PART 1.4 – ANALYSIS AND FINDINGS

Accident sortie – pre-tether strike

Tether strike

Post-accident

Organisation

Summary of findings

Introduction

1.4.1 On 11 Oct 15 at 1623 hours (hrs), a Royal Air Force (RAF) Puma HC Mk2 Helicopter, tail number XW229, struck the tether of a Persistent Threat Detection System (PTDS) aerostat and crashed within the confines of the NATO Headquarters in Kabul, Afghanistan. The aircraft was the subordinate element of a formation of two Pumas that were operating with the callsign [redacted]; the lead aircraft, ZJ955, was [redacted] (A21), and XW229 was [redacted] (A22). Two crew members and 3 passengers were killed. The third crew member and 3 additional passengers suffered various major injuries; one bystander was also injured.

1.4.2 This fatal accident occurred during an approach to an established landing site that the crews were familiar with. The weather was good and the only other aircraft in the vicinity of the occurrence was the formation leader. Both aircraft were fitted with Combined Voice and Flight Data Recorders (CVFDR) and the Inquiry benefitted from access to a high volume of evidence. As a result the Panel was able to establish the sequence of pre and post-accident events with a high degree of confidence.

1.4.3 However, in the absence of any testimony from XW229's crew it was impossible to determine their thoughts and considerations in the critical moments before the accident. The Panel consciously avoided assessing the crew's actions with the bias of hindsight and therefore were reliant on Human Factor specialist advice to understand factors that may have shaped individual behaviours. Whilst the circumstances of this tragic accident were relatively straightforward, many of the Human Factor aspects have an enduring quality and are emphasised in order to enhance Defence Air Safety and prevent recurrence.

Methodology

1.4.4 **Accident Factors.** Once an accident factor had been determined it was assigned to one of the following categories:

a. **Causal Factor.** An event which, in isolation or in combination with other factors and contextual details, led directly to the accident.

b. **Contributory Factor.** A factor which made the accident more likely.

c. **Aggravating Factor.** A factor which made the outcome worse.

d. **Other Factor.** A factor which was none of the above, but was noteworthy in that it may cause or contribute to future accidents.

e. **Observations.** An issue that was not relevant to the accident but worthy of consideration to promote better working practices.

Human Factors (HF) modelling

1.4.5 The Defence Accident Investigation Branch (AIB) Technical Report ruled out technical failure or fault prior to the tether strike. Therefore the main focus of this Service Inquiry was on HF rather than technical issues. Specialist advice was provided by the Royal Air Force Centre for Aviation Medicine (RAFCAM) to ensure that HF aspects were suitably considered. This advice was provided based on the Accident Route Matrix (ARM) approach. The ARM was developed by RAFCAM based on the systematic and validated framework of the Human Factors Analysis Classification System (HFACS), which is based on James Reason's Swiss Cheese Model, and experience of providing HF advice to over 50 accident and incident investigations. Exhibit 32

1.4.6 Due to its grounding in the HFACS and Swiss Cheese Models, the HF approach used in the SI considered the broad range of HF contributors to aviation accidents including organisational factors, the nature of the supervision and tasks undertaken, the equipment used, the operating environment, as well as individual actions and the condition of operators involved in the accident.

1.4.7 The Panel have considered the works of both Professor Sidney Dekker and Professor James Reason. The Panel decided to use a modified Reason model as utilised by the Australian Transport Safety Bureau to conduct their overall analysis, relying on the RAFCAM specialist to conduct detailed HF analysis.

Available evidence

1.4.8 The Panel had access to a significant volume of evidence which included:

a. Interviews with the crew of the formation lead aircraft, some of the accident survivors and other witnesses.

b. Formal statements from witnesses.

c. CVFDR data of the sortie from XW229 and ZJ955.

d. Various imagery including still photography, CCTV footage and iPhone video.

e. Relevant orders.

f. A range of publications including flying logbooks, aircraft documentation, sortie planning, briefing materials and engineering documentation.

g. Physical examination of XW229 at the crash site and in the UK.

h. Defence AIB Technical Report.

i. Technical reports by 1710 Naval Air Squadron (NAS).

j. Technical report by Airbus Helicopters.

k. Technical reports by Rotary Wing Test and Evaluation Squadron (RWTES) Test Pilots.

l. RAFCAM HF Report.

m. Aircraft Accident Aeromedical Report[1] provided by an Aeromedical Examiner.

n. Puma HC Mk2 Dynamic Mission Simulator at RAF Benson.

o. All flight safety related material, including previous Accident reports.

1.4.9 In considering the range of electronic evidence, most prevalently CVFDR data and CCTV imagery, the Panel and Defence AIB Investigators established a common time datum to ensure consistency of timings throughout the report. However, due to individual system recording constraints there remains a variable of circa +/- one second. Throughout the report all geographical images are orientated with north towards the top of the page unless otherwise indicated.

1.4.10 On [redacted] advice the Panel did not interview the surviving aircrew member of XW229.

Services

1.4.11 The Panel was assisted by the following personnel and agencies:

a. Defence AIB.

b. RAFCAM.

c. 1710 NAS.

d. Air Accidents Investigation Branch.

e. Airbus Helicopters (France).

f. Joint Aircraft Recovery and Transportation Squadron (JARTS).

g. RWTES.

h. Rotary Wing Operational Evaluation and Training Unit (RWOETU).

i. QinetiQ.

j. Puma 2 Gazelle Project Team.

[1] Incorporating an Equipment Technical Report from RAFCAM Survival Equipment Technical Investigator.

Factors considered by the Panel

1.4.12 With respect to the accident, the Panel analysed the following key areas:

a. Aircraft serviceability.

b. The relevance of individual acts.

c. The prevailing conditions at the time of the event.

d. Regulations and orders.

e. Levels of authority and supervision.

f. Aircraft design.

g. Safety management.

h. Post-accident activities.

Background

Op TORAL Aviation Detachment

1.4.13 Following the cessation of NATO's combat operations in Afghanistan on 31 Dec 14 the UK retained a residual military presence in Kabul in support of the international community's commitment to the country. Under the overarching NATO Operation RESOLUTE SUPPORT (Op RS) the UK's contribution was referred to as Operation TORAL (Op TORAL). Exhibit 36 Exhibit 8

1.4.14 Included within the UK military deployment was a detachment of Support Helicopters providing logistical and administrative support; they were referred to as the TORAL Aviation Detachment (TAD). The TAD was based at Hamid Karzai International Airport (HKIA) [redacted] in an established, self-contained facility that included engineering, operations and domestic amenities, known as Camp TAIPAN. Although the camp was administered by the detachment, domestic support was provided by civilian contractors and Force Protection (FP) by elements of a UK Infantry Battalion. Exhibit 8 Witness 9

1.4.15 Three Puma HC Mk2s deployed to Afghanistan in Mar 15 to replace RAF Chinook helicopters that had relocated to Kabul from Helmand Province to provide the initial support to Op TORAL. Exhibit 8 Exhibit 36 Witness 12 Witness 9

Puma HC Mk2 Life Extension Programme (LEP)

1.4.16 The Puma HC Mk2 LEP progressively modified and upgraded Puma HC Mk1 aircraft. The major enhancements included: Makila 1A1 Engines providing increased power, an upgraded Main Rotor Gearbox (MRGB), new composite Tail Rotor Blades providing increased Tail Rotor (TR) power/authority, a strengthened tail cone to cope with increased torque from the TR, enhanced avionics including a 'Glass Cockpit' and a digital Automatic Flight Control System (AFCS). The modified aircraft were termed Puma HC Mk2s, the first of which entered service in Sep 12 Exhibit 37

with an initial Release To Service (RTS)[2] granted in Aug 13. The Puma HC Mk1 was withdrawn from service in Dec 12. In Oct 15 all 24 aircraft in the Puma HC Mk2 fleet had completed the LEP and been delivered to the MOD. Exhibit 40 Exhibit 152

1.4.17 As part of the Initial Operating Capability (IOC)[3] and in preparation for deployment on Op TORAL, a Theatre Entry Standard (TES) suite was fitted to the aircraft as part of pre-deployment maintenance. This consisted of ballistic protection, pilots' armoured seats, a comprehensive Defensive Aid Suite (DAS) and pintle mounts for a crew served weapon in both cabin doorways. Exhibit 37 Exhibit 38 Exhibit 39 Exhibit 38

Puma Force development

1.4.18 Since the preparation for the initial deployment to Afghanistan the Puma Force had managed the development of the Puma HC Mk2 aircraft, including aircrew and technician training, with the requirement to train for and support Op TORAL. Consequently, although the number of available formed Flights (Flts)[4] was increasing, a balance between conversion and operationally focused training was required, with the latter having higher priority. A witness stated that as a consequence of Op TORAL and associated training, the pace of other activities reduced. Witness 24 Exhibit 41 Witness 30

1.4.19 Illustratively, on 11 Oct 15 the Puma Force had [redacted] aircraft available for operations and training, their disposition was: Exhibit 40

a. [redacted] deployed on Op TORAL.

b. [redacted] deployed to Morocco on Op TORAL related training.

c. [redacted] at high readiness for National Standby tasking (could also be used for local training within 1 hour of RAF Benson). Exhibit 42

d. [redacted] available for training in UK.

1.4.20 The remaining aircraft were accounted for as follows: Exhibit 40

a. 10 in Depth[5] maintenance.

b. 1 allocated to trials.

c. 2 others (1 in transit from Op TORAL, 1 awaiting maintenance/modifications).

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[2] The release document that authorises Service flying on behalf of the Service Chief of Staff. The limitations within the RTS are the definitive limits for the aircraft in-Service regulated flying.

[3] The ability to deploy 3 x Theatre Entry Standard (TES) Puma HC Mk2 on Enduring Operations worldwide, with an ability to deploy an additional 3 TES modified aircraft on Non-enduring operations to a separate location (worldwide) and to support UK requirements. IOC was declared by the Joint Helicopter Command on 23 Feb 15.

[4] A formed Flight was a sub-unit of a Squadron (Sqn). A Sqn would normally have 2 or 3 formed Flights, each commanded by a Squadron Leader. A Flight would typically contain 4 or 5 crews. A Puma crew consisted of 3; a pilot, a pilot or navigator and an aircrewman.

[5] 'Depth' is defined as those maintenance activities and functions that underpin the long term support of aircraft and associated equipment, or by their nature, are best carried out in Depth, and includes all maintenance elements not conducted at Sqn level.

1.4.21 Of the 11 aircraft that were available, 5 aircraft were at RAF Benson. In Oct 15 serviceability at RAF Benson averaged around 40% which meant that potentially only 2 of the 5 aircraft were available to meet the training and National Standby commitments. Figure 1.4.1 illustrates Puma HC Mk2 overall, operational and Main Operating Base (MOB) serviceability, for FY15/16. Exhibit 43

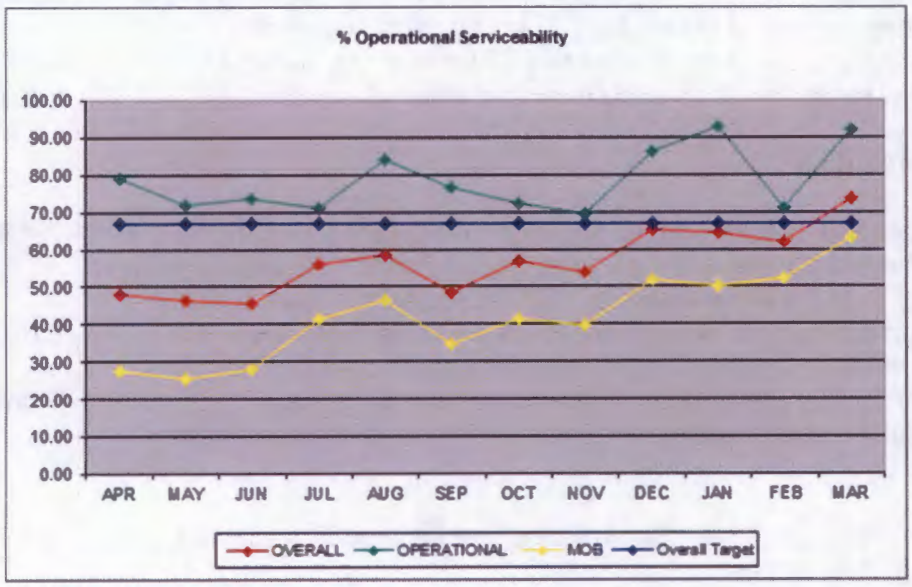


Exhibit 43

Figure 1.4.1 Puma HC Mk2 overall, operational and MOB serviceability FY15/16

1.4.22 In the Panel's opinion conversion training may have been constrained due to reduced availability thus placing pressure on overall Force development. However Op TORAL related training was not compromised.

1.4.23 **Fight-by-Flight.** The Puma Force deployed to, and sustained Op TORAL, on a 'Fight-by-Flight' basis. This involved Flts training, deploying and operating as 'formed' units rather than deploying as a 'trickle' of individuals from across the Force. Exhibit 44 Exhibit 45

1.4.24 **Puma Force Op TORAL deployment.** Op TORAL detachments were planned to deploy as formed Flts from their parent units of 33 and 230 Squadrons (Sqns), RAF Benson. The first deployment was B Flt, 33 Sqn in Mar 15, followed by B Flt, 230 Sqn in Jul 15. To achieve the mandated operational harmony ratio of 1:4[6] a total of 5 formed Flts were required to sustain the operation, however the rate of expansion of the Puma Force was insufficient to produce another formed Flt ahead of the third deployment in Sep 15. Consequently a decision was made in late 2014 to prepare a 'non-formed' Flt consisting of aircrew from both Sqns. These personnel were drawn from the Sqns' Headquarters (HQ) Flts[7] and the Puma Training Flt; they were not included in the formed Flt structure but were available for deployment. The composite flight was known as 'X' Flt. Witness 9 Witness 12 Witness 26 Exhibit 46 Witness 9 Witness 24 Witness 4

1.4.25 **X Flight.** The Flt was first constituted in Jan 15. Among the aircrew were Witness 4

[6] Deployment to non-deployment ratio eg 3 months of deployment would be followed by 12 months without deployment.
[7] HQ Flts normally consisted of the Sqn Second-in-Command, Sqn Adjutant, Standards Officers and the Crewman Leader.

the 230 Sqn Standards Officers (StanO) (Pilot and Crewman), a former pilot StanO and the 230 Sqn Crewman Leader. All aircrew were Combat Ready (CR)[8] and all bar 2 pilots and one crewman had operational experience. The Chain of Command (CofC) had no supervisory concerns with X Flt. Whilst there was an aspiration for the Puma Force to deploy formed Flts, in the Panel's opinion the creation and use of X Flt, within the context of a developing force, was pragmatic and effective. The Panel concluded that although individuals did not routinely work together at RAF Benson, the Flt was effectively a cohesive unit with personnel completing work up and Pre-Deployment Training (PDT) together. When compared against previous detachments, a witness stated that X Flt was the most experienced of the Flts to have deployed.

