the tank and reducer. A small deposit of congealed oil was also discovered adhered to the internal surface of the oil supply pipe wall on ZK 511. These samples were collected and the oil tanks of all in-Theatre aircraft were drained and cleaned. The SB instructions were completed on all UK H450 in Dec 11 and the oil supply pipes were replaced with new pipes. The samples were analysed by MIG and the results confirmed that most consisted of sand and other environmental matter. The congealed oil sample from ZK511 was found to be chemically consistent with the deposits removed from ZK515 proving the congealed oil phenomenon was not limited to a single UK aircraft.

Exhibit 58
Exhibit 59
Exhibit 60
Exhibit 2

1.4.34. The current method of filling the oil tank consists of an open jug, which pours the oil directly into the tank. The 250 micron strainer in the tank is the only filtration for the oil before it enters the engine. Although the oil system is designed so that any particles passing through the filter would normally be disposed of through the exhaust, the evidence shows that debris can bypass this filter and settle in the base of the oil supply pipe under the tank. The bypass of oil is due to a small opening at the top of the strainer, which permits the oil to overflow into the tank if poured too quickly or if the strainer is partially blocked. The position of the pipe below the tank produces a natural sump allowing these particles to collect. Although not a contributory factor towards this accident, the current method of replenishing the oil has the potential to bypass the strainer and therefore introduce debris into the oil system.

Exhibit 59,60
Exhibit 144

1.4.35. Following dialogue between the MilAAIB and the oil manufacturer, ExxonMobil commented that Mobil Pegasus 1 may not be the optimum oil for the H450 Wankel rotary engine. The Panel has found no evidence to support this claim and when this was put to the DA, Elbit Systems produced a summary of their extensive testing of this oil and engine combination. The information has been passed to UAS PT and 1 Arty Bde BARO.

Exhibit 61
Exhibit 2
Exhibit 62

TOR E – TRAINING, QUALIFICATIONS, COMPETENCY AND CURRENCY

Establish the level of training, relevant competencies, qualifications and currency of the individuals involved in the accident.

1.4.36. This TOR considers the training, qualifications, competencies and currency of each person, or group of persons, involved in the accident. The UAS-p and UAS-c will be covered first as the Panel looked in depth into the training and currency of H450 pilots and commanders. The UAS-p and UAS-c section will be followed by considering the 57 Bty SO, the MxC, the GTOLS Observer, the EP, the AO, UASS-c, ATC and REME.

UAS-Pilot and UAS-Commander

H450 Pilot Training

1.4.37. The continually increasing demands of the operational requirement[11] since the H450 UOR began in 2007 is constraining the length of time available to train and qualify H450 pilots. Moreover, the roulement cycle of UAS Bty's as a formed sub-unit requires an entire Bty[12] to be trained to pre-deployment standard every 6 months with the constraint that there is no H450 flying training available in the UK. Owing to postings and natural wastage between operational tours, approximately 50% of each Bty's pilots are ab initio every time the Bty deploys. This constant demand for new pilots is truncating the length of time available for training and restricting opportunity for their professional development. Whilst the continual delivery of new pilots every 6 months meets the specific needs of the operational requirement it does not provide the individuals, particularly the ab initios, with time to gain valuable consolidation training and hampers their ability to develop a wider understanding of aviation. The truncated training pipeline is producing H450 pilots and commanders to a standard that is "just enough, just in time". For example, an ab initio, newly qualified, UAS-c could begin his or her first operational tour after completing only 25 hours of live H450 flying and potentially with no previous aviation experience.

Witness 32, 33, 34, 36

Witness 32, 34

Exhibit 73

Exhibit 108

Witness 27, 32

[11] **(S26)**

[12] 57 Bty has 13 H450 crews consisting of 2 pilots and an un-constituted mission commander from a pool of 10 available.

1.4.38. Notwithstanding career leadership courses and other pre-deployment training, the minimum amount of specialist training required before a new recruit can deploy as a qualified H450 pilot comprises 31 weeks. The training pipeline for an H450 pilot that was in place at the time, from start to finish, is shown below:

(S26)

Figure 10 –The H450 Pilot Training Pipeline
(Exhibit 108)

The Panel looked in detail at key areas of the H450 pilot training system; the specific findings are covered in order below, starting with the Level 3 course.

1.4.39. **UAS Level 3 Course.** The Level 3 course is the basic foundation ground school for all UAS-p and UAS-c and therefore is critical to their professional knowledge and development. However, specialist lessons on the Level 3 course, such as ATC procedures, airmanship, principles of flight and human factors are underpinned by weak Training Objectives (TO). These subjects are currently delivered by Royal School of Artillery (RSA) instructors who, by their own admission, are not always comfortable teaching them and believe it would be more appropriate to use external speakers who are experts in each field, such as the current method employed for teaching meteorology on

Exhibit 109

Witness 29, 30, 31, 32, 34

the Level 3 course. The RSA instructors are not all experienced H450 operators and those who have previous experience acknowledge that whilst they should remain current and competent on type, it is extremely hard to achieve. The constraints are primarily due to the limited simulator time available and because live flying cannot be conducted in the UK. Some RSA instructors had no previous aviation experience at all, yet were expected to teach aviation related subjects on the Level 3 course shortly after joining. The Panel discovered that in the past a few Sergeant Major Instructor Gunners (SMIG) attended a 2 week UAS aviation ground-school package at RAF Cranwell,[13] designed to prepare them for the instructional role at the RSA. However, this appears to have been ad-hoc training for just a few individuals and was never formalised. The limitations of the Level 3 course have recently been acknowledged by Commander 1 Arty Bde and the Panel concur there is scope for significantly improving the content of the course. Consequently, the UAS Level 3 Course is undergoing a review in order to ensure it is fit for purpose for all UAS operators. However, the Panel has also found that not all the RSA instructors are suitably qualified or experienced to be teaching such specialist subjects.

