PART 1.4 – FINDINGS

METHODOLOGY

1. **Model of Detailing Factors**. In determining the causal and other factors that led to the accident, the Panel detailed each area broadly following Reason's 'Swiss Cheese' model[1], which divides the factors leading to the accident into the following 4 areas:

a. **Organisational Influences**. The factors that were in place at the commencement of the deployment of the crew of ZA708 to Afghanistan.

b. **Supervision**. Details of the supervision during the detachment of the crew of ZA708 in Afghanistan.

c. **Preconditions**. Those factors principally related to the sortie but prior to the final manoeuvre.

d. **Acts**. Acts, principally in the final manoeuvre.

2. **Accident Factors**. Each factor that was attributed to Reason's model was then detailed in accordance with JSP551 as one of the following:

a. **Causal Factor**. A factor which led directly to the accident.

b. **Contributory Factors**. Factors that did not directly cause the accident but made it more likely. In this SI an additional category of major contributory factors has been added to differentiate between different levels of severity.

c. **Aggravating Factors**. Those factors which did not cause the accident but aggravated the final outcome – i.e. made it worse.

3. **Available Evidence**. The SI Panel had access to a significant amount of evidence, which enabled a thorough investigation into all possible factors concerning the accident and left very few areas of uncertainty. Evidence included:

a. Interviews with the Crew of ZA708.

b. Cockpit Voice and Flight Data Recorder (CVFDR) coverage, providing cockpit voice and area microphone recordings of the final hour of the sortie and flight data from the final 4 hours of ac operation.

c. High-resolution IR video camera footage of the accident and post-incident imagery.

d. Interviews with and statements from witnesses, including those taken by the Special Investigation Branch (SIB) at PB Bahadur and FOB Khar Nikah.

e. Associated documentation including flying logbooks, all ac documentation and sortie planning and briefing materials including those documents held in the crew's navigation bags.

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[1] The Panel have adapted the James Reason Model of Accident Causation published in 1990.

f. The recovered airframe and role equipment of ZA708.

g. The ac recovery report.

h. The post-accident reports produced by MASU/Boeing Field Support Representative (FSR) and RNFSAIC.

i. The ac structural report from Vector Aerospace Ltd.

j. The review of the ac's documentation conducted by Forward Support Wing at RAF Odiham.

k. The analysis report provided by the RAF Centre of Aviation Medicine (RAFCAM) RAF Human Factors Psychologist (HFP) and Human Factors Investigator.

l. An assessment by SH STANEVAL of the profile flown.

m. The 1 MERCIAN Learning Account of the Accident on 10 Aug 10.

4. **Unavailable Evidence**. The Panel did not have access to the following:

a. The accident site, the emergency landing site and the ground based personnel at the site who witnessed the accident. This was due to the insurgent threat in the area and the fact that the SI Panel had not conducted pre-deployment training (PDT). Ground witnesses were interviewed by the Royal Military Police SIB.

b. The Night Vision Devices (NVDs) used by the HP and both Crewmen, due to their deliberate destruction following the accident.

c. The ac engines, rotor blades and cargo ramp, due to their removal and destruction at the emergency landing site.

5. **Services**. To assist the Panel, the services of the following personnel and agencies were made available:

a. JHC Units in the UK and forward deployed in Afghanistan.

b. Other operational units including the Camp Bastion Mobile Meteorology Unit (MMU), Joint Force Support HQ (JFSpHQ), Camp Bastion and the Joint Air Reconnaissance Intelligence Centre (JARIC).

c. Specialist technical support from RNFSAIC, QinetiQ, Vector Aerospace and MASU Accident Data.

d. RAFCAM.

e. RAF Service Inquiry (SI) Advisors.

f. Military Support Helicopter Aircrew Training Facility (MSHATF), RAF Benson.

6. **Factors Not Considered**. The Panel was unable to fulfil the requirement in the TORs to asses the environmental implications relating to the accident.

The Panel noted that the pressures to expediently recover the ac resulted in fuel and material, including engines and composite blades remaining at the site for destruction. The Panel did not have access to the final landing site.

ORGANISATIONAL INFLUENCES

7. **Operational Context**. Helicopter operations in Afghanistan are flown against a high insurgent threat, often at the edge of the aircraft and aircrew operating capability, and in the face of significant operational pressures to support those forces that are at even greater risk on the ground. In the year prior to the ZA708 accident, the number of ground forces in the Helmand AO increased and the number of established HLSs rose from approximately 20 to around 100. As part of the 'clear, hold and build' strategy, many of these HLSs were adjacent to populated areas and thus faced an increased threat. Despite the threats and other risks to aviation, the use of helicopters still represented the 'least bad' option when compared with road resupply, which was vulnerable to IED and other attacks. The increased threat to aviation was often mitigated by ac operating at night, which in itself increases the risk to crews by the greater difficulty of the flying task - crews operate with a restricted field of view and reduced depth perception during NVD operations. The combination of threat, environmental and other demands found in Afghanistan result in JHC aircraft operating with a level of risk that is higher than in other recent theatres of operation. This is borne out by data provided by HQ JHC detailing dust-related incidents in the year prior to ZA708's accident, many of which were attributed to the '*natural operating hazards*' of the theatre (Fig 1-9). **The Panel concluded that the demanding environmental nature of Afghan operations was a contributory factor to the accident.**

