INTRODUCTION

1.4.1 This section of the Final Report considers in depth the events on the day and relevant systemic factors. The incident occurred on 3 Oct 13 at RNAS Yeovilton, whilst the crew were conducting a training sortie in Sea King Mk 4 ZE428, to complete a simulated 40ft Advanced Single Engine Failure whilst load lifting (40ft ASEF). This section will describe the methodology used by the Panel when considering the evidence, particularly with regard to Human Factors (HF) modelling, selecting both the Epidemiological Model[1] and Systemic Incident Model[2] as guides. Using these models the Analysis of Factors clearly describes what happened and why and allowed the Panel to present a number of Wider Issues for further analysis. The conclusions from this Section provide for a Summary of Findings, which should provide Duty Holders (DH) and other responsible departments a series of recommendations and observations for further consideration.

METHODOLOGY

Incident Factors

1.4.2 Once an incident factor had been determined it was then assigned to one of the following categories:

a. **Cause**. The event which led directly to the incident.

b. **Contributory Factor**. A factor that did not directly cause the incident but made it more likely to occur.

c. **Aggravating Factor**. A factor that did not cause the incident but made the final outcome worse.

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

e. **Observation**. An issue that was not relevant to the incident but worthy of consideration to promote better working practice.

f. **Breached Defence**. Those rules, orders, practices and procedures designed to assure the safe operation of aircraft, which failed or were breached by those involved.

Factors Considered

1.4.3 The Military Air Accident Investigation Branch (MilAAIB) Technical Report, Enclosure 2 at Part 2.8, rules out technical failure or fault. The Panel also considered but ruled out bird strike, malicious intent and fatigue. Therefore the main focus of this inquiry was HF based. The Panel has considered the works of both Professor Sidney Dekker and Professor James Reason and both types of analysis are relevant in this case. The Systemic Incident Model presents the most applicable approach, although the shortcomings identified in the Epidemiological Model, known colloquially as the

Enclosure 2 at Part 2.8

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[1] Reason JT (1990) *Human Error.* Cambridge, UK: Cambridge University Press page 173.
[2] Dekker S (2006) *The Field Guide to Understanding Human Error.* TJ International ltd, UK: Ashgate Publishing ltd page 90.

'Swiss Cheese' model, provided an extremely useful hand rail for the Panel.

Evidence

1.4.4 The Panel had access to the following evidence:

a. Interviews with the crew of ZE428 and 3 other witnesses.

b. HUMS data of the sortie.

c. Photography from various sources.

d. Relevant orders, Terms of Reference (TORs) and documentation including flying logbooks, aircraft documentation, sortie planning materials, briefing materials and engineering documentation.

e. ZE428 aircraft at the incident site/hangar.

f. Aircraft technical report by MilAAIB.

g. Technical report by 1710 Naval Air Squadron (NAS).

h. Technical report by Defence Support Group (DSG).

i. HF Report provided by RAF Centre for Aviation Medicine (RAFCAM).

j. Sea King Flight Simulator.

k. Flight Data analysis by QinetiQ.

l. All Flight Safety related material including previous incident reports from Aviation Safety Information Management System (ASIMS).

Services

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

a. MilAAIB.

b. RAF Centre of Aviation Medicine (CAM).

c. 1710 NAS.

d. Naval Flying Standards Flight (Rotary Wing) (NFSF(RW)).

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

f. Military Aviation Authority (MAA).

g. QinetiQ.

Factors Considered By The Panel

1.4.6 The Panel considered the following factors:

a. Pre-Incident.

(1) Operational Conversion Phase Training.

(2) Documentation.

(3) Qualified Helicopter Instructor's (QHI) Training Record.

(4) Handling Pilot's (HP) Training Record.

(5) Planning of the Sortie.

(6) Pre-Sortie Brief.

(7) Flight Authorisation.

b. Incident Sortie.

(1) Briefing in the Aircraft.

(2) QHI's Rationale for Altering the Starting Parameters.

(3) Crew Resource Management.

(4) Flight Profiles – Forensic Analysis.

(5) HP's Understanding of the Technique.

(6) Potential for the QHI to Intervene.

(7) Rear Crew.

c. Post-Incident.

(1) Survival Aspects.

(2) Personal Aircrew Equipment Assemblies.

(3) Other Service Personnel.

(4) Post Crash Management.

(5) Costs of Damage to Aircraft and Civilian Property.

d. Wider Issues.

(1) Monitoring of Pre Certificate of Competence (pre CofC) Aircrew.

(2) Simulator Training.

(3) Radar Altimeter Partial Test Flight.

(4) Heavy Landing Detection.

(5) JHC Risk Register.

ANALYSIS OF FACTORS

Pre-Incident

Operational Conversion Phase Training

1.4.7 **848 NAS**. Commando Helicopter Force (CHF) Concept of Operations states: '*848 NAS is the Sea King Mk 4 training sqn, which conducts all Conversion to Type (CTT), Conversion to Role (CTR), refresher and ab-initio*[3] *Advanced*[4]*/Operational Conversion Phase (A/OCP) training for pilots, aircrewmen and maintainers. It is equipped with 9 Sea King Mk 4 aircraft and holds 4 of these at High Readiness for JRRF*[5] *and 5 at Very High Readiness for operations. 848 NAS also conduct 1st and 2nd line Depth A and limited Depth B maintenance.*' Exhibit 24

a. **Advanced Single Engine Package (ASE)**. ASE is taught on 848 NAS during A/OCP, in accordance with the 848 NAS Master Training Document and the Sea King HC Mk 4 Commando ACP/OCP Instructional Specifications 2011 Edition Change 1 (I-Specs); the package is intended to instruct student pilots in the actions to take in the event of an engine failure in configurations other than forward flight. Exhibit 19, 25

b. **The 40ft ASEF**. The 40ft ASEF is intended to simulate the failure of an engine during load lifting with the aim of landing the aircraft safely, having moved forward whilst in descent, to clear the load and associated personnel. The Panel understands that the requirement for it to be carried out from a 40ft hover is based on the fact that the initial design for the RN Sea King was the Anti Submarine Warfare variant, which hovered at 40ft for long periods when conducting sonar operations. The Panel also understands that this profile was adopted for the Sea King Mk 4 as it was appropriate when conducting load lifting, which commonly used a 30ft strop. To initiate the exercise the QHI will select the No1 engine into manual control and set a power based on the twin engine hover power plus 25%; the QHI will then count down and simulate failure of the other engine by retarding its Speed Select Lever (SSL) to ground idle; the technique is then flown using the procedure laid down in the CHF Sea King Mk 4 Flying Procedures (Flying Procedures), Volume 1, Exercise 9 (as described in para 1.4.8). Exhibit 12, 26

c. **40ft ASEF Instruction**. Before Jul 13 the ASE was taught in Sortie 'A7' of ACP and included the 40ft ASEF. Sortie A7 was scheduled during week 7 of the 14-week ACP along with an 'A7 Mass Brief', which would be conducted prior to the actual exercise. It would also have been covered in the 'X Stage' Mass Brief (Load Lifting and Dry Winching) and Sortie 'X1' (External Load Lifting, Exhibit 6, 18, 19, 25, 27, 28

