular mission was a contributory factor.**

Witnesses 1,
2

c. Operational Pressure. There was pressure placed on the crews to get the initial mission underway quickly. This led to a less than ideal planning timeline but the planning for the original hasty Op was completed satisfactorily. The real pressure came when the plan changed for the penultimate time and the target became **SECTION 26**. This change of target should have raised the requirement for a fuller re-brief as this was now a new situation. None of the operating crews, including the ML, were fully briefed into the likely intentions of the target or what threat the target now posed. The only thing that was made clear was the need to **SECTION 26**. Once airborne the pressure mounted as the radios became busier and the Lynx lead aircraft missed the target. Any member of the formation could have called for a reset at this point but chose not to. Instead a quick decision was made to change the plan and formation with less than 3 miles to run to the target area. It is clear that the formation did not know the ground truth or what the target was at this late stage but elected to press on. **The Board concluded that the operational pressure, both real and perceived, was a contributory factor.**

Witnesses 9,
10

Witnesses 1,
2, 9, 10

d. Authorisation Process. The authorisation was a standard format used on this detachment. The standard

Exhibit 9

format is designed to negate the requirement to write the authorisation out in full for every sortie: a pragmatic approach also used on other ops of this nature. The standard authorisation in this case covered the crews to do any tasking that they were asked to do without caveat or recourse to the supervisory chain. The authorisation sheets were signed at the end of the standard brief and without further detailed discussion between the authorising officer and the authorised captain. No further limits were set as to what tasking could or could not be done as at this time the nature of any likely task was unknown. The Board concluded that the authorisation process had lost the formal supervisory function that the process affords at the MOB. The Board fully understood the pressures of deployed Ops but felt that the process was to the detriment of flying supervision as it removed the final check of understanding and confirmation of crew suitability for the task at hand. Had this final check been done on this occasion it would have been clear that more suitable crews were available for this demanding **S26** task. **As a consequence the Board concluded that the authorisation process in place at the time was a contributory factor.**

Witnesses
10, 17, 24

58. Briefing Process. There were several briefings given throughout the day, all of which related to the task that was not in the end flown. It is noteworthy, however that not all formation crews, including the Dep Ldr, were present at the main briefs. Had they attended then they would have been better aware of the full situation and better placed to offer advice and guidance to the more junior crews. That said the crews walked to the aircraft as well prepared as possible for the mission at hand. The Board focused on the brief, or Quick Battle Orders (QBOs) that were given for the **S26** mission that was flown. The exact nature of the target and full intelligence picture was not clear to the ML as the target was a new one. He briefed the rest of the formation that were to be involved in the main assault over the radio using a non-aviation format, namely QBOs, however, all parties appear to have understood the general brief in that the Lynx would lead on the assault; generating some confusion as to who was now the formation lead. Puma 3 & 4 were not involved in this brief despite Puma 3 being annotated as the Dep Ldr. Therefore, Puma 3 was not in a position to take the lead had Puma 1 gone unserviceable. Had they been part of the brief they would have realised the complex nature of the task that was to hand, giving them the opportunity to take the lead themselves. **The Board concluded that the lack of a full brief with all formation elements present was a contributory factor.**

Witnesses 1,
2, 9, 10, 12,
17

Witnesses 1,
2, 4, 6, 9, 10,
12, 13, 14

59. The Formation. The Board noted that the inter-formation radio comms were poor and that this was a common occurrence. However, with a robust comms plan being briefed it is unclear if radio calls either did not get through, were missed by individual crews, crews were on different radios or they had their volumes turned down. The Board considered the actual flying of the formation and

Witnesses 1,
2, 9, 10, 12

the various elements that took part in it. The briefings delivered have been discussed above and, despite a degree of confusion on who was leading as they left base, there appeared to be no other major issues during the initial transit. The formation's problems seem to begin when the decision was made to split when Lynx 1 missed the target. Splitting the formation had two effects directly relevant to the crash. Firstly, it contributed to the uncertainty in the mind of Puma 2 HP as to the location of Lynx 1 at the critical moment of his overshoot. Secondly, it put all of the crews in an unknown, unpractised, and unplanned formation; effectively removing the validity of any pre-briefed deconfliction plans between the Lynx and Puma, which were based on the initial mission brief. **Therefore, the Board concluded that the decision to split the formation was a contributory factor.**

Witnesses 1,
2, 4, 6

60. The S26 Profile.The Board considered the **S26** profile and how it may have affected the decision making of the Puma 2 crews. The initial **S26** profile involving 2 Lynx, with 2 Puma as back-up, was a sound plan and would have worked. However, the change to 2 Puma and 1 Lynx was an untried formula, especially on this Op. It is unclear whether all crews fully heard the QBOs issued by the ML but they all believe they understood their part in the new plan. The Board noted that the terminology used in the QBOs related to **SECTION 26 SECTION 26**, which is not terminology used in either Puma or Lynx SOPs for **S26**; it was used in another theatre of ops some years ago. The ML did not update the target information when he reached **SECTION 26** and was not aware that the focus had moved to the **SECTION 26** and away from the **SECTION 26 SECTION 26** to the North. The ML saw what he believed to be the target **SECTION 26 SECTION 26 SECTION 26 SECTION 26** and briefed the TL that the **SECTION 26 SECTION 26**. The TL, believing this to be the target **SECTION 26 SECTION 26**. The Board considered this to be the critical point in this dynamic and confusing situation as no one challenged the decision to **SECTION 26**. Had anyone asked for the target to be confirmed it would have been clear they should no longer be focussed on the **S26**. Had the **S26** plan been challenged by any of the formation it would have become obvious that a reset was needed as only Puma 1 could see **SECTION 26** in question. The Board believes that there was a significant breakdown in CRM across the formation with a low standard of leadership and 'followership' being displayed throughout. **Therefore the Board concluded that the formation's acceptance of the decision to SECTION 26 SECTION 26 without confirmation of the target and a comprehensive brief was a contributory factor.**

Witnesses 1,
2, 4, 6, 9, 10,
12, 28

Witnesses 9,
10, 12

Witnesses 1,
2, 4, 6, 9, 10,

61. The Approach Profile. The Board went on to consider the approach profile that was flown by Puma 2. It is clear that the landing area was seen very late in the approach. This late sighting and the perceived pressure to land created by the tracer visible from Puma 1, meant Puma 2 was very close to what the HP saw as the only available landing area. Believing that he had to land he chose

Witnesses 1,
2

then to carry out a vertical approach from between **SECTION 26** (this is not exact as no one confirmed the height on the Rad Alt). This is not the standard approach profile and is not taught by any of the Puma training staff as it is considered to be inappropriate in dusty conditions as height judgement is very difficult and references are very difficult to maintain. The HP may not have lost references completely during this approach but they proved inadequate to ensure he was aware of his proximity to the ground as he failed to arrest his rate of descent in a timely manner. **The Board concluded that the choice of a vertical approach into a very dusty field was a contributory factor.**

Witnesses
17, 26

Witness 1

62. Enemy Action, Sabotage or Friendly Fire. The Board considered the likelihood of there being any external influences on the crash such as enemy action, sabotage or friendly fire. The Lynx 2 crew reported some incoming tracer from the vicinity of **S 26**, which was to the North of the landing point; however there were no other witnesses on the ground or in the air who saw this ground fire. The Board concluded that this tracer was likely to be 'tracer bounce' from Puma 1 as the Lynx was in a suitable position and the tracer was seen to deflect off trees in the area and go skyward. Enemy forces subsequently claimed that the aircraft had been blown up on a road in an Improvised Explosive Device (IED) attack, however the aircraft landed in a field and there were no reports of an explosion to back-up this claim. The Board could also discount sabotage as the aircraft had no apparent technical failure prior to the final impact and is believed to have been fully serviceable. Friendly fire was also discounted as there were no reported firings in the area except that from Puma 1. **The Board could therefore conclude that enemy action, sabotage or friendly fire were not contributory factors.**

Witnesses 4,
6, 7

63. Nr Decay and the Lynx. The Board considered the low Nr warning reported during the take-off after the first heavy impact, and the HP's response to it along side his response to seeing the Lynx above him. Given the fact that the HP thought the aircraft was about to topple over after the first heavy impact, it is likely that his collective pitch demand for the take-off was larger and more rapid than normal. The aircraft was also operating close to its Maximum All Up Mass (MAUM) making a rapid collective more likely to cause Nr decay. The ultimate reason for the low Nr warning is not know but is probably a combination of both of the above but the fact remains, it went off as the aircraft was lifted off. Neither of the cockpit crew looked at the Nr gauge so the Board does not know to what extent the Nr decayed, but it recovered quickly as only 2 'beeps' were heard. The correct response to hearing the Nr decay warning is to stop the upward movement of the collective lever, which allows the engines to catch up with the demands being placed on them. The HP reported taking the correct action however as this low Nr warning occurred simultaneously to the sighting of the Lynx in the 10 o'clock position he had to make another instant decision. The HP was fearful that he would now climb into the 2nd Lynx so he wanted to stop climbing. Normally this would be done by stopping raising the

Witnesses 1,
2

Annex B

collective lever, which he had already done to recover the Nr decay. The Board concludes that on seeing the Lynx the HP made a second input to the collective lever that resulted in it being lowered with the associated loss of upward thrust. This resulted in an unchecked downward vector as the pilot then attempted to transition forward. **Consequently, the Board concluded that Nr decay on its own was not a contributory factor. However, Nr decay coupled with the sighting of the Lynx and the HP's probable inputs on the collective to counter both simultaneously were contributory factors.**

64. Adherence to SOPs. The crew of Puma 2's actions diverged from those stated in SOPs in a number of significant areas. They willingly accepted that their role in the plan was to **SECTION 26** when this terminology is not in the SOP for **S26**. There was no Initial Point (IP) chosen for this target, therefore there was no earmarked point when the lower Rad Alt setting of **SECTION 26** could be set, so it was not. The lack of an IP led to the HP splitting the landing checks, asking his NHP to do them silently, and electing not to reset the Rad Alt. However, the aircraft was flown below transit height for a considerable distance en route to the final landing point. He also elected not to reset the Rad Alt to 25ft for the final approach, contrary to the SOP for Puma dust operations. The Board considers that the majority of the SOP divergences did not contribute to the final crash; however it felt that not setting the Rad Alt for the final approach was significant. Of note the Puma 2 HP directed that the Rad Alt audio warning should not be re-set for approaches as a matter of course: significantly no member of the crew questioned this stance. The Board noted that several other crews had also elected not to set the Rad Alt at 25ft as they found it distracting. This was not the view of the 33 Sqn training staff who believed it should be set at 25ft for all dust approaches, without exception. Had the Rad Alt been set to 25ft it would have warned the HP that he was approaching the ground somewhat faster than he had expected and would have allowed him time to check his RoD before the first heavy impact. The exact height the aircraft achieved prior to the final descent is not known as no crew member checked the Rad Alt but had it been greater than 25ft then the Rad Alt warning would have again warned the HP that he was descending and he may have been able to take corrective action prior to impact. **The Board concluded that non-adherence to the SOPs for dust operations, and specifically Rad Alt settings, was a contributory factor.**