Witness 29, 30, 31

Witness 30, 31

Witness 29

Witness 34

Witness 32, 33

1.4.40. Elements of the Level 3 course that specifically warrant further comment are as follows:

a. **Air Traffic Control Procedures.** Within the aviation community, phraseology is standard in order to ensure all users are able to understand what is being said by others on the same radio frequency. H450 students on the Level 3 course currently receive just 3 hours of ATC training, split evenly between RT phraseology and ATC procedures training[14] and conduct a familiarisation visit to Boscombe Down ATC Tower. This limited training helps to explain the Panel's findings through interviews that the crew's overall understanding of ATC procedures and phraseology was poor. This finding is further supported by the RAF CAM Human Factors report[15] that details that H450 crews felt unprepared for Theatre because of the limited opportunity to practice ATC management beforehand and had to learn and consolidate these skills during live operations.

Exhibit 110

Witness 27, 29, 30, 31

Witness 9, 10, 11, 12,

Exhibit 16

b. In the specific case of this accident, an important instruction issued by ATC was not read back correctly by the pilot. The ATC clearance issued was:[16]

Exhibit 110

(S26) *descend for PAPA 01, QNH 1015, report finals"*

Exhibit 4

The UAS-P read back:

"Happy, will report, **(S26)** *"*

However, ZK515 then commenced an approach to runway P19; a correct read back of the clearance may have alerted the crew that they were preparing for an approach to the wrong runway. ATC should also have sought a correct read back, but failed to do so. It is plausible that the UAS-p heard what he needed to hear in order to land the UA as fast as possible given the pressures he was

Exhibit 110

Exhibit 7

Witness 9, 10,

[13] This DSAT compliant course is still available at RAF Cranwell.
[14] Tactical voice procedures are delivered separately by an Army Signals SME covering Fire Control Orders.
[15] "RAF CAM Human Factors Investigation of Hermes 450 Operations in Camp Bastion, Afghanistan." Dated 1 Jun 11.
[16] Once the UA is given permission to "Descend for PAPA 01", it is cleared to leave **(S26)** Hold to conduct the landing procedure. ATC will have sterilised the airspace to avoid conflictions with other aircraft and allocated the runway to the UA.

operating under, but the UAS-c, SO and MxC also failed to pick up on the ATC clearance which is covered in more detail under Communications below. The Panel has found that the failure of the crew to read back the clearance correctly and act upon it was a **contributory factor** in the accident. | 11, 12

c. The RSA instructors who had attended the RAF Cranwell UAS ground school package used to teach the ATC procedures lesson, but as this was not formalised for all SMIGs the phraseology training has been watered down over recent years to reflect Bastion specific procedures and not standard ATC. A recent example of this is Watchkeeper personnel being unfamiliar with ATC phraseology when trying to operate within UK airspace. | Witness 27, 30, 35

Witness 35

d. **ATC Emergency Procedures.** The SO, UAS-c and UAS-p's knowledge of ATC emergency procedures was found to be poor. For example, the definition and use of the urgency condition 'Pan' was not fully understood. Even though the crew believed they had emphasised the urgency of the situation, they did not appreciate that ATC were treating the UA as a returning un-serviceable aircraft requiring a slightly higher priority for landing at Bastion Airfield. This was highlighted in an RT call from the Aerodrome Controller to another aircraft stating that ZK515 had a '*minor snag*'. The UAS-p heard this transmission yet instead of immediately correcting the controller over the radio, a phone call was made from the back of the GCS to the ATC Duty Safety Controller (DSC).[17] The crew of ZK515 were aware that once the engine air temperature reached 140°C an engine failure was a very real risk, yet they still did not declare an emergency even when the temperature reached the red section[18] on the gauge at 0932L. A 'Pan' call was eventually made, 11 minutes later, once ZK515's engine failed, but the transmission was non standard, broken and gave little relevant information. | Witness 9, 10, 12.

Witness 9, 10

Exhibit 4

Witness 9

Annex A

Exhibit 4

e. **Human Factors.** HF training for H450 pilots is 1½ days long and is delivered by an RSA instructor during Level 3 training. Whilst the instructor was a qualified HF facilitator and very enthusiastic in his subject, the level of HF training delivered is at a foundation level. During interviews, the UAS-p, UAS-c, MxC and SO all struggled to recall specific HF training content; their retained knowledge was vague and the overall understanding appeared weak. The concept of Crew Resource Management was not understood and they had not received any specific HF training on issues directly relating to their environment; for example, the hazards associated with working within a GCS for 8 hours.[19] The RAF CAM HF report also highlighted gaps in a number of HF areas such as Distributed Team Situational Awareness (SA), Internal Pilot vigilance and distraction. Therefore, the Panel has found that HF training requires expansion, specifically with respect to the H450 crew working environment. | Witness 34

Witness 31

Witness 9, 10, 11, 12.