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[3] Ab-initio – aircrew undertaking flying training prior to the award of their flying badge.
[4] The 'Advanced Conversion Phase' referred to here is also referred to as the 'Aircraft Conversion Phase' in other documents.
[5] JRRF – Joint Rapid Reaction Force.

ASEF Over Load & Dry Winching) of the OCP syllabus. Post Jul 13 the instruction of the 40ft ASEF was removed from the A7 Mass Brief and Sortie A7 and only covered in the X Stage Mass Brief and X1 Sortie. As the HP departed 848 NAS to join 846 NAS before this change in the I-Specs, his course received the ground instruction for the 40ft ASEF in the A7 Mass Brief early in the ACP and also in the 'X Stage' Mass Brief during OCP, approximately 2 years before carrying out the exercise in the aircraft (discussed further in para 1.4.19). A vertical descent from a simulated engine failure at 40ft is also part of sortie 'G3' (Confined Areas) but, as this is a different flight profile to the incident sortie, this is not considered further.

Documentation

1.4.8 **Flying Procedures**. The instructions for carrying out the 40ft ASEF are contained in CHF Sea King Flying Procedures, Volume 1, Basic Exercises 1-28, Exercise 9, Advanced Single Engine Failures and state as follows: Exhibit 12 Enclosure 1 at Part 2.8

'6. The actions from the 40 feet hover, if transitioning with an under slung load or winching.

a. Verbal warning. Call "Tq split, landing".

b. Call "Release the load".

c. Select approximately 5° nose down to gain some forward airspeed and, at the same time lower the collective lever to conserve Nr[6].

d. Rotate to the landing attitude (0-3° nose up) immediately before landing.

e. Cushion the touchdown at approximately 5-8 feet.

f. Once firmly down, lower the lever fully, centralize the cyclic and apply the brakes.

7. In the event of an engine failure below 40ft with an under slung load, it will not be possible to transition forward using the technique described above. Nr decay may prove to be rapid and considerable. To minimise this the lever should be lowered slightly as soon as possible after the engine failure, thus conserving Nr. The aircraft should be descended vertically until the load is in contact with the ground when some form of single engine performance may be re-gained.

Assessment of likely single engine performance should be discussed as part of the emergencies brief for load lifting.

WARNING!

8. It is most important to prevent drift and yaw and to land straight to prevent damaging the undercarriage.

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[6] Nr is the term used for main rotor speed expressed as a percentage in the cockpit on an Nr gauge.

9. The 40 foot hover exercises will be demonstrated during OCP; the maximum AUW is 18,000lbs with a minimum of 10kts wind.'

The Panel made **the observation** that the formatting of flying procedures was not uniform across publications: during interview the HP stated that he had 'missed the warnings', citing the fact that they were not in the same format as other instructions that he had recently read. The Panel considered that whilst the formatting of instructions was not uniform they were not confusing and therefore **not a factor** in the incident. However the HF report (Enclosure 1 at Part 2.8) makes the observation that 'Differences in the presentation of safety critical information may increase the risk that this information is missed' and therefore the Panel made **the recommendation** that the formatting of Flying Procedures is reviewed.

1.4.9 **Instructional Procedures**. The direction for instructing the 40ft ASEF is contained in 'X1' in the I-Specs. Exhibit 25

Qualified Helicopter Instructor's (QHI) Training Record

1.4.10 **QHI's Background**. The QHI was awarded his Flying Badge ('Wings') on 24 May 02 and after flying Lynx Mks 3 and 8 he converted to the Sea King Mk 4 in 2005. He was then employed on 846 NAS from where he deployed on operations as a Flight Commander. He joined Central Flying School (Helicopters) Sqn (CFS(H)) on 21 Jul and graduated as a B2 QHI on 27 Nov 08[7]. He then instructed on 848 NAS and was awarded a B1 instructor category on 20 Nov 09 and A2 (Helicopters) on 28 Apr 11, 3 days before joining 845 NAS as the Training Officer (TO1). He was still TO1 of 845 NAS at the time of the incident. His total flying hours on 3 Oct 13 were 3136.35, with 1715.20 hours on type. The Panel had access to the QHI's loose leaf folder entitled 'BRd 767 Naval Aviation Orders Order 401, Assessment and Achievement Log' (401A&A) which contained reports dating back to the beginning of his RN career in 1998. [redacted] Based on the reports available, the Panel assessed that the QHI is a highly respected officer with an exemplary record as a pilot and an instructor. The Panel considers that the QHI was qualified, current and competent to undertake the 40ft ASEF instruction. The Panel concluded that the QHI's Background was **not a factor**. Exhibit 4, 21, 22, 23 Witness 1

Handling Pilot's (HP) Training Record

1.4.11 **HP's Training History**. The HP left Royal Navy Initial Officer Training at Britannia Royal Naval College on 9 Apr 09 for the Air 424 Course, which was preceded by a short holdover with 727 NAS, before joining 703 NAS at RAF Barkston Heath for Elementary Flying Training (EFT) on 13 Jul 09. After leaving 703 NAS on 10 Dec 09, and holding for approximately 6 months with 702 NAS, he then conducted Basic Flying Training (BFT) on the Squirrel helicopter at 705 NAS, RAF Shawbury between 1 Jun 10 and 20 Jun 11. This included another 6 month holdover after completing BFT. He then attended Sea King Ground School at RNAS Culdrose between 23 May 11 and 17 Jun 11 before joining 848 NAS on 20 Jun 12 for conversion to the Sea King Mk 4 ACP followed by the OCP. He left 848 NAS to join Exhibit 5 Witness 2

[7] CFS award instructional categories B2 (Instructor on Probation), B1 (Capable Instructor), A2 (Above Average Aircrew and Instructor) and A1 (Exceptional Aircrew and Instructor).