65. Cockpit Gradient. The Board considered the cockpit gradient that existed on Puma 2 and elsewhere within the formation. There appeared to be a cross formation gradient in that the Puma and Lynx had not been fully integrated to operate seamlessly. This was apparent in that they had separate SOPs and neither group knew each other's methods of operation. The Lynx are also **SECTION 26** and the Pumas are not, which created a gradient of understanding of **S26**, though not significantly so in this case. The ML was the

Witnesses 1,
2,
Exhibit 22

Witnesses 1,
2

Exhibit 21

Witnesses
17, 26

Witnesses 1,
2, 4, 6, 7, 9,
10, 13, 14, 15

most experienced Op Puma pilot and was respected as such. There is nothing to suggest that there was a reason to question his judgement. The Puma 2 HP was more experienced than his NHP but this should not have prevented the NHP from speaking out against some of his captain's decisions. Neither the NHP nor the crewman were reported as being under confident and in interviews did not seem unduly concerned about any of the decisions that the HP or indeed the ML made, in fact it was apparent that the Puma 2 crew tended to make group decisions. The Board concluded that the reason no one questioned the decisions being made by the ML or by the Puma 2 HP was the perceived Op pressure to get the job done at all costs and not cockpit gradient. **Consequently, the Board concluded that cockpit gradient was not a contributory factor.**

66. Disorientation. The Board considered the issue of disorientation and formed the view that there were several instances of disorientation that contributed to the accident. The first was during the final approach when the Puma 2 HP lost adequate visual references. He initially stated that he lost references at about 15ft but subsequently stated that he did not lose them. Which ever is the case it is clear that his references did not give him adequate cues for judging either his RoD or his proximity to the ground. From the moment of first impact the HP had no real references so was flying effectively 'blind'. He could see very close in to the aircraft but he could not see anything around him. As he felt the aircraft roll from side to side he would not have been able to judge this rate of roll without reference to his instruments, which he did not look at. His intuition then told him he was about to roll over so he elected to 'overshoot': again he elected not to use his instruments but instead chose to look outside for external cues. It is not possible to ascertain what attitude; RoC or angle of bank was achieved during the manoeuvre. However, the HP did not achieve external references before seeing the Lynx that was high in his 10 o'clock: a moving Lynx is not a suitable reference on its own. Furthermore, he was given no indications from his NHP that he was in any kind of unusual attitude. His next actions would appear to have completely disorientated him as he attempted to transition forward without a visual horizon or reference to his instruments. He then could not determine if he was climbing or descending or indeed turning. **The Board concluded that the disorientation of the HP was a contributory factor.**

Witness 1

Witness 2

COMPLIANCE WITH ORDERS AND INSTRUCTIONS.

67. It appears that some variations from Puma Dust landing SOPs were not uncommon on the det. As an example, the decision was made by the Puma 2 HP not to re-set the Rad Alt bug audio warning to 25' on approaches and this was not questioned by any of his crew. The Op crews have been re-briefed to use the SOPs

Witnesses 1,
2, 28

68. The Board noted that an MSH was not normally calculated for the route or area of operation.

Witnesses 1,
2, 9, 10

69. There were two separate sets of SOPs, one for **SECTION 26** aircraft and one for Puma aircraft, despite them operating on the same Op and in the same formation. SOP integration work is underway. Witnesses 4, 10, 13, 17
70. There was a lack of knowledge of the Puma Specialist SOPs by the Lynx crews and vice versa. There was also uncertainty as to which set of SOPs was to be used on mixed formation. Witnesses 4, 10, 13, 17
71. No dispensation for the carriage of unrestrained passengers (JHC FOB J130.103.3) was in place at the time of the crash. The Board noted that this practice may be considered necessary for this Op and dispensation was granted shortly afterwards by HQ JHC. Exhibit 23
72. The Op training directive states that all crews should be both NVD Cat 'B' and NTF qualified prior to BMQ training. The HP, NHP of Puma 2 and NHP of Puma 1 were not correctly qualified to NVD Cat B before their BMQ training. A review of qualifications is underway. Exhibits 3, 4, 10 & 22
73. The ADC and AA TORs specify a Command function and therefore a supervisory role for them with regard to the Puma detachment as either TACOM or TACON. The vigour with which this role was exercised had become diluted over time; partly because of a lack of helicopter qualified incumbents and partly due to the short tour lengths. Exhibits 32, 34

SUMMARY OF CAUSES AND FACTORS

CAUSE

74. The cause of the accident was controlled flight into terrain, brought about by the HP's disorientation due to the use of an incorrect technique for a dust take-off.

CONTRIBUTORY FACTORS

75. The Board concluded that the following were contributory factors:

- a. The un-anticipated downwind component experienced on the final approach and landing. Para 51
- b. The HP's inability to see usable references through the dust. Para 53
- c. The lack of a detailed recce. Para 55
- d. The reduction in supervision provided by the ADC and the AA due to their lack of knowledge of helicopter ops. Para 57a

- e. The Puma 2 HP's perceived need to reduce the NHP's workload, thereby increasing his own. Para 57bii
- f. The crew composition of Puma 1 & 2 for this particular mission. Para 57b
- g. Operational pressure, both real and perceived. Para 57c
- h. The authorisation process in place at the time. Para 57d
- i. The lack of a full brief with all formation elements. Para 58
- j. The decision to split the formation. Para 59
- k. The formation's acceptance of the final decision to **SECTION 26** without confirmation of the target and a comprehensive brief. Para 60
- l. The HP's decision to do a vertical approach. Para 61
- m. The HP's probable double input to the collective; to counter the Nr decay and to avoid the unseen Lynx. Para 63
- n. The non-adherence to the SOPs for dust operations and specifically Rad Alt settings. Para 64
- o. The disorientation of the HP in the final stages. Para 66

POSSIBLE CONTRIBUTORY FACTORS

- 76. The Board concluded that it is likely that the HP input exaggerated control movements during the final transition due to a high arousal state. Para 63

AGGRAVATING FACTORS

- 77. The Board found the following were aggravating factors:
 - a. The intensity of the post crash fire. Para 28
 - b. Lack of restraint of passengers and crewman. Para 26
 - c. The combustion of the passengers' munitions, the aircraft GPMG ammunition and self-defence flares. Para 28
 - d. The lack of a second layer of clothing to provide protection against fire on the crewman's arms and hands. Para 31
 - e. The hand held fire extinguishers fitted to the Puma were not suitable for fighting the type of fire that occurred. Para 28

f. The anti-spill valves failed to operate when the aircraft rolled over.

g. Loose articles in the cabin including the fast rope and passenger baggage.

Annex D

OTHER FACTORS

78. A number of personnel held operational status that they were not correctly trained or qualified to hold. The operational imperative and command pressure to achieve the task appears to have led individuals to cut short essential training. If left unchecked this will contribute to future incidents.

Para 72

OBSERVATIONS

79. The Board made some observations that fell outside its TORs but which it felt were relevant to the overall operational output and the task at hand. Many are either the subject of current work or have already been addressed. The Board made the following observations:

Supervision

a. The Det Cdr lacked self-confidence, which may have contributed to his lack of intervention on the night.

Para 3c

b. The Aircraft Commander of ZA 938 and the ML were both acting as HPs and may have been in a better position to make tactical judgements had they been acting as NHPs. Consideration should be given to flying the ML as the NHP.

c. There was no clear overall command of engineering standards and practices across the det. The Board felt that co-ordination between aircraft operators should be improved.

Witness 5

d. The two most experienced crews on the det were not part of this formation.

Exhibit 9

e. The Lynx Det had a policy of destroying the original auth sheets after a sortie was complete and printing a fresh auth that contained both the pre- and post- flight details. No **SECTION 26** was reminded of the necessity to keep original auth sheets with the original signatures on.

Witness 14

f. The standard formation construction had not been amended since the integration of Lynx, which led to a deputy formation leader being nominated who was neither part of the briefing process nor planned to be present on this sortie. This practice has already been curtailed.

Exhibit 9

g. There was a lack of integration between Puma and Lynx operations. The Board recommended that a review be conducted of the pre-deployment training carried out with particular emphasis on the amount of dissimilar type training.

Para 3b

h. The standard of report writing of aircrew insert slips was variable and no longer focussed on purely flying supervision. A review should be carried out into the standard of report writing being produced for inclusion in the F 5000 series, with a view to ensuring that they can be used as a reliable supervisory tool.

Cabin Security

i. Work is currently underway to increase the length of the passengers' seatbelts in response to a perceived problem with strapping in. Interviews with survivors indicate that the issue is not the length of the straps but the width of the seats.

j. The practice of securing troops to the aircraft with 'helibelts' is not authorised in the RTS. The requirement to utilise this form of restraint in the Puma should be assessed and clear guidance be issued regarding their configuration and employment.

Adherence to SOPs

k. The SOP calls for the hovermeter to be selected to the HP's side but at no time is the HP expected to use it as a reference. A review should be undertaken regarding the requirement to select the hovermeter to the HP's Horizontal Situation Indicator (HSI) during dust landings.

Exhibit 21

l. The practice of not setting the Rad Alt for some dust landings was not confined to this crew.

m. No route or area specific Minimum Safe Height (MSH) is planned for NVD Ops in Theatre. The Board considers that an MSH should be planned for all routes and likely areas of operation.

Witnesses 2,
9, 10, 25, 27,
28

n. After the split, Lynx 1 was left unsupported by any of the formation. Crews should be reminded of the threat to single aircraft Ops and ensure that mitigating action is considered.

Post Crash Management

o. The in-use crash plan did not call for the impounding of all relevant aircrew documents and should be amended accordingly.

p. Very little flying clothing was recovered from the injured crewman for examination. Flying clothing should be recovered from all crewmembers of a crashed aircraft and be retained for examination by RAFCAM.