Exhibit 11 & 14
Witnesses 12 & 13
Exhibit 5
Exhibit 11, 12 & 14
Exhibit 80

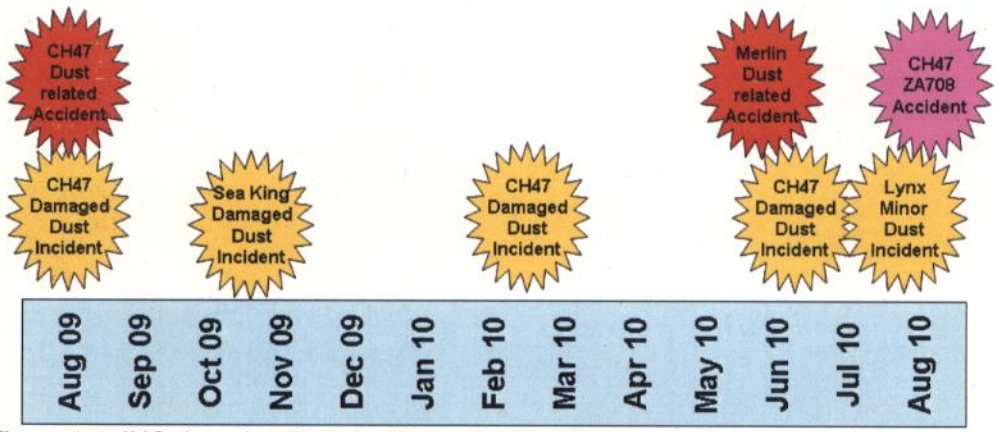

Figure 1-9 JHC data detailing significant dust incidents in the year prior to the ZA708 accident

8. **HLS Management**.

a. **HLS Directory**. The Panel found that the expansion of HLSs occurred at a pace that was beyond the MAOT's ability to track the changes and conduct ground recces of the landing sites. The primary reference for all JHF(A) crews for HLS information was the HLS directory, which was carried by each crew and was used during planning and in flight. The Panel found this directory had major shortcomings: It was inaccurate in many areas, did not reflect actual landing site details and was subject to updates without an appropriate audit trail. Despite the guidelines on HLS size laid down in ATP49(E), many HLS fell significantly short of ATP49 standards for HLS sizes, yet only some detailed this clearly. The Panel found that all the MAOT personnel interviewed had a

Witnesses 30-35
Exhibit 5
Exhibit 17
Witnesses 30-36

differing idea of what minimum HLS dimensions were acceptable to JHF(A) ac, highlighting a lack of standardisation within the team. MAOTs in theatre were made up from both Commando Helicopter Force (CHF) and Joint Helicopter Support Squadron (JHSS) MAOT and the Panel found that the 2 elements appeared to be uncoordinated and not standardised. Both teams were unsure as to each others' capabilities and joint Theatre TORs and command guidance did not exist. It was also clear to the SI Panel that there were insufficient MAOT personnel to maintain the HLS directory, considering the burgeoning number of HLSs and their constant modification. This was exacerbated by the fact that Task Force Helmand (TFH) units did not appear to be notifying JHF(A) of changes to the HLSs as a matter of course. The Panel further found that the MAOT had no plan of action for its tasking requirements and held no record of actions. Their duties also included deploying with ground troops on deliberate operations in order to establish temporary HLSs for their extraction upon completion of missions. This duty involved being in the field for extended periods of time, removing the team from their day-to-day job of HLS Directory maintenance.

Witnesses 30-35

Exhibit 46

b. **PB Bahadur**. The HLS directory entry for PB Bahadur contained significant errors. The HLS image orientation was approximately 140° inaccurate, the grid was several hundred metres inaccurate and the data did not reflect the construction of a wall on the HLS. While some sites of a similar size to PB Bahadur, such as PB Haji Alem (size 30m x 40m), carried a warning stating that a blade clearance of only 12 ft could be maintained by a Chinook within the HLS, the Bahadur insert carried no such warning, despite the fact that it was actually smaller (Fig 1-10) than Haji Alem. The Panel found that the establishment of a new HLS should be accompanied by a MAOT ground recce of the site, but no such reconnaissance of PB Bahadur took place. Three MAOTs interviewed reported each other as having conducted the recce, but all denied doing it themselves. The Panel considered it most likely that the ground unit at the site had provided the data, which was then added to an aerial photograph taken on 8 May 10 by a MAOT from a Lynx helicopter, in order to complete the PB Bahadur insert.

Exhibit 5

Witnesses 30-35

Exhibit 5

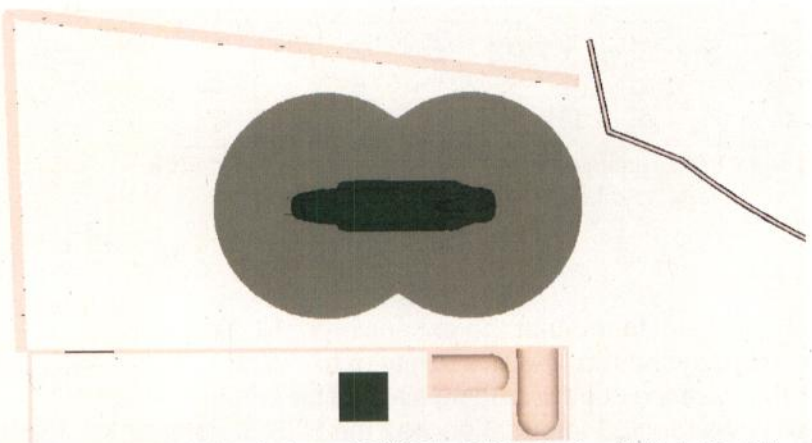

Fig 1-10 Computer model 'plan' view of CH47 in PB Bahadur HLS (with FP wall built)