846 NAS on 10 Apr 12 where he remained until joining 845 NAS on 1 Jun 13. His total flying hours on 3 Oct 13 were 564.40 with 386.20 on type. The Panel noted that the HP had been on 7 different units during his flying career but did not consider this to be unusual or detracting and therefore **not a factor**.

a. **HP's Overall Progress**. The HP's assessed flying report forms, from key sorties and courses throughout his CHF flying career, are contained in his 401A&A. These report forms begin with his End of Course Report from the conversion unit, 848 NAS, and continue to his most recent sortie on 845 NAS, his CofC assessment flight that he passed on 16 Sep 13. Not all instructional sorties flown on the Front Line produce a written sortie debrief, therefore the Panel was only able to consider the reports available to them in the 401A&A. [redacted] He had also passed both a QHI check on 25 Apr 13, followed by his final CofC assessment flight on 16 Sep 13. The HP just needed to complete this sortie on 3 Oct 13 to meet all the requirements for the award of CofC. 845 NAS and, prior to its closure on 31 May 13, 846 NAS, both held quarterly training office meetings where the progress of all pre CofC pilots was discussed and recorded in formal minutes. The last training office meeting was held on 16 Mar 13, [redacted] The Panel assessed that the HP's previous progress **was not a factor**.

Exhibit 6, 15, 16, 17, 29

Witness 2, 1, 6

b. **HP's Flying Record**. The Panel compared the HP's overall progress with the individual reports in his 401A&A and made a number of observations [redacted] The Panel considered the training mechanisms and procedures that were used by CHF to assess the HP's overall progress, particularly given the issues raised in his flying record folder; this is considered in Wider Issues. The Panel further considered why these characteristics, which had also been in evidence whilst flying with the QHI on previous sorties, did not give the QHI cause for an increased level of preparation, or a raised level of defences, prior to the sortie when the incident occurred. This is also considered in Wider Issues in para 1.4.75.

Exhibit 6

c. **HP's Training Shortfalls**. The HP joined 846 NAS with shortfalls[8] from his training on 848 NAS in Fighter Evasion, Cabin Door Gunning and the 40ft ASEF, with a recommendation in his final training report from 848 NAS that the

Exhibit 6, 18, 19, 20

[8] Shortfall – a term used in Flying Training to describe aspects of training not carried out during the training course and therefore required to be completed at a later date.

40ft ASEF be carried out during his Change of Unit Check on joining his first Front Line NAS[9]. The shortfalls were transferred to the HP's FAA[10] Officer Aircrew Workplace Training Task Book (Task Book) in accordance with the CHF Sea King Mk 4 Commando Pilot Operational Performance Statement (OPS) contained in the 848 NAS Master Training Document. The shortfalls were not completed during his 13½ months on 846 NAS and he joined 845 NAS with the shortfalls still outstanding. Using the Epidemiological Model, the Panel was able to identify the failure to complete the 40ft ASEF during the HP's Change of Unit Check on arrival at 846 NAS as being a 'hole in the cheese'[11], whereby this training shortfall would not be addressed until some 18 months after leaving the conversion unit, 848 NAS, when this incident occurred. The Panel also considered this to be a **breach of defence** in that the HP was allowed to continue to fly underslung load sorties whilst on the Front Line without completing any 40ft ASEF training. The Systemic Incident Model was used by the Panel when considering the training mechanisms and processes used by CHF to track and address training shortfalls for pre CofC pilots under Wider Issues, Training Shortfalls for Pilots in para 1.4.78.

Planning of the Sortie

1.4.12 Having realised the previous week that abseiling was an outstanding Task Book requirement for his CofC, the HP asked the QHI whether it could be achieved before the HP departed on operations. It was decided between them that the only day that it could be achieved was 3 Oct 13, the day the HP was due to deploy. Having established that the HP was content to fly that day, and had no preparations for his departure that would impact the sortie, the QHI agreed to conduct the abseiling on 3 Oct and directed the HP to organise it. The planning required the HP to liaise with the Sqn engineers regarding the availability of aircraft, the Sqn aircrewmen to identify an in-date abseil dispatcher and instructor and with the Mobile Air Operations Team (MAOT) who were to be the abseilers on the day. It was during this planning that the Aircrewman for the sortie was selected. Witness 1, 2, 3

1.4.13 The crew for the sortie was the QHI, 5 pre CofC pilots, a pilot undertaking a refresher course and the Aircrewman. During the morning of 3 Oct 13 the pilot who was to give the first part of the pre-sortie brief, the Briefing Pilot, along with the Aircrewman and the HP, were involved in the detailed planning for the abseiling sortie. The weather was poor at RNAS Yeovilton with a thunderstorm warning expected later in the day. Due to serviceability issues, the intended aircraft changed during the morning, meaning that the planned sortie timings were, according to the HP, "*slipping left and right by about half an hour either way*". At some point during the morning (the Panel was unable to identify the actual time) the HP and the QHI were scrutinising the HP's Task Book and realised that there was also an outstanding requirement for the HP to complete a 40ft ASEF before he could be awarded CofC; this was not a requirement for his operational deployment preparation, which is discussed further in para 1.4.17. The HP requested that it be included in his section of the abseiling sortie and the QHI agreed to this. The QHI stated that the HP and Briefing Pilot came into Exhibit 18, 55 Witness 1, 2, 3, 5, 7

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[9] The requirement for a change of unit check is contained in CHF Flying Order Book, 2103.100.8

[10] Fleet Air Arm

[11] In the Swiss Cheese model, according to Professor James T Reason, an organisation's defences against failure are modelled as a series of barriers, represented as slices of cheese. The holes in the slices represent weaknesses in individual parts of the system and are continually varying in size and position across the slices. The system produces failures when a hole in each slice momentarily aligns, permitting (in Reason's words) 'a trajectory of accident opportunity,' so that a hazard passes through holes in all of the slices, leading to a failure.

his office a number of times during the morning. During one of those visits, the order in which the pre CofC pilots and the refresher pilot would fly the abseiling was decided. As the HP had an aircrew medical booked in the afternoon the QHI decided that he would fly the first part of the sortie and, on completion of his abseiling section, would carry out the 40ft ASEF.