Exhibit 47
Exhibit 48
Exhibit 41
Exhibit 47
Witness 3
Witness 9
Witness 25

Environmental Training (ET) and Environmental Qualifications (EQ)

1.4.26 The UK Permanent Joint Headquarters (PJHQ)[9] directed that deploying crews should be current, competent, SERE level C[10] and Mountain Flying trained with the appropriate EQ; the Operational Capability Certificate (OCC)[11] for the Puma HC Mk2 directed this to be a valid EQ (Desert). The Joint Helicopter Command (JHC) ET policy[12] defined the minimum ground and air training required for the award of an EQ. The EQ (Desert) syllabus contained elements that were not required for Op TORAL and therefore the deploying crews did not need to complete the entire syllabus[13]. For Op TORAL, crews required a qualification to complete unplanned landings away from approved landing sites and as such, a restricted EQ (Desert) was satisfactory. All X Flt aircrew had valid EQ (Desert) qualifications from training that had been completed in the previous 12 months in Jordan. Although Jordan[14] was 'hot' its elevation was lower than Kabul and as a result Jordan did not provide an opportunity to practise at representative Density Altitudes (DA)[15] that would be experienced during the start of their Op TORAL deployment. The CofC considered this within the context of what was practically achievable ahead of X Flt's deployment and the anticipated environmental conditions for the period Sep 15 to Jan 16[16]. Additionally, all except one crewman had operated the Puma HC Mk1 in Kenya and had experienced operations at DA in excess of 8000 ft[17].

Exhibit 49
Exhibit 50
Exhibit 51
Exhibit 47
Witness 12
Exhibit 47
Exhibit 12

Pre-Deployment Training

1.4.27 The aim of the PDT was to give aircrew the skills and knowledge to operate safely whilst on Op TORAL; X Flt's PDT was carried out in accordance with the Puma Force Op TORAL PDT Course Specification[18]. The course consisted of 5

Exhibit 52

[8] Combat Ready status infers competence to undertake tasks safely and efficiently within prescribed skill sets. Once relevant Environmental and Theatre Qualifications are achieved it applies in environments other than temperate.
[9] PJHQ exercised Operational Command over all UK overseas operations.
[10] Survive, Evade, Resist and Extract Level C is a practical course undertaken by frontline helicopter crews.
[11] The OCC was a declaration by the Operating Duty Holder (ODH) to the Operational Commander (Commander Joint Operations) detailing the capabilities of the TAD in support of tasking in accordance with PJHQ direction.
[12] It recognised 5 distinct environments: Temperate, Desert (hot and dry), Cold Weather (down to -30°C), Jungle (hot and wet) and Maritime.
[13] Elements not required were day and night formation landings (including reduced illumination formation (very low ambient light levels) and black illumination formation (artificial infra-red illumination) and night Under Slung Load operations.
[14] The crews operated from Aqaba (175 ft Above Mean Sea Level (AMSL)) over terrain up to 4000 ft AMSL.
[15] Density Altitude is Pressure Altitude adjusted to take into consideration the actual temperature of the air. (AP3456 Vol 10, Ch 22)
[16] Average temperatures, and therefore Density Altitudes, decreased during the winter period.
[17] The elevation of HKIA was 5877 ft AMSL.
[18] Course Specification Version 1.2 was produced by the Puma Force Trg staff, sponsored by SO1 J7 JHCHQ and owned by the Puma Force Cdr. It had been amended in Apr 15 after feedback from the initial detachment.

hrs of ground briefs, 2 hrs of simulator training and 12 hrs of flying. The flying covered urban operations as a formation by day and night, air to ground gunnery and DAS management. Some elements were conducted in the Puma HC Mk2 Dynamic Mission Simulator (DMS)[19]. The only training omission for A22's crew was flare firing on the aircraft but this was a common shortfall for deploying crews because the opportunities to fire flares in the UK was limited due to armoury support when away from RAF Benson and time constraints[20]. PDT summary paperwork accepted the omission and noted that it would be addressed during Theatre Qualification (TQ) flying. Witness 4 Witness 8 Exhibit 56 Exhibit 55 Exhibit 54 Exhibit 57 Exhibit 58 Exhibit 59

1.4.28 Notwithstanding the recognised minor omissions, X Flt aircrew had completed their PDT to the required standard and were fit to deploy. The Panel concluded that the content and conduct of PDT were **Not Factors** in the accident.

1.4.29 **Reporting.** The Panel noted varying expectations relating to the requirement to generate Sortie Report Forms (SRFs) for PDT sorties. JHC Support Helicopter Training and Standardisation Instructions (TASIs) directed that qualifications which resulted in the recording of a qualification in an aircrew logbook should have an associated report. As PDT did not require an entry in a log book the Panel considered that it was implicit that SRFs were not required. However, witnesses were uncertain as to whether SRFs were required for the final PDT formation sorties; one Training Captain stated that reports should have been generated but were not due to an administrative error and competing tasks in the final days before deployment. In addition, a Sqn Commander wrote on the PDT summary paperwork for a crewman that he would like to see SRFs generated for certain sorties. Although not a factor in the accident, the Panel **observed** that it generated ambiguity and potentially nugatory work for training staff. Exhibit 60 Exhibit 52 Witness 8 Exhibit 162 Exhibit 54

Recommendation

1.4.30 The Puma HC Mk2 Delivery Duty Holder (DDH) should clarify reporting requirements for PDT sorties.

Theatre Qualification (TQ)

1.4.31 The requirement to complete a TQ was stated in the JHC Flying Order Book (FOB); the purpose of which was to familiarise individuals with local operating procedures, threats and hazards prior to undertaking tasking. Detailed direction for the Op TORAL TQ was provided in the TAD FOB. The TQ consisted of three elements: Reception, Staging and Onward Integration (RSOI), ground briefings and flying training. Crews were not permitted to fly within the first 3 days of their deployment due to a mandatory period of acclimatisation. This period was utilised for RSOI, arrivals administration and orientation briefs. TQ related ground briefs[21] were also delivered during this period. Therefore, the Panel observed that prior to commencing flying all crews would have had the opportunity to gain a general understanding of the procedures and an awareness of the environment, Area of Operation (AO) and associated implications on the employment of the aircraft. Exhibit 48 Exhibit 61 Exhibit 62 Exhibit 61 Witness 26

[19] Flight Simulators are used widely across Defence aviation.
[20] Flare firing was planned for Ex CHAMELEON but exercise tasking took priority, the omission had no effect on the accident.
[21] Briefs included: aircraft engines and performance, handling considerations, aircraft configuration, TES equipment, Area of Operations (AO), intelligence, documents, local procedures, Air Traffic Control and Training, Tactics & Procedures (TTPs).

1.4.32 The TAD FOB directed that pilots complete the following flying serials to achieve TQ: Exhibit 61

a. Day operations as Handling Pilot (HP) and Non-Handling Pilot (NHP).

b. Night operations as HP.

c. Tactical climbs and descents (day and night).

d. DAS management and Mutual Support.

A pilot's first TQ sortie was flown from the centre seat[22] and afforded an opportunity to observe the AO without having an active role. The second sortie was flown as the HP by day, the third was flown as the NHP by day and the final sortie was conducted as HP at night. Crewmen TQ sorties were flown concurrently with pilots in order to maximise the use of aircraft flying hours. TQ sorties could be conducted as either dedicated training serials or combined with tasking at the discretion of the Detachment Commander. Exhibit 61 Witness 25

1.4.33 The outgoing TAD Training Officer determined which Helicopter Landing Sites (HLSs) must be seen prior to the award of TQ; the Panel could not find a mandated list of HLS although several SRFs stated omissions[23] during the TQ process. Witnesses stated that the list was updated prior to the arrival of the next detachment to ensure that relevant HLSs were visited. On successful completion of the TQ sorties an individual was awarded 'Op TORAL TQ' by the Detachment Commander[24]. A complete detachment TQ declaration was then presented to Commander British Forces (COMBRITFOR) in Afghanistan. Exhibit 61 Witness 26 Witness 25 Exhibit 61

1.4.34 X Flt completed the TQ package between 21 Sep and 30 Sep 15. A summary of A21's and A22's TQ sorties is at Table 1.4.1. The TQ sorties provided opportunities to experience operations from both lead and subordinate formation positions. Both A21 and A22's crews flew an approach into Soccerfield HLS (SOC) on every sortie during their TQs. In the Panel's opinion, the crews had gained experience of SOC by the end of their TQ. Exhibit 82 Exhibit 64 Exhibit 65 Exhibit 66 Exhibit 67 Exhibit 68 Exhibit 69

Role	Number of TQ Sorties Flown	Total TQ Hours:Min	Date of TQ Award	
A22 Captain	5[25]	10:30	30 Sep	Exhibit 64
A22 Co-pilot	4	11:20	28 Sep	Exhibit 65
A22 Crewman	3	7:55	28 Sep	Exhibit 66
A21 Captain	4	10:40	29 Sep	Exhibit 67
A21 Co-pilot	4	8:00	30 Sep	Exhibit 68
A21 Crewman	3	7:45	30 Sep	Exhibit 69

Table 1.4.1 A21 and A22 Crew TQ Details

[22] A removable forward facing seat between the cockpit and the cabin providing a clear view of the cockpit.
[23] Such as "HLS XXX over-flown but not approached".
[24] The Detachment Commander was also referred to as Officer Commanding TAD (OC TAD).
[25] The Captain of A22 flew a fifth sortie as earlier sorties had not included 2 x HLSs and an Inadvertent Instrument Meteorological Conditions abort.

1.4.35 In the Panel's opinion the TQ flying provided sufficient opportunities for the newly arrived crews to familiarise themselves with the AO and experience operations ahead of their planned handover with the outgoing Flt. The Panel considered that the time taken to achieve a TQ would have allowed the training staff to highlight the intricacies and nuances of operations in the small AO and that the omissions[26] stated on individuals' SRFs had no relevance to the accident because they related to seldom used locations.

1.4.36 **Conclusion - EQ, PDT and TQ.** In the Panel's opinion, the EQ, PDT and TQ packages were well thought out, delivered at a suitable pace and appropriate for the Op TORAL mission. As a result the Panel concluded that they were **Not Factors** in the accident.

Air operations

1.4.37 **Tasking process.** The TAD was integrated into the NATO aviation tasking process which was coordinated by the US Aviation Task Force at Bagram Air Base, Afghanistan. TAD operations staff liaised with US planners to ensure that UK requirements and priorities were met, spare capacity utilised effectively and a coherent programme developed. TAD tasking was scheduled and agreed the night prior to the day of the planned execution; in effect the TAD had the ability to select tasks as required. Reactive tasking or changes were coordinated through the TAD operations staff. Exhibit 70 Witness 17 Witness 7 Witness 7

1.4.38 **TAD operations.** Aviation planning, briefing and authorisation were conducted in the TAD Operations room which contained all relevant flight publications, Theatre regulations, aviation data and planning tools. The Operations Room was manned by staff solely dedicated to air operations who managed tasking and all associated administration and support. In addition to the 3 crews[27] an extra pilot deployed in a non-flying capacity to be the TAD Operations Officer. This provided a further level of supervision over both the planning cycle and execution of the mission. All tasks were of an administrative or logistical nature and only conducted to PJHQ approved secure sites[28] in accordance with directed national priorities. The majority of TAD operations occurred in a circa 32 nm square area (approximately 8 nm x 4 nm) with 5 primary HLSs used on a routine basis; consequently crews quickly became familiar with the operating area and landing sites. Occasionally tasking would include sorties to Bagram (24 nm) or Jalalabad (65 nm). Witness 7 Witness 8 Witness 7 Exhibit 47 Exhibit 8 Witness 9 Witness 25 Witness 4 Witness 3 Witness 25

1.4.39 **Operating tempo.** The prescriptive and routine nature of the TAD's tasking, combined with the operations staff's liaison with the US planners, resulted in the TAD managing the programme to ensure that crews could maintain a steady working pattern of typically 0800 to 1800 hrs. After the TQ flying there was no regular night flying except to maintain currency. During the initial period of Op TORAL the TAD, in consultation with the US Aviation Task Force, had agreed a weekly no-fly day, which in Oct 15 was Friday and provided an opportunity for scheduled maintenance to be conducted. Aircrew could expect to fly for up to 4 of the 6 days. When not tasking, aircrew were occasionally required for maintenance Witness 7 Witness 17 Witness 12 Witness 3 Witness 12 Witness 3 Exhibit 71 Witness 4

[26] All omissions related to HLSs that had been overflown for identification but not approached.
[27] 6 pilots and 3 crewmen.
[28] Some locations required dedicated FP troops to secure the HLS prior to the aircraft's arrival.

ground runs or air tests and to be the Duty Authoriser[29].

1.4.40 The first Puma Detachment Commander stated that, prior to deploying, the CofC had considered the potential issue of low arousal levels for crews, caused by an extended period of low-demand tasking in a small AO. Mitigations included social and sports events, secondary duties and, when possible, arranging for TAD personnel to access the greater spectrum of welfare facilities available at HKIA (North (N)). The Panel could find no evidence that low levels of arousal were a concern with X Flt. Witness 12 Witness 24 Witness 17

1.4.41 The Panel concluded that due to the short period that X Flt had been in Theatre the nature of tasking, levels of stimulation and tempo of operations were **Not Factors** in the accident.

Fatigue

1.4.42 **Individual fatigue.** In considering the potential issue of fatigue one witness stated that on the day before the accident he had seen the Co-pilot of A22 *'having a little nap'* and *'just nodding off'* in the aircrew rest area between sorties. However, the same witness also stated that he had flown with the Co-pilot in the previous days and that he was always *'switched on'* during the flying period. The Panel could find no further evidence to indicate that A22's Co-pilot or any of the other aircrew were fatigued. Witness 5 Witness 27

1.4.43 **Cumulative fatigue.** The Panel were made aware of a potential issue of cumulative fatigue due to insufficient opportunities to take leave. The evidence was limited; interviews, a review of leave taken by the crew of XW229 and an email directing leave to be controlled centrally by a limited number of Sqn personnel. The leave history of A22's Crewman indicated short breaks but no blocks of leave, however, it could not be determined if this was due to personal choice or lack of opportunity. In the Panel's opinion the direction to centrally control leave demonstrated tautness across the Puma Force but was unlikely to have contributed to any cumulative fatigue. The Panel did not find any conclusive evidence of fatigue related issues. Exhibit 72 Exhibit 73 Witness 4 Exhibit 74

1.4.44 The Panel concluded that fatigue was **Not a Factor** in the accident.

Aviation activity over Kabul

1.4.45 The Kabul cluster[30] contained important and frequently used HLSs and was therefore the focus of activity for rotary wing operations; the airspace between HKIA and SOC was routinely busy during daylight hours. The volume of operations is illustrated at Table 1.4.2 which details the number of individual helicopter landings at SOC in Aug, Sep and the first 13 days of Oct 15. Witness 26 Witness 3 Witness 25

[29] An officer empowered to authorise flights and specified by name or appointment under arrangements promulgated by the Aircraft Operating Authority (JHC). The Duty Authoriser provided independent oversight of the planning and briefing of the task.
[30] Area containing primary HLSs. Also known as the 'Kabul bowl'. The Panel could find no definition of size but assumed it to be approximately 1 square nm centred on the Green Zone.

Exhibit 75

Month (2015)	Total number of individual aircraft landings	Daily average of individual aircraft landings
August	1719	55
September	1088	36
October (up to 13th)	703	54

Table 1.4.2 Number of aircraft landings at SOC

1.4.46 In addition to NATO's military helicopters (US, UK and Turkey), other helicopter operators in the Kabul area included: the United Nations, civilian contractors, other American Government Agencies and Afghan military. Witnesses stated that it was not unusual to see 3 other formations[31] operating within the cluster. This resulted in significant radio activity on multiple frequencies.