9. **The Panel concluded that the lack of robust HLS management was a major contributory factor to the accident.**

10. **Service Support to 1310 Flt.**

a. **Accommodation**. The Panel found that 1310 Flt were the only aircrew detachment accommodated in tented accommodation. Each tent contained up to 10 personnel, often under widely different sleep patterns and with some occupants required to carry duty radios. Furthermore, the tented accommodation contained limited cooling and poor noise suppression. It was noted that a previous option to move to upgraded accommodation was rejected by the crews within 1310 flight as it didn't provide the 'crew-room' facility afforded by the tented area. Fatigue was identified as a factor in the accident by the HFP and is detailed further under 'supervision'. Witnesses 1-4 Annex F

b. **Catering**. The UK catering support at Camp Bastion reflected a 'traditional' working day and sleep pattern. Consequently, those elements of JHF(A) that operated a night routine were denied the opportunity for regular hot meals. Instead, they relied upon the provision of in-flight rations, which were often of a poor quality, stale and difficult to eat in the cockpit of a Chinook. This issue had been formally declared to JHF(A), by 1310 Flt, through the minutes of their flight safety meetings as early as 16 Jun 10. The Panel found that although JHF(A) was aware of the problem and had spoken to the catering personnel at Camp Bastion, only temporary improvements in the standard of meals were reported. Regular revisiting of the issue by JHF(A) and 1310 Flt personnel was required, as and when catering standards declined. When challenged by members of 1310 Flt over the quality of the provisions, the catering staff informed them that, as aircrew, they received high-energy rations (chocolate, crisps, etc) at the expense of a quality in-flight meal. All crewmembers of ZA708 reported their nutrition as 'poor' and the HFP detailed that the inadequate levels of fruit, vegetables, protein or carbohydrates feasibly influenced crew energy and ultimately the physical readiness of the crew. Furthermore, the Panel noted that 1310 Flt were denied access to the US Dining Facility (DFAC), which did offer hot food at other times, and that a pseudo 'black market' may have existed amongst other JHF(A) personnel who had 'acquired' passes to this facility. Witness 3 Exhibit 9 Witness 15 Exhibit 74 & 79 Witness 3 Witness 1-4 Annex F Witness 19

c. **MT**. The Panel found that there were insufficient MT vehicles to support 1310 Flt's requirements and several members of the Flt expressed concern over the perceived lack of support at Bastion. Due to the inadequate provision of MT, crews that would otherwise be at rest were required to transport operating crews between the accommodation and the ac. Conversely, the MT provision at Kandahar was very flexible, with sufficient vehicles to allow operating crews to self-drive. The lack of available MT at Bastion was a long running problem shared by all detachments within JHF(A) and had been highlighted during flight safety meetings; efforts made by JHF(A) to secure more vehicles had been unsuccessful. Following the accident, JHF(A) succeeded in redeploying some vehicles from Kandahar to Bastion to alleviate this problem. The SI Panel found that these issues, although apparently minor, had a profound effect on the morale and contributed to cumulative fatigue. The crews reported to the HFP that when such provision of MT was not available, crews were expected to walk, with their kit in the heat, exacerbating their fatigue levels. Witnesses 1-4 Exhibit 74 Exhibit 75 Annex F

In sum, the Panel found the service support to 1310 Flt at Camp Bastion was more akin to a short-term operation, rather than a detachment that had been supporting an expeditionary force in Afghanistan for 5 years. The culture appeared to be based on meeting the 'minimum military standard' alone, the impact of which was increased fatigue and risk. **The Panel concluded that the lack of service support to 1310 Flt was a contributory factor to the accident.** Witness 38

SUPERVISION

HLS FACTORS

11. **HLS Size Requirements**. ATP49(E) states that the Chinook requires a size 5 HLS, which measures 50 x 100 metres for all obstructions cleared above 0.6 metres. ATP49(E) also states that whilst these dimensions can be reduced by negotiation, '*during night, USL as well as brown- white-out operations…a Size 5 landing Point will be chosen*'. During his interview, the OC of the JHSS stated that the size of an HLS can only be reduced from the parameters in ATP49(E) if a MAOT member is actually present during flying operations. The Panel found that this guidance often could not be followed in theatre, but there was no clear policy as to how small a HLS was allowed to be, with crews operating closer to their Minimum Separation Criteria (MSC); some HLSs had become more akin to 'confined areas'.