1.4.14 As a result of the thunderstorm warning and associated lightning risk there was concern that refuelling during the sortie may not have been possible so the decision was made to fuel the aircraft to 3600 lbs, a higher fuel load than might normally be used at the start of the planned sortie. The QHI stated during interview that when he had taught the 40ft ASEF in the past he had ensured that it took place at the end of a sortie and, in retrospect, he realised that this allowed the aircraft to be below the 18000 lbs weight limit. The QHI had intended that the 40ft ASEF would take place at the end of the sortie but, on hearing about the HP's other tasks in the afternoon, changed the order so that the HP could go first and so maximise his time available for his departure preparations. The first part of the sortie then effectively became a sortie in its own right with the 40ft ASEF at the end, which fitted the QHI's previous experience and did not cause him to question the All Up Weight (AUW) at the start of the 40ft ASEF element. Witness 1

1.4.15 The Panel concluded that, although the abseiling element of the sortie had been planned correctly, insufficient planning had taken place to allow the 40ft ASEF element to be conducted safely and within limits and that this was a **contributory factor**.

1.4.16 **QHI's Preparation for the Sortie**. The day of the incident was the QHI's first day back in office after returning from a 3 day training visit to RNAS Culdrose. During interview he stated that his workload was high on the morning of the sortie and he was busy catching up with his administrative duties, switching between office duties and responding to queries regarding the sortie plan. The QHI stated during interview that he had last carried out the 40ft ASEF approximately 6 months previously. Before the sortie he discussed the planning of the abseiling and the intention to carry out the 40ft ASEF with the HP but did not check the HP's 401A&A or read the Flying Procedures or I-Specs. The QHI also stated during interview that he had no concerns over the HP's ability to conduct the 40ft ASEF. The Panel concluded that the QHI's workload distracted him from properly preparing for the sortie and that this lack of preparation particularly combined with a lack of recent practice was a **contributory factor**. Exhibit 9 Witness 1

1.4.17 **HP's Preparation for the Sortie**. The HP was due to deploy on operations in the evening of 3 Oct 13. His Aircrew Medical was due to expire on the day he was scheduled to return to the UK and he had been trying to plan an appointment for some time. There were various problems with the scheduling of the medical and it only became possible to achieve on the day of the sortie. During the morning he attended a preliminary examination in the RNAS Yeovilton Medical Centre and had been due to undergo the actual medical examination in the afternoon. During his interview with the Panel the HP was questioned as to whether he had any personal administration that he felt under any pressure to complete before his deployment. He stated that *"It was just the deployment stuff"* and he was looking forward to going. The HP stated that he had 45 minutes "*spare*" before his preliminary medical, during which time he refreshed himself on the procedures for abseiling and the 40ft ASEF but missed the section that contained the warnings for the 40ft ASEF. The Panel concluded that, although the HP had a number of additional tasks that day, they did not impact on the time available for sortie preparation and he was not under any Witness 2

undue pressure. Therefore, the Panel concluded that time pressure was **not a factor**. However, the Panel concluded that the HP had not conducted sufficient preparation for the 40ft ASEF aspect of the sortie and that this was a **contributory factor**.

Pre-Sortie Brief

1.4.18 The sortie was briefed in accordance with the instructions laid down in Military Aviation Authority Regulatory Article (MAA RA) 2305(5), Naval Aviation Order (NAO) 2305(5), Joint Helicopter Command Flying Order Book (JHC FOB) 2305.125 and Commando Helicopter Force Flying Order Book (CHF FOB) C2305.125 and briefed using the format contained in the Joint Helicopter Command (JHC) Mission Reference Cards. Attending the brief were the QHI, the HP, the Aircrewman, the four pre CofC pilots and the pilot undertaking the refresher course. The MAOT abseilers did not attend and were to be briefed by the Aircrewman after the sortie brief. The Authorising Officer did not attend the pre-sortie brief. The initial part of the brief was given by one of the pre CofC pilots who was expecting to take part in the later part of the sortie after a front seat crew change. The initial part of the brief covered the weather, Air Traffic details and the aircraft details, including limitations that applied to the airframe (none of which were germane to this incident but are covered in the Engineering Report at Enclosure 2, Part 2.8). The QHI took over the brief when it came to the conduct of the sortie and covered the order in which the pilots would conduct the abseiling and the procedures for swapping pilots after each serial. The potential emergencies during the abseiling were briefed at length by the QHI and the Aircrewman, including a 'case study' of an abseiling sortie that had gone wrong, causing an abseiler to be injured. During the brief it was mentioned that the 40ft ASEF would take place but, apart from the QHI stating where in the sortie it would occur, it was not briefed any further.

Exhibit 20, 31, 32, 33, 34

Witness 1, 2, 3, 5, 7

1.4.19 The QHI stated during interview that, because it did not involve the rest of the pilots, his intention was to brief the HP on the 40ft ASEF in the aircraft before carrying out the exercise as opposed to covering it during the sortie brief. The Panel considered that the briefing for the abseiling aspect of the sortie was correctly briefed and comprehensive. However the Panel concluded that because the HP had last been briefed on the 40ft ASEF procedure during his training on 848 NAS, approximately 2 years previously, and had not had exposure to it since, there should have been a more thorough briefing process before carrying out the exercise in the aircraft. The Panel concluded that an excessive amount of time had elapsed since receiving instruction on the 40ft ASEF and carrying out the exercise and that this was a **contributory factor**. Additionally, the Panel concluded that the briefing for the 40ft ASEF was insufficient to mitigate the potential risks and so it was also a **contributory factor**. Using the Epidemiological Model, the Panel concluded from the evidence that there were a number of breached defences prior to the incident, namely: cross referencing the weight of the aircraft to the 18000lbs weight limit in the Flying Procedures Warning, the decision to conduct the exercise briefing in the aircraft and without notes and the late notice to amend the order in which the pilots were to fly.