Witness 17
Witness 3
Exhibit 70
Witness 25
Witness 26
Witness 10
Witness 26
Witness 11

1.4.47 Several witnesses stated that they considered the greatest risk-to-life was that of mid-air collision due to the multiple helicopter formations operating to and from a limited number of landing sites within a small AO. As mitigation, and to improve situational awareness, aircraft made 'blind'[32] transmissions when flying around Kabul on the Common Traffic Advisory Frequency (CTAF)[33]. TAD crews commented on how useful the CTAF was although it relied on helicopters having appropriate radio equipment as they were required to speak concurrently on both the CTAF and to HKIA Air Traffic Control (ATC). Several interviewees perceived that some non-NATO helicopters lacked the radio equipment to monitor both CTAF and ATC, or were not aware of the procedures because helicopters would occasionally arrive at an HLS without having made a radio call, thus undermining the purpose of the CTAF. The Panel were unable to determine whether or not this was the case.

Witness 25
Witness 9
Witness 25
Witness 26
Witness 11
Witness 7
Witness 25
Witness 19
Exhibit 76

1.4.48 **Rotary wing coordination.** NATO tasking was not coordinated or specifically de-conflicted with non-NATO operators. Some of the operators were either reluctant to provide their flying programme due to security concerns or did not have access to a secure IT system that was NATO compatible. Witnesses stated that the only method of gaining information to aid deconfliction in the Kabul cluster was via the SOC operations (OPS) and New Kabul Compound (NKC)[34] programmes. SOC OPS published a programme that included all movements into the HLS; by examining this plan TAD aircrew could anticipate busy periods and form an appreciation of the traffic volume around the city.

Witness 7
Witness 17
Witness 7
Witness 3
Witness 4

1.4.49 The Panel **observed** that despite the use of the CTAF and provision of programmes from the 2 main HLS's, there was an elevated risk of mid-air collision in and around Kabul.

[31] Formations over Kabul generally consisted of 2 aircraft.
[32] A 'blind' transmission involves transmitting relevant information but not expecting or requiring a reply.
[33] The CTAF was an insecure frequency provided to allow crews to share their position and intention when operating in the cluster without adding to the already busy Kabul ATC frequency.
[34] NKC was a NATO compound in Kabul.

Recommendation

1.4.50 PJHQ COS(OPS) should engage with NATO HQ RESOLUTE SUPPORT to implement improved Rotary Wing coordination and deconfliction measures in the Kabul operating area.

Background – summary

1.4.51 Whilst there were a range of factors that shaped the deployment of the aircraft and crews to Op TORAL, the Panel concluded that they were not factors in relation to the accident. The Puma HC Mk2 was suitably configured for the task and the aircrew had completed appropriate EQ, PDT and TQ training. The TAD was integrated into an established and effective tasking process, which when combined with the prescriptive and routine nature of the task, resulted in a balanced operating tempo; the Panel found no evidence of aircrew fatigue.

1.4.52 The airspace around the main HLSs in Kabul was routinely busy with the presence of multiple helicopter formations and a high volume of radio transmissions; there was no formal coordination or deconfliction of tasking between NATO and non-NATO operators. The combination of these factors, and despite the presence of some mitigation, resulted in an elevated risk of mid-air collision. However, whilst this was not a factor in the accident, it is important in appreciating the context of the normal operating environment; during the accident sortie there were no other aircraft in the vicinity of A21 and A22.

Pre-flight

Planning, briefing and authorisation

1.4.53 On 11 Oct 15 A21 and A22 were scheduled to undertake 4 programmed sorties evenly planned throughout the day. The planning, briefing and authorisation for the tasking was completed in the TAD Operations Room at 0800 hrs prior to the first scheduled launch at 0900 hrs.

Exhibit 3
Exhibit 7
Exhibit 4
Exhibit 5
Exhibit 77

1.4.54 The crews briefed in accordance with the TAD FOB Annex A[35] with the Duty Authoriser and Operations Officer present. A21's Captain, as the formation leader, delivered the majority of the brief with allocated elements briefed by the Intelligence Officer and the lead aircraft's Co-pilot as per normal practise.

Exhibit 61
Witness 3

1.4.55 Individual aircraft crew briefs took place after the formation brief followed by a short Out Brief[36] conducted between the aircraft Captains and the Duty Authoriser. The sortie was then authorised in accordance with extant regulations and orders.

Witness 3
Exhibit 3

1.4.56 The crews rebriefed the afternoon serials in the Operations Room at 1335 hrs; other than covering the scheduled tasking, subjects covered in the morning brief were not revisited.

Exhibit 77

[35] Op TORAL - Puma HC Mk2 Briefing Format.
[36] An Out Brief is a final check of preparation for flight. It is given to the Duty Authoriser by the aircraft Captains immediately prior to walking to the aircraft.

1.4.57 The Panel concluded that planning, briefing and authorisation were completed in accordance with TAD procedures and were **Not a Factor** in the accident.

Formation briefing

1.4.58 JHC Command Instruction (CI) 7003, Helicopter Tactical Formation, stated that within the emergency procedures to be covered in all formation briefs was the '*loss of visual contact within the formation*'. Neither the Puma Force Standard Operating Procedure (SOP) 7, Formation Flying, the Aircrew Flying Guide nor the TAD FOB Annex A, made reference to the required actions within a formation during day time operations[37]. As a result, although the crews briefed in accordance with the TAD briefing template, the Panel could find no evidence that loss of visual contact procedures were considered during the formation brief. Exhibit 78 Exhibit 79 Exhibit 15 Exhibit 61

1.4.59 The loss of visual contact within the formation will be examined at paragraph 1.4.153. However, within the context that the formation was operating at the time of the accident, following a go around from a known HLS, positioning for a further approach, in good weather and with no other aircraft present, the Panel considered that the absence of a brief regarding the loss of visual contact was **Not a Factor**.

1.4.60 Nevertheless, in other circumstances such as in a larger formation conducting low level tactical operations, the Panel considered that the actions required in the event of a loss of visual contact should be included, or considered, within the formation brief and therefore deemed it to be an **Other Factor**.

Recommendation

1.4.61 Commander JHC should direct the standardisation of formation briefing procedures across the JHC to ensure conformity with higher level documents.

Flying currency and proficiency

1.4.62 The JHC FOB defined the minimum flying hours for currency; additional direction for flying hours to ensure proficiency was also provided. Prior to deployment, each crew member required 45 hrs of flying in the preceding 3 months to ensure that they were both current and proficient in accordance with JHC and Puma Force orders. X Flt achieved the majority of these hours during a routine exercise with UK ground forces in Jul 15 with any outstanding requirements being flown in Aug and the start of Sep 15. The flying hours achieved by the crews of A21 and A22 during the 3 month period prior to deployment and then until 10 Oct are shown in Tables 1.4.3 and 1.4.4 respectively. Exhibit 48 Exhibit 53 Exhibit 81 Exhibit 82 Exhibit 83 Exhibit 85 Exhibit 84 Exhibit 57 Exhibit 59 Exhibit 58 Exhibit 86 Exhibit 87

[37] The publications did refere to actions required at night and for inadvertant entry into cloud.

Dates	Captain		Co-pilot		Crewman	
2015	Live	Sim	Live	Sim	Live	Sim
17 Jun – 17 Sep (3 months prior to deploying)	63.20	10.30	58.45	10.30	78.10	6.00
17 Sep – 10 Oct (In Theatre)	26.25	-	22.35	-	25.45	-

Note: Live refers to actual flying, sim to the Puma HC Mk 2 simulator.

Table 1.4.3 Flying hours for the crew of A21

Dates	Captain		Co-pilot		Crewman	
2015	Live	Sim	Live	Sim	Live	Sim
17 Jun – 17 Sep (3 months prior to deploying)	83.35	8.30	65.55	6.30	63.10	2.00
17 Sep – 10 Oct (In Theatre)	35.35	-	32.05	-	30.40	-

Table 1.4.4 Flying hours for the crew of A22

1.4.63 The crews of A21 and A22 were current and in the Panel's opinion were proficient for the activity they were undertaking.

1.4.64 **Simulator emergency training.** Puma HC Mk2 aircrew were required to carry out emergency training in an approved simulator every 3 months. A22's Captain completed his mandatory emergency simulator sortie on 3 Aug. He completed two sorties on that day, his own, and one as Co-pilot; both sorties included a Tail Rotor Drive Shaft (TRDS) failure. In addition he completed a general simulator sortie on 10 Aug 15 which included a TRDS failure. The Co-pilot also completed his mandatory emergency simulator sortie on 3 Aug and the crewman completed his on 10 Aug; both of their sorties included TRDS failures. Exhibit 60 Exhibit 83 Exhibit 85 Exhibit 84 Exhibit 81 Exhibit 88

1.4.65 The Panel concluded that the crew of A22 was current for their mandatory emergency training and had practised a TRDS failure in the simulator within the previous 10 weeks.

1.4.66 The Panel concluded that flying currency and proficiency were **Not Factors** in the accident.

Crew composition

1.4.67 Due to the routine nature of the tasking and the number of crews, the TAD had adopted a policy of rotating both pilot and formation positions which enabled responsibilities within the aircraft and the formation to be varied. All X Flt aircrew were CR which enabled all pilots to be an aircraft Captain, and every pilot could operate as either HP or NHP as the formation leader or number 2 position. The Detachment considered this policy was fair and allowed a relatively even distribution of experience, captaincy opportunities and flying hours between aircrew. Witness 27 Witness 4 Exhibit 47 Witness 4 Witness 27

1.4.68 **A21's crew.** The more experienced pilot acted as aircraft Captain and HP in the right hand seat, with the less experienced pilot in the left hand seat. Exhibit 3

a. **A21 Captain.** The Captain of A21 was the 230 Sqn StanO. He Exhibit 57

qualified as a pilot in 2007 and had over 1350 hrs of flying experience; approximately 780 hrs on Puma HC Mk1 and 330 hrs on Puma HC Mk2. He joined 230 Sqn in 2011 where he flew Puma HC Mk1 and Mk 2; he was awarded CR Puma HC Mk2 in early 2015. He had completed one previous operational flying deployment in 2009.

b. **A21 Co-pilot.** The Co-pilot of A21 qualified as a pilot in 2010 and had over 1000 hrs of flying experience; approximately 370 hrs on Puma HC Mk1 and over 350 hrs on Puma HC Mk2; he was an Instrument Rating Examiner. He joined 230 Sqn in 2010 where he flew Puma HC Mk1 and Mk 2; he was awarded CR Puma HC Mk2 in Sep 15. This was his first operational flying detachment. Exhibit 59

c. **A21 Crewman.** The Crewman of A21 qualified as a Weapons System Operator (Air Loadmaster)(WSOp(ALM))[38] in 2009. He had 1330 hrs of flying experience; 780 hrs on the Puma HC Mk1 and 410 hrs on the Puma HC Mk2. He was awarded CR Puma HC Mk2 in May 15. This was his first operational flying detachment. Exhibit 86 Exhibit 58

1.4.69 **A22's crew.** The less experienced pilot was aircraft Captain and HP in the right hand seat with the more experienced pilot in the left hand seat. Exhibit 3

a. **A22 Captain.** The Captain of A22 qualified as a pilot in 2009. He had 985 hrs of flying experience; approximately 370 hrs on the Puma HC Mk1 and 350 hrs on the Puma HC Mk2. He was awarded CR on the Puma HC Mk1 in May 12. After converting to the Puma HC Mk2 he was awarded CR on the Puma HC Mk2 on 10 Sep 15. Although he had previously completed a ground tour[39] in Afghanistan, this was his first operational flying detachment. Exhibit 83 Exhibit 56

b. **A22 Co-pilot.** The Co-pilot of A22 was the Detachment Commander. He qualified as a pilot in 2000 and converted to Puma HC Mk 1 in 2005. He had over 2800 hrs of flying experience; including approximately 1170 hrs on Puma HC Mk1 and over 315 hrs on Puma HC Mk2. He completed multiple deployments to Iraq between 2005 and 2009. After a non-flying assignment, he returned to the Puma HC Mk1 in late 2012 and subsequently completed his conversion to the Puma HC Mk2 in 2013; he was awarded CR Puma HC Mk2 in May 15. He was a Training Captain, an Instrument Rating Examiner and the 33 Sqn Second-in-Command. Exhibit 84 Exhibit 63 Exhibit 55

c. **A22 Crewman.** The Crewman of A22 qualified as an Air Load Master in 1997. He had over 3850 hrs of flying experience; approximately 2700 hrs on the Chinook, 990 hrs on the Griffin and 185 hrs on the Puma HC Mk2. He was commissioned in 2014 and completed the Puma HC Mk2 conversion in Nov 14. He was awarded CR Puma HC Mk2 in Jul 15. He was the Crewman Leader on 230 Sqn and was also an A2 Qualified Helicopter Crewman Instructor, although not qualified to instruct on the Exhibit 85 Exhibit 54 Exhibit 80

[38] The terms used predominantly in the rotary wing community are 'crewman' or 'aircrewman'.
[39] A ground tour was a non-flying appointment.

Puma. He had considerable operational experience including multiple deployments in the Former Republic of Yugoslavia, Kosovo, Afghanistan (2002), Iraq and more recently from Afghanistan (2013).

1.4.70 **Recent crew composition.** In the preceding 4 days the pilots of A22 had flown together in a variety of crew and formation positions. On 5 Oct 15 A22's Captain had flown as Captain in the subordinate aircraft and completed 15 landings by day and night at various HLSs including SOC. The decision for the less experienced pilot to be the aircraft Captain on 11 Oct 15 was made the previous week by the Detachment Second-In-Command when allocating crews. Exhibit 82 Witness 27

1.4.71 Although A22's Captain was junior in rank and had only recently attained Puma HC Mk2 CR, the Panel were of the opinion that the nature of the Op TORAL tasking and limited AO meant that it was an ideal environment for junior captains to develop captaincy in an operational environment. The Panel considered the crew composition was reasonable; its influence on the accident sequence will be covered later in the report at paragraphs 1.4.159 and 1.4.230.

Aircraft serviceability

1.4.72 XW229 arrived in Theatre on 1 Oct 15 following maintenance and TES modification at RAF Benson which had been completed on 28 Sep 15. On arrival in Kabul the aircraft was rebuilt, ground and air tested before being declared serviceable on 3 Oct 15. The aircraft was operated and maintained without incident until 11 Oct 15. Exhibit 24

1.4.73 Defence AIB Engineering Investigators and the Panel Engineering Member reviewed the in-use Aircraft Technical Logs (MOD Form (MF) 700)[40] for both XW229 and ZJ955 at the TAD following the accident and did not identify any evidence that either aircraft had been released for flight with any defects that would impact the execution of the planned sorties. Exhibit 24

1.4.74 Subsequently, XW229's post depth maintenance aircraft documentation was independently reviewed[41], and whilst there were no airworthiness concerns raised, further investigation identified discrepancies in Weight and Moment calculations; these are discussed in paragraph 1.4.105. Exhibit 89

1.4.75 Within the maintenance entries in the MF700C, there were a large number of minor documentary errors such as missing information and references, failure to call up maintenance activities, and mathematical miscalculations. In the Panel's opinion these indicated potential engineering educational and supervisory issues as well as potential shortcomings in the engineering Quality Assurance (QA) system. Exhibit 32 Exhibit 89

1.4.76 The Panel concluded that at the commencement of flying operations XW229 and ZJ955 were serviceable and ready in all respects for tasking. Aircraft serviceability prior to the accident was not a **not a Factor**.

[40] The MOD Form 700 is an omnibus title given to a collection of MOD Forms in the 700 numerical series. When assembled and allocated to a specific aircraft these forms provide the means of compiling a complete technical history of the in-service use of that aircraft/equipment and provide a current statement of its condition. Military Air Publication (MAP)-01, Chapter 7.2.1, Para 1.1.
[41] Independent review conducted by RNAS Yeovilton, Air Engineering Department, Quality Support Team.