Exhibit 17

Witness 36

12. **Adjustments to the PB Bahadur HLS.** PB Bahadur fell far short of the ATP49 requirements and the Panel noted that one previous OC 1310 Flt had declined to operate into the site at night. Prior to any knowledge of the reduced size caused by the unexpected wall build, CO JHF(A) directed it as a night-only HLS in consideration of the substantial recent threat. However, the Panel found that in the days prior to accident sortie, Force Protection (FP) work was conducted at the HLS that included the construction of an additional wall. This reduced the HLS size to 49 metres long and 21 metres wide at the narrowest point – at the widest point, the HLS was 24 metres wide. The HLS size was now slightly smaller than the ATP49(E) requirements for a Lynx (the smallest JHF(A) ac), but, importantly, a Chinook landing in the absolute centre of the HLS would have been unable to maintain the absolute minima of 10 ft MSC (Fig 1-11). However, the FP work and HLS size change was not notified to JHF(A). **(S41)**

Exhibit 40

Exhibit 37

Witness 7

Exhibit 17

Witness 37

. **The Panel concluded that the omission to notify JHF(A) of the FP measures that reduced the HLS size was a major contributory factor to the accident.**

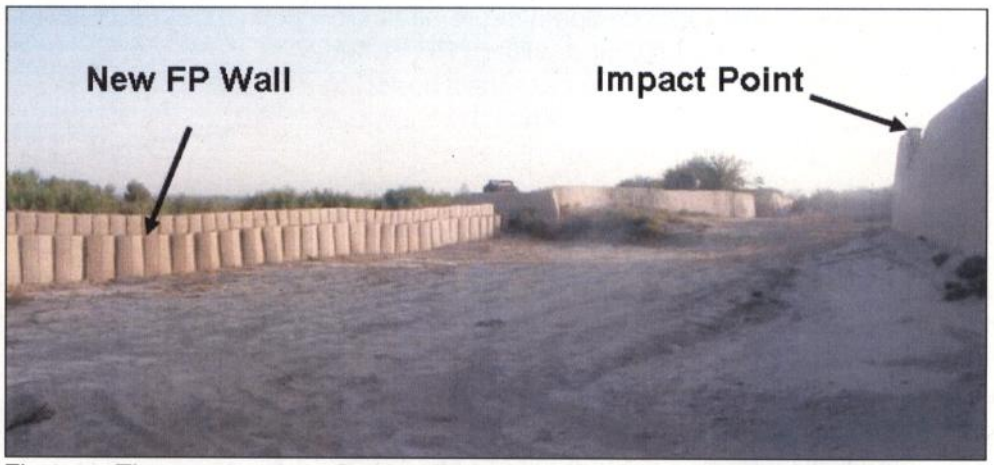

Fig 1-11 The construction of a new FP wall and the impact point of the CH47 on the pre-existing wall

Witnesses 12 & 13

13. **HLS Dust Suppression Measures**. Dust suppression is achieved in Theatre through the laying of aggregate, AM2 dust suppression matting, Durasoil (a clear synthetic organic fluid which is sprayed onto the site, binding with dust particles to produce a dust suppressing barrier) or a combination of the above. PB Bahadur was identified by JHF(A) as requiring dust suppression on or before 8 May 10. On 28 May 10, a Statement of Requirement (SoR) for

Exhibit 33

the dust suppression of the site was passed to Joint Force Support (Afghanistan) (JFSp(A)) by JHF(A). After negotiation with JFSp(A), who had stated that such an SoR should come from the HLS owner, JHF(A) resubmitted a SoR for the dust suppression of both PB Nahidullah and Bahadur on 6 Jun 10. Nahidullah had been incorporated due to the fact that on 2 Jun 10, a Merlin crew had raised a flight safety concern regarding the dust at the HLS. The Panel found that the meaning of HLS 'owner' was poorly defined, with some witnesses thinking it was the MAOT and some thinking it was the user unit. The only definition found was that of an 'HLZ Manager', which in the Headquarters Regional Command (South) SOP 3706, was defined as '*a suitably experienced/ qualified soldier nominated*' from the user unit. On 19 Jun 10, JHF(A) submitted a report to JFSp(A) citing the potential for loss of life if the requested HLS dust suppression work was not afforded adequate priority. Due to the limited engineering resources in Afghanistan, on 21 Jun 10 COMJAG requested for CO JHF(A) to provide a list of the 10 HLS at which crews encountered the worst brown-out conditions. This information would be used to prioritise HLS dust suppression engineering works. The 'Top Ten' priority list for dust suppression, produced by JHF(A), originally listed PB Nahidullah and PB Bahadur as the worst and second worst HLSs respectively. On 23 Jun 10, shortly after this list was compiled and on the same day that dust suppression was discussed and not approved at an informal meeting in TFH, Merlin **(S26)** crashed while approaching PB Nahidullah HLS. Brown-out and un-notified ground engineer work were cited as contributory factors to the accident. Dust suppression measures were subsequently put in place at PB Nahidullah on 28 Jun 10.