Annex F

q. The recovered CVR was so badly damaged by fire as to be unusable. The position of the CVR data card makes it unlikely to be recovered quickly from a crashed aircraft. The Board suggests that an FDR and/or a more crash worthy CVR be fitted to the aircraft.

Appendix 1
Annex D

Aircrew Qualifications

r. Puma 2 HP's documents had no record of the training for, or award of NVD Cat B status on the Puma.

s. NHP Puma 2, a BMQ qualified NHP was signed up as NVD B Cat qualified but had not done a recognised course.

t. Puma 1 NHP's documents indicate that he had not been Night Accepted nor awarded Combat Ready status, NVD Cat B nor Night Tactical Formation qualified at the time of the crash.

u. Relatively little night flying is undertaken in the simulator. Consideration should be given to increasing the level of simulated night flying.

Exhibit 33

v. There was no simulator sortie in the syllabus for this Op. Puma sim training presently being carried out should be reviewed, to make it more relevant to current Puma Ops.

w. There is no currency requirement for dust landings. Consideration should be given to introducing a simulator currency requirement for dust landings.

x. Sim training and currency requirements were not designed for current ops. A review of these requirements, ordered by the Puma Force Cdr is currently being undertaken.

Engineering

y. There were a number of minor errors in the F700 and LITS documentation, such as the lack of recording of mandatory crypto updates. Personnel should be reminded of the need to record crypto uploads in the F 700. A review should be undertaken as to the accuracy of engineering paperwork against LITS across the Puma Force and, if necessary, an educational process should be instituted to ensure the correct use of these forms.

Annex E

z. The Detachment Engineers' shift change routine left

Witness 5

the FOB without engineering support for a 24-hour period every week. Engineering shift patterns/manning levels should be reviewed with a view to providing continuous engineering support at the FOB.

aa. No flight servicing schedules were available for reference at the FOB, but servicing was routinely being carried out there. Servicing schedules should be included in all aircraft paperwork pack-ups when servicing is likely to be carried out away from the DOB.

Witness 5

ab. Puma Det EngOs appear to go through their normal unit chain of command rather than the directed in-theatre chain of command for issues of airworthiness, standards and practices. A review should be undertaken to clarify the role of the Level K engineering authority in Theatre and ensure that Det EngOs are aware of the correct airworthiness chain.

ac. A FS signal for a servicing error, which occurred on the 20th Nov, was not sent until the 26th Nov 07.

Exhibit 14

ad. The phrase "ensure locked" (card 1 of Flight Servicing Schedule Puma HC1, (Airframe (AF) Trade) in the servicing schedule was interpreted differently by different personnel. Some assumed a visual check was enough; others thought a physical check was required. Clear guidance should be given in the Puma servicing schedule as to whether "ensure locked," means a visual or a physical check of the mechanism.

Exhibit 14

ae. There is no purpose designed weapon stowage in the detachment Pumas. Common practice is to store the personal weapon in the cockpit **SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26**. A suitable crew weapons stowage system for the Puma should be investigated.

Witness 2

af. There are no crash switches fitted to the Puma. Had there been they might have operated to disconnect electrical power on impact and reduce the sources of ignition for the post crash fire. The requirement for crash switches should be investigated.

ag. The HEELS assisted passenger egress.

Para 35

ah. Engineering personnel at RAF Benson provided excellent assistance to the Board.

AEA

ai. There was a lack of familiarity, both on the part of the aircrew and the passengers, with the quick release mechanisms in place on both the passengers' body armour

Para 34

and the crewman's ACLP. Pre-Deployment Training (PDT) should include a familiarisation of the said equipment.

aj. It is common practice for aircrew to refuel and service the aircraft wearing the same pair of gloves they use for flying. This practice leads to contamination of the gloves by Petrol, Oils and Lubricants significantly degrading their fire retardant properties.

Witnesses
12, 28

Documentation

ak. Errors in logbooks and trg folders were not picked up by sqn supervisors or Staneval.

al. Puma FRCs list the emergency evacuation on the ground drill under "Ditching" and do not call for the passengers to be supervised during their evacuation. FRCs should be amended for clarity.

Exhibit 26

Rules of Engagement (ROE)

am. The airborne ROE were not well understood and no guidelines on allowing troops to fire from aircraft using either personal or aircraft weapons were available. Clear guidance must be given on both ROE and the rules regarding troops opening fire from helicopters during pre-deployment training.

General

an. A complete functional check of all the contents of the crash boxes should be undertaken before issue to a Board of Inquiry (BOI). The IT provided in Box 4 was not fully compatible in that: the encryption of the laptop does not meet current security requirements; the passwords given did not work as they were for a different laptop computer; the lead provided to link the computer to the printer did not work; no batteries were provided for the Dictaphone and its software was not compatible with that of the laptop computer; the laptop itself still had all the details of a previous BOI on it; and it was not authorised for storing any material above Restricted. The extracts from Joint Service Publication (JSP) 551 were also out of date.

ao. The support provided by the passenger handling facility at RAF Brize Norton and the Detachment in theatre was excellent. The only exception being the requirement for the Board to share accommodation with the Sqn Cdr of the detachment being investigated. The Board suggests that wherever possible Board members should be accommodated separately from individuals who are subject of its investigation

ap. Joint Personnel Administration (JPA) tracking was not

carried out for any of the Board entering or leaving theatre. Clear guidance should be provided as to the JPA tracking procedures for members of a BOI.

aq. Liaison with Special Investigations Branch (SIB) both in theatre and in the UK was excellent and saved a good deal of the Board's time in terms of gathering evidence. Future BOIs should be briefed to liaise with SIB personnel at the earliest opportunity when at the incident location.

ar. The assistance normally available from Joint Air Reconnaissance Intelligence Centre (JARIC) was severely hampered by a moratorium on work for BOIs, which came into force during the period of the Board's deliberations. The letter explaining the new protocols was dated 13 Feb 08 but its contents were not made known to the President until 13 Mar 08 and only then by means of a copy being sent from JARIC.

Exhibit 35

as. Despite the risks to personal safety, a number of personnel made brave attempts to rescue trapped crew and passengers. Soldiers A and E were particularly noteworthy.

Para 27

at. Crews were routinely using photographs rather than maps as the primary means of navigation. The Board felt this was not best practice due to the lack of aeronautical and grid information provided on the photographs.

Witnesses 2,
9

au. The majority of paperwork relating to this operation and the associated SOPs and instructions lacked the correct privacy marking and security caveat and was therefore uncontrolled. All personnel must be reminded of the OPSEC requirements and the need to correctly mark ALL documents of a sensitive nature.

Exhibit 17, 18

RECOMMENDATIONS

80. The Board recommends the following:

a. Supervision. The supervision of this Detachment should be strengthened in a number of areas:

Para 75

i. Properly experienced crews should be selected for this Op based on their general skill sets and experience levels not simply the number of hours they have flown or their combat ready status. If crews are not suitable then they should not be given a qualification.

ii. Sustaining the capability is paramount therefore the task must be properly resourced with quality individuals and equipment at all levels. This may mean

less capability forward whilst experience is gained but the training of individuals must not be curtailed in any way.

iii. Deployed ADC, AA, Det Cdrs and authorising officers must be briefed on their responsibilities and fully understand the management of risk at all levels. Risk must be held at the highest practicable level and not simply devolved down to individual crews. The use of a daily non-flying supervisor would address the short-term issue and JHC should consider mandating a Support Helicopter (SH) background for the ADC and AA where possible.

iv. The in-theatre authorisation process should be reviewed with a view to making it less generic and more relevant to the task that is to be flown, thereby ensuring the process remains a key link in the supervisory chain.

b. Cabin Security. The Board notes that this is a repeat recommendation from the fatal crash of Apr 07. Passengers should not be allowed to fly unrestrained without a full risk assessment being carried out. The Aircraft Operating Authority (AOA) must be alive to this requirement on Ops and proactively ensure a suitable assessment has been carried out prior to the issue of any dispensation from the requirement iaw JHC FOB J130.103.3. Passenger and crewman restraint in the Puma should be fully reviewed with a view to providing more suitable systems that better equip the operations and passengers of today.

Para 77

c. Adherence to SOPs. The requirement to adhere to SOPs must be reinforced to all operating crews, as it is clear that they feel they are routinely permitted to go beyond the accepted normality when they believe the task requires it. The flexibility to alter SOPs in extremis must remain in place for the odd occasions when they do not fit the task. However, crews must be taught the difference between adapting a procedure to fit the moment based on a risk assessment and the amending of procedures as they see fit.

Para 75

d. Post Crash Management (PCM). The in-theatre PCM measures had several key areas that need to be addressed:

Para 79

i. Thought should be given to impounding all formation aircraft CVRs in the event of a major incident. The Board would have benefited greatly from the other aircraft's recordings.

ii. The Board would have had no evidence of note had the crew been less fortunate and not survived.

Therefore, an ADR should be fitted to the Puma.

iii. A medical examination should be given to all participants following any aircraft accident. This was not done on this occasion and could have had serious consequences if any of the victims had hidden injuries.

iv. Most operational accident sites are now out of the reach of BOI and other investigation personnel. All AOAs should consider the requirement to gather as much data as possible from the crash site as quickly as possible. This may require the setting up of teams in country or ensuring that non-UK CSAR crews are briefed on national requirement regarding the taking of pictures etc. Wherever possible the President or one of the BOI members should be consulted on the requirements to gather evidence prior to any attempt to destroy the aircraft. Consideration should be given to creating a standing collection task on JARIC to ensure the correct resources are tasked quickly to gain as much imagery as possible.

e. Aircrew Qualifications.

Para 79

i. A review of all training records and qualifications awarded over the past 2 years on the Puma force should be carried out to ensure that crews have completed the recognised syllabus requirements and that the award has been correctly annotated.

ii. The exact categorisations and qualifications that are to be awarded and how these are annotated should be reiterated to all SH units to ensure the meaning of qualifications is fully understood.

iii. The AOA must re-emphasise the requirement for units to alert them of any shortfalls in training to allow them to manage the risk associated with sending partially qualified aircrew on Ops: this decision should not rest at sqn level.

f. Engineering. The post crash fire was a major concern to the Board:

Para 79

i. An investigative report into the consequences of fuel spilling from the Anti-spill valves should be commissioned without delay. The Board can confirm several occasions where fuel leaked from this device and it is likely that this has happened on previous incidents.

ii. A maintenance schedule should be introduced

for the Puma anti-spill valves. (This process is ongoing with the Puma IPT).

iii. A review should be undertaken as to the current level of fire protection on the Puma, with particular regard to the utility of the hand held fire extinguishers and the number of engine fire extinguishers.

g. Brownout. Further consideration should be given to the procurement of a system that would allow aircrew to effectively see through dust during brownout conditions.