1.4.77 The Panel observed that the volume of minor documentary errors in XW229's MF700 had the potential to generate a safety related occurrence and therefore was considered an **Other Factor**.

Recommendations

1.4.78 The Puma HC Mk2 DDH should ensure that the required levels of technical education are provided, and the supervision appropriate, for the accurate completion of engineering documentation.

1.4.79 The Puma HC Mk2 DDH should review the Puma Force Quality Management System to ensure that the engineering QA procedures and periodicity are appropriate to identify emerging safety trends.

Task

1.4.80 The formation was programmed to conduct 4 sorties evenly scheduled throughout the day; sorties were expected to last between 45 to 60 mins. All sorties involved the administrative/logistical movement of personnel between secure HLSs. Exhibit 7

1.4.81 The first 2 sorties were separated by a refuel, following which the formation planned to shut down at the TAD for 3 hrs over lunch time. The 2 afternoon sorties were separated by an hour when the formation planned to shut down at the TAD. In the Panel's opinion the schedule provided the crews with a balanced work load and appropriate breaks. The routing and timings for the 4 planned sorties are shown in Table 1.4.5; also shown at serial 3.a is the unplanned task that was completed before the accident sortie. The locations of HKIA and HLSs are shown in Figure 1.4.2. Exhibit 5 Exhibit 7

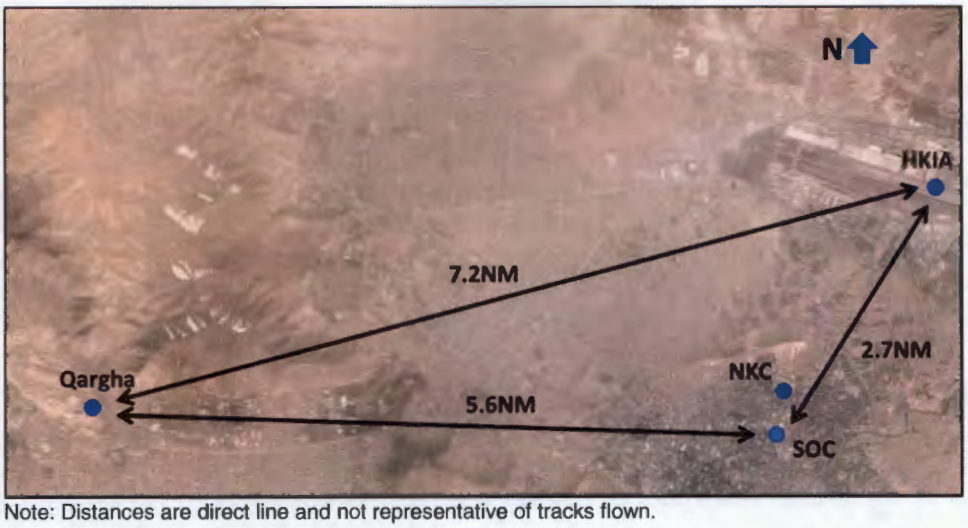
Sortie	Take-off	Landing	HLS				
	Planned (Actual)						
1	0910 (0910)	1000 (1010)	HKIA	QARGHA	SOC	NKC	HKIA
2	1015 (1020)	1100 (1102)	HKIA	SOC	NKC	QARGHA	HKIA
3	1400 (1401)	1445 (1502)	HKIA	QARGHA	NKC	SOC	HKIA
3.a	(1549)	(1557)	HKIA	NKC	HKIA		
4	1600 (1615)	1625	HKIA	SOC[42]	*NKC*	*HKIA*	

Note:
1. Take-off and landing times in brackets are those actually flown on 11 Oct 15. The timings were +/- 5 mins and taken from a manual log the TAD maintained in the Ops room. Timings for serial 3.a were taken from XW229's CVFDR.
2. All sorties commenced from HKIA(S) (Camp TAIPAN) but passengers were embarked at HKIA(N).

Exhibit 7 Exhibit 4 Exhibit 5 Exhibit 9 Exhibit 34

Table 1.4.5 HLSs visited by A21 and A22 on 11 Oct 15

[42] Accident occurred at SOC.



Note: Distances are direct line and not representative of tracks flown.

Figure 1.4.2 HLS Locations used by A21 and A22 on 11 Oct 15

1.4.82 The Panel concluded that the tasking content and intensity were within the capabilities of the aircraft and crews, and were, therefore, **Not a Factor** in the accident.

Pre-flight considerations – summary

1.4.83 The Panel concluded that notwithstanding the lack of a brief regarding formation loss of visual contact, sortie planning, briefing and authorisation were completed in accordance with TAD procedures and Puma Force SOPs. The crews were current and, in the Panel's opinion, proficient for the activity that they were undertaking. The policy of rotating both pilot and formation positions to evenly balance experience, captaincy opportunities and flying hours between aircrew was reasonable.

1.4.84 The Panel concluded that at the commencement of flying operations on 11 Oct 15 both aircraft were serviceable and ready in all respects for tasking. Although documentary errors were evident in XW229's MF700, these did not affect the accident.

1.4.85 The day's tasking content and intensity were within the capabilities of the aircraft and crews.

Accident sortie – pre-tether strike

1.4.86 The formation completed the first 3 scheduled sorties as planned. An additional reactive task to move 2 x UK military passengers to NKC following a Vehicle Borne Improvised Explosive Device attack against a UK military convoy resulted in the final scheduled sortie commencing 10 mins later than planned; this sortie was to transfer 6 passengers to SOC and 6 to NKC, before returning with 6 passengers from SOC to HKIA.

Exhibit 4
Witness 3
Witness 4
Exhibit 34

Passenger embarkation

1.4.87 On completion of the reactive task the formation landed at HKIA(N) to embark passengers. The passengers had been checked-in and manifested at the HKIA military passenger terminal, which was operated by civilian contractors. Routinely passengers walked a short distance from the terminal direct to their aircraft under the direction of a marshaller. However, for this sortie embarkation was undertaken approximately 500 m away from the normal loading point due to an on-going crash response exercise on the airfield; this required the use of two minibuses to move passengers between the terminal and the aircraft. Witness 1 Witness 3 Witness 4 Witness 5

1.4.88 The Panel could not establish whether the minibuses were specifically allocated to each aircraft in which the passengers were expected to travel. However, the Panel found evidence on the TAD tasking sheet that there had been an inadvertent mix up of passengers, with those passengers originally scheduled against A21 being loaded onto A22 and vice versa. A21's crewman recognised that the passenger allocation was contrary to that detailed in the original tasking sheet. However, it was common practice that both aircraft would land at an HLS and this was therefore not considered an issue by the crew. Exhibit 5 Exhibit 34 Witness 5

1.4.89 Through interview the Panel established, and experienced at first hand, the inconsistent nature of passenger handling at HKIA and other HLSs. Control and management of passengers varied between locations, and whilst passengers were assembled to embark in a formation of aircraft (generally 2) the actual tracking of individuals to specific airframes was not evident. As a result, when A22 crashed there was initial confusion as to which passengers were in which aircraft. Witness 17 Witness 7 Witness 17

Aircraft loading

1.4.90 **Loading guidance.** The Panel were made aware of aircraft handling anomalies discovered during flight testing at high Density Altitude (DA). TAD crews were provided with guidance on the loading of passengers, freight and fuel.

a. **Loss of Lateral Cyclic Authority (LCA).** During Rotary Wing Test and Evaluation Squadron (RWTES) Puma HC Mk2 flight tests it was discovered that in certain low speed flight profiles at high AUM and high Density Altitude[43] the aircraft could roll left and irrespective of the application of full right cyclic[44] the roll could not be countered. Consequently, revised AOB limitations were introduced through Advance Information Leaflet (AIL) 3/15 to the Puma HC Mk2 Aircrew Manual, dated Jul 15. Within the AIL aircrew were advised '*Where possible, the aircraft should be loaded such that the Centre of Gravity (CofG) is starboard (right) of the centreline'*. Exhibit 90 Exhibit 91 Exhibit 92

b. **Duty Holder Advice Note.** A Puma Duty Holder Advice Note (DHAN) dated 10 Sep 15 was produced in response to the loss of LCA. It was disseminated across the Puma Force and the TAD where it was Exhibit 91

[43] The condition was experienced at 40 kts IAS, 7120 kg at 13,500 ft Density Altitude.
[44] The cyclic controls the pitch and roll attitude of a helicopter.

placed in the aircrew information folder [45] and signed as having been read by all crews. Mitigation within the DHAN included the requirement to generate a prescriptive loading plan and aircraft role fit to ensure a right hand forward bias to the aircraft lateral CofG for all passenger/freight combinations at high DA. Until formal staffing could be completed crews were verbally briefed to comply with the guidance. A formal written loading plan was produced on 19 Apr 16. Exhibit 13 Exhibit 93 Witness 5 Witness 22 Exhibit 94

c. **Advice to crewmen.** During interviews the Panel established that verbal guidance had been given to crewmen to sit passengers from the front right, filling right hand seats before utilising the left side passenger seats, as well as refuelling the right hand fuel tanks first. However, there was an additional constraint that had to be considered by crewmen when loading passengers. The extant RTS in Oct 15 stated '*with the starboard GPMG mount fitted, the troop seat immediately forward of it should not be occupied when other seats are available*'. Whilst this was not a factor in the accident it demonstrated that aircrew had to be aware of differing directives relating to aircraft loading. Witness 5 Witness 22 Exhibit 95

In the Panel's opinion, crews were provided with layered progressive advice on aircraft loading which, although contained in several documents, mitigated the risks associated with loss of LCA. The possibility of LCA in the accident sequence is considered in paragraph 1.4.241.

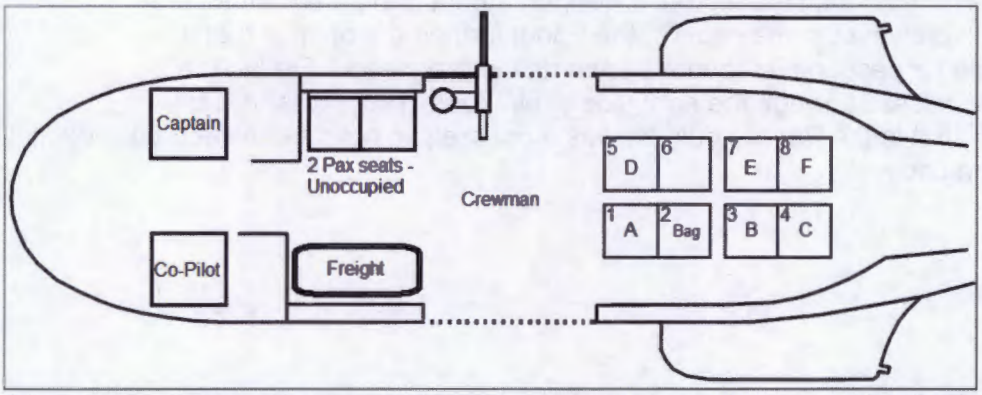
1.4.91 **A22 loading.** On the accident sortie, passengers embarked A22 through the right hand cabin door and sat in the rear of the cabin with 3 each side of a centrally mounted bank of 8 seats. The Panel were unable to ascertain if they were directed to a seat. However with the aircraft's weapon mount filling the front third of the doorway and the crewman in the cabin[46], the Panel formed the opinion that it would be reasonable for passengers to move towards the rear seats. Figure 1.4.3 shows the restricted access through the right side cabin door. There was at least one item of freight[47] that in the Panel's opinion was most likely to have been secured in the front left of the cabin. Witness 18 Exhibit 6 Exhibit 25

[45] The aircrew information folder provided details of issues that crews should be immediately aware of (new warnings/notices). Crews were required to sign for having read it before flight.
[46] The Panel could not ascertain where in the cabin the crewman was, but based on cabin size, seat configuration and location of weapon it was more likely than not that he was in the forward area.
[47] The freight was a hardened plastic item of luggage that measured approximately 1 m x 0.5 m x 0.5 m, which was witnessed on CCTV footage being thrown clear of the wreckage during the post-crash recovery.

Figure 1.4.3 Image showing restricted access to passenger Cabin caused by Crew Served Weapon

1.4.92 The 2 front right passenger seats were unoccupied and were therefore available for the Crewman in the event of an emergency. Exhibit 179 Witness 22 Exhibit 96

1.4.93 The Panel's assessment of crew and passenger seating positions is shown in Figure 1.4.4.



Note: Passenger seating positions were established through interview, extraction sequence from the aircraft and the Aeromedical Report. Passengers are referred to from A to F. Exhibit 6

Figure 1.4.4 Schematic of assessed A22 crew and passenger seat locations

Safety briefing

1.4.94 There was no evidence that any safety briefing was provided to the passengers during pre-flight check-in at HKIA(N) or on boarding the aircraft. Witness 18

1.4.95 The JHC FOB[48] stated that passengers should be given a safety briefing prior to flight which included aircraft emergencies; this was reiterated in Puma Force SOP 1 - Carriage of Passengers. Although non-germane to the accident all UK nationals (military, civil service and contractors) received a safety brief from TAD personnel during their mandatory RSOI. However, accident survivors (all non-UK nationals), were unaware of specific Puma related passenger drills, or indeed those for other aircraft, stating that they had not received aviation induction training on arrival in Theatre. Due to the operational environment and the embarkation of passengers with engines and rotors running the Panel were of the opinion that it was impractical for crewmen to deliver a brief as passengers boarded the aircraft and, for UK nationals, crewmen could assume that passengers had been briefed during RSOI. Exhibit 6 Exhibit 48 Exhibit 97 Witness 5 Witness 17 Witness 18 Exhibit 98

1.4.96 The RS Aviation Procedures Guide (APG) stated that all passengers should receive a formal safety brief on the particular type of helicopter in which they would be flying prior to arrival in Theatre. Furthermore it directed that HLS staff should routinely brief personnel before each sortie. Within the HLS manager's terms of reference there was the requirement to ensure that passengers were correctly briefed. Passengers in the Kabul area could expect to be transported in a variety of helicopter types and therefore in the Panel's opinion it was unlikely that they would receive type specific briefings. This would also apply to the requirement to be briefed prior to arrival in Theatre as the type of aircraft in which passengers travelled for administrative flights around Kabul was not programmed in advance. Exhibit 99 Exhibit 99 Exhibit 70 Exhibit 100

1.4.97 The Panel flew twice in a non-UK NATO helicopter in Kabul; on neither occasion did they receive a safety briefing. In addition they could find no evidence of helicopter safety posters in either SOC or HKIA(N) passenger handling areas.

1.4.98 The Panel concluded that whilst the lack of a passenger safety briefing was unlikely to have altered the outcome of this accident, the absence of a brief was an **Other Factor** that could contribute to, or aggravate, a future accident.

Recommendation

1.4.99 PJHQ COS(OPS) should engage with NATO HQ RESOLUTE SUPPORT to ensure the provision of passenger safety briefings and briefing material.