Exhibit 30
Exhibit 42
Exhibits 47 and 64
Witnesses 23 & 29
Exhibit 45
Exhibit 31 & 69
Witnesses 13 & 22
Exhibit 29
Exhibit 34

14. **Dust on PB Bahadur HLS**. A further SoR was submitted by JHF(A) on 29 Jun 10 for dust suppression at PB Bahadur. However, due to the mistaken belief that the laying of aggregate at the HLS had commenced on 10 Jul 10, it was removed from the JHF(A) dust suppression priority list (as a work in progress) by SO3 Infra at JHF(A). This belief was reinforced on 27 Jul 10 when a member of the MAOT was reportedly informed by a member of JHF(A) aircrew that PB Bahadur HLS was no longer dusty; a note of this occurrence was placed in the audit trail by SO3 Infra at JHF(A). The Panel has been unable to identify either of these individuals, despite speaking to all aircrew and MAOT personnel that have either been involved with, or visited PB Bahadur prior to the accident. The Panel considered that aggregate transported to PB Bahadur for the erection of the new, un-notified, Hesco Bastion wall was mistaken for HLS dust suppression measures being put in place. This misconception still existed within the JHF(A) and the JAG after the accident involving ZA708, when on 16 Aug 10 it was stated in a letter to PJHQ and JHCHQ. Despite their belief that aggregate had been laid at PB Bahadur, JHF(A) submitted a request for the laying of Durasoil at the site on 10 Jul 10, in order to further improve the HLS. In addition, USLs of AM2 matting were scheduled for deployment to PB Bahadur on 6 Aug 10, but due to an increased insurgent threat to aviation in the area, these loads were twice cancelled by the aviation tasking cell located in the **(S27)** – the last cancellation was on the day of the accident. The Panel spoke to the 6 JHF(A) ac captains who visited PB Bahadur during the period 1 Jul – 3 Aug 10, with all stating that the HLS was quite dusty, but not significantly so and that there was no Hesco Bastion wall in place on the north-western side.

Exhibit 30 & 61
Exhibit 34
Witness 37
Exhibit 44
Witnesses 30-35
Exhibit 40
Exhibit 41 & 63
Exhibit 32 & 39
Exhibit 43, 48 & 59
Exhibit 44

15. **Impact of FP Measures on Dust in HLS**. The Panel found that the construction of the new FP wall at PB Bahadur was achieved by the frequent and regular movement of armoured plant machinery heavy vehicles (Fig 1-12a) over and across the HLS between 5 and 9 Aug 10. The weight and non-pneumatic tyre design of this vehicle served to break up the surface of the HLS

Exhibit 40
Exhibit 45

and transform it from compressed mud and sand into talcum-powder like dust. The Panel found that while existing HLS management procedures in Theatre prohibited the use of vehicles on a HLS in wet weather, they were not clear about dry weather. In the case of Bahadur, the only entrance to the Bahadur PB compound was across the HLS itself and constant movement of vehicles across the HLS would have served to further exacerbate this situation. The Panel consider that the effect of this work was to significantly increase the levels of dust on the HLS (Fig 1-12b), which was unsuppressed (i.e. no matting or gravel); this dust was described as ankle deep by a MAOT officer during a visit to the HLS over the period 18-19 Aug 10, a week after the accident. ZA708 was the first aircraft to approach this HLS after the FP work was completed and, tasked with the carriage of an USL, would have been exposed to the dust for a significant period of time. **The Panel concluded that the omission to notify JHF(A) of the unsupressed and excessive dust as a result of the FP work on the HLS and mitigate against its presence was a major contributory factor to the accident.**

Witness 33

Fig 1-12a Type of vehicle used for FP work

Fig 1-12b Excessive dust (note footprints)

SUPERVISION OF FLYING

Exhibit 16

16. **Supervision of the HP by the Crew of ZA708 – Cockpit Gradient**. The SI Panel analysed the full hour of cockpit voice recorded prior to the accident, which covers all but the first 10 minutes of the sortie. The crew conversations throughout the sortie are of a professional nature, with no indications of poor working relationships or clashes of personality. However, during the Panel's interviews of the NHP, No 1 and No 2 crewman, it was discovered that the HP's flying abilities were held in high regard by his crew. This was possibly due to his standing within the Chinook Wing as a previous Sqn Standards Officer (StanO) and Chinook Display Pilot and the flying ability associated with these positions. There was evidence that the HP had previously flown non-standard profiles but, due to his experience and handling skills, these profiles had been accepted and not questioned by his crew. **(S41)**

Witnesses 2-4

Exhibit 71

Witness 2

Annex F

Consequently, the Panel felt the supervision of the HP by the remainder of the crew may have been affected by this cockpit and experience gradient. **The Panel found that the over-reliance of the crew on the ability of the HP was a contributory factor in the accident**.

17. **Supervision of the crews of 1310 Flt**. The Panel noted that OC 1310 Flt deployed as part of a constituted crew, with a flying workload as high as

Exhibit 38

other aircrew on the detachment. However, he was additionally faced with the supervisory responsibilities of a flt cdr, including ensuring JHF(A) tasking was appropriate. The Panel found that Chinook tasking from JHF(A) was very demanding, requiring frequent changes of aircrew shift patterns that occurred without full consideration of the cumulative impact on the flt. The Panel found some members of 1310 Flt – but none of the crew of ZA708 – had resorted to the prescribed use of Temazepam to overcome the frequent changes in sleep patterns (covered further in para 18). The Panel found evidence of one occasion where an ac captain had declared himself unfit to fly for a training sortie due to fatigue, but had been persuaded by OC 1310 Flt to conduct the sortie regardless. Further, the crew of ZA708 comments to the HFP included:

Witnesses 14-17

Witnesses 1-4

Witness 28

Annex F

(S41)

