the Captain's plan. The AO did not get on headset, and thereby was unable to fully discuss the problem faced by the crew and assess the course of action they intended to take.

1.4.4.80. **1 ISR Bde AO training.** AOs were mandated to attend the MAA's Flight Authorizers Course (FLAC) and the RA AO Briefing Day, as previously highlighted. The AO of WK006 had attended the FLAC but not the RAAO briefing day. The Panel found no evidence that the AO had received any further training for his role as an AO. The Panel looked at other Remotely Piloted Air System units and established that their Auth procedures were borne from many years of experience, both in the UA and manned aviation world. Most units conduct further 'on the job' training, in addition to the FLAC, before individuals are qualified to act as an AO. The FLAC enables individuals to have a broad grounding in general themes relating to authorisation, but type specific training is essential to ensure that personnel have the required level of technical and organisational knowledge, in order to act as an AO. One of the opportunities afforded to operators and supervisors of unmanned aviation is the ability to reach back to the chain of command, and seek guidance and advice from industry before a course of action is decided upon and enacted. This routinely occurs on other Military UAS, such as the RAF's Reaper capability. The opportunity to understand and attempt to control the risk was not taken during the recovery of WK006. The Panel found no evidence of any formal dynamic risk management to mitigate the potential hazard in selecting MO when recovering WK006. The absence of role specific WK authorisation training resulted in a situation where the AO was not well equipped to effectively carry out the function of an AO during the flight of WK006 and this was a **contributory factor**.

1.4.4.81. **Recommendation. The Panel recommends that the Delivery Duty Holder implements a bespoke WK Authorising Officer training package, to ensure individuals have the required knowledge, skills and experience to act as effective Authorising Officers.**

## Supervision of Flying

### Flying Supervisor

1.4.4.82. **Policy – 1ISR Bde FOB.** The 1ISR Bde FOB listed the duties of the UAS Flight Supervisor, an extract of which is reproduced below: Exhibit 5

> a. *'The UAS Flight Supervisor is responsible for the overall command of a UAS 'System of Systems', across all '4-worlds' – Aircrew, Maintainers, Supporters and Battlespace Managers; for their training, deployment, safety and effective operation'.*
>
> b. *'The UAS Flight Supervisor is responsible to the Duty Holders, under whose authority they enact their supervision, for ensuring that the requirements of appropriate Command Instructions, Flying Orders and directive are met. They have an overarching responsibility to ensure safe UAS operations and to promote a culture of airmanship and air safety throughout their command'.*
>
> c. *'The Flight Supervisor does not have any responsibility for the captaincy or piloting of any UA but remains ultimately*

*responsible for the system as a whole at all times and may be responsible for a number of concurrent UAS flights or missions'.*

1.4.4.83. **Policy – 1ISR Bde Pers Directive**. The 1ISR Bde Pers Directive stated that '*Flight Supervisors are to hold, or gain within 6 months of their assignment, a Certificate of Qualification on Type (First Pilot Qualification) for at least one of the types over which they are to exercise flight supervision'.* It also stated that Flight Supervisors should remain current, on at least one type which they are to exercise flight supervision. Exhibit 113

1.4.4.84. **Delegation and TORs UAS – Flying Supervisor**. The DDH had issued the BC, 43 Bty RA, with a set of TORs on 4 Sep 15. The BC had signed as having read and understood these by the time of the accident. Exhibit 122

1.4.4.85. **Flying Supervisor selection and qualification**. The Panel was satisfied that the Flying Supervisor met the selection criteria laid down in the 1ISR Bde FOB. At the time of the accident, the Panel **observed** that the Flying Supervisor was not qualified on type, and there were no plans to gain this qualification within 6 months of his assignment. In the Panel's opinion, it was imperative that the WK Flying Supervisor was Qualified on Type, in accordance with the ISR Bde Pers Directive, as without this qualification, it would be extremely challenging to understand the UAS in sufficient detail, in order to supervise flying to the required standard. Additionally, in the opinion of the Panel the Flying Supervisor should be WK CQT before he assumes his position as the Flying Supervisor, in order to ensure that the required level of supervision and knowledge is maintained during the changeover of personnel. The Panel therefore noted that the Flying Supervisor was unable to authorise flights on his unit, due to the requirement for Authorisers to be CQT and current on type. Exhibit 5