[48] JHC FOB J2340.110.4

Ammunition container used as Crewman rest

1.4.100 The Panel became aware that the Puma Force was utilising an ammunition container[49] within the aircraft cabin as a seat/knee rest for the crewman. It was also utilised to hold small items such as water bottles. The use of the container had become common practice for deployed operations[50], particularly when a crew served weapon system was fitted to the aircraft. Due to the nature and size of the Puma cabin, the container was used to provide a degree of relief to knee/back discomfort. The container was secured to the cabin floor by 2 x 'P' strops; it was reported that during passenger embarkation and deplaning the container was released and moved clear. An example of the use of a container is shown in Figure 1.4.5. Witness 22 Witness 24

Figure 1.4.5 Ammunition Container in Puma HC Mk2 Cabin

The Panel could find no evidence within the Puma HC Mk2 RTS or Aircrew Manual that the container was cleared for use as an approved aid to the crewman. The Panel considered there were potential safety risks[51] associated with the practice that may not have been appropriately considered and accepted by the Duty Holder chain; this was raised by the Panel in a Safety Advice Note. Exhibit 177

1.4.101 Whilst the Panel concluded that the uncleared presence of the ammunition container was an **Other Factor**, action has been taken by the Duty Holder chain during the course of the Inquiry to address this issue. Exhibit 140

Aircraft weight

1.4.102 In considering XW229's weight at the time of the accident, the Panel calculated the detail contained in Table 1.4.6. Passenger and freight weights[52] were estimated from the JHC guidance. Exhibit 101

[49] Flare Ammunition Container A480 Mk 1.
[50] It had been used on Puma HC Mk1.
[51] Potential risk as a trip hazard for the crewman moving in the cabin and the risk of impact injury from the container in the event of a heavy landing or accident.
[52] One item of freight was observed on CCTV footage being manually thrown from the cabin post-crash, indicating that it was not overly heavy.

Item	Mass (kg)	Source	
Basic Aircraft Mass[53]	5082	MF700C – MF702 Series Weight and Balance Data-Basic Weight and Moments	Exhibit 24
Additional Equipment[54]	113	TAD documentation	Exhibit 102
Crew	305[55]	Based on Aeromedical Report.	
Zero Fuel 'Weight'	**5500**		Exhibit 6
Fuel (on impact)	350	A22 CVFDR	
Passengers	690	6 x 115 kg[56]	
Freight	30	1 box and personal bags (estimation)	Exhibit 34
All Up Mass Total	**6570**		Exhibit 101

Table 1.4.6 XW229 weight breakdown at the time of the accident

1.4.103 As A22 prepared for departure from HKIA the crewman stated "*six-six, maybe six-seven*"[57]; in the Panel's experience that meant 6600 kg confirming the approximate aircraft weight at the time of the accident. Exhibit 34 Exhibit 15

1.4.104 The maximum all up mass of a Puma HC Mk2 was 7400 kg, therefore A22 was operating well within its authorised clearance. Exhibit 95

Centre of Gravity

1.4.105 During the Inquiry the Panel and Defence AIB investigators became aware of irregularities relating to Puma HC Mk2 Weight and Moment (W&M) and Centre of Gravity (CofG). In direct relation to XW229, key elements of information were unavailable on 11 Oct 15 (eg weight of items removed for weight saving and the lack of associated W&M recalculations). In addition, mathematical adjustments to other W&M calculations in the MF700C were incorrect. Furthermore, an AIL relating to the ballistic protection contained incorrect W&M data which introduced significant errors in the calculations. Aircraft engineers were responsible for the W&M data contained within the MF700C and the aircraft Captain was responsible for ensuring that the CofG remained within limits during flight. The Panel were advised that Puma aircrew did not routinely calculate an aircraft's CofG. Due to the nature of support helicopter tasking, and as an aircraft's weight would vary considerably throughout a day, the crewman would load the aircraft such that the weight was evenly distributed around the cabin. There was a belief that, unless carrying heavy asymmetric internal loads, the CofG would remain within limits. Having completed the calculations with the information available to the crew, the Panel found that had the crew calculated the aircraft's CofG using the data available in the MF700C on 11 Oct 15 it is likely that they would have concluded that it was out of limits. Exhibit 32 Exhibit 103 Witness 16 Exhibit 103 Exhibit 32

1.4.106 In an attempt to definitively establish if XW229 was within CofG limits, a

[53] Included Theatre Entry Standard equipment.
[54] Included flares, emergency water, daily water, chocks, crewman stores box and survival equipment.
[55] JHC J3 CI 19 Planning Weights for Battlefield Helicopters stated 135 kg per crew member however medical evidence proved that figure was too high for A22 crew.
[56] JHC J3 CI 19 Planning Weights for Battlefield Helicopters.
[57] Crewman's responsibilities include: passengers, load, weapon, voice marshalling, weight and balance and refuelling.

Defence AIB Engineering Investigator and a member of Rotary Wing Operational Evaluation and Training Unit (RWOETU) used corrected data (as opposed to that available on 11 Oct 15) to calculate the CofG. They concluded that once fuel, passengers and freight were added the aircraft was within RTS limits despite the passengers not being loaded in accordance with the direction provided in the Aircrew Manual and the DHAN concerning LCA. Exhibit 104 Exhibit 32

1.4.107 The Panel concluded that CofG was **Not a Factor** in the accident. However, the errors within the MF700 relating to W&M data and the lack of aircrew CofG calculations were both **Other Factors**.

Recommendations

1.4.108 The Puma HC Mk2 DDH should:

a. In conjunction with the Puma Project Team, Release to Service Authority and Handling Squadron conduct a review of associated documentation to ensure that information appertaining to W&M and CofG is standardised across all relevant publications.

b. Conduct a review of all MF702 Series to ensure the accuracy of information relating to weight and lateral and longitudinal moments.

c. Conduct a review of procedures to ensure pre-flight calculation and briefing of CofG.

Departure from HKIA(N)

1.4.109 The formation departed HKIA(N) at 1617 hrs initially following the track of Runway 29 before turning south east for the 2.4 nm (4.5 km)[58] transit towards SOC[59] at HQRS. The formation flew at a height of 500 ft above ground level (AGL). Exhibit 34

1.4.110 **Transit to SOC**. The transit height was a compromise between constraints on the use of the aircraft's defensive flares, threat risk from small arms fire, ATC clearances and the transit distance. These competing factors are discussed below: Exhibit 105 Witness 3 Witness 4 Witness 12 Witness 8

a. **Missile counter measure flares.** [redacted] Witness 3

b. **Small Arms.** [redacted] AGL placed the aircraft in a height band where it was accepted that there was an increased threat from small arms fire. Exhibit 106

c. **ATC.** HKIA and the area out to 6 nm were within Controlled Airspace. The Aeronautical Information Publication (AIP) (Aerodromes) stated that VFR[60] traffic should route outbound from HKIA at 500 ft AGL Exhibit 12

[58] Straight line distance.
[59] SOC HLS elevation was 5923 ft AMSL.
[60] Visual Flight Rules. Meteorological conditions must allow a pilot to fly an aircraft using external references.

and inbound at 300 ft AGL. Deviations from directed procedures were permitted subject to Kabul ATC Tower clearance. An additional consideration for helicopter traffic was that fixed wing aircraft under VFR were directed to fly circuits at 1100 ft AGL to the south of the airport, placing them directly above helicopters routing to/from the city. | Witness 10

d. **Transit distance.** The transit time from HKIA to SOC was circa 3 to 4 mins[61] which meant aircraft transited at 500 ft AGL instead of climbing out of the small arms threat band before conducting an almost immediate descent. | Exhibit 10 Witness 5

e.

1.4.111 In the Panel's opinion the geography of the AO, and most specifically the close proximity of the main HLSs in Kabul, meant that aircrew attention quickly transferred between phases of flight (take-off, transit and landing). As the crews were unable to comply with all of the individual constraints on height (articulated above) a compromise was required. As a result, the Panel concluded that the flight profile that was adopted routinely to achieve an efficient transit, was pragmatic.

1.4.112 The aircraft flew Trail Formation[62] which allowed A22 to operate anywhere between 2 rotor spans[63] and 2 km from the lead aircraft. The transit from take-off to arrival at SOC took 3 mins 30 sec, during which the maximum speed was 95 kts Calibrated Airspeed[64]. Once in the vicinity of SOC the formation established a downwind profile approximately 1000 m to the east before executing a right hand turn for a northerly approach to SOC. In manoeuvring to the final approach the formation passed approximately 350 m to the south of the HQRS compound. The aircraft's flight paths are shown in Figure 1.4.6. | Witness 3 Exhibit 10 Exhibit 79 Exhibit 15 Exhibit 61

[61] Allowing for take-off, a transit at 90 - 100 kts and manoeuvring to land.
[62] Aircraft had full freedom to manoeuvre as individuals and the ability to select individual tracks. Each crew was responsible for their own navigation, terrain clearance and collision avoidance.
[63] A Puma rotor span is 15 m.
[64] Calibrated Airspeed (CAS): combination of static and dynamic pressure and air temperature displayed to pilots as the aircraft's speed.

Exhibit 108

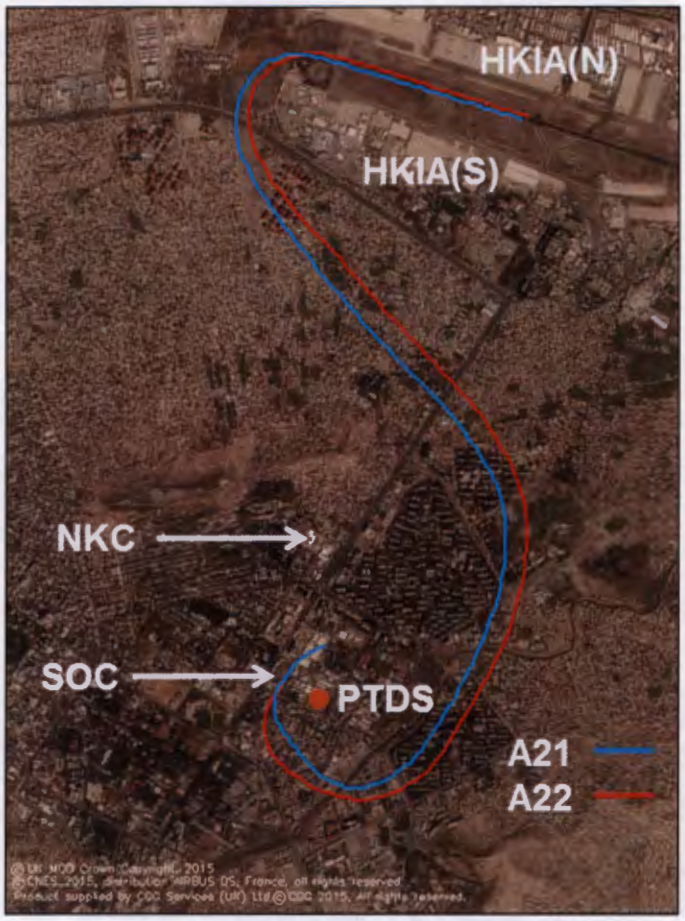


Figure 1.4.6 A21 and A22 flight paths from HKIA to SOC

Aviation activity

1.4.113 Witnesses stated that the airspace over the city was normally busy with a large number of helicopters operating in the area. However, on the afternoon of 11 Oct 15 there was no other helicopter activity, resulting in minimal inflight deconfliction for the formation. Witness 3 Witness 4 Witness 3

1.4.114 TAD Operations were notified by an email from the HKIA Flight Safety Officer that air and ground movements on the airport would be restricted on 11 Oct due to a crash exercise on the airfield. Disruption at HKIA would occur between 1345 and 1700 hrs affecting one of the main taxiways resulting in aircraft potentially experiencing 30 min holds for arrivals and departures. Therefore it was down to individual organisations to decide whether or not to fly during that period. TAD Operations staff liaised with ATC to facilitate the formation's fourth planned sortie. The Panel were unable to obtain a definitive answer on why no other aircraft were operating over the city at the time of the accident but concluded that it was probably related to the crash exercise. Exhibit 13 Witness 17 Witness 7 Witness 3 Witness 4

Radio communications with SOC OPS

1.4.115 During the transit A22[65] made 3 attempts to call SOC operations (SOC OPS) on the Air to Ground FM[66] radio to advise them of their arrival. The first 2 calls, 1 min 20 sec and 1 min 45 sec after take-off, were not responded to; these calls were made 1.6 nm (3 km) and 1.3 nm (2.5 km) respectively north of SOC. It is possible that these calls were masked by a ridge 0.8 nm (1.5 km) north of SOC. The crew of A21 commented that communications were not normally established with SOC OPS until they were '*around this corner*' referring to an area clear of the ridge and about 0.9 nm (1.7 km) north east of SOC. Exhibit 10 Exhibit 33 Exhibit 189

1.4.116 A third call when 0.9 nm (1.7 km) from SOC and 1 min before the formation arrived, was acknowledged but difficult to interpret by the Panel from the CVFDR recording due to interference from FP equipment and a simultaneous transmission on another radio. SOC OPS did not give the formation clearance to land[67] until the formation was 15 sec away from touchdown and coincident with A21's decision to conduct a 'go around'. The SOC OPS transmission was not an authoritative clearance; in effect it provided a situational update on the state of the HLS, eg if aircraft were already present. However, SOC OPS utilised what would be recognised as ATC terminology. SOC OPS was operated by civilian contractors and as far as the Panel could ascertain did not have visual sight of the HLS or formal ATC qualifications. They provided an advisory clearance to aircraft arriving/departing the HLS. Exhibit 10 Exhibit 33 Exhibit 189 Witness 25 Witness 4 Witness 25 Exhibit 109 Witness 25

1.4.117 Radio communications relating to SOC had been raised during a HQRS Safety and Standardisation Council[68] meeting on 2 Jul 15. The minutes stated: Exhibit 110

> *"When flying to SOC, approaching aircraft have no idea what is on the LZ, if aircraft are present aviators must decide to land or hold. The Palace ROZ and PTDS ROZ present challenges if go-around is needed. We must introduce a Landing Zone control before an accident occurs."*

Within the minutes, a recommendation was made for a Landing Zone controller with a dedicated radio frequency the minimum range of which was to be 2 nm. At the next meeting on 6 Oct 15 the issue had been updated with a review of the Prior Permission Request (PPR) system being considered. Despite the use of the radio, a lack of positive communication with aircraft while operating in and out of the HLS was still cited as the main issue. Exhibit 110 Exhibit 76 Exhibit 111

1.4.118 The Panel concluded that poor air-to-ground communications was an **Other Factor**.

1.4.119 The Panel were of the opinion that SOC OPS's clearance to land had the potential to cause confusion in the future and therefore considered it an **Other Factor**.

[65] Within the TAD it was the responsibility of the left hand seat pilot in the second aircraft to make radio calls to landing sites.
[66] The FM (Frequency Modulation) air to ground radio is a tactical short range radio that is effectively limited to line of sight operations.
[67] SOC OPS contractual staff transmitted '*clear to land*' but this is not an authoritative clearance as would be received from an Air Traffic Control Agency.
[68] The Safety and Standardisation Council is expanded upon in para 1.4.354.

Recommendations

1.4.120 PJHQ COS(OPS) should engage with NATO HQ RESOLUTE SUPPORT to:

a. Improve the capability of air to ground communications at HQRS HLS (SOC) in order to ensure the timely establishment of communications with approaching aircraft.

b. Clarify Radio Telephony terminology to be used by civilian contractors and confirm the associated meaning within the RS Aviation Procedures Guide.

Meteorological conditions at SOC

1.4.121 The meteorological conditions at the HLS were: wind variable 4 kts, visibility 10 km or greater with no cloud reported, temperature +28°C, Dew Point -6°C, DA 8730 ft. Astronomical data placed the sun's elevation at 250°M and approximately 11° above the horizon. The crew of A21 stated that they did not feel that the meteorological conditions or the sun's azimuth/angle had impeded their conduct of the sortie. Exhibit 16 Witness 4

1.4.122 The Panel assessed that the meteorological conditions were very benign and concluded that they were **not a Factor** in the accident.