Para 75b

h. AEA. All aircrew should be reminded of the need to wear multi-layers of clothing wherever possible to increase the protection against fire. The Board fully understands the issues relating to heat stress however the chances of being involved in a fire are real, especially in a high tempo kinetic conflict environment. Thought should also be given to affording proper protection for the hands as the present aircrew glove would appear to be less than adequate in the event of a fire.

Para 77e

President
SECTION 40

Members
SECTION 40

.....
SECTION 40

RECORD OF QR1269 ACTION TAKEN BY BOI ZA938:

- 5 Dec 07 At this stage the Board considered that **SECTION 40 SECTION 40** might be affected by its findings and, in accordance with Board of Inquiry Rule 11 and QR 1269(1), he was informed that he could, if he so wished, be present during the remainder of the sittings of the Board or at such times as the convening authority or the President may specify, and, if he so wished it, could also be represented at his own expense. He was warned that the proceedings were privileged and were not to be disclosed to third parties except in the circumstances set out in QR 1272. He was also informed that he was entitled to cross-examine the witnesses, to give evidence, and to call witnesses to give (further) evidence on the matters which may affect him **SECTION 40** was present during the interviews of **SECTION 40** and **SECTION 40** and he elected to cross-examine them. **SECTION 40** elected not to be present at the interview of **SECTION 40** elected to be present for the remainder of the inquiry.
- 05 Dec 07 At this stage the Board considered that **SECTION 40 SECTION 40** might be affected by its findings and, in accordance with Board of Inquiry Rule 11 and QR 1269(1), he was informed that he could, if he so wished, be present during the remainder of the sittings of the Board or at such times as the convening authority or the President may specify, and, if he so wished it, could also be represented at his own expense. He was warned that the proceedings were privileged and were not to be disclosed to third parties except in the circumstances set out in QR 1272. He was also informed that he was entitled to cross-examine the witnesses, to give evidence, and to call witnesses to give (further) evidence on the matters which may affect him **SECTION 40** was present during the interviews of **SECTION 40** and **SECTION 40** and he elected to cross-examine them. Following these interviews **SECTION 40** elected not to be present at the remainder of the inquiry.
- 5 Dec 07 At this stage the Board considered that **SECTION 40** might be affected by its findings and, in accordance with Board of Inquiry Rule 11 and QR 1269(1), he was informed that he could, if he so wished, be present during the remainder of the sittings of the Board or at such times as the convening authority or the President may specify, and, if he so wished it, could also be represented at his own expense. He was warned that the proceedings were privileged and were not to be disclosed to third parties except in the circumstances set out in QR 1272. He was also informed that he was entitled to cross-examine the witnesses, to give evidence, and to call witnesses to give (further) evidence on the matters which may affect him **SECTION 40** was present

during the interviews of **SECTION 40** and **SECTION 40** and he elected to cross-examine them. **SECTION 40** elected not to be present for the interview of **SECTION 40**. **SECTION 40** elected to be present at the remainder of the inquiry.

04 Mar 08

At this stage the Board considered that **SECTION 40** **SECTION 40** might be affected by its findings and, in accordance with Board of Inquiry Rule 11 and QR 1269(1), he was informed that he could, if he so wished, be present during the remainder of the sittings of the Board or at such times as the convening authority or the President may specify, and, if he so wished it, could also be represented at his own expense. He was warned that the proceedings were privileged and were not to be disclosed to third parties except in the circumstances set out in QR 1272. He was also informed that he was entitled to cross-examine the witnesses, to give evidence, and to call witnesses to give (further) evidence on the matters, which may affect him. **SECTION 40** elected not to be present for the remainder of the Inquiry.

11 Mar 08

At this stage the Board considered that **SECTION 40** **SECTION 40** might be affected by its findings and, in accordance with Board of Inquiry Rule 11 and QR 1269(1), he was informed that he could, if he so wished, be present during the remainder of the sittings of the Board or at such times as the convening authority or the President may specify, and, if he so wished it, could also be represented at his own expense. He was warned that the proceedings were privileged and were not to be disclosed to third parties except in the circumstances set out in QR 1272. He was also informed that he was entitled to cross-examine the witnesses, to give evidence, and to call witnesses to give (further) evidence on the matters, which may affect him. **SECTION 40** elected not to be present for the remainder of the Inquiry.

PART 1.3: COMMENTS BY PUMA FORCE COMMANDER

INTRODUCTION

1. I thank the Board for a comprehensive report into the accident to Puma HC1 ZA938 in Iraq on 20 Nov 2007. I strongly praise the efforts of those who acted to save life at the crash site, particularly **SECTION 40**¹. My sincere condolences go to the relatives and loved ones of the two soldiers that died, and my heartfelt sympathy to those who were injured.

2. This lengthy and complicated Report bears some clarification, particularly if the bereaved are not technical experts. In this part of the Report, I attempt to show the wider context of the mission before commenting on the core issues directly affecting the crash, the chain of issues or events related to the crash, and then the recommendations and actions arising.

CONTEXT

3. At the time of the accident, the Puma Force was about to enter a 'reset' period of reduced tasking in order to improve the generation of trained aircrew for deployed operations. The necessary improvements had already been recognised by JHC HQ. Significant actions were underway, or have subsequently been taken, to place the Force on a more sustainable footing.

4. This was a high pressure tactical situation to prosecute a series of high value targets. Troops were to be inserted at a number of landing sites. The plan was quickly conceived and the helicopter crews prepared to conduct the inserts in rapid sequence. As the crews manned their aircraft, the plan suffered major change: they then acted in good faith to try and achieve the revised task, which exceeded their recent experience. Choices had to be made in very short order whilst airborne and under significant tactical pressure: the key decisions spanned little more than 5 minutes of concentrated activity. This was not a peacetime mission, so we need to understand the pressures on individuals in that difficult environment if we are to properly explain what happened.

CONTRIBUTORY FACTORS RULED OUT

5. I agree with the Board that the following were not contributory factors in this accident: technical failure of the aircraft², weather (other than a downwind component)³, light levels⁴, aircraft performance⁵, other hazards⁶, enemy action / sabotage / friendly fire⁷, and an inappropriate cockpit gradient⁸.

¹ BOI Para 27.

² BOI Para 50.

³ BOI Para 51.

⁴ BOI Para 52.

⁵ BOI Para 54.

⁶ BOI Para 56.

⁷ BOI Para 62.

⁸ BOI Para 65.

CORE ISSUES

6. This section examines the core issues, which I define as those factors that directly affected the operation of ZA938 after it commenced an approach to land.

CONTRIBUTORY FACTORS

7. I need to expand on the preceding Report as follows:

a. Crew Composition. The Report states that the Handling Pilot of Puma 2 was compensating for an inexperienced Non Handling Pilot⁹. This is true: the Handling Pilot was a relatively experienced Training Captain who was 'bringing on' a relatively new Non Handling Pilot. Both pilots were appropriately trained for the planned mission. **SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26** they were competent to perform the range of aviation support tasks required for that particular Operation. As some elements of the Operation cannot be simulated in UK, there was a need for some 'on-the-job' training. Puma 2 was not leading the formation, so the crew composition was reasonable for their planned mission. The issue was less with the constitution of the crew and more with the way that the crews acted: I add Crew Resource Management as a contributory factor to better capture the relevant points.

b. Crew Resource Management. When the mission changed, the crew composition of Puma 2 was put under significant and unusual strain. The core issue is whether the crew delivered a reasonable service to the Handling Pilot during the initial approach, decision to overshoot, and subsequent failed overshoot. The Report implies that this service was sub-optimal during the unusually steep approach¹⁰ but offers little direct evidence in the absence of the Cockpit Voice Recorder, which was destroyed in the post crash fire. That said, there is also little evidence that the Non Handling Pilot of ZA938 was properly engaged and giving an adequate service. On the balance of probability, I think the Non Handling Pilot¹¹ of ZA938 could have done significantly more to inform and advise the Handling Pilot and that the Handling Pilot could have been more explicit in organising his crew. Crew Resource Management is, therefore, a contributory factor.

c. Detailed Reconnaissance. The Board state that a lack of detailed reconnaissance was a contributory factor¹². In peacetime, Puma crews are trained **SECTION 26 SECTION 26 SECTION 26 SECTION 26** updating and adding information during the final approach. Using that technique on this Operation (and this mission) would have drawn

⁹ BOI Para 57b.

¹⁰ BOI Para 19.

¹¹ NHP described by BOI Annex G Para 8 as having a 'rather unimaginative and passive approach'.

¹² BOI Para 55.

unwelcome attention to the formation and the troops, so Puma crews are trained to conduct their reconnaissance **SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26 SECTION 26**; these approaches are normally pre-planned and supported by imagery. This 'straight-in' reconnaissance and training also applies to any flight where an emergency dictates an immediate landing. The crew of ZA938 had sight of the proposed landing site during the approach and were trained to make the appropriate judgements during that approach. Adopting this procedure was more risky than conducting a **SECTION 26 SECTION 26 SECTION 26** but entirely reasonable in the tactical circumstances. In any case, under either of these reconnaissance procedures, the final detail of the landing surface often cannot be fully ascertained until the aircraft is very close to the ground. In this case, at the height where surface imperfections should have been picked up, there were reduced or inadequate visual references. The Puma has a narrow undercarriage track and a high centre of gravity, so the crew would have appreciated that it could have become unstable on uneven ground, potentially leading to an unrecoverable situation, well known to Puma crews, called dynamic rollover. The uneven nature of the surface of the selected landing site caused the aircraft to be unstable on initial landing, requiring a late overshoot to avoid the possibility of dynamic rollover. In conclusion, I believe that a late appreciation of the uneven nature of the surface of the selected landing site was the true contributory factor here.

d. Downwind Component. An unforeseen downwind component was present¹³, leading to: an increased dust cloud beneath the aircraft impinging on the Handling Pilot's line of sight, plus a possible un-demanded over-rotation of the aircraft nose downwards due to aerodynamic forces during the attempted transition into forward flight¹⁴. These remain extant as contributory factors. However, the early loss of translational lift and any subsequent increased power demand for landing noted by the Board would have been mitigated by the power margin available¹⁵, so I would discount the loss of translational lift as a contributory factor¹⁶.

e. Visual References. The Board considers a loss of adequate visual references (to which I would add the *inappropriate use of limited* visual references) by the Handling Pilot during the final stages of the initial landing¹⁷. The evidence is somewhat contradictory – in his statements, the Handling Pilot is adamant that he maintained visual references 'all the way to the ground'. This does not explain why the instability on landing took the crew by surprise. The Handling Pilot also states that, 'with hindsight', his references were not good enough¹⁸ and that they

¹³ BOI Para 51b/c.