Witness 1, 2, 3, 5, 7

Flight Authorisation

1.4.20 The sortie was authorised in accordance with the regulations laid down in MAA RA 2306(1), NAO 2306(1), JHC Command Order 2306, CHF FOB Order 2306 and the CHF Commanding Officer's Temporary Memorandum 24/12. The Authorising Officer was the 845 NAS Senior Pilot, who had temporary command of the Sqn while the Commanding Officer was deployed on operations. The authorisation took place at

Exhibit 20, 30, 31, 35, 36

Witness 1, 6

the Duty Desk in 845 NAS building, using the CHF out-brief format at Annex A of CHF FOB Order 2306. The Authorising Officer was not a QHI and during the authorisation process asked the Aircraft Captain to expand on some details; the 40ft ASEF was discussed and the 10kt wind limit for the exercise was mentioned but there was no discussion of the 18000lb weight limit. The Panel concluded that, although there was a missed opportunity to discuss the weight limit for the 40ft ASEF, the Authorising Officer discharged his duties correctly, especially given the experience, role and seniority of the QHI. The Panel concluded that the authorisation was carried out appropriately and therefore was **not a factor**.

Incident Sortie

Briefing in the Aircraft

1.4.21 As planned in the pre-sortie brief (para 1.4.18), the brief for the 40ft ASEF section of the sortie was given in the aircraft by the QHI before his demonstration of the profile. The QHI gave the brief from memory without the use of notes. He first briefed the setting up of the engine controls for the exercise, confirming with the HP that he should retard the SSL to the ground idle gate to simulate the engine failure before going on to brief the exercise itself. Although detailed in part the brief lacked clear structure and missed some of the specifics of the handling of the profile, notably the required angles of nose down and landing attitudes. The minimum wind limit of 10kts was talked about in the brief but the maximum 18000lbs weight limit was not mentioned. There was reference during the brief to other single engine failure profiles that had the potential to cause confusion and the HP, when questioned by the QHI about the actions he would take in flying the profile, did not mention selecting a nose down attitude to gain forward speed, and described actions that would be taken in a vertical descent from an engine failure – profiles he had previously flown. The Panel considered that, not having fully read the Flying Procedures, nor having received any refresher training in the simulator, or a full briefing of the 40ft ASEF for approximately 2 years, the HP may not have had a full understanding of the profile to be flown from the brief given in the aircraft. The Panel concluded that this lack of knowledge and understanding was a **contributory factor**. Exhibit 2 Witness 1, 2

QHI's Rationale for Altering the Starting Parameters

1.4.22 Having experienced a firm landing during the demonstration, the QHI elected to alter the only 2 start parameters available to him; power and start height. These were altered to reduce the likelihood of the HP also having a firm landing. The QHI decided that he would give an increased power on No1 engine for the HP's exercise. This would have the effect of reducing the rate of Nr decay. This would have potentially given the HP more time to react as the Rate of Descent (RoD) would have been reduced, making it easier for the HP to cushion the landing (this is further explored in the forensic analysis below). The Panel was of the opinion that this decision to start from 30ft may well have drawn on experience from teaching single engine failures from the hover from 10-15ft; if the exercise is started from a lower height there is less time for the rate of descent to build and more residual Nr to cushion the landing. Although a reduction in start height to mitigate against a high RoD would be a valid course of action, the Flying Procedures state '*…it would not be possible to transition forward…*'. The effect of both of these variations to the 40ft ASEF Flying Procedures starting parameters are examined in detail during the forensic analysis, para 1.4.53 – 1.4.56. Witness 1,

Crew Resource Management.

1.4.23 The Panel considered that there was an opportunity for any of the crew members to comment on limitations when the decision to continue was made after the firm landing during the demonstration.

a. During interview the HP stated that he did not consider there to be a cockpit gradient and he felt able to comment on any aspects of the sortie. However, although both were Front Line pilots, the Panel assessed the relationship between the QHI and the HP was that of an instructor and student, based on the fact that the QHI was senior in rank, they had flown numerous instructional sorties together over the previous 15 months and the QHI was the Sqn TO1, so in a position of significant authority. In these circumstances the Panel considered that it was possible that the HP did not think to question the decisions of the QHI. Exhibit 5 Witness 2

b. The Aircrewman offered information on 4 Health and Usage Monitoring System (HUMS)[12] exceedances without prompting from the QHI. The QHI responded by correcting the interpretation of the Nr figures and then declared that he was *"happy"*, "*no probs*" and that it was "*as expected*"; this reaction that the situation was normal curtailed any further input from the Aircrewman. The Aircrewman was unaware of the exercise limitations and was, therefore, not in a position to relate the firm landing and HUMS exceedances to the aircraft being overweight for the exercise. Exhibit 2 Witness 3

c. The supernumerary crewmember was made aware of the inclusion of the 40ft ASEF during the pre sortie brief, but stated during interview that he had not read the Flying Procedures regarding that exercise following the brief, could not remember the limitations and therefore was not in a position to make comment. Witness 4

1.4.24 The Panel concluded that it was possible that a cockpit gradient existed which may have resulted in a reluctance to question the QHI's decision to continue. This, combined with a lack of knowledge, resulted in the crew not questioning the start parameters of the exercise. This constituted a **breached defence**.

1.4.25 The Panel concluded that the decision to continue the 40ft ASEF element of the sortie following the firm landing was a **breached defence** and a **contributory factor**.

Flight Profiles – Forensic Analysis

1.4.26 **Methodology**. The following graphical representations have been compiled from the HUMS data collected during the incident. It should be noted that the HUMS data is not all gathered at the same sampling rate (some at 8 samples per second (Hz) and some at 2 Hz). It should also be noted that some of the parameters Exhibit 11

[12] HUMS collects a wide range of aircraft data across a number of parameters and stores this data onto an electronic storage medium. This data can be downloaded and interrogated by the aircraft maintainers.

which are useful to the analysis have been derived[13] through mathematical calculation of available data in order to make the data more meaningful. The base data from which a number of the parameters are derived is collected from the equipment which are fitted to the aircraft, rather than the cockpit instruments. Data derived from vertical accelerometers can become unreliable for the period immediately following a heavy impact. In order to alleviate these potential errors all the graphical representations stop at the point of impact; the landing for the QHI's demonstration and the impact of the tail wheel for the HP. A common start point is used throughout the analysis; this is the moment the Main Rotor Gearbox No2 Input Torque decays. This coincides with the No2 SSL being placed in the ground idle position.