Witnesses 38 & 39

In contrast, the Panel interviewed the previous and subsequent OC 1310 Flts and found that both deployed as an additional crew member, outside of the constituted crew system, in order to have the flexibility to balance the flying against the wider managerial, supervisory and leadership challenges of the role. Both stated that this system, combined with their previous experience from a ground tour as a sqn ldr, allowed them greater opportunities to influence, adjust – and if required reject – tasking at an early stage. As such, they did not assess the fatigue issues as being as significant, they did not personally or collectively conduct the same high level of flying and, to their knowledge, their crews were not using Temazepam. Further, the Panel interviewed the detachment commanders of the other aircraft types at JHF(A), with none reporting fatigue as a significant factor. Consequently, the Panel concluded that while not an endemic, force-wide problem *across* detachments, there was a cultural shift from '*Can-do – safely*' to '*Can-do*' on this detachment that was not addressed due to the high workload on OC 1310 Flt as part of his role in a constituted crew. **The Panel concluded that the lack of robust fatigue management and supervision of 1310 Flt was a contributory factor in the accident.**

Witnesses 18-21

Witnesses 16 & 17

18. **The Use of Temazepam**. The Panel found that some 1310 Flt aircrew had resorted to the prescribed use of Temazepam to maximise the amount of sleep they could get during their erratic and often short-notice crew rest periods. When questioned, all members of the crew of ZA708 stated that they had not taken the drug during the days leading up to this mission. **(S41)**

Witnesses 1-4

Witness 3

. The Panel found that those members of 1310 Flt who used Temazepam and the medical personnel who prescribed them did so at variance to the regulations specified for its use in JSP 550. Specifically, they did not inform their chain of command before taking it. When interviewed about this subject, COMJAG, CO JHF(A) and OC 1310 Flt all expressed surprise and concern that their aircrew were using this drug without their knowledge. Whilst not a contributory factor for this SI, the Panel found cause for concern that the treatment of fatigue was an in-Theatre issue only for the Chinook crews and that the COMJAG/JHF(A) command chain had no knowledge of the use of Temazepam by some aircrew. **The Panel concluded**

Exhibit 10

Witnesses 1, 13 & 22

that the use of Temazepam was not a contributory factor in this accident

19. **Supervision of OC 1310 Flt (HP)**. The HP had only recently been promoted to sqn ldr and, on his first detachment as OC 1310 Flt, was responsible for **(S26)** aircraft, **(S26)** crews, engineers and ground staff (all split between Kandahar and Bastion airfields) as well as being ac captain of one of the crews. Witness 1 Annex F

(S41)

Witness 26

The HP's fatigue was noted by his sqn cdr during a weekly telephone conversation from the UK, with the sqn cdr commenting that the HP appeared tired; he reported sensing an improvement during their subsequent conversation. During his interview, CO JHF(A) stated that he regularly attended JMBs and sent individuals to bed that he thought were fatigued. Indeed, during his interview, the COS JHF(A) stated that the CO JHF(A) would lead by example on the issue of crew rest when he was flying and that he considered it a rule not to be broken. However, the Panel found that the evidence of fatigue on 1310 Flt and with OC 1310 Flt in particular did not reflect this. The Panel noted an acceptance that the Chinook detachment would 'run hot', compared with other JHF(A) detachments, due to their shorter deployment periods and the significant cumulative fatigue of OC 1310 Flt was either not recognised or was not addressed in HQ JHF(A). **(S41)**

Witness 13

Witness 12

Witness 22

Annex F

Witness 13

. The Panel concluded that the lack of robust supervision of OC 1310 Flt – the HP – in theatre was a contributory factor in the accident.

Exhibit 62 & 72

20. **Supervision of JHF(A)**. COMJAG was responsible for the direct supervision of JHF(A) and other UK aviation operations in Afghanistan. Geographically some distance away from the JHF(A) infrastructure in the **(S27)** , he maintained a command overview of JHF(A) operations and coordinated the employment of JHF(A) assets within the **(S27)**, but also dealt with TFH on a daily basis. His position was therefore more akin to a stn cdr than a sqn cdr; he ensured tasking apportionment was correct and appropriate, set direction for commanders and provided appropriate representation and reporting to higher formations. While COMJAG would speak with aircraft detachment commanders on arrival and would regularly engage with CO JHF(A), JHF(A) was responsible for day to day supervision and implementation of flying. The Panel found the JAG command chain had a high level of risk awareness. In terms of threat, there was a firm mission-orientated atmosphere within JAG and therefore an understandable and justifiable focus on a recent dramatic rise in SAFIRE events against UK aviation. For other risks, the Panel also found that COMJAG was strongly pursuing measures to increase aviation safety and minimise risk to aviation operations. For HLS management and dust suppression, there was compelling evidence of COMJAG and JHF(A)'s efforts to resolve this problem, activity that commenced before the Merlin accident of

Witness 22

Witness 12

Exhibits 11 & 12

Exhibit 41
Witnesses 23 & 29

23 Jun 10. However, interviews with DCOS TFH and CO 21 Eng Regt confirmed these requirements were balanced against other demands for engineering assistance, in particular measure to improve protection for ground elements. While evidence did show that COMJAG acted swiftly on all safety issues raised, the Panel could not find evidence that the creeping reduction in HLS size was ever raised to the COMJAG level. The Panel recognise that, with troops already on the ground, there may still have remained an operational imperative to support them until adjustments could be made. **The Panel concluded that supervision of JHF(A) by COMJAG was not a factor in the accident.**