¹⁴ This would have had the secondary effect of tilting the lift vector forwards away from the vertical, reducing the climb performance of the aircraft for a given collective lever setting.

¹⁵ BOI Para 54.

¹⁶ BOI Para 51a.

¹⁷ BOI Para 53.

¹⁸ Witness 1, Page 8.

degenerated to 'dust being pushed from the peak of a furrow'¹⁹. On the balance of probability, I believe that the visual references were inadequate for a safe and controlled landing in the given situation. This remains a key contributory factor.

f. NR Decay and Lynx. The Board discount the droop in the speed of the rotor (known as NR decay) in the initial part of the overshoot as a contributory factor; I agree that a small amount of droop and a limited audio warning (as shown in the evidence) is both reasonable and normal in the circumstances of such overshoots. This would normally be accompanied by a 'check' on the collective lever – an action correctly defined by the Board as 'to stop the upward movement of the collective lever, which allows the engines to catch up with the demands placed on them'²⁰. This 'check' of the collective lever was carried out by the Handling Pilot. The contentious issue is whether the movement of the collective lever was more than was required: *i.e.* leading to a reduction in power / climb and a subsequent descent back into the dust cloud. In the absence of a Flight Data or Accident Recorder, this is difficult to ascertain. The Handling Pilot does not recall lowering the lever in the climb, but he does recall the stress of seeing a Lynx in close proximity and deciding to translate some climb momentum into a level transition into forward flight. There was also an unforeseen downwind component that could have led to an un-demanded nose down, consequent tilting of the available lift vector away from the vertical, and a reduction in climb²¹. Although it is not recorded in the Report, I know that Board members adopted the same overshoot parameters in the Puma dynamic motion simulator and found that a lowering – rather than a check - of the collective lever was required to induce a descent. This implies perfect computer modelling of those parameters in the simulator, which is not proven. On the balance of probability, however, I believe that an overly assertive check on the collective lever, coupled with a decision to reduce or stop the climb to avoid a perceived conflict with the Lynx plus a potential un-demanded nose down rotation reducing climb performance forms a group of key contributory factors that I re-title 'incorrect overshoot'.

g. Adherence to Standard Operating Procedures. The Standard Operating Procedure for a night approach on Night Vision Devices is to set the radar altimeter audio and visual warning to go off at 25 feet above the ground, giving an audio and visual warning of the very close proximity of the ground. For this Operation, that setting would normally be done at an Initial Point several miles and several minutes before the approach and landing. I believe the Handling Pilot was correct to leave the radar altimeter in a cruise setting whilst the aircraft was in the cruise and the mission unclear- this gave him maximum notice of an inadvertent descent from cruise flight. The contentious issue is whether the radar altimeter settings should have been reset for the approach to land. Normally this

¹⁹ Witness 1, Page 12.

²⁰ BOI Para 63.

²¹ Cross refer Para 7d.

would be so, but the normal sequence of events was truncated and it would have been inappropriate for both of the pilots, in sequence, to look into the cockpit and make adjustments to an instrument whilst below 100 feet above the ground and descending to land in difficult circumstances, with friendly gun fire in close proximity²². It would have been more appropriate for the Non Handling Pilot to have acted – it is his instrument that would have set off the warnings had it been set to 25 feet. So, the Board's criticism that the radar altimeters were inappropriately set for landing is correct, but significantly mitigated by operational pressure. The Standard Operating Procedure for an overshoot in limited visibility due to dust or sand is to transfer onto instruments until above or clear of the cloud, an event announced by the Non Handling Pilot, after which the Handling Pilot may revert to visual references. This Standard Operating Procedure was not followed, but the Board offers little mitigation as to why. There is evidence that the Handling Pilot had conducted a successful overshoot only days before, so this appears not to be a procedural or training error. There is evidence that, on this occasion, the Handling Pilot was over-stimulated by the close proximity of a Lynx, which allegedly caused him to deviate from the standard overshoot procedure. Whilst the proximity of the circling Lynx was of understandable concern, the normal procedure would be for the higher aircraft – the Lynx - to take avoiding action on the aircraft taking off – the Puma - and not the other way round. The central issue is the handling of the overshoot: Puma pilots are trained to go onto instruments, adopt a suitable aircraft attitude, pull to maximum power, and wait until the Non Handling Pilot calls the exit from the sand cloud. This did not occur in this case, so it is the single most important contributory factor to the accident.

SUMMARY OF CORE ISSUES

8. In summary, I believe that the following factors directly contributed to the accident:
- a. Crew Resource Management.
 - b. Operational Pressure. Real or perceived operational pressure²³.
 - c. Selected Approach Profile. Puma 2 decided to follow Puma 1, accepting an unusually steep approach profile²⁴.
 - d. Downwind Component.
 - e. Inadequate Visual References.
 - f. Late Appreciation of Uneven Landing Surface.

²² BOI Para 61.

²³ BOI Para 57c

²⁴ BOI Para 61.

- g. Incorrect Overshoot.
- h. Disorientation. Having looked up at the Lynx during the overshoot, the Handling Pilot of ZA938 suffered from spatial disorientation²⁵.
- i. Inadequate use of Standard Operating Procedures.

PUMA FORCE COMMANDER'S NARRATIVE

9. The following narrative - my words - indicates the probable series of events:

The reconnaissance failed to pick up that the landing site was uneven or that there was a downwind component. The Puma adopted a steep approach that increased the sand cloud and reduced the available visual references. When, on landing, the Puma became unusually unstable due to the uneven ground, the correct decision was made to overshoot. The climb was truncated because of the close proximity of a Lynx helicopter. The Puma descended back into the sand cloud, either because of an un-demanded nose down change in aircraft attitude due to the wind or an inappropriate movement of the collective lever. This incorrect overshoot led to pilot disorientation and an un-demanded impact with the ground.

CAUSE OF THE ACCIDENT

10. The cause of the accident was controlled flight into terrain brought about by the Handling Pilot's disorientation following an incorrect overshoot²⁶.

CONTRIBUTORY CAUSES OF FATALITIES

11. It was usual for the troops on this Operation to un-strap shortly before landing in order to make a rapid exit from the aircraft, anticipating incoming fire. This should be a tactical risk judgement taken for each individual mission: it is a difficult judgement for both soldier and aircrew. It is generally understood that if passengers remain inside the cabin during a crash, their survival rate increases. If they are thrown from the cabin, the hazard to life increases. In this case, the fatalities arose when un-restrained passengers were thrown clear of the cabin and beneath the aircraft.

²⁵ BOI Para 66.

²⁶ At Para 74, the Board refer to a 'dust take off', but I believe that 'overshoot' is more appropriate language as it implies a reaction to an inability to land.

RELATED ISSUES

CONTRIBUTORY FACTORS

12. The Board raises a number of other contributory factors that do not relate directly to the cause of the accident, but help us to understand the circumstances that led up to it:

a. Supervisors. The Board state that the limited helicopter knowledge of key supervisors in the operational command chain was a contributory factor²⁷. I agree and note that action has already been taken by JHC HQ to change the type of person employed as Air Detachment Commander and Air Adviser. The chain of events that led to this accident might have been broken by a more robust supervisory presence, either as part of the routine of this detachment or before this specific mission: even those without detailed helicopter knowledge could have 'broken the chain'. Inadequate supervision remains a contributory factor.

b. Briefing Process. I agree that the lack of a full brief for all formation (and ground) elements was a contributory factor²⁸. However, the time critical nature of the planning process meant this was difficult to achieve. The Board state that 'the crews walked to the aircraft as well prepared as possible for the mission to be flown'²⁹. The re-tasking came through as they were starting the aircraft. The issue was then more with the Quick Battle Orders that were issued by the Mission leader in response to the change of task: these may not have been standard, but they appear to have been adequate. The fact that Pumas 3 and 4 were not at the brief³⁰ was not, *per se*, a contributory factor. Overall, inadequate briefing was present, but it was reasonable in the circumstances and only a minor contributory factor to this accident.

c. Authorisation. The Board states that more suitably qualified crews were available and it was a failure of the authorisation process that these crews were not employed on the mission³¹. In fact these crews were not brought forward until late in the planning process as a reaction to the task changing; they would have had great difficulty in taking over this time sensitive mission. On balance, in the time available, I believe it was the correct decision to use those crews as a Quick Reaction Force. I therefore discount authorisation as a contributory factor. However, I fully accept that the authorisation process was sub-optimal: this process has already been changed to increase the oversight by the revised supervisory chain for this Operation.

²⁷ BOI Para 57a.

²⁸ BOI Para 58.

²⁹ BOI Para 58.

³⁰ BOI Para 58.

³¹ BOI Para 57d.

d. Decision to Split the Formation. The decision to split the formation was assessed by the Board as a contributory factor³². However, faced with similar circumstances (the lead Lynx departing the area with communication and navigation problems) I believe that many Mission Leaders would consider such a decision to be reasonable, even though it left Lynx 1 temporarily without close mutual support in a hostile area. The decision to split the formation was a contributory factor, but it was not a totally unreasonable decision for a high-value mission that could have delivered strategic effect. The issue is what the split formation subsequently attempted to do: **SECTION 26**.

e. **SECTION 26 SECTION 26 SECTION 26**. I agree that the original **SECTION 26 SECTION 26 SECTION 26**, using **SECTION 26 SECTION 26 SECTION 26** to provide a back up cordon, was sound³³. The Mission Leader's decision to order an immediate **SECTION 26** procedure after the formation had split was, with hindsight, less sound. This decision was based on limited tactical information and without adequate situational awareness of the wider tactical picture; with hindsight, a tactical pause would have allowed the mission to regroup. The decision to attempt a **SECTION 26 SECTION 26** procedure was, therefore, a major contributory factor that led up to the circumstances of the crash to ZA938.