SOC

1.4.123 The HLS was located at the western edge of, but outside, the HQRS compound; it was owned by the Afghan National Army (ANA) and was a soccer field. As an HLS its primary function was for the movement of personnel. Exhibit 14

1.4.124 There were 2 main points of entry[69] [redacted]. Exhibit 109

1.4.125 The HLS measured 80 m x 100 m and had a number of associated hazards including high trees, a security wall and a 9 storey building immediately to the north[70]; approaches and departures were orientated north/south. Exhibit 14

1.4.126 The landing area was procedurally divided longitudinally into 2 lanes to aid the management of aircraft arrivals, loading and departures. It was routine practice for a formation to be cleared into one of the lanes with aircraft landing one behind the other. Figure 1.4.7 is an aerial image of SOC HLS. Exhibit 14 Exhibit 112 Witness 3

[69] There was a third 'secondary' access point for fire fighting purposes.
[70] Hazards were highlighted in the Op TORAL HLS Directory.

Figure 1.4.7 SOC HLS

HLS management

1.4.127 SOC was managed and operated by contract staff in accordance with the APG which stated that HLS managers (generic) were responsible for ensuring that an HLS be clear of personnel 5 min prior to any helicopter commencing an approach. NATO had to balance the maintenance of Host Nation relations whilst meeting the operational requirement to move personnel by helicopter. HQRS had a formal process for using the HLS for non-aviation activities, but the ANA would utilise the field as they required. Exhibit 113 Exhibit 114 Exhibit 99 Exhibit 109

1.4.128 All rotary wing transits[71] of SOC required a PPR authorisation to establish procedural and airspace de-confliction as well as contributing to HLS security, ground activity de-confliction and control. However it was not unusual for aircraft to be late, resulting in consequential impacts to other operators. Exhibit 113 Witness 4

1.4.129 It was reported to the Panel that historically during warmer weather the ANA played sports late afternoon and when individuals were on the field NATO FP personnel would move them clear before aircraft approached. This would happen after aircraft contacted SOC OPS, approximately 1 to 2 min before arrival, at which point SOC OPS would notify the FP team. Exhibit 109

1.4.130 As the formation approached SOC there were approximately 40 people conducting sporting activity on the northern quarter of the HLS. A21 sighted football players on the HLS approximately 20 sec before arrival on final approach at a range of circa 500 m; their location is indicated in Figure 1.4.8. Within a matter of seconds a decision to go around was made and transmitted to A22. At the point that the formation executed the go around the aircraft had descended to 150 – 200 ft AGL and reduced speed to approximately 60 kts. Exhibit 2 Exhibit 10

[71] 'Transits' is used in the NATO Standard Operating procedure 117000 HQRS Soccerfield Helicopter Landing Zone Operations, however it is assumed to mean arrivals/departures.

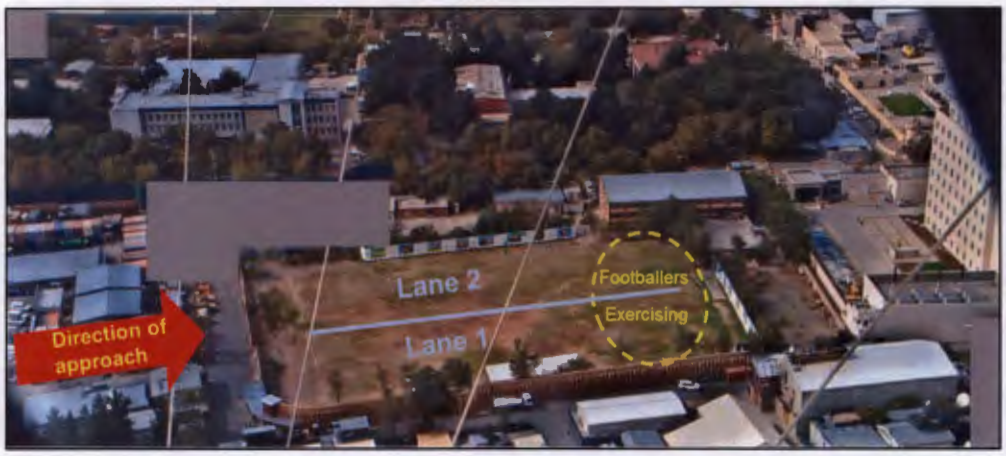


Figure 1.4.8 Location of footballers on SOC HLS

1.4.131 Although the formation had an approved PPR and was scheduled to arrive at circa 1605 hrs, it did not prevent sporting activity from taking place. The PPR was valid for 15 min and was a 'no earlier than' time. Irrespective of the PPR, the HLS should have been cleared 5 min prior to arrival or at least when the aircraft established radio communications with SOC OPS. However, as this was not achieved until the aircraft were 1 min away from SOC, the field was not clear of footballers to enable an immediate approach to be made. As a result the Panel concluded that the formation had no option other than to go around. Exhibit 4 Exhibit 2 Exhibit 116 Witness 7 Exhibit 99 Exhibit 2

1.4.132 A FP soldier moved onto the HLS after the formation had executed the go around but on the security CCTV footage appeared to make little effort to move the footballers off the site; the footballers only cleared the area in the final seconds before A22 impacted the ground. Exhibit 2 Exhibit 10

1.4.133 The APG direction regarding the clearance of HLSs was generic and in the Panel's opinion appropriate for an HLS with infrequent activity. However the high volume of aircraft movements into SOC led the Panel to consider that this direction was unrealistic for such a busy site. In the Panel's opinion the dual use nature of SOC increased the risk of a safety related incident and was an Other Factor.

Recommendation

1.4.134 PJHQ COS(OPS) should engage with NATO HQ RESOLUTE SUPPORT to review the feasibility of using Soccerfield as a combined HLS and sports facility, and if this is unavoidable, ensure that robust deconfliction measures are in place.

Go around to tether strike

1.4.135 After initiating the go around and overflying SOC the formation commenced a right turn to follow a similar track to their previous 'downwind' profile although slightly further displaced to the south east. Still in trail formation A22 initially remained on the left hand side of A21, between 200 – 550 m behind. Exhibit 10 Exhibit 115

SOC clearance

1.4.136 Shortly after A22 commenced the go around and as it overflew SOC, it Exhibit 33

received confirmation from SOC OPS that the footballers were being moved. However, CCTV imagery showed that the FP soldier had not moved onto the HLS, and the footballers were not vacating the HLS. | Exhibit 189 Exhibit 2

1.4.137 1 min and 8 sec after commencing the go around, and when parallel with the HLS, A21's Captain concluded from what could be seen of the HLS that it was still occupied. He asked A22 for confirmation of whether the HLS was being cleared: | Witness 3

A21: *"Doesn't look like those footballers are getting out of the way, can you just confirm that they will be doing that?"* | Exhibit 10 Exhibit 33 Exhibit 189

A22: *"SOC OPS sending someone as we speak."*

This was the only intra-formation communication after the initiation of the go-around.

Crew perceptions after go around

1.4.138 The crew of A21 discounted dropping passengers at NKC, their second task, whilst waiting for SOC to clear. Twelve sec after the reply from A22, A21's Captain directed for the aircraft's flares to be set to "auto". [redacted]. In the Panel's view this indicated to his crew A21's Captain's intention not to descend for an approach to SOC. He then maintained a right hand turn to conduct a circular hold (500 ft AGL, 70 kts) to the south east of the HQRS compound. | Exhibit 10 Exhibit 33 Exhibit 189 Witness 3

1.4.139 Conversely, specialist Human Factors (HF) analysis of discussions between A22's crew suggested that they perceived that the HLS was clearing. 12 sec after over flying the HLS the Crewman reported that the footballers were "getting off" the pitch; however this was not supported by CCTV imagery. When abeam the HLS, in a 'downwind' position and immediately before the inter-aircraft discussion, he stated that "back left back right are free if you want " meaning the southern area of the HLS. In the Panel's opinion the crew's collective perception may have been influenced by the crewman's comments regarding the HLS. CCTV footage showed that whilst there was activity on the HLS there was no positive move by the footballers to vacate the area. | Exhibit 10 Exhibit 33 Exhibit 189 Exhibit 2

Notification of intent to orbit

1.4.140 Throughout the initial approach and go-around the southerly half of SOC remained clear; to have landed in that area would have required the aircraft to land next to each other. Aircraft were routinely cleared to land in either Lane 1 or Lane 2 and would do so one behind the other; as there was no urgent requirement to land the formation leader was content to orbit. | Witness 3

1.4.141 A21 did not notify A22 that they would conduct an orbit whilst the HLS was cleared. As the aircraft were in trail formation A21's Captain felt that it was reasonable to assume that A22 would follow around the orbit. A21's Captain asked his Crewman for confirmation of A22's position as the formation headed south after | Witness 3 Exhibit 34

the go around – the Crewman stated "playmate's six o'clock around 15 spans[72]". Contextually the formation was at a familiar location, undertaking a relatively simple task of a go-around, they were the only aircraft in the area and there was no noted time pressure; the aircraft were at a similar height and the distance between them was 230 – 460 m[73]. Analysis of A22's CVFDR, and comments made during interviews with A21's crew, suggest that there was informal guidance to minimise intra-formation communications. The Panel recognised that the use of radio calls to clarify intentions is an airmanship consideration the use of which is dependent on circumstance and perceptions of requirement. Noting the relatively simple nature of the go-around and the absence of any other aircraft in the area, the Panel considered that the lack of a radio call was not unreasonable.

Exhibit 33
Exhibit 189
Witness 3

1.4.142 HF specialist analysis advised that a strategy to minimise communications would be beneficial in reducing the risk of distraction and cognitive overload but was associated with a risk that the crews would not share a common understanding (have reduced shared situation awareness). In the Panel's opinion the limited communications between the 2 aircraft meant that the difference in expectations over landing was not identified.

Exhibit 72

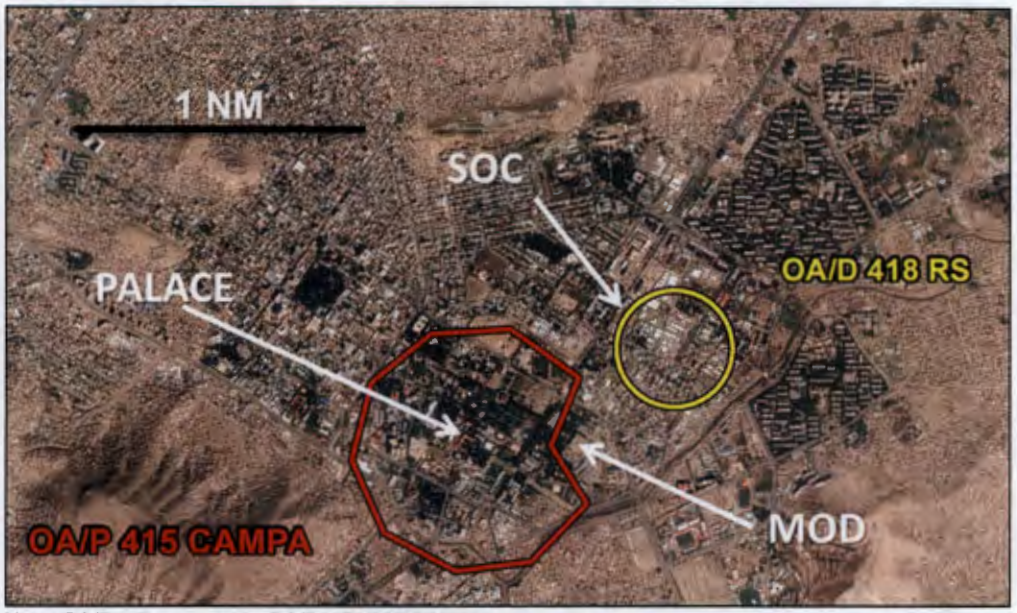
1.4.143 In the Panel's opinion, and having considered all available evidence, it could not be determined whether the lack of a radio call regarding the intent to orbit affected the outcome of the accident.

A22 aircrew focus

1.4.144 Immediately after the intra-formation discussion regarding SOC OPS clearing the HLS, A22's pilots commenced a 17 sec long discussion regarding the location of ground features, specifically the Presidential Palace and the Afghan Ministry of Defence (MOD) which are shown at Figure 1.4.9. The MOD was not a formal avoid, however a witness stated that it was not overflown because of its proximity to the Palace Prohibited Area. The MOD was immediately east of the Palace Prohibited Area boundary.

Exhibit 34
Witness 9
Witness 25
Witness 26
Witness 3

[72] 15 spans would equate to approximately 225 m. CVFDR ground tracks showed the actual distance to be approximately 500 m.
[73] The distance between the aircraft is further analysed at paragraph 1.4.153.



Note: OA/D – Danger area, OA/P – Prohibited area

Figure 1.4.9 Location of Presidential Palace Prohibited Area

1.4.145 The discussion was initiated by the Co-pilot over a perception that the lead aircraft had infringed the avoid around the Presidential Palace, shown in red in Figure 1.4.9. A22's Co-pilot stated: *"Don't go over the Palace …..oops too late."* Exhibit 34 Exhibit 33 Exhibit 189

1.4.146 The positions of the aircraft in relation to each other and the MOD at the time the Co-pilot made the palace statement are shown at Figure 1.4.10. The direction of the aircraft headings are represented by the white arrows but is a snap shot as both aircraft are in right turns.

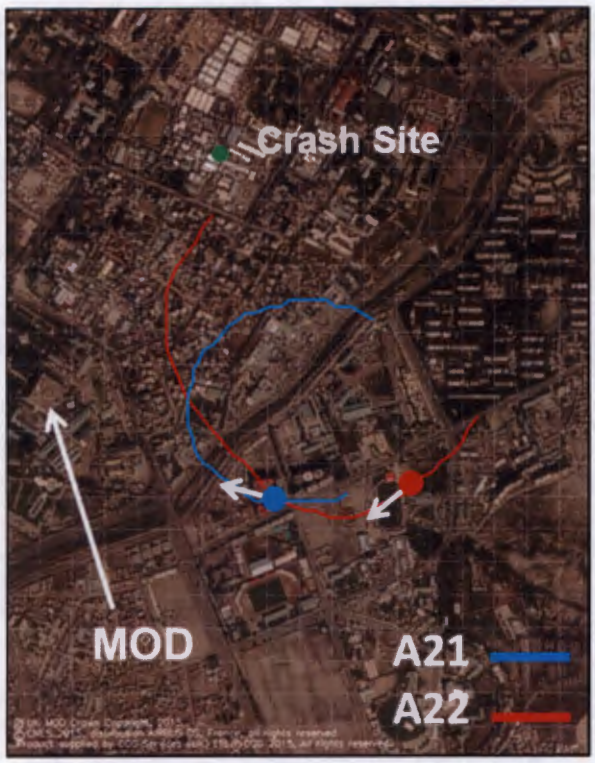


Figure 1.4.10 Position of aircraft when Co-pilot states '*Don't go over the Palace..*'

1.4.147 The conversation immediately continued with:

Exhibit 34
Exhibit 33
Exhibit 189

Captain: *"He's not over the Palace."*

Co-pilot: *"He is."*

Captain: *"The Palace is the nice clear area. You've got the MOD and the road."*

Co-pilot: *"No it's that one there,…. that building down there left at 11 o'clock of the road."*

Captain: *"That's the MOD, the sandy coloured one."*

The relative positions between the aircraft as the pilots discuss the MOD is shown in Figure 1.4.11. The CVFDR evidence showed that this was the moment that the aircraft started to diverge from each other.