Exhibit 74

Exhibit 16

1.4.41. **Hermes 450 Theory Course and Simulator Course.** On completion of the 5 week Level 3 course, pilots conduct the 5 day H450 Theory | Exhibit 112

[17] Due to the intensity and complexity of the air traffic environment at Bastion the DSC is an additional fully qualified and experienced controller who acts as an overall safety supervisor within the Visual Control Position.
[18] Greater than or equal to 135°C.
[19] Elbit Systems recommend 4 hours at a time.

Course and a 3 day Operator Simulator Course.[20] Both of these courses were designed by Elbit Systems and form part of the Project Lydian Training Programme with TO's approved by the RA Training Development Team (TDT). The courses are delivered in the UK by an H450 Regt Instructor (RI) who has been approved by Elbit Systems and is also the H450 simulator manager. Both Elbit and U-TacS each provide an instructor to assist the RI with the delivery of the courses. The 1 Arty Bde Risk to Life Register identifies that Tactical UAS crews' system knowledge requires improvement.[21] Following SI interviews and a visit to observe the students' application of their technical knowledge in **(S26)** , the Panel also found that the depth of this training is insufficient to give the students, and help them to retain, the required technical understanding of the H450 systems.

Exhibit 113

Exhibit 114

Exhibit 15

1.4.42. **Live Flying Training.** On completion of H450 Theory and Simulator courses, the students conduct approximately 6 weeks initial flying training at **(S26)** . This course is their first experience of live flying an H450. During a visit to **(S26)** in Jan 12, the Panel observed that overall the standard of tuition is acceptable, with knowledgeable instructors employing recognised brief, monitor and debrief techniques whilst displaying a genuine interest in the students' development. An experienced UAS-c is also available as a mentor. Students are tested throughout the live flying training and remedial training is provided if required.

Witnessed by the Panel

Exhibit 113

1.4.43. The output standard of live flying training is a UAS-p technically capable of operating the system competently and safely in order to conduct operational tasks. It is noteworthy that when the syllabus was designed in 2006, an essential input criteria was previous Phoenix (UAV) experience. Once all the Phoenix personnel had transitioned to H450, ab initio students were required to maintain throughput. Without any UAS background, the ab initio students were not able to cope with the steep learning curve and the **(S26)** flying training had to be doubled in order to achieve the required pass rate. As a UOR, H450 was a temporary, 2 year, ISTAR solution for Op HERRICK until Watchkeeper was introduced, originally planned for Aug 09. However, Watchkeeper programme delays and the success of the operational capability have necessitated H450 remains in service longer than intended; the projected in-service date for Watchkeeper is now 2013 following recent further delays.

Exhibit 113

Exhibit 136

Exhibit 136

Exhibit 115

1.4.44. There remain some significant constraints on the **(S26)** training, which prevents the flying from being representative of operations from Bastion Airfield. For example, the students cannot interact with ATC or other aircraft as all communications are made in Hebrew by the instructor. This leaves the student solely to focus on operating the H450, but could also inadvertently train them to ignore what is going on around them and therefore impact on their ability to develop airmanship and SA. Additionally, pressure inducing emergencies and system failures are injected by the instructor creating the need for pilots to divide their attention and prioritise tasks. But the Panel observed some students' systems knowledge was quite weak and several of the key failures could only be simulated, with 'actions in the event of…' a talk through exercise, rather than allowing the student to practise and learn through the actual event. At this stage of training, the students operate as a single pilot and are not yet part of a crew, but a teamwork ethic was seen to be encouraged by

Witness 25, 27, 28

As witnessed by the Panel

[20] Students are taught about the H450 system and its logics and to be familiar with system messages, displays and basic UGCS operation.
[21] UAS/1ARTYX/TO13 – Crew Knowledge of Systems.
[22] A relatively remote airfield with a small ATC presence where a number of gliders and crop spraying aircraft operate from. Airspace restrictions can be enforced due to the close proximity of a military airfield.

the instructor. Notwithstanding the individual constraints, the Panel found the main limitation of the flying training is that it can only be conducted in **(S26)** with no ability to conduct any training on return to the UK. Therefore students get short sharp bursts of activity each time they travel to **(S26)** and no time to consolidate the flying training in a live environment. Such flying training constraints impose restrictions on the development of the students' RT, emergency handling, airmanship and captaincy skills.[23] Such constraints are acknowledged widely by staff in 1 Arty Bde, with a typical quote from interview as:

"across the board training in **(S26)** *before we go to theatre, I think we'd be in the "just enough" category. I think it is just enough, but I don't think it is much more than that."* — Witness 34