FACTORS NOT FULLY REPORTED BY THE BOARD

13. The following factors were not fully brought out in the Report:

a. Wider Supervision. The chain of events could have been broken by other in-theatre commanders and advisers, particularly those in the ground operations rooms that were running or monitoring this mission. The Board did not investigate how the supervision of the air mission fitted within the command and control of the overall mission: the operational command chain should identify if any improvements to the command and control of the overall mission are appropriate.

b. Pre Deployment Training. The Board records irregularities in the pre-deployment training of individuals without considering these to be contributory factors. The Puma Force was not in best shape in Nov 07 – having been heavily committed to Iraq since 2003, the training system was struggling to produce the quality and quantity of aircrew required to sustain operations. In addition, a laudable 'can-do' attitude of individuals within the Force may have become too overt and task focused: this potential culture is being targeted and safety margins increased.

c. Crew Resource Management. The interaction between individual crews, with the Mission Leader, with the troops, and with the controlling elements on the ground was less than perfect. The situation became extremely confused and the Mission Leader, in particular, had a series of

³² BOI Para 59.

³³ BOI Para 60.

difficult decisions to make on limited information and in rapid time. In his QR1269 statement³⁴, the Mission Leader outlines the inadequate communications that hindered his decision making process. There is a fine dividing line between a decision that results in a successful mission and the award of a gallantry medal, and a decision that results in a mission that fails. With hindsight, I believe that the Mission Leader should have ordered the formation to stand off whilst the tactical situation was clarified. I also believe that his intent could have been better communicated to the formation. This is typical of the tone of the mission, which was very task focused, probably to the detriment of sound risk evaluation and decision making. Of note, we have increased ground training in what is becoming known as 'operational risk management'.

SUMMARY OF RELATED ISSUES

14. In summary, I believe that the following factors contributed to the chain of events leading up to the accident:

- a. Inadequate supervision.
- b. Briefing Process.
- c. Decision to Split the Formation.
- d. **SECTION 26.**
- e. Wider Supervision.
- f. Pre Deployment Training of Individuals.
- g. Crew Resource Management.

AGGRAVATING FACTORS

15. I agree with the aggravating factors outlined by the Board³⁵, with the following amplification:

- a. Lack of Passenger Restraint. A 'block clearance' to allow local tactical judgements on when to allow passengers to un-strap in flight had not been obtained by the operational command chain under regulation J130.103.3 of the Joint Helicopter Command Flying Order Book³⁶. However, the subsequent issue of the requisite written clearance by JHC HQ³⁷ indicates that the decision to allow the troops to un-strap was reasonable.

³⁴ Witness 48.

³⁵ BOI Para 77.

³⁶ BOI Para 77.

³⁷ Exhibit 23.

b. Lack of Crewman Restraint and Loose Articles in Cabin. Advice had been issued shortly before this accident on the proper use of the crewman harness and the need to restrain items within the cabin³⁸.

OBSERVATIONS/RECOMMENDATIONS/ACTIONS

OBSERVATIONS

16. I have the following comments on the Board's observations:

- a. Observation 79a (Detachment Commander). The Board may have over-estimated the negative effect of the limited self-confidence of the Detachment Commander on his ability to intervene (see the Detachment Commander's later comments under QR1269³⁹). This Puma detachment is now always led by a nominated flight commander of squadron leader rank under a new 'Fight by Flight' force generation process.
- b. Observation 79b (Aircraft Commander). Whether the Mission Leader flies as Handling or Non Handling Pilot is largely a matter of opinion: this remains under consideration at Force level.
- c. Observation 79d (Use of Crews). As per my Para 12c.
- d. Observation 79g (Integration of Puma/Lynx). The Board did not record that pre-deployment integration between Puma and Lynx had been achieved through meetings between executives and collective flying training in the UK with specialist troops⁴⁰.
- e. Observations 79i and j (Cabin Security). As per my Para 15. In addition, troops on this Operation are now using longer lap straps that make it easier and quicker to strap in.
- f. Observations 79k-n (Standard Operating Procedures). As per my Para 17 below. In addition, JHC HQ should remind the operational command chain of Observations 79 m and n.
- g. Observations 79r-x and ak (Aircrew Qualifications / Documentation). A revised and enhanced Puma Force Training Directive has been issued to control aircrew training⁴¹. This has given clear guidance on exactly what quality and quantity of pre-deployment training is required, and how it is to be checked and certified. The training documentation and training process used by the Puma Force has received a complete overhaul after this accident.

³⁸ SECTION 26.

³⁹ Witness 50.

⁴⁰ Exhibit 19.

⁴¹ SECTION 26.

h. Observation 79z (Engineering). The engineering shift system and manning levels for this Operation are being reviewed by my OC Forward Support Wing in consultation with JHC HQ and the JHF(Iraq)⁴²; against this, there is a need to deploy the minimum possible manpower footprint to theatre.

i. Observations 79ai-aj (Aircrew Equipment). As per my Para 17h below.

RECOMMENDATIONS/ACTIONS

17. I have the following comments on the Board's Recommendations:

a. Recommendation 80a (Supervision). Fully accepted. The Puma Force has now been re-organised onto a 'Fight by Flight' basis that moves away from 'trickle posting' of individuals to deployed operations by preparing known teams of aircrew under a nominated flight commander responsible for the preparation and training of the individuals in that team. This was ordered by a Puma Force Fight By Flight Directive⁴³. The output of each Flight is now ordered and constrained by a Capability Document owned by JHC HQ⁴⁴; this no longer includes **SECTION 26 SECTION 26** by Puma aircraft. The defined output is delivered in accordance with a new Puma Force Training Directive⁴⁵. The force generation process is supervised by the Squadron Commander and the Puma Force Commander⁴⁶, who have better defined responsibility for down declaring operational capability if forces cannot be generated and trained to the required standard. The JHC HQ has ordered the deployment of Air Detachment Commanders and Air Advisers with revised and enhanced rotary wing skill sets. The in-theatre authorisation process has been reviewed and enhanced and is encapsulated formally within the Capability Document. This process now has 4 supervisory check points: an Air Adviser forward, an Air Coordinator at the rear, the crews led by a Detachment Commander, and an overall Air Detachment Commander of wing commander rank and significant rotary wing experience.

b. Recommendation 80b (Cabin Security). Fully accepted. JHC HQ 'block approval' to allow passengers to un-strap where tactically justified is now in place⁴⁷. Enhanced guidance on passenger security risk judgements has been issued to Puma operators⁴⁸ and reinforced by operational command chain. Extant guidance to Puma crewmen⁴⁹ has been reiterated by command chain. Improved methods of securing crewmen are being investigated as a high priority by Puma Integrated Project Team.

⁴² SECTION 40

⁴³ SECTION 26.

⁴⁴ SECTION 26.

⁴⁵ SECTION 26

⁴⁶ SECTION 40.

⁴⁷ Exhibit 23.

⁴⁸ SECTION 40.

⁴⁹ SECTION 26.

c. Recommendation 80c (Adherence to Standard Operating Procedures). Fully accepted. This is being inculcated through a reinforcement training package that has been designed for all Puma aircrew and is currently being delivered. This draws on the lessons of all recent Puma accidents and incidents. A requirement for crews to plan a formal power margin for landing on this Operation has been also issued to enhance the margin for error at field landing sites⁵⁰. Additional handling advice has been issued to Puma aircrew⁵¹. A series of specialist Standard Operating Procedures for this Operation has been revised and re-issued⁵².

d. Recommendation 80d (Post Crash Management). I believe that impounding all other Cockpit Voice Recordings on the night would have incurred an engineering penalty and prejudiced the safe and timely recovery of casualties and troops from the crash site. Nevertheless, I have asked my OC Forward Support Wing to confirm that we have sufficient data cards in our forward support stores at deployed locations to enable such an action when appropriate. I concur with the long-standing recommendation to fit a Flight Data or Accident Recorder to the Puma. I leave it to the operational command chain to explain the perceived lack of medical checks for the survivors in theatre, which should have taken place. Recommendation 80d(iv) is for the Convening Authority to consider.

e. Recommendation 80e (Aircrew Qualifications). Fully accepted. An exhaustive external investigation of the training processes on 33 Squadron has led to extensive changes to training and the recording of training. The risk of sending partially qualified aircrew on operations now rests with the Puma Force Commander in the first instance. The new training process has been encapsulated in a Puma Force Training Directive⁵³.

f. Recommendation 80f (engineering). Fully accepted. Actions are outside my area of responsibility, but I praise the Board for its lateral thinking in identifying the fuel valve issue, which has been resolved by the Puma Integrated Project Team.

g. Recommendation 80g (Brownout). Fully accepted. Updated handling advice has been issued to current Puma aircrew⁵⁴. The Puma Integrated Project Team is leading an urgent project to procure and introduce **SECTION 26**, which will enhance the situational awareness of aircrew operating in this environment. Aircrew are now receiving enhanced environmental training (including overshooting in brownout conditions) before deployment.

⁵⁰ SECTION 26.

⁵¹ SECTION 26.

⁵² SECTION 26.

⁵³ SECTION 26.

⁵⁴ SECTION 26.

h. Recommendation 80h (Aircrew Equipment). My HQ is making a case to JHC HQ for the provision of extra equipment for pre-deployment training.

ADDITIONAL RECOMMENDATIONS

18. I have the following additional recommendations:

a. The operational command chain should identify if any improvements to the command and control of the overall mission are appropriate⁵⁵.

b. Given the destruction of the Cockpit Voice Recorder in this accident, I recommend an investigation by the Puma Integrated Project Team into the location and survivability of the existing Cockpit Voice Recorder.

c. There is a potential blanking of the signal from special-to-type radios in some arcs, as raised in the QR1269 statement from the 33 Squadron Qualified Helicopter Instructor⁵⁶. This would bear further examination.

RECORD OF QR 1269 ACTION

19. Having received this Report, I ordered that QR1269 be afforded to the following individuals:

SECTION 40

20. This Part 1.3 considers the comments made by all individuals afforded QR1269⁵⁷.

[Signed]

P LYALL
Group Captain
Puma Force Commander

28 May 2008

⁵⁵ Cross refer Para 13a.

⁵⁶ Witness 45.

⁵⁷ These are recorded at Witness 44-53.

PART 1.4: COMMENTS BY COMMANDER JHC

MAIN REPORT

1. The Board has produced a very comprehensive report on the tragic accident involving the loss of 2 lives in Puma HC1 ZA 938 in Iraq on 20 Nov 07. This thorough and detailed work has enabled us to understand the circumstances surrounding the crash and has been conducted with considerable professionalism. This is particularly commendable given the difficulties associated with the operating environment and the limited physical evidence available from the crash site.
2. I also welcome the considered comments from the Puma Force Commander (PFC) and the Military Component Commander (MCC). Both shed significant light on the accident and the PFC, in particular, provides valuable context to enable a greater understanding of the wider issues surrounding this loss.
3. After very careful consideration of the evidence presented, and following a review of the submissions made by those acting under QR1269, I fully support the Board's conclusion that the accident was the result of controlled flight into terrain. I agree that this was predominately due to the handling pilot's disorientation. I agree with the Board's and the PFC's summary of contributory factors, especially the insufficient supervision provided by the Air Detachment Commander and Air Advisers, the shortfalls in the authorisation process and the consequences of the real and perceived operational pressure felt by the aircrew. I also accept the Board's recommendations, many of which have already been implemented.