1.4.27 **Height**. Figure 1-4-1 graphically illustrates the height profiles of both the QHI's demonstration and the HP's exercise. Exhibit 11

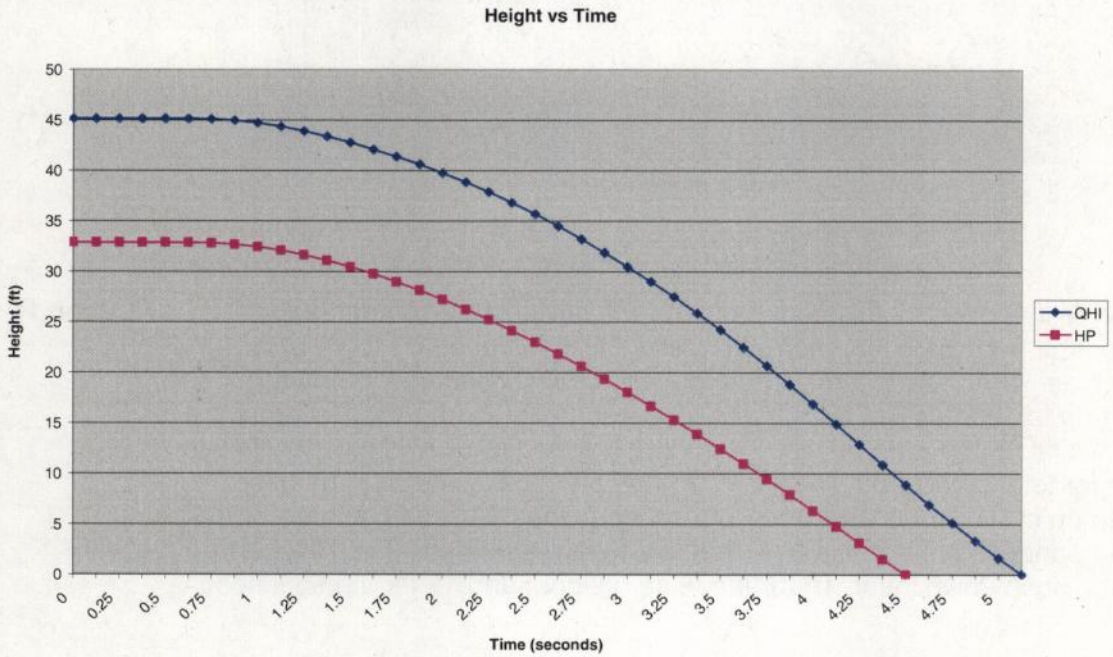

Figure 1-4-1

1.4.28 The QHI's profile starts from a height of 45.2ft and has a duration of 5.125 seconds (s). The HP's profile starts at 32.9ft and has a duration of 4.5s. In both profiles the aircraft loses very little height in the first second before descending at a comparable rate. The rate of descent is better illustrated in Figure 1-4-9. Exhibit 11

1.4.29 It can therefore be concluded that the HP has approximately 0.625s less time and 12.3ft less height than the QHI in which to complete the exercise, although only 7ft less than the Flying Procedures stipulates. The HP therefore had reduced height and time available, which the Panel concluded may have contributed to the incident. This theory is explored further below.

1.4.30 **Pilot Cyclic Input**. Figure 1-4-2 graphically illustrates the pilot's cyclic input in pitch during both the QHI's demonstration and the HP's exercise. Exhibit 11

[13] Height and Rate of Descent are both derived form the main vertical accelerometer data.

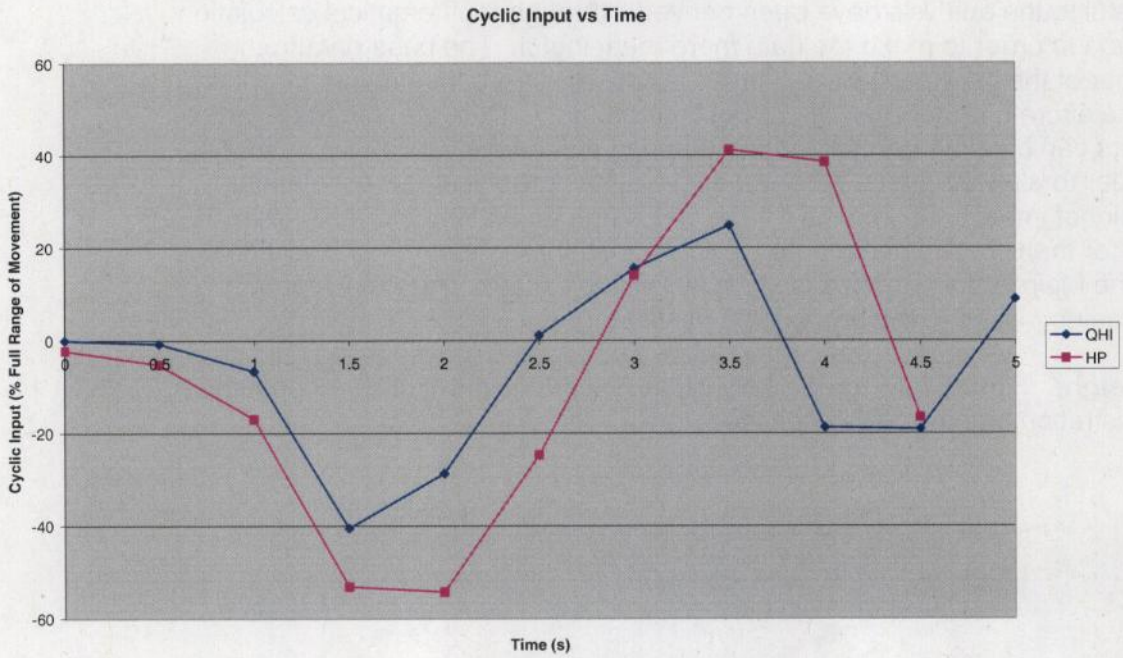

Figure 1-4-2

1.4.31 The QHI applied a maximum of 40.1% full range of movement (FRM)[14] nose down input by the 1.5s point, thereafter he reduces his nose down input in a relatively linear fashion to reach a maximum of 24.8% FRM nose up input before again applying up to 19.2% FRM nose down to arrest the pitch up rotation before the landing. By calculating the area between the input line and the x axis it is possible to derive a value for total cyclic input (TCI)[15]. This has been calculated for the nose down and nose up cyclic inputs for both pilots as it provides a useful comparator that includes the amount of input and the time that input was sustained. The QHI had a TCI of 38 for the nose down input, 15 for the nose up input and 12 for the final nose down input. Exhibit 11

1.4.32 The HP applied more cyclic input in pitch for a longer duration, reaching 53.2% FRM nose down and holding to 54.3 % FRM 0.5s later. He then applies a maximum nose up input of 41.1% FRM holding 38.5% FRM 0.5s later before applying 16.6% FRM nose down by the point of impact of the tail wheel with the ground. The HP had a TCI of 74 nose down input followed by 39 nose up input. Further analysis shows that the HP used almost double (1.95x) the amount of TCI to get the aircraft's nose down (74 vice 38). He also used more than double (2.6x) the amount of nose up TCI (39 vice 15). Exhibit 11

1.4.33 From the analysis of the evidence outlined above the Panel concluded that the significant cyclic input used by the HP was a **contributory factor**, as it is this cyclic input that controls the aircraft to the attitudes described below.