1.4.4.86. **Recommendation. The Panel recommends that the Delivery Duty Holder should ensure that WK Flying Supervisors hold a WK Certificate of Qualification on Type and are in current flying practice before they assume the role of Flying Supervisor.**

1.4.4.87. **Flying Supervision on 43 Bty**. The Panel is aware that the Flying Supervisor was relatively new in post at the time of the accident and a significant number of the Panel's findings in this section relate to systemic failings within the Bty, which have their origin well before the Flying Supervisor took command. The Panel **observed** that there was an inadequate level of flying supervision on 43 Bty at the time of the accident. This section has highlighted how the failure to keep accurate and detailed records led to the Panel being unable to ascertain the flying currency of individuals. Furthermore, the Panel has established that the Bty did not comply with all Flying Orders and directives. The Flying Supervisor was aware that the weather was challenging, but due to his experience and not being qualified on WK, had to rely on the AO and Captain to ultimately make the decision about whether to launch WK006. Between the sortie brief in the morning and the crash of WK006 at 1550 hrs, the Flying Supervisor was not actively involved in the flight of WK006 and was first made aware of the problems in recovering WK006 when the UA crashed. Witness 2

1.4.4.88. **Recommendation. The Panel recommends that the Delivery Duty Holder should review the pre-employment qualifications and**

**experience to become a WK Flying Supervisor.**

**Availability of SQEP within the DDH and ODH organisations**

1.4.4.89. Figure 18 provides a summary of the RA Unmanned Air Systems DDH SQEP table. In 11 individual roles, a WK CQT was listed as being desirable; none of the individuals within these roles held a WK CQT at the time of the WK006 accident. Although it was only desirable that these individuals held a WK CQT, the cumulative effect of none of these individuals holding the qualification, nor any plan for them to become qualified and obtain 'hands on' operator experience, resulted in the **observation** that there was a paucity of WK SQEP across 43 Bty, 1ISR Bde and JHC. Additionally, at times, key safety positions, such as the DDH Senior Operator, were gapped due to resettlement and terminal leave causing a delay in their replacement entering post. Due to the fragility of the WK programme and the planned rapid expansion required to meet FOC, the Panel believe that these positions need to be continually filled and should be afforded high priority. Additionally, the Panel believe that there is a need for officers to be trained as WK Pilots, to ensure that there is a spread of experience across the Army rank structure. The Panel accept that many of the incumbents have considerable Hermes 450 experience, however also noted that there is a significant difference between Hermes and WK operations, particularly in the take-off and recovery phases and when operating WK in the UK. Exhibit 123

| Domain | Role | WK CQT | WK CQT Status 2 Nov 15 |
|---|---|---|---|
| Supervisory | DDH | Desirable | No WK CQT |
| | CO 47 RA | Desirable | No WK CQT |
| | BC 43 Bty | Desirable | No WK CQT |
| | BK 43 Bty | Desirable | No WK CQT |
| | XO 43 Bty | Desirable | No WK CQT |
| Air Safety | SO2 DASO | Desirable | No WK CQT |
| | SO3 DASO | Desirable | No WK CQT |
| | SSgt DAEMS Ops | Desirable | No WK CQT |
| External Posts | SO1 UAS CD CS | Desirable | No WK CQT |
| | SO1 UAS JHC | Desirable | No WK CQT |
| | SO2 UAS JHC | Desirable | No WK CQT |
| Op Stds | SO2 DDH Snr Op | Any Army UAS | No WK CQT |

**Figure 18 - RA Unmanned Air Systems DDH SQEP Table, Nov 14**

1.4.4.90. **Recommendation. The Panel recommends that the Operating Duty Holder (ODH) review WK qualification and experience requirements to ensure there is a baseline of Watchkeeper suitably qualified and experienced personnel across JHC, 1ISR Bde and 47 Regt RA. Until this is achieved, consideration should be given to embedding personnel with manned aviation experience, across the WK organisation.**

1.4.4.91. **Recommendation. The Panel recommends that the Royal**

**Artillery HQ Regimental Colonel, reviews officer career development paths to grow UAS Troop and Battery Commanders with sufficient experience as UAS operators to enable them to be effective supervisors.**

**Summary**

1.4.4.92. The Panel established that the crew were qualified on type, but did not meet all of the stipulated currency requirements. It would not have been possible, from the records kept, for the AO or Flying Supervisor to readily ascertain the crew's currency. The AO was not well equipped to carry out the function of the AO, by intervening in what was identified by the Panel to be a premature selection of MO. The Panel found that whilst the DDH organisation was extremely proactive and that orders, procedures and the supervisory framework were all in place, there was a limited availability of suitably qualified and experienced personnel in key supervisory posts; of note no commissioned officers in 1 ISR Bde or JHC were qualified on type and a heavy reliance was placed on a small cadre of non-commissioned instructors and Thales UK employees.