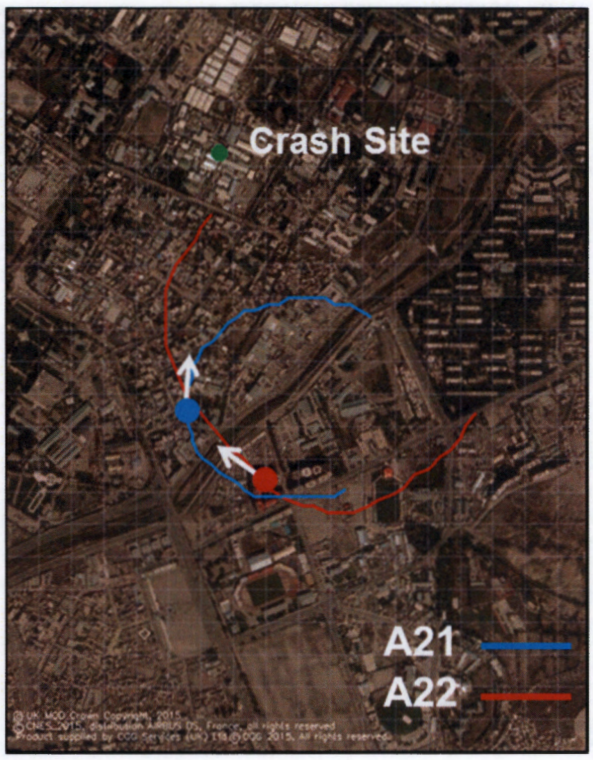


Figure 1.4.11 Image showing the start of aircraft track divergence; 11 sec after Figure 1.4.10

1.4.148 The discussion concluded with:

Exhibit 34
Exhibit 33
Exhibit 189

Co-pilot: *"Isn't that an avoid as well?"*

Captain: *"It is but you stay north of the road which we've got."*

As A22's Captain mentioned being north of the road, the divergence between the aircraft's tracks increased, at this moment the aircraft were 230 m apart; this is shown at Figure 1.4.12.

Figure 1.4.12 Increasing track divergence; 5 sec after the positions shown in Figure 1.4.11

1.4.149 In the Panel's opinion, due to the relative position of the aircraft to the ground features, and the clarity of the comments regarding the MOD, both A22 pilots were more likely than not looking forward, down and left from the aircraft. Interpretation of CVFDR evidence showed A21's ground track was clear of the Palace Prohibited Area. Exhibit 34 Exhibit 115

1.4.150 A22 had been into SOC on 3 previous occasions that day and the pilots had been there circa 25 times in the previous 3 weeks. The approach profile flown on the previous sortie was similar to that executed during the accident sortie and is shown in Figure 1.4.13. As a result the Panel could not determine why the Co-pilot of A22 misidentified building locations. Witness 3 Exhibit 82 Exhibit 117 Exhibit 108

Figure 1.4.13 Comparison of approach profiles. Sortie 3 on left at 1449 hrs and arrival from HKIA(N) on right at 1620 hrs

1.4.151 HF analysis of both aircraft flight paths and A22's CVFDR identified 2 potential explanations. Exhibit 72

a. **Spatial judgement of A21 position.** The assessment of an aircraft's ground track from another aircraft is subjective and associated with a degree of error; it is a complex spatial judgemental task. Therefore, it is possible that A22's Co-pilot judged the position of A21 to be within the boundary of the Palace avoid when it was not.

b. **Misidentification of the MOD as the Presidential Palace.** During the discussion the Co-pilot identified the MOD as the Palace but was corrected by the Captain. The Palace Prohibited Area extended approximately 600 m to the east of the Palace buildings finishing just before the MOD; in identifying the MOD as the Palace the Co-pilot may have transposed the boundary of the avoid to the east, which would have been coincident with A21's position. Exhibit 33 Exhibit 189 Exhibit 34 Exhibit 107 Exhibit 72

Whilst both explanations are plausible the Panel could find no evidence to indicate any specific reason to explain the Co-pilot's comments.

1.4.152 **MOD as an avoid.** In response to the Co-pilots question "*isn't that an avoid as well?*", the Captain replied "*it is*". Although the Panel found no evidence to support his comment, a witness stated that the MOD was not overflown due to its proximity to the Palace avoid. Witness 25

A22 loss of visual contact with A21

1.4.153 At the end of the downwind leg A21 commenced an orbit to the right using approximately 20° Angle of Bank (AOB), A22 used a greater AOB (up to 33°) which resulted in the aircraft moving from the left of A21 to the right. During the discussion regarding ground features the distance between the aircraft reduced from 460 m to 230 m, this was caused by A21 gently decelerating while A22 maintained airspeed. Exhibit 34 Exhibit 33 Exhibit 189

1.4.154 Midway through the discussion, serial 8 in Table 1.4.7, and as the MOD was directly in front of the aircraft, A22's AOB started to decrease. AOB was reduced for 7 sec by which time the MOD was to the left of the aircraft between the 10 and 11 o'clock position at approximately 500 m; thereafter AOB was increased. Table 1.4.7 shows A22's crew comments with associated AOB. Exhibit 34 Exhibit 33 Exhibit 189

Ser.	Time (sec) (XW229 CVFDR counter)	A22 Captain	A22 Co-pilot	AOB°	
				A22	A21
1	98097		*"Don't go over the Palace"*	20	16
2	98099	*"He's not over the Palace"*		25	16
3	98100			28	17
4	98102		*"He is"*	30	19
5	98103	*"The palace is the nice clear area, you've got the palace and the road"*		30	19
6	98104			32	19
7	98105		*"No, it's that one there……..*	33	20
8	98106			31	20
9	98107	*"That's the MOD, the sandy coloured one"* (over-talking)	*……that building down there, left of the eleven o'clock (low) of the road"*	26	20
10	98108			19	20
11	98109			10	19
12	98110		*"Isn't that an avoid as well?"*	8	18
13	98111			6	17
14	98112	*"It is but you stay north of the road which we've got"*		5	17
15	98113			4	17
16	98114			5	18
17	98115			9	18
18	98116			14	18

Exhibit 33 Exhibit 189 Exhibit 185

Table 1.4.7 A22 Pilot's comments with aircraft AOB

1.4.155 In the Panel's opinion the clarity of discussion regarding ground features would only have been possible if both the aircraft Captain and Co-pilot could see the associated buildings. The reduction in AOB may have improved the Captain's view of the area as the aircraft neared the MOD and would explain the change in aircraft attitude.

1.4.156 As a consequence of A22's AOB reduction the aircraft crossed back to the left of A21 and their tracks started to diverge. A Graphical Data Analysis System (GDAS) generated fly through demonstrated that as A21 sustained its right turn and as A22's AOB reduced, A21 moved rapidly from being ahead of A22 to moving away to the right. Exhibit 35

1.4.157 As noted previously, A22's pilots' attention was more likely than not focused on ground features for 17 sec. However, from analysis of the CVFDR data, the Panel concluded it was during the period when the AOB was at its lowest, (a period of approximately 5 sec) and the aircraft neared the MOD, that the aircraft flight paths diverged. Exhibit 10 Exhibit 34 Exhibit 35

1.4.158 Five sec after the aircraft Captain's comment regarding being north of the road he stated to the crew that he was "*off lead*": Exhibit 10 Exhibit 33 Exhibit 189 Exhibit 34 Exhibit 35

Captain: *"now I'm off lead,….sorry"*.

Crewman: *"Roger, we're beginning to pattern set*[74] *a touch now".*

Captain: *"Yeah we are a bit".*

3 sec pause.

Crewman: *"Both back left, back right free, they are only in the top half".*

Co-pilot: *Yeah they've got…. do I tell him?"*

Captain: *"Oops, fuck it".* Coincident with avoiding action/tether strike.

At the moment the Captain stated that he was "*off lead*", the difference between the 2 aircrafts' headings was circa 90°, with A21 approximately 230 m to the right of A22; the relative positions of the aircraft are shown at Figure 1.4.14. Other than the brief acknowledgement by the Crewman, no further mention was made of the lead aircraft. The Panel considered that the Captain's terminology of "*off lead*" could have been open to interpretation by the other crew members. However, in the Panel's opinion the Captain meant that he did not have visual contact with the other aircraft. Exhibit 72

[74] 'Pattern setting' is a term used to describe repeated flight profiles. It is considered tactically undesirable in an operational environment.

Exhibit 34

Figure 1.4.14 Relative positions of A21 and A22 when A22's Captain declared he was "*off lead*"

A22 crew reactions

1.4.159 In assessing the crew's reactions and considering specialist HF analysis, the Panel considered each individual's actions/comments.

1.4.160 **Captain.** The Panel concluded that between the end of the conversation about ground-avoids and stating that he had lost sight of the lead, it was probable that A22's Captain attempted to regain sight of A21. It was most likely that the Captain only reported to the crew that he had lost the lead once he had been unsuccessful in his own initial attempts to regain visual contact. HF analysis assessed that the Captain's tone of voice when reporting the loss of leader was quiet and included an explicit apology. Having raised the subject, there was no subsequent instruction to the crew to address the issue. Although the Crewman mentioned pattern setting the Captain's response was unspecific. However, no positive action was taken, either verbally or in adjusting the aircraft's flight profile and there was no input from the other crew members. Exhibit 72 Exhibit 35 Exhibit 33 Exhibit 189

1.4.161 **Co-pilot.** The Co-pilot did not comment on the loss of the leader but did respond to the Crewman's remark regarding the clearing of SOC. In the absence of any other explanation and in the Panel's opinion, he was more likely than not focused on the HLS. Exhibit 33 Exhibit 189 Exhibit 35

1.4.162 **Crewman.** While the Crewman acknowledged the Captain's statement about losing sight of A21 by saying "*Roger*" his main comments related to pattern setting and SOC. He had mentioned that the southern area of SOC was clear when Exhibit 33 Exhibit 189 Exhibit 35

the aircraft was 'downwind' 45 sec previously, and when considering both comments the Panel concluded that he was focused on landing.

1.4.163 **Intra-formation communication.** A22 did not inform A21 that they had lost visual contact and therefore, as formation leader, A21 was unable to respond or assist and remained unaware that the other aircraft could not see them. Exhibit 33 Exhibit 189 Exhibit 35

1.4.164 **Loss of Situation Awareness (SA).** During the discussions regarding the Palace/MOD, and after the Captain's statement concerning the loss of visual contact with A21, HF specialist analysis suggested that a loss of SA with regard to both the lead aircraft and the PTDS location was likely to have occurred. The Panel considered it most likely that the crew did not perceive the available information regarding aircraft/PTDS location correctly due to a number of factors. Exhibit 72

a. **Attention capacity.** Attention capacity is a finite resource which influences the ability to build SA. Very low and high levels of workload reduce the attentional resources available and so hamper the ability to gather information. Due to the unusually quiet airspace, relative to the crew's recent experience, the Panel considered that the crew may have been experiencing comparatively low workloads during the sortie. Consequently, they may have had less mental resources to attribute to other tasks, such as maintaining visual contact with A21, whilst concurrently discussing the ground features.

b. **Attention allocation.** HF specialist analysis stated that when attention is focussed on one aspect of a task, fewer attentional resources are available to allocate to other tasks. During the discussion regarding the Palace/MOD the focus of at least 2 crew member's attention was on the buildings and not A21. Similarly, the Co-pilot's and Crewman's comments concerning pattern setting and the HLS suggested that these subjects were the focus of their attention leaving fewer resources to allocate to addressing the loss of the formation lead. In the latter seconds before tether strike and whilst the attention of 2 crew members was on SOC, the attention of the Captain may have been on any part of the airspace looking for A21. Collectively, less of the crew's attentional resources may have been allocated to the position of the lead aircraft and successively the PTDS, reducing the ability to recall the hazard and maintain SA.

c. **Crew Resource Management (CRM).** In the 13 sec prior to tether impact, the CRM within A22 changed from a previously effective level. Although the crew remained task focused, there were frequent changes between issues being discussed. Pattern setting, the availability of SOC, and the loss of sight of the lead aircraft were all raised during this short period; however crew resources quickly transferred from one topic onto another without the previous issue being resolved. There also appeared to be no allocation of crew resources to the task of detecting the PTDS. Thus, CRM did not enable the shortfalls in the allocation of attention to be identified and overcome and therefore may have contributed to the loss of SA.

1.4.165 In the Panel's opinion it was more likely than not that during the latter

part of the conversation regarding ground features both pilots' attention was primarily focused on the MOD. During this short period, circa 5 sec, the difference in AOB between the 2 aircraft was such that A21 moved rapidly away to the right, which resulted in A22 losing visual contact. In the Panel's view, had A22 not lost sight of A21 it would, in all probability, have followed the lead aircraft into the orbit. The Panel determined that the loss of visual contact with the lead aircraft was a **Contributory Factor** in the accident.

1.4.166 Whilst the Panel acknowledged that the crew's discussion was relevant to their activity it was deemed inopportune for that phase of flight. This, combined with the subsequent level of CRM, resulted in a loss of SA in relation to the PTDS. The Panel concluded that the crew's focus on ground features, pattern setting, the HLS and lost leader led to a momentary loss of SA regarding the PTDS which was a **Contributory Factor** in the accident.

Lack of search for the PTDS

1.4.167 From analysis of the CVFDR and consideration of the HF specialist report, the Panel formed the opinion that the Co-pilot and Crewman were likely focused on the HLS (which was to the left of the aircraft and away from the PTDS) and that the Captain was most likely looking to the right (direction of turn) for the lead aircraft. There was no evidence to indicate that any member of the crew's attention was on the position of the tether. Exhibit 33 Exhibit 189 Exhibit 72

1.4.168 As previously discussed in paragraph 1.4.164 when attention is focused on one aspect of a task, fewer attentional resources are available to allocate to other tasks. In addition, the manner in which the available capacity is allocated can influence the outcome of a visual search. For an item to be detected, the person conducting the search must focus their visual attention on that item. If attention is not allocated to the required area of the visual field then the item will not be detected[75]. In the Panel's opinion as all 3 crew members were already focused on separate tasks, and there was no verbal recognition of the PTDS, no consideration was given to its position and therefore it was less likely to be detected. Exhibit 72

Potential equipment distraction

1.4.169 Although there was no evidence of equipment related distractions during the accident sortie, there were documented occasions when aircrew had suffered discomfort from the armoured seats, In Ear Communications Device (IECD)[76], and the Mk 10 helmet; all had been reported in Defence Air Safety Occurrence Reports (DASORs). Exhibit 118 Exhibit 119 Exhibit 120

1.4.170 **Armoured seat.** The Puma HC Mk2 armoured seat was the subject of multiple DASORs specifying discomfort/pain experienced by pilots. The onset of discomfort tended to occur after approximately 1 hr of flying and could endure for several hrs; A22's Co-pilot submitted a DASOR on 8 Oct 15 to that effect. The Panel were aware that a solution to this issue was being investigated. The Panel could find no evidence from the available (2hrs) CVFDR data that either of A22's pilots Exhibit 118 Exhibit 121 Exhibit 122

[75] Eysenck, M.W and Keane, M.T. (2000). *Cognitive Psychology: A Student's Handbook 4th Edition.* Hove, UK: Psychology Press.
[76] Also referred to as Communications Ear Plug (CEP).

were experiencing seat related discomfort during the accident sortie.