COMMENTS

4. **Crew Resource Management (CRM).** In agreeing that disorientation was at the heart of this accident, I believe we must also look hard at the style of CRM engendered in and expected of our Puma crews. It is clear to me that the level of flying difficulty imposed by this mission profile should have been within the capability of a crew of this experience and composition, despite the numerous re-plans. However, this assertion is only valid if correct CRM was fully employed. The PFC is right that the BOI implied a poor non-handling service from the co-pilot. This has prompted a full review of the way non-handling duties are devised, taught and checked. I also intend to examine CRM across the JHC to ensure that the sort of breakdown implied by the Board is not latent in other Forces.
5. **Standard Operating Procedures (SOPs).** It is clear that the crew of ZA 983 did not adhere to SOPs during the brief period from cruise to landing. This meant that the radar altimeter (radalt) was not set to provide an alert of ground proximity. There is an implication in the evidence that this non-adherence to radalt setting procedures was not limited to this sortie. There is an implicit suggestion that this variance from SOPs was in some way accepted by the officers in command or supervisory positions; perhaps it was seen as an inevitable expedient connected with routine short transit flying and frequent landings. Whilst slavish adherence to inappropriate SOPs can be as dangerous as non-adherence to essential SOPs, the use of the radalt is absolutely

fundamental to the safe operation of helicopters, especially at night and when the operating environment is so challenging. I have therefore ordered a review by all JHC helicopter Forces of radalt setting procedures, with particular emphasis on the importance of creating both realistic SOPs and full adherence to them. I have also reviewed the part played by key supervisors as part of the ongoing Puma Review to ensure that custom and practice within the Puma Force fully reflects the extant SOPs at all times.

6. **Command and Control (C²) of In-Theatre JHC Assets.** The Board did not probe too deeply into the aspect of C² of JHC aircraft and crews. What is clear to me is that the C² states prevalent at the time did not allow my predecessor, as the Aircraft Operating Authority (AOA), to exercise sufficient functional control over the deployed Puma Force. This meant that visiting JHC officers from the HQ and from RAF Benson were, to some extent, isolated from supervision in a way not seen on conventional operations. This aspect has now been addressed to the satisfaction of all parties, the MCC, PJHQ and JHC, and for all theatres. However, we must ensure that future C² states properly reflect the essential need for tight Functional Control as an integral part of the formal Operational Control (OPCON) state.

7. **Equipment Issues.** Three serious equipment issues stand out following this accident. None are new, and we do need urgent, continuing action to address them:

a. **Brown-out.** The disorientation at the heart of this accident arose because of brown-out. By definition, helicopters will continue to experience this phenomenon whilst we operate in sandy or dusty environmental conditions. The rapid inception of **SECTION 26 SECTION 26 SECTION 26** in Puma and other JHC helicopters is very welcome, but **S26** will not 'see' through dust during landing. It is therefore vital that we see a sustained effort to fund and develop suitable technologies to increase pilot spatial awareness and orientation during this most challenging of flying regimes.

b. **Communications.** I fully concur with the comments made by the MCC regarding communications. The inability of the crew of Puma 1 to communicate with Lynx 1 led directly to the type of approach selected by the crew of ZA 938 (Puma 2). The issue of communications within JHC battlefield helicopters (BH) seems, at the coalface, to be a little too divorced from the pure airframe modification process. Without doubt, the interaction with multiple Integrated Project Teams (IPTs) is part of this problem, but my sense is that we need to try to simplify the fitting of new communication equipment, especially secure radios, by balancing security risks better with the sort of risks exposed by this accident. This an issue that I will take up with MoD and DE&S with the aim of securing faster, and more effective integration of several of our extant BH communication equipments.

c. **Cabin Security.** A recurring feature of Puma accidents and incidents is the poor level of cabin security for passengers, and critically, for the crewmen. We have addressed the issue of passenger restraint on operations and have reiterated the rules relating to unstrapping prior to landing. We have also directed crewmen on the precise way to ensure that the harness used to provide limited restraint (the 'monkey harness') is set so as to prevent accidental egress from the cabin. However, the Puma does not have a dedicated crash-attenuating seat for the crewman. This is an aspect that my predecessor attempted to solve with the Puma/Gazelle IPT and Martin-

Baker¹ but without success. I would like to see re-doubled effort on this relatively straight forward equipment issue, perhaps using military in-house expertise to expedite the normal processes.

SUMMARY

8. This tragic accident has been well investigated, and the PFC and MCC comments add to the picture. I accept and agree with the conclusion and recommendations of the Board, but have added a series of comments aimed at tightening CRM and adherence to properly crafted SOPs. I also urge care over future C2 arrangements and seek urgent, continuing work on solutions for brown-out, communications and Puma cabin security. If these aspects and the full recommendations from the Report are fully implemented, then we will make significant steps towards the prevention of a similar accident whilst also mitigating the risks more effectively.

(Original signed)

C A JOHNSTONE-BURT
R Adm
Comd JHC

17 Sep 08

¹ A company specialising in simple, effective crew-station seats for aircraft.

PART 4A

REMARKS BY THE MILITARY COMPONENT COMMANDER

MAIN REPORT

1. The Board has completed a comprehensive and detailed report into the accident of Puma ZA938 on 20 Nov 2007 in Iraq. I am grateful to the Board members for their in-theatre actions, which minimised the impact of the accident on operational tempo. It should also be noted that the actions of several individuals, post accident, in recovering colleagues from the crash site demonstrated selfless regard for their own safety and commendable gallantry. In commenting on this tragic accident, I consider it appropriate to highlight the outstanding support and commitment of the Puma Force over the last 4 years and their extraordinary contribution to operations.

2. I support the Board's conclusion that the accident resulted from controlled flight into terrain, brought about by the handling pilot's disorientation. The Board conclude that this was due to the incorrect technique for a dust take-off. There are clear indications in the evidence to suggest that a non-Standard Operating Procedures (SOP) technique was adopted due to concerns over the possibility of a collision with Lynx 1, the position of which was unclear to the Puma crew.

CONTRIBUTORY FACTORS

3. The Board raised a number of contributory factors upon which I consider it to appropriate to comment:

a. **Decision Making Process.** As the Board notes, '*the initial SECTION 26 plan involving 2 Lynx, with 2 Puma aircraft as back up was sound*'. However, the decision to continue the operation once the formation had split resulted in loss of formation integrity. With only 3 miles to the target, the inter aircraft briefing was compressed. Confusion as to the lead Puma crew's assessment of the target location and their selected approach profile (turning 110 degrees on the final approach) led to a less than desirable aircraft approach profile for the second Puma. The decision to continue the approach from the high hover for Puma 2 may have been flawed. An immediate go-around (mini circuit) may have been more appropriate. The decision to conduct a steep descent, having noted that the lead aircraft was encountering very dusty conditions, made it more likely that external references might be lost at some stage. The decision to adopt a non standard approach, not taught by Puma training staff, coupled to non adherence to SOPs for dust landings (specifically Rad Alt settings) compounded the likelihood of an accident.

b. **Use of Incorrect Technique.** Mention is made of the use of inappropriate technique for a dust take off. My interpretation is that, whilst one might question whether the approach profile of Puma 2 was ideal, there is no evidence to suggest that the pilot did not attempt to carry out a lift from an aborted landing in accordance with SOPs. From his own account, however, this procedure was circumvented after the appearance of Lynx 2, uncertainty in his mind about the position of Lynx 1, and the possibility of a mid air collision. This caused him to make what appears to me to have been a reasonable decision to check his climb. This, however, led him to re-enter the dust cloud, at which stage lack of help from the NHP became a critical factor. As the Board noted, it is likely that the handling pilot would also have been unaware of a 5 to 10 kt surface wind, which would again have been a factor. On the initial run-in this information would have been registered by the Doppler system and would have been available to the NHP had he been engaged in observing the Doppler system instrumentation. In the final approach stages

however, criticism for failure to identify surface wind is not justified as crews are directed to ignore the Doppler system at low airspeed due to reduction in accuracy.

c. **Operational Pressure.** The pressure to deliver a successful operational outcome may have been a contributory factor. However, I disagree firmly with the observation that targets are prosecuted with a 'getting the job done at all costs' attitude. Having visited this unit, and accompanied them on operations frequently, I am quite confident that commanders are making sensible assessments of risk in the formulation of their plans. This would apply as much to aviation aspects as any other. Rapid re-plans during high tempo operations are sometimes required and are carried out with a clear head by, in the case of the unit ground commanders, experienced individuals. It is of course necessary for air commanders to be appropriately experienced and confident in order to have the confidence to veto any quick re-planning which in their view is not safe. In this case the Mission Leader was an experienced individual and both he and supporting aircraft captains seem to have been content with the Quick Battle Orders given over the secure radio, apparently understanding the Mission Leader's intent. What is not clear, however, is the degree to which their understanding may have been flawed due to reportedly poor communications.

d. **Communications Problems.** Certainly communications problems led to the position of the Lynx 1 not being completely clear to all, and there is strong evidence that uncertainty about its position, and the assumed danger of a mid-air collision, seems to have been a strong contributory factor in the pilot of Puma 2 deciding to check his climb out of the dust cloud just before the accident.

e. **Crew Composition.** I concur with the Board's view that crew composition of Puma 1 and Puma 2 was a contributory factor. Although I agree that in-theatre exposure is a way to 'bring on' less experienced aircrew, the composition of the crews must be above a reasonable experience threshold before committal to such tasking. The evidence suggests this was not the case. Both aircraft captains of the Puma aircraft were reportedly working to capacity in order to compensate for the abilities of the NHP's. Indeed, the NHP at one stage apparently stopped providing any service to the Puma 2 aircraft captain at a critical stage of the approach. Moreover, the HP was already undertaking several of the NHP's cockpit duties in order not to overload his inexperienced NHP, and it is hard not to conclude that this was a significant factor in the outcome of events¹. Clearly it is important that crew members do not carry blame for not carrying out actions which could not reasonably be expected from pilots of insufficient experience. Insufficient experience of the NHP of Puma 2 would appear to explain the reported deficiencies in Crew Resource Management, and seems to be a significant contributory factor in the accident.