## SECTION 1.4.5 – LEVELS OF PLANNING AND PREPARATION

*TOR5: Identify if the levels of planning and preparation were commensurate with the activities objectives.*

### Introduction

1.4.5.1. This section of the report covers the planning and preparation conducted by the crew and other personnel, prior to the accident on 2 Nov 15. It is divided as follows:

a. Meteorological Considerations.

b. Sortie Planning and Briefing.

### Meteorological Considerations

1.4.5.2. The Meteorological situation on the day was a significant planning factor for the crew, Authorising Officer and Flying Supervisor and was a key consideration during their decision on whether to launch WK006. This Section will focus solely on the Met aspects of the planning and preparation on 2 Nov 15. Witness 1,2,3,4 Exhibit 124

### Regulation, Policy and Orders

1.4.5.3. **RA 2305(5) - Aircrew Briefing**. RA 2305 stated that the briefing of aircrew before flight was essential and should be conducted in a thorough and professional manner. Guidance Material stated that '*Meteorology, including significant meteorological features during the flight and landing conditions at the aircraft's destination*', must be briefed, when appropriate, during sortie briefings. Exhibit 117

1.4.5.4. **RA 2115 - Responsibilities of Aircraft Commander**. RA 2115 stated that an Aircraft Commander should ensure that an appropriate meteorological briefing has been obtained. Exhibit 117

1.4.5.5. **RA 2306 - Authorisation of Flights**. RA 2306 stated that '*the Authorizing Officer should assure himself that due consideration has been given to meteorological considerations, and be prepared to adjust the sortie profile accordingly*'. Exhibit 117

1.4.5.6. **WK BDN SOPs**. The WK BDN SOPs stated that Met Services are provided from BDN as detailed in the BDN FOB and that the Met Office would distribute Met products to the Bde via the Bty Met email account and MOMIDS, a computer based programme allowing access to various Met Office products. The SOPs stated the '*the OpsO/AO was to ensure that any Met update is recorded and briefed to the GCS/L&R crew as soon as possible. This was to be recorded within the Operations cell*'. Exhibit 125

1.4.5.7. **Aircraft Data Set (ADS)**. As discussed previously in Section 1.4.2, the Panel established that there were no formal weather limitations relating to cloud or visibility during the recovery phase, in the ADS and this was a **Contributory Factor**. Within the IETP and FRCs, there was guidance and procedures relating to recovering the UA when cloud existed at/below the CP

and the normalisation of its use was also a **Contributory Factor**.

**Met Products received**

1.4.5.8. **Forecast conditions**. The personnel involved in the flying activity received the following Met forecast products during the sortie planning and preparation phase.

a. **Morning Brief**. The crew, AO and Flying Supervisor attended a 'face to face' Met brief from a BDN Met Forecaster at 0800 hrs. This brief commenced with a surface chart detailing the synoptic situation over the UK (a ridge of high pressure covered the UK, with a moist South Easterly flow over BDN and the local area) followed by an overview of the current weather conditions at selected military airfields in the southern half of the UK. A BDN Cross-Section was then briefed (Figure 19), before the brief concluded with an overview of local Terminal Aerodrome Forecasts (TAFs).

Exhibit 124.