1.4.171 **IECD.** Aircrew discomfort related to the wearing of IECD was a common, well documented, issue across several platforms. The Co-pilot was issued special fit IECD in Sep 15 (known as VAMP27) to address reported discomfort. The aircrew helmets from the Crewman and Co-pilot indicate that they were wearing IECD on the day of the accident; it was unclear from the Captain's helmet whether he was wearing IECD. However his grab bag contained an empty IECD case and therefore on the balance of probability the Panel assessed that he was wearing them. While the Panel noted that the Captain of A22 submitted a DASOR on 8 Oct 15, they could find no evidence of discomfort due to IECD from the available CVFDR data. Exhibit 6 Exhibit 123 Exhibit 34

1.4.172 **Mk10 aircrew helmet.** Discomfort related to the Mk10 helmet was well reported. All A22 crew members were wearing Mk10 aircrew helmets however, the Panel found no evidence of related issues. The Captain had previously raised issues but they had been resolved. The Aeromedical specialist report noted that problems were normally associated with the fitment of night vision devices and therefore they were not considered within the context of the accident. Exhibit 120 Exhibit 72 Exhibit 6

1.4.173 **Conclusion.** Although the lack of verbal evidence of any discomfort is not absolute, the Panel considered that the reporting culture among the aircrew was robust and any discomfort or sub-optimal performance of equipment would most likely have been highlighted during the afternoon. Therefore, the Panel consider that although not a factor in the accident, distraction due to equipment discomfort could contribute to future accidents and was therefore an **Other Factor**.

Recommendation

1.4.174 The Puma Project Team Leader should instigate a programme of measures to reduce aircrew discomfort associated with the Puma HC Mk2 armoured seat.

Initiation of avoiding action

1.4.175 In the final seconds before A22 collided with the tether it was in level flight at 82 kts and in a 19° AOB turn to the right. Analysis of the CVFDR indicates that the aircraft Captain commenced avoiding action to the left immediately before the aircraft struck the tether; when combined with reports from witnesses on the ground, this suggests that the tether made contact on the right hand side of the aircraft. The nature of the Captain's comment immediately before tether strike, suggests that the tether was seen at the last moment and that he may have recognised it. Exhibit 35 Exhibit 33 Exhibit 189

Persistent Threat Detection System (PTDS)

1.4.176 The PTDS was located in the south east corner of the HQRS compound; it was one of 3 operating in the Kabul area providing Intelligence, Surveillance, and Reconnaissance data to aid FP across the city. All 3 PTDSs had Danger Areas established around them. The PTDS at HQRS was at the centre of Danger Area Exhibit 18 Exhibit 19 Exhibit 107

OA/D418RS which had a radius of 0.2 nm (370 m) and extended to a height of 2500 ft AGL; it was designated as Special Use Airspace[77] within which flight by military aircraft was prohibited. PTDS location details and airspace dimensions were included in the Afghanistan Aeronautical Information Publication (AIP)[78] which crews were required to sign as having read. Although both A21 and A22 crews had signed to that effect, during interview one crew member stated that he was unaware that the PTDS had a Danger Area around it. There was also confusion as to whether it was a Danger Area or a Restricted Operations Zone (ROZ)[79]; this will be further considered in paragraph 1.4.361.

Exhibit 61
Exhibit 93
Witness 4
Witness 3
Witness 4
Witness 27
Witness 5

1.4.177 The PTDS was installed at HQRS in May 15 and marked in accordance with Theatre-wide PTDS protocols, which had been standardised in Feb 12. Consideration had been given to locating the PTDS at the [redacted][80] but it was stated that it would limit SOC approach and departure routes; therefore the PTDS was established at HQRS.

Exhibit 19
Exhibit 127
Exhibit 126
Exhibit 125
Witness 19
Witness 10

1.4.178 The PTDS comprised an aerostat, tether, base station[81], mission payloads and associated ground support and control equipment. The aerostat was helium filled and aerodynamically designed to fly into wind to maintain stability; it had no propulsion system. The tethered aerostat was free to drift with the wind; in strong winds the aerostat was recovered to the base station. The hull of the aerostat was 35 m in length, 12 m in diameter and had a volume of 74,000 cubic feet.

Exhibit 19
Exhibit 124

Figure 1.4.15 - HQRS PTDS in down position

[77] AIP ENR 5.1-2, 2.4.1: For all military aircraft these areas were to be considered as no Fly Areas (Special Use Airspace, NO FLY).
[78] Version 20 Aug 15.
[79] ATP-49F. A ROZ is defined as "Airspace of defined dimensions, designated by the airspace control authority in response to specific situations and/or requirements, within which the operation of one or more airspace users is restricted." ROZ is an operational term – it has no meaning in peacetime.
[80] [redacted]
[81] Also known as a mobile tying down platform (PTDS site manager) or deployed mobile mooring (US Department of Army).

1.4.179 The aerostat was connected to the base station by means of a tether which was 0.58 inches (14.7 mm) in diameter and consisted of a central core of fibre-optics, copper cored power cables and a braided Vectran[82] sleeve all of which were encased in a black rubber environmental outer. The tether was used to restrain/anchor the PTDS to the base station and to provide power and data transfer to and from the payload. Figure 1.4.16 shows an exposed section of tether. Exhibit 124 Exhibit 128

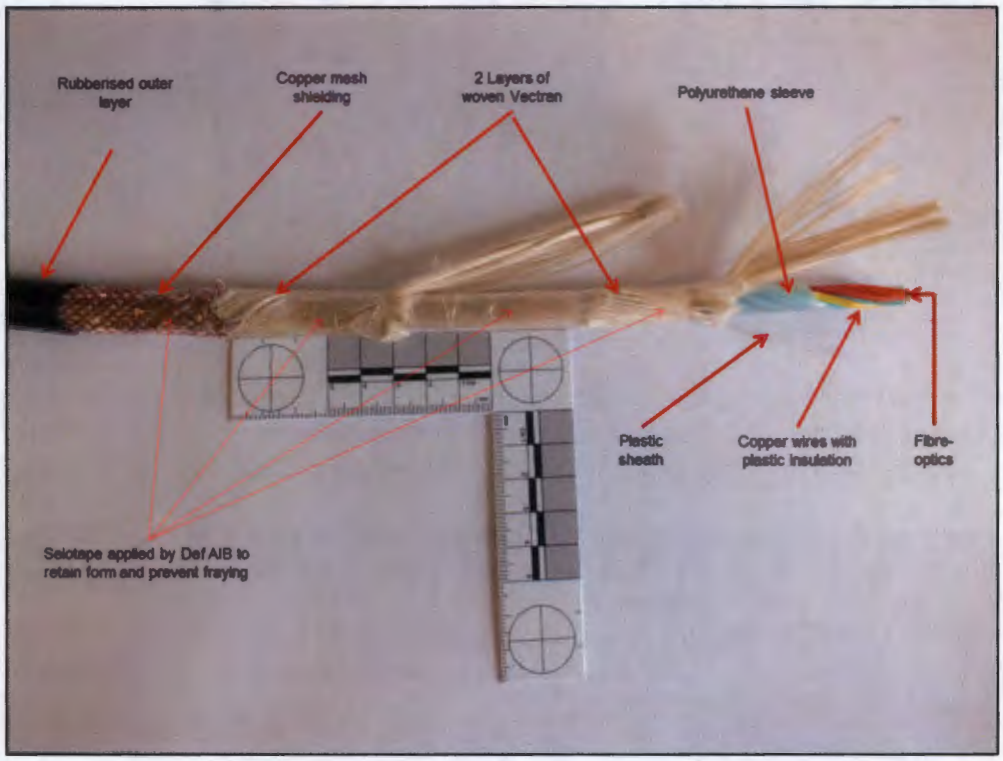


Figure 1.4.16 - PTDS tether construction

Conspicuity

1.4.180 During daylight hours white flashing obstruction lights were affixed to the aerostat tail fins and orange flags attached to the tether. Each flag was 23 inches square with a 2 inch strip of reflective tape secured on each side and a stiffener used to expose the flag and prevent drooping in calm wind. Flags are shown in Figure 1.4.17. The flags were attached 1000 ft below the aerostat and thereafter at 200 ft intervals with a final flag at 100 ft AGL; they were affixed to the tether as the aerostat ascended to operating altitude. The flags were not free to rotate with the wind but were attached at varying angles to provide differing aspects to aid conspicuity. At night either red visible or infra-red obstruction lights were used, these were located slightly above each flag so as not to impede observation of the other and were activated automatically by light sensors. Exhibit 127 Exhibit 126 Exhibit 124

[82] Vectran are manufactured fibres, which are noted for their thermal stability at high temperatures, high strength and modulus, low creep, and good chemical stability. They are moisture-resistant and generally stable in hostile environments. Although the tensile strength is similar to Kevlar, Vectran still tends to experience tensile fractures when exposed to significant stress.

Figure 1.4.17 - PTDS flags

1.4.181 The APG stated that the purpose of aerostat markings was to indicate the presence and general definition of balloons to aviators when converging from any normal angle of approach without compromising Forward Operating Base FP. Exhibit 127 Exhibit 126 Exhibit 124

1.4.182 In good weather it was possible to see the 2 aerostats in the centre of the city from the northern side of the airport. The Panel clearly observed the HQRS PTDS from HKIA(N) during their time in Theatre, a direct line of sight distance of 2.7 nm (5.1 km); an image of the PTDS aerostat viewed from HKIA(N) is at Fig 1.4.18. The HQRS aerostat was reported to the Panel as an indicator of the location of HQRS and could be used as a navigational feature. Witness 25 Witness 4

Figure 1.4.18 - HQRS PTDS viewed from HKIA(N), a distance of 2.7 nm

1.4.183 As aircraft transited towards the PTDS, it was reported that pilots would Witness 12

lose sight of the aerostat due to the restrictions of the cockpit airframe structure limiting upward visibility. Using the altitudes of the aerostat (2200 ft AGL) and aircraft (500 ft AGL) and the Field of View (FOV)[83] available to the crew, Defence AIB investigators calculated that the aerostat could cease to be visible to the pilot in the right hand cockpit seat as close as 0.13 nm (242 m) from the PTDS. However, the distance could vary considerably due to differing aspects depending on which particular window the pilot looked through, and changes induced by variations in aircraft roll attitude. It was theoretically possible to see the aerostat at 242 m if the pilot looked up and right through the highest cockpit window[84] while flying straight and level ie with the PTDS to the right of the aircraft. However, when flying directly towards the PTDS, the aerostat ceased to be visible at 518 m (straight and level), at 740 m during a 10° AOB turn and at 1111 m during a 20° AOB turn.

Witness 4
Witness 25
Exhibit 129

1.4.184 If crews could not see the aerostat they used ground features to identify the PTDS base station. Located in the south east corner of the HQRS compound there were distinct road and river features to aid identification. Once crews identified the base station they would, if necessary, project the location of the tether.

Witness 25
Witness 3
Witness 4
Witness 5

1.4.185 It was reported to the Panel that the tether and flags could be difficult to see. In interview a TAD pilot stated that the tether could be seen when contrasted against a clear sky, however when set against the urban backdrop it was harder to detect. Figure 1.4.19 shows the flags on the PTDS tether when viewed from the ground at a horizontal distance of approximately 120 m.

Witness 3
Witness 26
Witness 25
Witness 5
Witness 27
Exhibit 72

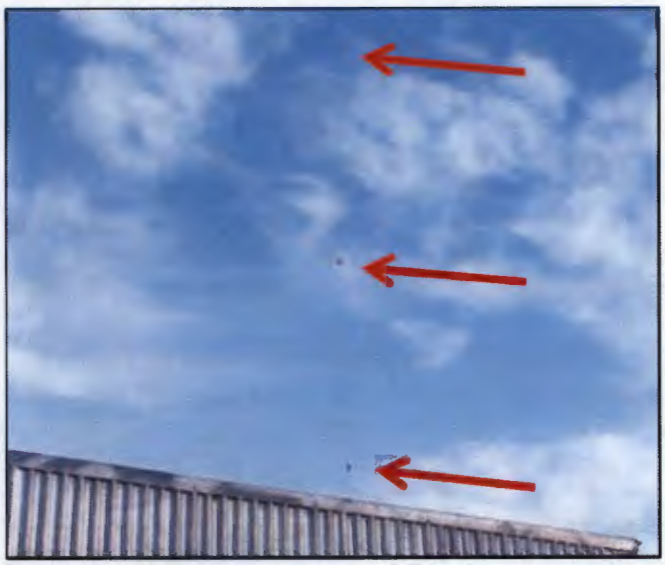


Figure 1.4.19 - Flags on PTDS tether viewed from the ground at a distance of approximately 120 m

1.4.186 On 11 Oct 15 the aerostat was operating at 2200 ft AGL; flags were located at 1200 ft and every 200 ft thereafter down to 200 ft AGL. The final flag was

Exhibit 127
Exhibit 126

[83] FOV is defined as the FOV provided by the cockpit transparencies, taking into account any structure and/or controls that might block either pilot's view out of the cockpit. Defence Standard 00-970, Part 7, Leaflet 104, View and Clear Vision requirements.
[84] In the Panel's experience this was not a routine lookout direction due to the required head/neck position.

at 100 ft AGL. A22 struck the tether at approximately 430 ft AGL[85] with one flag being circa 30 ft below and another 170 ft above the aircraft. The PTDS was marked in accordance with APG Chapter 12.

1.4.187 At the time of the accident the aerostat had been at its operating height for 6 hrs and 24 mins. It took circa 90 mins to raise to that height and was airborne during the formation's first approach to SOC at 0932 hrs. Exhibit 19 Exhibit 9

1.4.188 **Previous detachment near miss.** During interview a member of a previous Puma detachment stated that he had narrowly avoided the HQRS PTDS tether during a transit from south to north; this was corroborated by a crew member from the accompanying aircraft. Although both stated that they thought a DASOR had been raised, the Panel could find no evidence of a report being submitted. As a result of the near miss, crew members visited the PTDS during which the possible impact of a rotor blade strike on the tether was discussed. The crews were assured that the tether was frangible and designed to break in the event of a rotor blade strike. In the Panel's opinion, the opportunity to visit the site and discuss the potential impact of a tether strike assuaged any concerns the TAD had at that stage. Furthermore, the Panel were provided with the details of other tether strikes by NATO helicopters; in each event the tether had broken and the helicopter had landed safely. In one instance the crew were unaware that they had hit the tether. In the Panel's opinion, the reports reinforced the view that the tether would part if impacted by a rotor blade. Witness 12 Witness 22 Witness 12 Exhibit 130 Exhibit 131

Familiarity

1.4.189 Due to their familiarity with the relatively small operating area, crews navigated to and from the main HLSs without reference to maps. As a comparator, the primary operating area was only slightly bigger than a UK Military Aerodrome Traffic Zone (MATZ)[86] with occasional flights extending further out of the city. Aircrew from X Flt and the previous detachment stated that after 3 weeks of regular flying in such a limited area crews would have been familiar with Kabul and the use of maps reserved only for infrequently visited locations. Witness 25 Witness 3 Witness 24 Witness 22 Witness 4 Witness 5 Witness 26

1.4.190 SOC was one of the most frequently visited landing sites and since arriving in theatre an A21 crew member estimated that he had flown into SOC at least 25 times. The crew of A22 had each flown in excess of 30 hrs in the previous 3 weeks and, in the Panel's opinion, would have had similar experience of SOC. Witness 3 Witness 4 Exhibit 82

1.4.191 The formation had been into SOC on 3 occasions on 11 Oct; the accident sortie was their fourth planned landing there. On the approach during the day's third planned sortie, neither crew mentioned the PTDS; during the first approach of the accident sortie (from which they performed the go-around) there was no reference to the PTDS by either crew. Due to the CVFDR recording cycle there was no evidence to indicate whether or not the PTDS had been discussed on the morning sorties. Exhibit 9 Exhibit 34

1.4.192 As A21 commenced the right hand orbit to the south east of HQRS the

[85] Height taken from the aircraft's Radar Altimeter and therefore varied dependent on angle of bank, buildings etc that the aircraft overflew and the CVFDR sampling rate.
[86] A standard UK MATZ has a radius of 5 nm.