PERSONNEL ON THE HLS

21. **Sleeping Accommodation Adjacent to the HLS**. There were 2 structures within the PB Bahadur compound; one was used as the Ops Room and the other as accommodation. Both buildings were of adobe-type construction and attached to the perimeter wall of the compound adjacent to the HLS. The accommodation building was located exactly where the fuselage of ZA708 struck the compound wall and due to its construction, led to the collapse of the roof. The serviceman involved in the accident was alone in the building because most of the PB personnel slept in the open at night. Due to the restricted size of the HLS and irrespective of the fact that the accident occurred, the Chinook's rotor blades would have been overlapping the compound wall. The Panel questioned the efficacy of having non-duty personnel so close to flying operations, especially given the infrequent use of this HLS and the fragility of local constructions. In addition, the Panel has also found that ZA708 may have been in a state of dynamic rollover when, due to incredible fortune, the rear rotor struck the top of the sangar and the ac righted itself. Given the compound size, the Panel opined that if the ac had rolled into the compound there would have been significantly more danger to the PB personnel and a high risk of additional loss of life or serious injury, both to the crew and those within the compound. When interviewed, the CO of 21 Engr Regt stated that the arched roofs of these adobe-type buildings sometimes collapse under the weight of a gun position or even personnel walking on them. The 1 Mercian Learning Account recognised these points and, inter alia, recommended that all personnel should be in Personal Protective Equipment (PPE) for flying operations. Given the small size of the HLS, which increased the likelihood of an incident, the Panel found that having personnel accommodated within this building during flying operations was an unacceptable risk. **The Panel found that the use of an 'adobe'-type structure, adjacent to the HLS, for sleep during a helicopter insert was an aggravating factor in the accident.**

Exhibit 57 & 70

Witness 29

Exhibit 57

PRECONDITIONS

AIRCRAFT SERVICEABILITY

22. **Overview**. The majority of the airframe of ZA708 was recovered, with the major components left on site for destruction being the engines, rotor blades and ramp. Combined with the CVFDR data, this allowed a thorough technical investigation by RNFSAIC to take place. This investigation confirmed, as far as possible, that ZA708 was serviceable in all respects prior to the accident, with the exception of the Radalt, which failed a system test. This section provides further detail on the Panel's consideration of the possibility of a technical failure leading to ZA708 colliding with the PB Bahadur compound wall.

Exhibit 16
Annex A

Annex C

23. **Engines and Fuel System**. A loss of engine power at a critical stage of the approach could have led to the HP having a reduced ability to control the height of the ac in close proximity to the PB compound wall. The SI Panel analysed crew interviews, IR video footage of the accident, engine data recorded by the CVFDR system, HUMS data and ZA708's F700. CVFDR data showed that both engines were well matched and were performing normally. During the overshoot from PB Bahadur, following the accident, Engine 1 and 2 achieved 119.75 % torque and 123.5 % torque respectively. This power output exceeds the estimated maximum power output of the engines (at the operating density altitude) obtained from the ac's performance planning data. Both engine power turbine inlet temperatures (PTITs) remained within the specified transient power limits for the duration of the sortie, with the maximum temperature recorded being on Engine 2 at 914°C. HUMS data analysis has shown no excessive engine vibration levels or exceedances. The CVFDR data also shows that engine fuel flow was commensurate with the power being demanded by the HP. However, the 'L FUEL PRESS' (left fuel pressure) CAP caption illuminated for a duration of approximately one second, one second after the initial collision with the compound wall. The Panel consider that this transient caption may have been the result of the sudden increase in demanded fuel flow, reducing the pressure in the engine HP pump supply line to value below the CAP caption trigger value of 10 psi, but there was no evidence to suggest that the fuel supply to either engine had been interrupted. No reference was made to any perceived or actual engine problems during crew interviews. There were several reports of smoke coming from Engine 1 after the impact from witnesses who observed the IR camera footage. The SI Panel has analysed the IR video camera footage of the accident. As the IR camera was set to 'black hot', the heat of the engine exhaust plume appeared as black smoke in the footage. The SI panel has concluded that the witnesses mistook this IR plume for smoke. Fuel and engine oil samples were taken and subsequently analysed. There were no unusual findings.

Witnesses 1-4
Annex A & B
Exhibit 16

Annex A (Fig 3)

Annex B

Annex A (Fig 8)

Witness 1
Exhibit 1

24. **Automatic Flying Control System (AFCS)**. As the Chinook AFCS has a direct input to the roll, pitch and yaw channels of the ac flying controls, the possibility of an AFCS malfunction was investigated. Although there were no indications of any issue with this system, both AFCS computers were sent to RAF Odiham for testing. They were subsequently found to be serviceable, despite minor testing errors associated with barometric pressure changes resulting from their transportation from Afghanistan to the UK. The Chinook AFCS performs several functions relevant to the USL drop-off profile:

Annex C

a. **Heading Hold. (S26).**

Annex A (Fig 6)

b. **Pitch Attitude Hold. (S26).** Annex A (Fig 2)

c. **Bank Angle Hold. (S26).** Annex A (Fig 1)

25. **Flying Controls**. Interviews with the crew and analysis of CVFDR and HUMS data indicated that the ac was responding correctly to flying control inputs. This data, combined with the extensive damage inflicted on the aft rotor during the accident, the expedient rotor blade removal process and the aerial recovery process (which involved lifting ZA708 by its rotor heads), led the Panel and RNFSAIC to conclude that a full flying control inspection was not required. Annex C Hydraulic oil samples were taken and subsequently analysed, with no unusual findings