Witness 1,2,3,4,

Exhibit 124

Exhibit 21

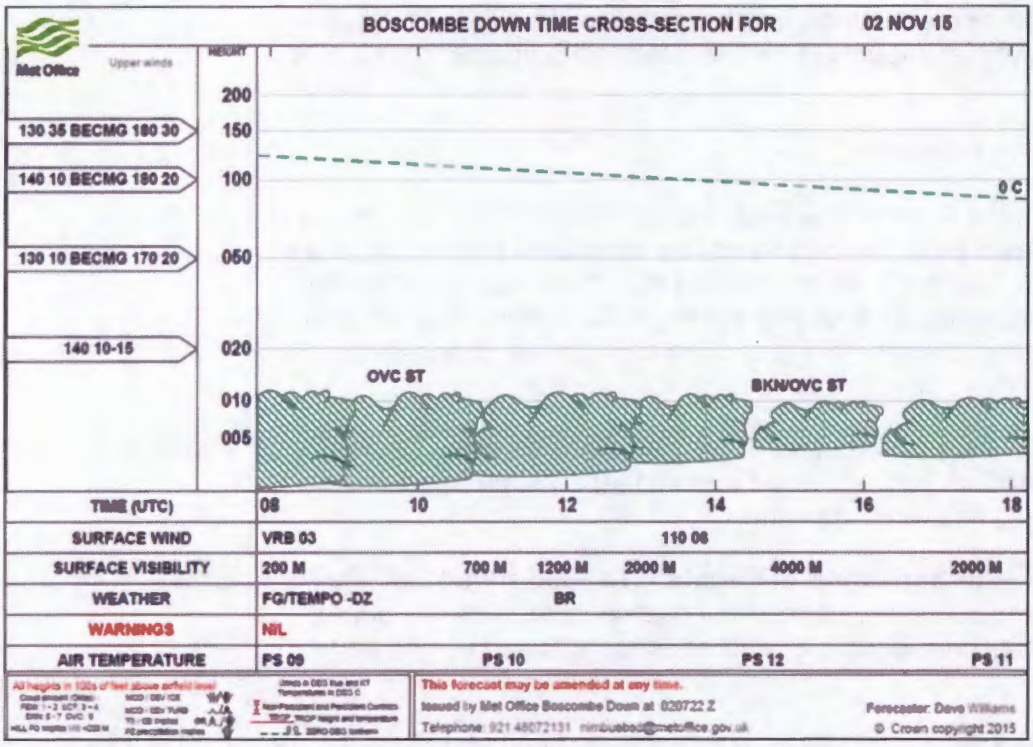


**Figure 19 - BDN Cross-Section, Issued at 0722 hrs, (briefed in Met Brief)**

b. **Updated Cross Section**. A second BDN Cross-Section was issued at 1124 hrs (after WK006 had taken off) and is shown at Figure 20. If viewed in isolation, the cross section presented an improved forecast, with cloud reducing during the recovery window from BKN to temporarily FEW/SCT, albeit with a more pessimistic forecast improvement of surface visibility.