1.4.34 **Aircraft Pitch**. Figure 1-4-3 graphically illustrates the aircraft pitch during both the QHI's demonstration and the HP's exercise. Exhibit 11

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[14] FRM is calculated from the datum (central) position and is measured 0 – 100% forwards (nose down) and 0 – 100% back (nose up).

[15] TCI is calculated by the cyclic input distance multiplied by the time of input.

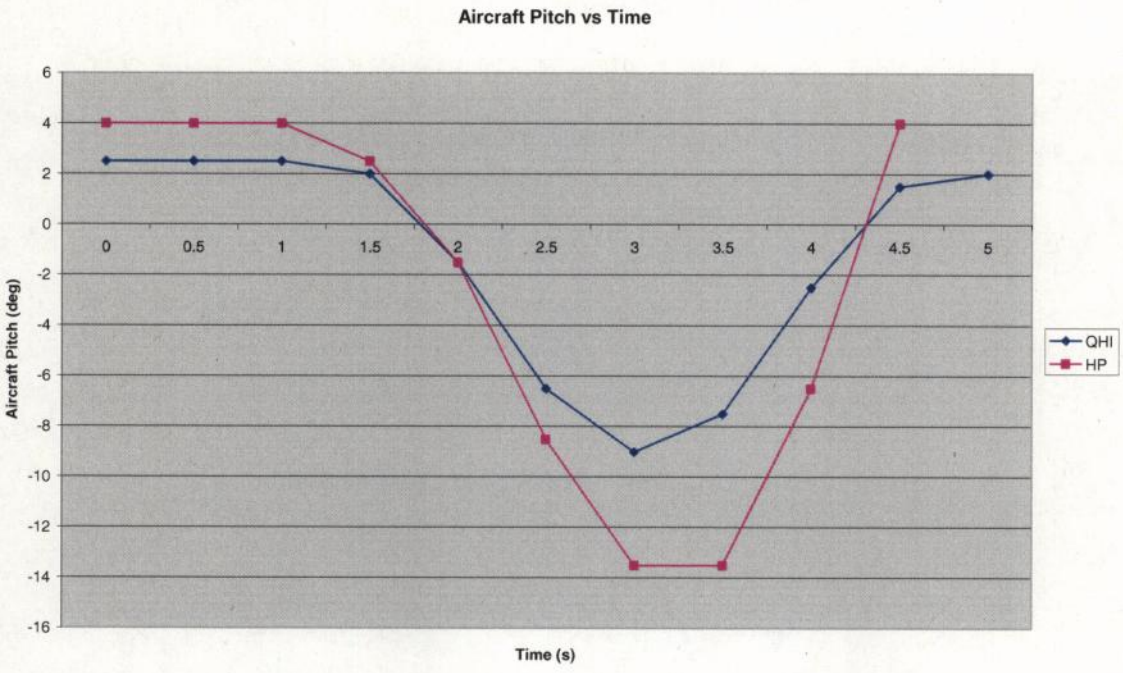

Figure 1-4-3

1.4.35 The difference in the aircraft attitude at the start of the exercise can be attributed to a number of causes, those being; change in wind speed, the difference in amount of ground effect, the difference in the power setting at the start of the exercise and the fact that the Aircrewman was standing during the QHI's demonstration and moved aft to sit in the rear crew seat during the HP's exercise, which would have had some effect on the centre of gravity. The Panel is however unable to identify how much influence, if any, can be attributed to each of these factors individually. The Panel concluded that one or all of these factors may have influenced the starting attitude but that the difference in starting attitudes was **not a factor**. Exhibit 2 Witness 3

1.4.36 The cyclic inputs made by the QHI as described in para 1.4.31 show that he controlled the aircraft to a maximum nose down attitude of 9 degrees before returning the aircraft to a landing attitude of 2 degrees nose up for the landing. The Flying Procedures stipulates approximately 5 degrees nose down attitude to gain forward motion before returning to a landing attitude of between 0 and 3 degrees nose up; para 1.4.8. The QHI adopted a nose down attitude which was nearly double (1.8x) that described in the Flying Procedures. It can also be seen that the QHI had adopted a landing attitude of 2 degrees nose up by the point of impact, which is as described in the Flying Procedures. Figure 1-4-4 further illustrates the pitch achieved by the QHI at various heights during the demonstration; of note he achieved a landing attitude by 10ft. Exhibit 11