1.4.45. **GPS Take-Off and Landing System (GTOLS).** The Panel found there were a number of GTOLS related contributory and aggravating factors in this accident and so were keen to understand the GTOLS training provided to the H450 crews. GTOLS is an automated GPS take-off and landing system that has recently been introduced to operations in Afghanistan; prior to this the EP was required for all take-offs and landings. The H450 crew are responsible for the set up and operation of the GTOLS system. During the interviews it became apparent that the UAS-c and UAS-p's knowledge of the GTOLS system logic and modes was limited. The Panel also considered the SO's understanding to be inadequate, particularly as he had been given the responsibility to oversee correct GTOLS use as part of the **(S26)** following a 4-month suspension. During interviews the Panel received mixed comments on the Bty's confidence in GTOLS, and the RAF CAM HF reports highlighted a lack of crew's GTOLS knowledge and confidence when using the system. — Witness 9, 10, 12; Witness 9, 10; Witness 12; Witness 9, 10, 11, 12; Exhibits 7, 16

1.4.46. GTOLS is taught during the live flying phase in **(S26)** ; the UAS-c received GTOLS training as part of her initial H450 flying course, but as the UAS-p initially qualified on H450 before GTOLS was introduced, his training was provided as a subsequent stand alone course. The **(S26)** GTOLS training differs from the procedures at Bastion Airfield because at **(S26)** the students are able to abbreviate the GTOLS procedures below 1000' agl following a go-around, rather than let the UA fly the whole GTOLS route, in order to save time for the next approach. However, at Bastion, the H450 pilots are not allowed to abbreviate a GTOLS go-around route below 1000' agl for safety. Therefore, it is conceivable that crews operating under pressure, as in the case of this accident, could revert to their original training when conducting a GTOLS go-around. A local procedure such as this should have been thoroughly disseminated to all H450 crews, however it did not appear in the 'Pilots to See' folder where a signature is required to confirm an individual has read the document. Apart from the GTOLS Handover Notes, the Panel has found no other evidence to show how this information was circulated. — Witness 25, 27, 28; Exhibit 11; Witness 27; Exhibit 97; Exhibit 11

1.4.47. Following the return to the UK of the newly GTOLS qualified 57 Bty pilots they were required to maintain currency in the simulator, of 10 hours in a 3 month period. However, they did not practise GTOLS again[24] until they returned to **(S26)** for their Technical Confirmation Training. As pilot training courses are staggered over a 3-4 month period, qualified pilots from early courses were at risk of skill fade as they could be back in the UK for up to 3 — Witness 35; Witness 25, 28; Exhibit 16, 74, 116

[23] UK Simulator currency and constraints are covered later in this TOR.
[24] The RI who is responsible for managing the simulators was not GTOLS qualified, at this time, so no GTOLS scripts existed. He qualified in Dec 11. This is covered in greater detail under Currency.

months before being able to practise GTOLS again. Additionally, immediately prior to this accident **(S26)** . The Panel believes this **(S26)** , and a lack of a simulator in Theatre, exacerbated the GTOLS skill fade of the crew and they were allowed to resume GTOLS operations without an independent assurance that they were operating to an acceptable and safe standard, by an instructor who was current in GTOLS procedures. The specific GTOLS factors identified as contributory factors in this accident are as follows: Exhibit 101

a. An incorrect flight plan parameter for the P19 GTOLS landing was loaded by the crew. The UA should have been instructed to join the GTOLS route at Way Point (WP)1 in order to validate the procedure as it passed through WP2. However, the crew incorrectly instructed the UA to route 'Direct', thereby allowing the UA to join the route at its closest point, which in this case was between WP2 and WP3. Therefore, the incorrect GTOL joining parameter resulted in the UA self aborting the approach and the Panel has found that this action was a **contributory factor** to the accident. Annex A

b. Following the UA self abort, the crew commanded the UA straight to **(S26)** Hold; this action was contrary to direction not to intervene with a UA whilst in GTOLS mode below 1000' agl. This action placed the UA in a position approaching **(S26)** hold without an associated ELS that was within glide range. Had the crew not carried out this action, the UA would still have crashed following the engine failure, but the position of the impact would have been on the GTOLS route which had been designed to have a ground track which did not interfere with persons or infrastructure on the airfield. Therefore, the Panel has found this action to be an aggravating factor in the accident. Of note, the Panel discussed with the OSC during the visit to Theatre the requirement to ensure the GTOLS route remained safe as the airfield and associated infrastructure developed. At the time of the accident, it did not appear that the Bastion GTOLS route had been reviewed since the new main runway had been built, though the route remained clear of existing infrastructure. Annex A Exhibit 11 Annex A

c. **Failure of the UA to route towards an ELS.** When ZK515's engine failed on the approach to **(S26)** hold, the crew were rapidly preparing for a GTOLS approach to P01. The UA was not within glide range of a selected ELS[25] and was no longer in GTOLS mode owing to the action detailed in paragraph b above. The logic in such a situation directs the UA to adopt the No-Comms route: this route is pre-determined to be along a safe ground track should an engine failure occur. WP6 happened to be closest when the engine failed and the UA routed towards it in a glide descent. However, the particular No-Comms route had been designed with a 'Critical Altitude' restriction of **(S26)** [26] at WP6. Without power, a climb to **(S26)** proved impossible and the UA glided in a circle around WP6 until it crashed. The critical altitude restriction at WP6 is the cause of the turn towards the airfield that the crew were not expecting and the Witness 9, 10 Annex A Annex A

[25] For a GTOLS approach the ELS are deliberately placed outside of UA gliding range, in order to force the UA to continue to follow the GTOLS route, pre-determined along a safe ground track.