26. **Transmissions and Rotor System**. There were no unusual transmission indications for the duration of the sortie. Although the HP reported seeing possible transmission-related CAP captions during the overshoot manoeuvre after the accident, there was no evidence of this in the CVFDR data. HUMS Annex A (Fig 8) data has shown that there were no unusual vibrations from the airframe or transmissions prior to the accident. Photographic evidence has shown that the aft 'green' rotor lag damper had detached from the rotor blade (Fig 1-13). It is likely that this occurred as a result of the impact of the aft rotor blades on the sangar structure in PB Bahadur. Oil samples were taken from all gear boxes and subsequently analysed, with no unusual findings. Annex C

Fig 1-13 Aft 'Green' Lag Damper Failure

27. **Hover Meter**. As the hover meter can be used as an aid to the pilots during brown out conditions, the gauges and feeding Doppler radar were sent to Annex C DSG Sealand for testing. All items tested were serviceable.

28. **Centre Hook**. Following the difficulties experienced during the first USL drop-off by the No 1 crewman, the SI Panel ensured that the centre hook assembly was checked for serviceability. The centre hook was inspected by the Annex C RAF Odiham Hydraulics Bay and found to be serviceable.

29. **Radalt**. Analysis of the CVFDR data indicated that the Radalt was indicating a height of 13 ft agl with the ac on the ground after the emergency landing. Further analysis showed that the Radalt had indicated 5.6 ft and 9.4 ft agl on the previous two weight-on-wheels (WoW) events. The Radalt was subject to detailed testing by the Defence Support Group (DSG) Sealand, where it over-read by 6 ft when bench tested 'on the ground', but gave correct indications for all other test signals up to 5000 ft. The Panel could not confirm whether this fault occurred as a result of the accident or was already present. Combined evidence of the video of the accident and analysis of the CVFDR/ HUMS data suggests that the Radalt was over reading by approximately 10 feet during the approach and load drop-off at PB Bahadur. During interviews, the NHP stated that the load came off the ground at Camp Bastion at 40 ft (Radalt indicated), but analysis of the fused data appeared to indicate that the load touch the ground at PB Bahadur at an indicated 50 ft. RNFSAIC, in consultation with Defence Equipment & Support (DE&S) are continuing a more detailed investigation in this area to determine the potential for the problem to exist on other platforms. However, RNFSAIC have, by use of trigonometry and modelling, proved that if the aircraft had been at 31.9 ft, as indicated on the Radalt, with the same attitude at the time that it impacted the wall, it would have missed the compound wall (Fig 1-14). While the dust USL procedure was still a visually flown manoeuvre, **the Panel concluded that the inaccuracy of the Radalt by approximately 10 ft was a contributory factor to the accident.**

Annex A (Fig 9)
Annex C
Witness 2
Annex C

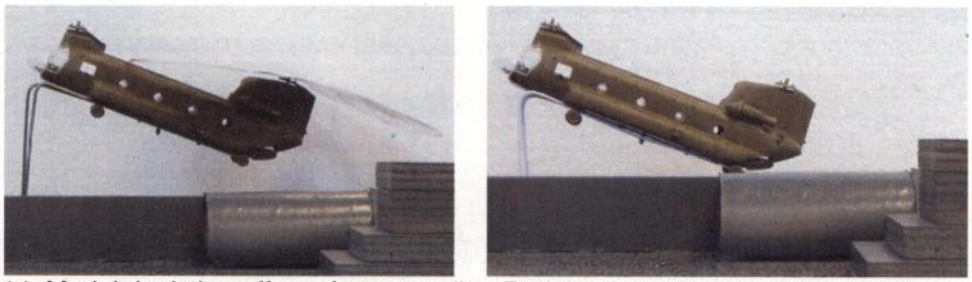

Fig 1-14 Model depicting effect of over-reading Radalt prior to impact. At impact Radalt indicated 32 ft (which would have cleared the wall – image on the left); it was actually at 22.6 ft – image on the right

30. **Documentation**. The ac's in-use and archived paper and electronic documentation set was impounded and quarantined as part of the PCM and subsequently sent to RAF Odiham, Forward Support Wing (FSW), for formal review. The documentation set was generally found to be in good order, with all maintenance and servicing requirements correctly completed and in date. Minor administrative discrepancies were identified, but would have had no effect on the ability of the ZA708 to complete tasking. The review of work carried out showed that all necessary documentation had been completed correctly, though some Serial Numbers of Work (SNOWs) (a unique 'job number') had been inadvertently duplicated, including some for work carried out on the Radalt. Other than the issue concerning SNOWs, which had no bearing on the accident, all other work had been recorded correctly.

Witnesses 12 & 25
Exhibit 2 & 54
Annex E

31. **Post-Accident Ac Serviceability**. The report from MASU provides a detailed assessment of the damage inflicted on ZA708. It reported that the initial damage was caused by the left-hand side of the fuselage contacting a structure in flight with a subsequent aft rotor blade strike. Further, it reported that additional damage was caused to the ac structure during the expedient removal of the rotor blades and engines and the subsequent aerial recovery of ZA708 to Camp Bastion. **The Panel concluded that, aside from the Radalt, ZA708 was serviceable before the accident.**

Annex C
Exhibit 67