f. **Crew Resource Management (CRM).** The breakdown of CRM both within the formation and within the Puma 2 aircraft, appears to have been, as indicated above, a significant contributory factor. The breakdown of the service provided by the NHP to the HP in Puma 2 would seem to have contributed significantly to the likelihood of an accident in the final stages of the approach. The provision of height and speed information to the HP whilst in the dust cloud would I suspect have reduced considerably the likelihood of a damaging collision with the ground.

g. **Training.** The Board is incorrect in its assumption (BOI Para 3b) that no training took place between the Puma and Lynx crews. Without repeating the details contained in Witness 45's (**SECTION 40**) evidence, some Puma and Lynx collective training did take

¹ In the immediate aftermath of the accident, in order to allow limited operations to continue my air staff felt it necessary to re-constitute crews to ensure experience levels were appropriate for this demanding task.

place prior to deployment. The time available for this training was limited by poor weather and a lack of available and serviceable aircraft in the UK. Once in theatre, the operational tempo and threat level precluded additional training. However, by the time of the accident the Lynx crews had been in theatre for almost a month, having declared IOC and conducted their first joint operation with the Puma aircraft on 10/11 Nov 07. Lack of Puma/Lynx collective training is not therefore felt to be a major contributory factor. On the other hand, the fact that CRM broke down during a dust manoeuvre suggests that insufficient crew training had taken place in dust conditions, a requirement that I have flagged up in the previous Puma BOI (XW211/XW218, Apr 07).

h. **Supervision.** A detailed account is given in the evidence of Witnesses 51, 52 and 53 of the role of the AA, which is not fully reflected in the Board's findings. I have no evidence that the supervision at the ADC and AA level was not appropriate. Their oversight in managing a detachment of various aircraft, in a particularly complex battlespace, where close supervision was required in order to risk mitigate both fixed wing and rotary wing operations, is regularly confirmed by my senior Air Cdr during visits. I also hold a different view to the Board who believe that the role of the ADC had been 'diluted'. The Board fails to note that in the week prior to the accident the Det was visited by the Puma Force Commander who concluded that the 'ADC was exercising solid op oversight'. The level of supervision within the Puma Det (MLs) appears to have been adequate and concomitant with extant Mission Command principles but could not make up for lack of experience within those selected as NHPs.

RECOMMENDATIONS ALREADY ACTED UPON

4. Several of the recommendations and observations made as a consequence of this accident have already been actioned, as follows:

a. **Supervision.** Supervision has now been enhanced by means of the Puma Force Re-Set, which not only allows the crews to 'fight by flight' but also allows the deploying Flt Cdr operational flexibility in intimately knowing all his crews capabilities. Rules of Engagement have also been re-briefed to all crews and troops in theatre as this may have had led to an element of distraction. The Puma Force Capability Document has bounded the Force and crew competencies and operational capability are now better defined including that of in theatre supervision. Additionally, it has now been mandated that the ADC is a RW SME. If this reflects a need for specialist RW oversight at this level, I will be questioning where this leaves us with such specialist oversight on the FW side, which would seem to involve safety issues which are just as pressing, given the busy airspace and lack of TCAS on some of our aircraft.

b. **Cabin Security.** Prior to landing, troops would un-strap in order to exit the aircraft on immediate touchdown; this was viewed by the AOA as reasonable. JHC has now given troops the authority to un-strap from the aircraft where it is appropriate for operations.

c. **Adherence to SOPs.** Through the Puma Re-Set and the parallel work bounded in the Puma Capability Document the requirement to adhere to SOPs has been reinforced to all deploying crews.

d. **Post Crash Management (PCM).** Following the Board's departure from theatre the PCM plan was updated immediately and a request for additional Cockpit Voice Recorder cards to be held in theatre initiated. The Coalition CSAR provider was also approached in the aftermath of the accident to discuss the possibility of photographing the

crash site as part of their procedures. As the secure communications log clearly highlight this is not always possible due to the impending threat on the ground from insurgents.

e. **Brownout.** The Board noted that further consideration should be given to the procurement of a system that would allow aircrew effectively to see through brownout conditions whilst on Night Vision Devices. Central staffs are currently taking this work forward.

CONCLUSIONS

5. This was a tragic accident that resulted in the death of two Service personnel. I have read the Board's findings with interest. It is worth pointing out that such an accident would have been considerably less likely if this operation were supported by CH-47, an aircraft better suited for such tasking in a number of respects, including being less prone to rollover on the rough field surfaces typical in Iraq. I recognise however that there are other priorities for the limited numbers of CH47 owned by Defence, and we therefore do not have access to the 14 x CH47 endorsed by PPSG as an enduring requirement **SECTION 26**. In the absence of dedicated aircraft and crews to support **SECTION 26** we are enormously grateful to the Puma crews and support staff who have supported this operation magnificently, displaying great bravery and commitment to a vital mission.

6. It is very clear to me that poor air to air communications between aircraft was a significant factor in this accident. It is possible that this interfered in the re-briefing and quick orders process, during which comms were reported to be very poor, and it is quite clear that poor comms led to uncertainty as to the position of Lynx 1, which led the crew of Puma 2 when they saw Lynx 2 as they lifted from an aborted landing, to believe that they might be at risk of colliding with Lynx 1. The evidence suggests that this led them to abandon what we must assume was, up to that point, an SOP compliant transition from an aborted landing. They subsequently then re-entered the dust cloud and crashed.

7. Whilst there are a number of times at which a more experienced NHP might have lent useful assistance, it is at the point that the aircraft re-entered the dust cloud that the inexperience of the NHP would seem to have become critical, with no assistance being provided on instrument information which might have assisted the HP to avert a crash. Any amount of careful external supervision will not make up for the inadequacies of inexperienced crew who are faced with the coming together of a number of unpredictable factors which contribute to an accident of this nature.

8. I observed after a previous accident (XW211/XW218) the importance of carrying out rigorous training in night landings in dusty condition prior to service on operations, and once again stress the importance of dust landings in the pre-operational training. Crews must have the confidence that proper Crew Resource Management will occur whilst operating in dusty conditions, at night, on demanding operations before they find themselves in such circumstances. The failure of the NHP to lend assistance in this case would appear to have contributed to this accident.

9. We have responded to a number of lessons identified from this incident and stand ready to discuss any other measure as might be deemed appropriate to avoid such tragic and wasteful accidents in the future. We will also continue to make the case strongly for this organisation to be properly resourced with the appropriate (and endorsed) aviation needs to support such demanding commitments.

PART 5

REMARKS BY COMMANDER-IN-CHIEF AIR COMMAND

1. Given the operational restrictions around the crash site, the Board of Inquiry has completed as full and as comprehensive an investigation as was possible into the circumstances surrounding this tragic accident; I commend their work. And I agree all the Board's recommendations, noting that the great majority have already been addressed (the remainder being in progress).

2. A series of events, organisational and individual, culminated in the eventual outcome – ie flight into terrain brought about by the handling pilot's disorientation. The degree to which circumstances outside the cockpit could have changed the eventual conclusion is much less clear and various considerations have been put forward (by the Puma Force Commander, by the Military Component Commander, and by the Commander Joint Helicopter Command). Whilst I agree with most of these comments, my views differ somewhat from those of the Military Component Commander, most notably in his paragraph 3c concerning operational pressure.

3. Military aviation, particularly during operations, demands a constant assessment of the balance between risk against gain. In this accident, the desire (at various levels) to fulfil operational requirements resulted in inadequately trained and supervised crews accepting a mission that was executed outside the boundaries of SOPs. This is not to say that a change in any one (or all) of these factors would necessarily have prevented the accident. But it is clear that, organisationally, the crews were not configured – either by experience or by mindset – to create the highest likelihood of mission success. Thus I agree with the Board, with the Puma Force Commander, and with Commander JHC that the limited helicopter knowledge of key individuals in the supervisory chain was a contributory factor. The lack of visibility of the qualification of crews further degraded the supervisors' ability to assess increasing risk during operations. Indeed, following a number of Puma accidents in 2007, I became concerned as to whether commanders (at all levels) were correctly balancing risk against gain in considering the capability of the assigned forces versus what was being asked of them. I therefore initiated (in February 08), in concert with Commander-in-Chief Land, a Review of the Puma Force. Following that Review, and the implementation of its findings, I am now more confident that every aspect of Puma Force operations, most notably including in-theatre supervision, is at an appropriately high standard. In addition, Commander JHC is now explicitly fully empowered to 'down declare' capability where crews cannot be provided to meet the operational need (either in enduring quantity or quality) – no matter how high the perceived operational imperative. Processes have also been put in place to prevent mission creep – an ever-present hazard in operations.

4. This Board correctly identifies the main equipment issues relevant to this accident. The problem of helicopter 'brown-out' is, of course, acknowledged at all levels and solutions are being vigorously pursued. Technical solutions aside, the best mitigation currently available remains realistic environmental training. The specific issue raised by the MCC and Commander JHC regarding the poor Puma communications fit also warrants further investigation.

5. Returning to individual responsibility, and noting that I view organisational responsibility as a 'contributory factor' (rather than an 'other factor'), the decision by the mission leader to undertake a different profile to that briefed and authorised, without a full re-brief, started a series of events that should have raised concern throughout all crews in the formation. And, as with so many accidents in our Service's flying history, several links made the final accidental chain; the chain leading to this eventual loss might well have been broken if any of the crew/formation members had requested an airborne 'reset'. (Certainly, the true nature of the revised situation/task would have become evident, all would have known their part, and details could have been amended accordingly.) By the same token, non-compliance with SOPs (coupled with a sub-optimal service for his handling pilot) by the co-pilot in Puma 2 provided the penultimate links that allowed the handling pilot's subsequent disorientation (thus creating the final conditions for the accident).

6. In closing, I wish also to express my deep admiration of the actions by a number of personnel after the accident, most notably **SECTION 40** and the passengers of Puma 1. Their bravery should remind us of the great cost in death and injury at which the lessons from this Board of Inquiry have been learned. It is therefore vitally important that all of the causal factors in this accident, especially in the areas of supervision and training, are not only communicated as widely as possible but, critically, henceforth remain permanently woven into the very fabric of our thinking and planning.

A handwritten signature in cursive script that reads "Clive Loader". The signature is written in black ink and is positioned above the typed name and title.

Air Chief Marshal Sir Clive Loader
Commander-in-Chief
AIR Command

3 November 2008