[26] Restriction: The UA must climb **(S26)** before leaving WP6 for WP7. This restriction had been programmed into the No-Comms route to ensure a UA in a genuine no-comms situation would climb at **(S26)** above the rotary-wing transit areas before subsequently routing out to **(S26)** and attempting to re-establish communications.

reason the UA impacted on the airfield and not outside the boundary. The Panel has found this to be an **aggravating factor** in the accident.

1.4.48. **Technical Confirmation Training.** Prior to an operational tour, all H450 pilots attend a 2 week flying training package in **(S26)** . The output standard is a pilot with a Certificate of Competence (CofC); a current CofC is a key competency requirement for pilots to operate a H450 unsupervised. Of significance, this is also the first time that pilots are teamed up to operate together as a crew. The crewing together of a UAS-p and UAS-c at this late stage in their training has already been identified as a risk within the 1 Arty Bde Risk to Life Register.[27] The crew are assessed by members of the OSC or Army Aviation Flying Standards (AAVn Stds); on successful completion they are awarded their Annual CofC.[28] Exhibit 113 Exhibit 117 Exhibit 15

1.4.49. **Exercise FINALE.** This UK based exercise provides collective training for the Bty Ops staff, H450 crews and command chain. It is used to bridge the training gap between technical H450 training in **(S26)** and operational flying in Afghanistan. Apart from 2 smaller scale unit led exercises[29] this is the only opportunity for all participants to operate together before deployment. The exercise is highly regarded within 1 Arty Bde and has evolved significantly, but there remain a number of key constraints: Witness 35 Exhibit 27 Exhibit 116

a. There is only one full GCS simulator for 13 crews. Crews achieve approximately 8 hours working together. Witness 25, 35

b. There are 2 Single Console Trainers (SCT) available, but they only serve as a procedural trainer for pilots to practise on in isolation. Witness 27

c. Regt personnel are used to simulate ATC. They are not always pilot trained but do receive some training from an H450 RI before fulfilling the role. Witness 25, 35

d. Until recently GTOLS could not be practised during exercise FINALE and would not be until the crews started their ThQ process at Bastion Airfield which could be up to 7 weeks later. Witness 25, 35

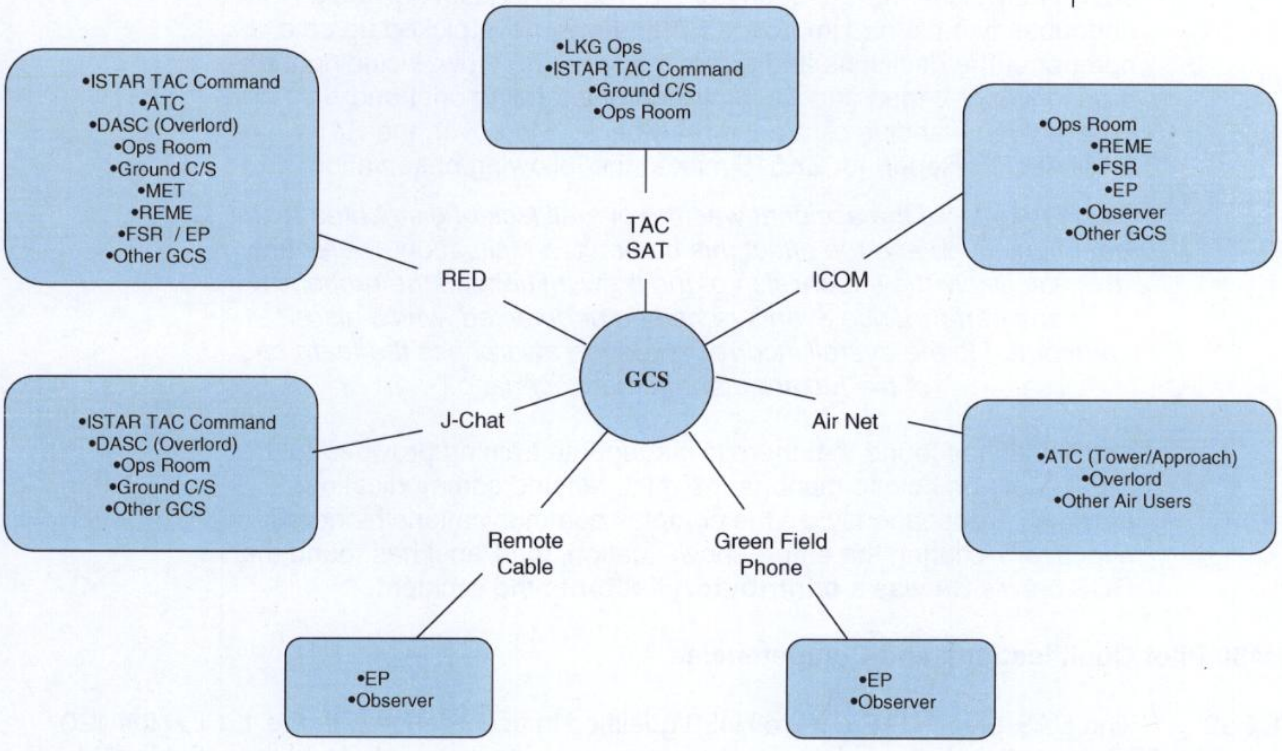
1.4.50. **Theatre Qualification.** On arrival in Theatre, all H450 pilots, EPs and GTOLS Observers must conduct a ThQ process before being allowed to conduct flying operations from Bastion Airfield. All operators must be TQC2 before they can start the ThQ process. The ThQ process, in company with the pilot CofC, is a key competency for delivery of the H450 capability. The UAS-p must conduct 2 sorties, made up from a minimum of 10 hrs flying, where a set of objectives must be achieved including one manual and one planned GTOLS take off and landing. ThQ flying is the first time that a crew would have used GTOLS since Technical Confirmation Training in **(S26)** and the first time ever they will use RT and interact with other aviation. Exhibit 93, 95 Exhibit 119 Exhibit 118 Exhibit 119 Witness 25, 35