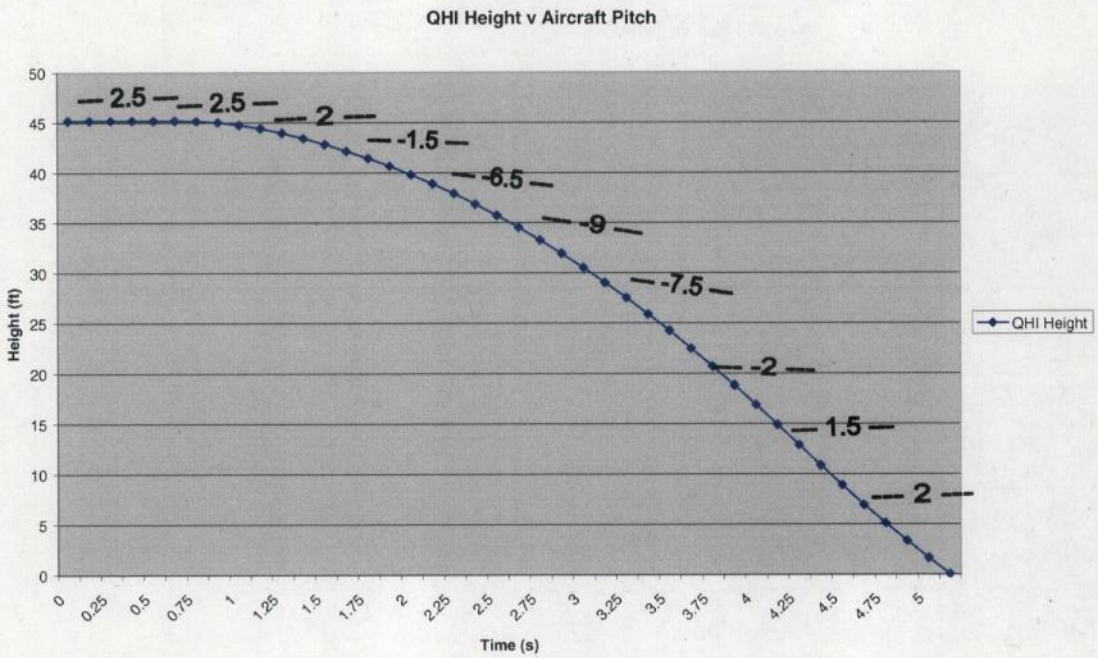

Figure 1-4-4

1.4.37 The cyclic inputs made by the HP as described in para 1.4.32 show that he controlled the aircraft to a maximum nose down of 13.5 degrees, which was held for a period of 0.5s. The cyclic pitch up input achieved a nose up attitude of 4 degrees as the tail wheel impacted the ground. It can therefore be seen that the HP adopted a nose down attitude of more than double (2.7x) that described in the Flying Procedures and greater (1.5x) than demonstrated by the QHI. It can also be seen that the HP had adopted a 4 degree nose up attitude by the point of impact which, whilst outside of the parameters in the Flying Procedures, is not excessively so and in itself is not a considered to be a factor. It should however be noted that the aircraft was rotating with considerable angular velocity at this point, a factor that is considered further in para 1.4.44. Figure 1-4-5 further illustrates the aircraft pitch achieved by the HP throughout his exercise. It should be noted that he is still at his maximum nose down at 12.4ft and passes through the level attitude at some point between 4ft and 3ft. Exhibit 11

1.4.38 **Cause of the Incident**. The Panel concluded that the combination of nose down attitude and the duration for which that attitude was sustained, was **the cause** of the incident, as once a 13.5 degree nose down attitude was sustained for 0.5s, the incident was unavoidable.

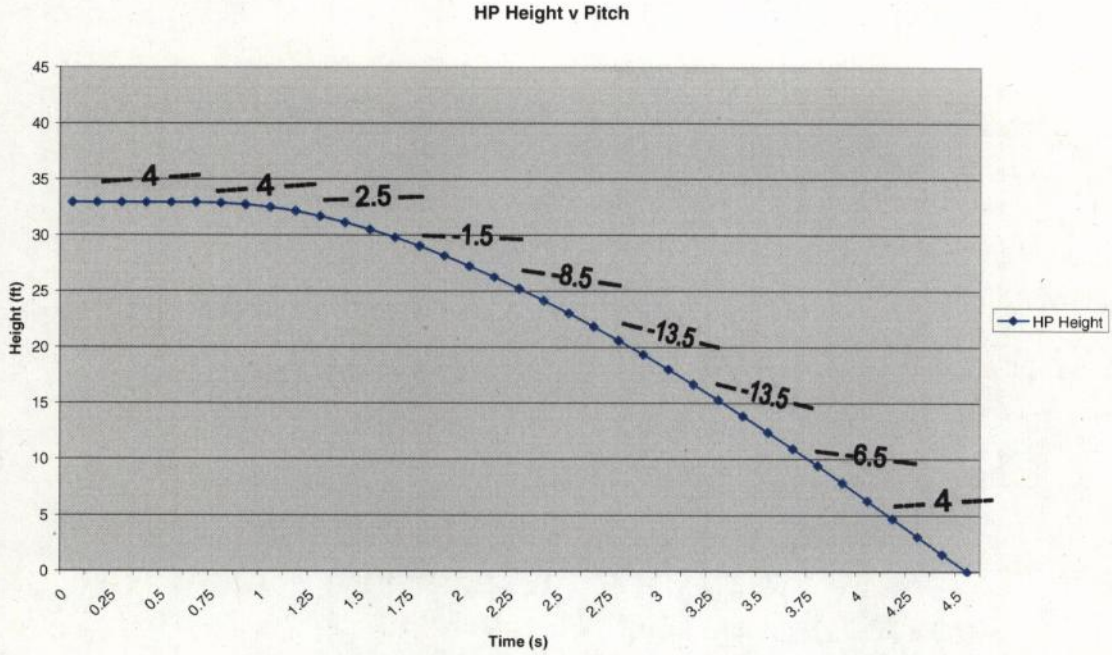

Figure 1-4-5

1.4.39 As discussed in para 1.4.36, the QHI achieved a 9 degrees nose down pitch during the demonstration. The HF report, Enclosure 1 at Part 2.8, considers that the 9 degrees nose down pitch attained by the QHI could have contributed to the HP's selection of 13.5 degrees nose down pitch. The Panel therefore considered how this may have influenced the HP's flying of the exercise. The HP stated during interview that he had read the FP before walking out to the aircraft that morning and, although he stated that he had missed the warnings towards the end of the section, he had read the first third of the text covering the exercise. The first third of the text includes the instruction *'Select approximately 5° nose down to gain some forward airspeed'*. The Panel considered that this instruction, combined with the HP's previous flying experience (564.40 hours total, with 386.20 hours on type) and the fact that the 40ft ASEF is visually judged (i.e. without reference to the flight instruments), would have made the pitch angle selected by the QHI during his demonstration appear as a reasonable approximation of the required technique. The Panel considers that the HP's decision to select 13.5 degrees nose down was not attributable to the 9 degrees nose down used by the QHI in his demonstration. The HP would have known from reading the FP that the recommended procedure was to use 5 degrees nose down and that there are no manoeuvres in the hover that require a nose down attitude of 13.5 degrees. The Panel therefore considers that the pitch angle selected by the QHI in his demonstration was **not a factor**.

Exhibit 1, 11, 12

Enclosure 1 at Part 2.8

Witness 2