1.4.51. **Communications and Situational Awareness.** Following a

[27] UAS/1ARTYX/T022 – Fully Trained and Formed Teams Prior to Deploying.
[28] A UAS-p/c is awarded a CofC before deploying. CofC is valid for 12 months. Initial and routine assessment should be conducted by the OSC. Additionally an external agency (AAvn Stds/RA GTT) should conduct a biennial check.
[29] Exercises RUNOUT and APPRENTICE are individual unit led programmes for the Bty Operations staff and crews. Whilst the intent is to run both concurrently to exercise all personnel together this cannot always be facilitated. There are no formal Collective Training standards however products and processes used are from Ex FINALE. Crews achieve approximately 8 hours operating together however if an individual is identified as particularly weak he may be given additional time in place of a stronger pilot. 57 Bty conducted a number of these 1 day serials however this was not formally documented.

thorough review of the H450 pilot training pipeline, the Panel could not find any evidence of specific training into handling of the detailed communications network that is crucial when operating a UA from within a remote GCS. The ThQ process appears to be the first instance when the H450 crews are properly introduced to the full system.

a. The communications network from within the GCS to other players is multi-faceted, with 7 different means of communication linking the 3 GCS crew members to the distributed team. Communication is achieved through a series of single ear piece headsets, telephones, a computer terminal and hand-held radios and loudspeakers. After observing a live H450 operation during their initial visit to Bastion Airfield, both SI Panel members who are used to managing multiple RT frequencies and communications systems,[30] assessed the network as complex and potentially confusing without adequate training. | Exhibit 10



RED	– Telephone	Air Net	– External RT
JChat	– Computer Terminal	Remote Cable	– Hardwired Cable
TACSAT	– Satellite Communications	Green Field Phone	– Hardwired Phone
ICOM	– Handheld Transmitter / Receiver		

Figure 11 – H450 Communications Network
(Exhibit 10, provided by 32 Regt RA).

b. H450 pilots do not receive any training on how to manage the complexity of such a communications system or how to maintain distributed team SA, with only limited opportunities to practise ATC management, such as during Exercise FINALE. The UAS-p and UAS-c acknowledged that it is possible for information to be missed because of multiple transmissions received into the same ear and | Witness 9, 10

[30] The President, an experienced pilot, and the ATM Member, an experienced air traffic controller.

can be further compounded with additional messages received over a loudspeaker. This finding is further supported by the recent RAF CAM HF report that noted:

"Although IPs (internal pilots) received some training in communicating with other team members, this training appeared to be limited to basic communication and understanding of the other persons role" — Exhibit 16

c. The MxC does not routinely wear a headset whilst in the GCS and cannot support the pilots in maintaining good crew SA. The SO, who at the time of the accident events was present in the GCS in a supervisory role, did not wear a headset either; according to his evidence there were only 2 headsets within the GCS at the time of the accident. The Panel believes the lack of a third headset must have affected the SO's ability to carry out his supervisory function adequately. Had the SO been able to wear a headset he would undoubtedly have had improved SA and may have picked up on a number of the decisions and errors made by the crew; including the breakdown of 2-man checks, omission of a landing brief and incorrect ATC landing clearance read-back. Moreover, the RAF CAM Aircraft Report for ZK515 makes the following observation: — Witness 11, Witness 12

"Fundamental to the accident was the overall lack of distributed team communication and the effect this had on team situation awareness. It is also likely the supervision of the crew influenced the probability any performance events remained undetected, which also contributed to the overall incorrect situation awareness the team had of the hazard management scenario." — Exhibit 7

The Panel has found that there is inadequate training provided to the H450 pilots on how to manage the multi-faceted communications network. Consequently, as the complex communications hindered effective SA during the emergency situation, the Panel has found the GCS crew's SA was a **contributory factor** to the accident.

H450 Pilot Qualifications and Competencies

1.4.52. The UAS-p and UAS-c were H450 qualified in accordance with the 1 Arty Bde FOB issue 5 that was in force at the time of their deployment. Both the UAS-c and UAS-p held the relevant competencies; a valid CofC, TQC2 and had completed the appropriate ThQ process. — Exhibit 120, Exhibit 92, 93, 94, 95

H450 Pilot Currency

1.4.53. **Simulator Constraints.** 1 Arty Bde has only one 3 man GCS simulator, 2 SCT and 3 Virtual Battlefield Simulators (VBS). These simulators, which are managed and run by one Staff Sergeant, are used for Exercise FINALE and all currency requirements for both 32 and 47 Regts.[31] The simulators cannot replicate all system failures accurately and crew dynamics and captaincy development can only be practised within the GCS. Pilot currency and competency checks are conducted in isolation and with only one GCS available, opportunities to work as a crew to develop emergency, — Witness 25; Witness 25, 27, 28

[31] With a number in the order of 250 trained UAS-p across the 2 Regts and one trained manager the simulators would be required to run 17 hours a day to keep everyone current and competent. Requests for RA GTT support were made, but not supported.

airmanship and captaincy skills are limited. Exercise scripts and TOs have been developed (without TDT support) by the Simulator Manager, who became qualified in GTOLS in Dec 11; the Panel believes simulator GTOLS training serials are now under development. There is no GCS simulator at Bastion Airfield, so crew continuation training in Theatre is limited to live flying, briefings and theoretical discussion. Witness 9, 10, 12

1.4.54. **Live Flying Constraints.** Live flying cannot be conducted in the UK. H450 flying can only be conducted in **(S26)** , where flying conditions do not replicate flying on operations, or in Afghanistan, where continuation training is difficult to achieve due to the operational tempo and the airspace restrictions at Bastion Airfield that are necessary when a H450 takes off or lands. From interviews the Panel has learnt that it should be possible for the Theatre UAS Bty to conduct some training when a UA returns from a sortie, dependent upon the level of airfield activity at the time. Witness 24, 26

1.4.55. **H450 Currency Requirements.** Following initial qualification, currency and continuation training in the UK is required. 10 hrs simulated flying in a 3 month rolling period[32] and 6 hrs live flying in 6 months rolling period is the minimum. Ab initio H450 pilots can comprise up to 50% of the Bty's pilot cadre and, as such, this volume of new students takes time to progress through initial flying training as they cannot all attend the same course. This situation can result in the early course members returning to the UK for up to 3 months whereby they require simulator hours to maintain current and competent.[33] Exhibit 108 Exhibit 121 Exhibit 73 Witness 25, 27, 28, 35

1.4.56. 1 Arty Bde FOB Issue 5 clearly states that individual operators are responsible for ensuring they remain current in both the live and simulated environments and this must be recorded in a pilot's logbook. Due to the inadequacies and availability of the UK simulator at Larkhill, an inability to live fly in the UK and personnel not expecting to operate H450 again due to future postings, a culture has evolved where some individuals do not remain current between operational tours; H450 crews will only regularly achieve the currency requirements in the 6 months preceding, and during, an operational tour: Exhibit 121 Witness 25, 27,28 Witness 25 Witness 12

"The majority of pilots will go out of currency within 6 months of returning to the UK as no flying is conducted until they go back through the training pipeline in ***(S26)*** *6 months prior to their next deployment."* Witness 35

In this respect, the Panel could not discover any evidence that BCs or the Regt Training Officer (RTO) are keeping track of H450 pilot currency between operational tours. The limited availability of the GCS simulator and instructional staff also results in the RSA instructors, RIs and the OSC struggling to maintain currency. The Simulator Manager has very recently started a currency tracker spreadsheet in an attempt to capture all qualified pilots; however, it is the Panel's belief that tracking simulator currency would be better managed by the RTO and individual BCs. Witness 12, 27 29, 30, 31, 35

1.4.57. **Currency Imbalance.** The H450 pilot currency requirement was derived from what was achievable within the resources available, rather than based on what was actually required.[34] There is no evidence to indicate an Witness 32

[32] This is supervised by either a member of the OSC or Regimental Instructor but conducted in isolation on either a Single Console Trainer or in the sole GCS available.
[33] Simulators are GTOLS capable. There were no qualified GTOLS instructors available to create GTOLS scripts and run the training.
[34] Largely as a result of the inability to live fly in the UK and the requirement to cycle all personnel through the limited simulator facilities at Larkhill with a finite number of qualified instructors.

analysis has been conducted to establish an adequate currency requirement. As live flying can only be accomplished outside the UK and simulated hrs only achieved when in the UK this has resulted in a 'Feast or Famine' situation that has created two imbalances:

a. During H450 training in **(S26)** and whilst on an operational tour[35] the operators gain significant flying hours. In Afghanistan the flying is purely operationally focussed, with little or no opportunity to conduct continuation training or to practise emergencies; this routine operational tasking is often highly repetitive over a number of days or weeks and thus can limit opportunities to develop captaincy and airmanship skills. Following a focussed pre-deployment training package, without the facility in-Theatre to train, there is a very real risk of skill fade, particularly in abnormal and emergency procedures towards the end of the 6-month tour. Exhibit 92, 93, 94, 95

b. Continuation training in the UK is limited to exercises in isolation in the simulator and, until very recently, without the ability to practise GTOLS. Simulator currency is further constrained by the limited number of GCS simulators and instructors available which in turn restricts the capacity to operate as a crew and therefore develop experience as a team. The Pre-Deployment Training (PDT) of the Bty preparing to deploy necessarily takes precedence, often resulting in pilots who have returned from Theatre losing currency for extended periods. Witness 25, 27, 28 Witness 35 Witness 35

1.4.58. The Panel believe this 'Feast or Famine' situation is placing immense pressure on an inadequately resourced training system. H450 pilots have to continually re-qualify as TQC2 in the 6 months prior to their deployment, because they previously lost currency when they returned to the UK, due to the simulators working flat out with the re-qualifying process for the Bty preparing to deploy. Additionally, a culture existed within the RA that it was acceptable not to maintain currency between operational tours. The knock on effect was that H450 pilots struggled to develop and maintain confidence in key skill sets such as airmanship, captaincy, system knowledge and the ability to handle unusual or emergency situations. As a result of identifying these factors, the Panel looked at more depth into the training and development of H450 pilot airmanship and captaincy skills which are covered in the next two sub-sections of this TOR.

H450 Pilot Airmanship

1.4.59. The limited airmanship skills of H450 crews is acknowledged by Commander 1 Arty Bde. The 1 Arty Bde Risk to Life (RtL) Register has H450 UAS airmanship as one of its formally recorded risks.[36] The detailed description of the risk is: "*Competence, confidence and general awareness of airmanship*". On the associated Hazard Risk Matrix it is recorded as having both HIGH Likelihood and HIGH Severity and it appears this risk was raised following an accident involving ZK518 during May 11. The risk mitigation strategies largely involved improved awareness and training of airmanship during the ThQ process and a review of UAS airmanship trg by the Delivery Duty Holder (DDH)'s SO. The risk level following planned mitigation is assessed as low and the DDH statement within the Risk Register from 17 Nov 11 assesses RtL as Exhibit 15 Exhibit 15

[35] The 6 live hours required in 6 months for currency is quickly achieved and theoretically clears them as current for the whole of their operational tour without having to fly again.
[36] UAS/1ARTYX/F031.

Tolerable and ALARP.[37]

1.4.60. The RAF CAM Human Factors Investigation from Jun 11 also raised the airmanship of H450 crews as a factor and noted that:

"Although airmanship principles were taught at a basic level, this did not seem to be sufficient considering the age and rank of the IPs(internal pilots). Specifically, there appeared to be insufficient help on how to manage large amounts of information in the pilot folders and how to improve skills through use of the simulator, mission tapes and mission debriefs." Exhibit 16

The RAF CAM report recommended that H450 training should include sufficient airmanship training to enable the crews to effectively manage the mission and mission preparation.

1.4.61. During visits to Bastion Airfield, where operational flying was observed, and **(S26)** where live flying training was observed, the Panel noted the limited aviation experience of the crews and questioned many members of 57 Bty on their opportunities to develop airmanship. From the formal interviews, the Panel found that in the case of ZK515's accident the operating crew displayed some good aspects of airmanship during their attempts to recover the UA back to Bastion Airfield. They did, however, also display some aspects of poor airmanship as the emergency situation developed, which ultimately contributed to the accident. Furthermore, the Panel found that the SO displayed elements of poor airmanship whilst he was overseeing the operating crew. Witness 9, 10 Exhibit 7 Witness 12

1.4.62. From investigation into the training pipeline, the Panel has found that H450 training was truncated in order to meet the demand for the operational capability, which has severely restricted the growth of aviation knowledge and H450 experience of the UAS pilots and commanders. For 57 Bty, approximately half of the pilots were on their first operational tour, having recently qualified on H450; the Panel understands this is a typical figure for each Bty. Airmanship is first introduced on the Level 3 UAS course, by virtue of one lesson. This lesson introduces the students to the principles of airmanship to enable them to develop the skills and attributes expected during flying periods. The airmanship lesson content is a very good introduction which, if delivered effectively, should provide the students with a clear understanding of what airmanship comprises. The lesson ends with the summary slide reproduced below: Witness 32 Witness 17 Exhibit 17

[37] As Low As Reasonably Practical.

Figure 12 - Airmanship Model from RSA Lesson
(Exhibit 17)

1.4.63. Using the RA's own model, the Panel analysed each of the components that combine to provide airmanship:

a. Mental Capacity. The mental capacity of the UAS pilots is difficult to determine as there is no specific aptitude testing prior to training, as covered under TOR L. There is evidence that the students can struggle during their training with numeracy skills and mental capacity. For example, students used to have difficulty in calculating the glide range of the H450 following simulated engine failure, using a glide ratio of 4km per 1000' of altitude. To address this, a table was added into the QRH that the students could refer to rather than calculating glide range using mental arithmetic. The RSA SMIG who teaches the 'Glide Ratios' lesson explained to the Panel there was not really a need to conduct Mental Dead Reckoning (MDR) as the pilots now have a table in the QRH and they tend to lean on the technology in the GCS to help them work out a solution. This evidence points towards the phenomena of 'automation induced complacency'. The Panel has found no evidence that the UAS pilots are given any specific training or testing of their mental capacity and thus this is considered an area of potential weakness.

Witness 36, 29

Exhibit 18
Witness 36

Witness 29

Exhibit 19

b. Situational Awareness. H450 pilots do not share the same level of situational awareness as pilots of manned aircraft; their remote position in a GCS without windows means they have to rely heavily on their instruments and on the communications with the external GTOLS Observer and/or EP. The RAF CAM report