Exhibit 126

Exhibit 126

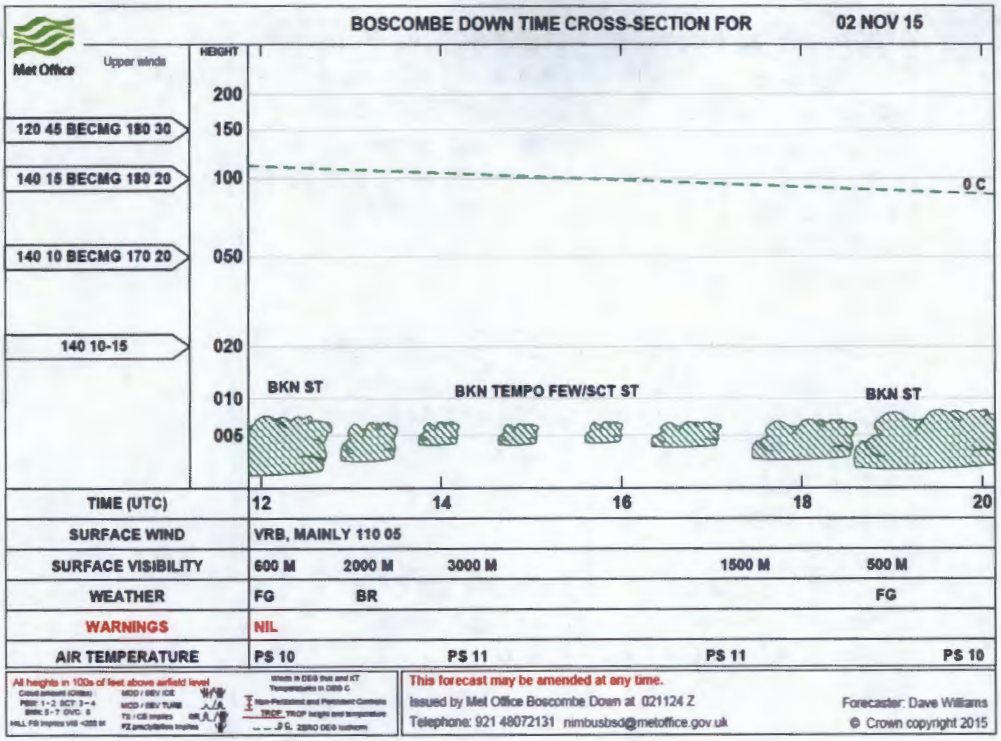


**Figure 20 - BDN Cross-Section, Issued at 1124 hrs. (post take-off)**

c. **BDN Terminal Aerodrome Forecasts (TAFs)**. On 2 Nov 15, there were a total of 7 TAFs issued by the BDN Met Office, 3 of which were issued before take off, listed below; Exhibit 20

(1) 0700 hrs TAF[56] (briefed in Met Brief). EGDM 020700Z 0208/0215 10004KT 0300 FG VV/// BECMG 0211/0213 2000 BR BKN002 BECMG 0213/0215 4000 BKN004=

(2) 0730 hrs TAF[57]. EGDM 020730Z 0209/0218 10004KT 0300 FG VV/// BECMG 0211/0213 2000 BR BKN002 BECMG 0213/0215 4000 BKN004 BECMG 0215/0217 2000 BKN002 PROB40 0217/0218 0500 FG OVC001=

(3) 1101 hrs TAF. EGDM 021101Z 0212/0219 10005KT 0500 FG BKN001 PROB40 0213/0216 1500 BR BKN002 PROB30 0213/0216 3000 BR FEW002=

d. **BDN Area Forecasts on 2 Nov 15**. The BDN Met Office produced Area Forecasts which covered BDN airfield and a 35km radius from the airfield. During the morning, 2 Area Forecasts were issued for BDN, covering the 0800 to 1800 time period. Figure 21 shows the cloud, visibility and general weather forecasts from the 2 Area Forecasts. Exhibit 45 Exhibit 127

[56] The 0700 hrs TAF only forecast until 1500 hours, before the planned recovery window of 1530-1600 hrs.

[57] The 0730 hrs TAF was the first TAF which forecast weather for the planned recovery window.

Exhibit 45

| | 0702hrs Area Forecast | 1105hrs Area Forecast |
|---|---|---|
| **Cloud** | OVC ST base 100-500, top 1500 gradually lifting to BKN/OVC ST base 500-800 top 1500 by 1200z with LCA breaks to SCT/BKN between 1300 and 1700z. | BKN/OVC ST base 100-500, top 1500 LCA lifting and breaking to FEW/SCT ST base 700 top 1200 to 1700z. |
| **Surface Visibility** | WDSPR 100-500M in fog/drizzle, gradually BECMG 1500-3000M in mist by 1300Z, LCA 4000M-6KM in haze between 1300 and 1700z. | WDSPR 200-700M in fog, LCA thinning to 2000-4000M in mist TL 1700Z. |
| **Weather** | WDSPR fog gradually lifting and thinning to mist by 1300Z. LCA fog re-forming FM 1700z. | WDSPR fog LCA thinning to mist TL 1700z. |

Exhibit 127

**Figure 21 - BDN Area Forecasts**

**Actual Met Conditions recorded on 2 Nov 15**

1.4.5.9. **Actual conditions**. Figure 22 and Figure 23 show the actual recorded visibility and cloud base recorded during 2 Nov 15 by the BDN Met Office and passed to BDN ATC. BDN airfield was recorded as colour code RED[58] from 0750 hrs until 1641 hrs. A slight improvement was detected after the crash of WK006 at 1650 hrs, with conditions reported as AMBER[59]. The cloud base remained at/below 100ft throughout the flight of WK006, and there was only a temporary improvement in surface visibility in the early afternoon, to 1600 metres (YLO2).

Exhibit 22

Exhibit 23

[58] RED conditions are defined as the lowest cloud base (SCT or more cloud) below 200 ft, with surface visibility less than 800 metres

[59] AMBER defined as SCT or more cloud with a lowest cloud base of 200ft, and surface visibility equal/greater than 800 metres

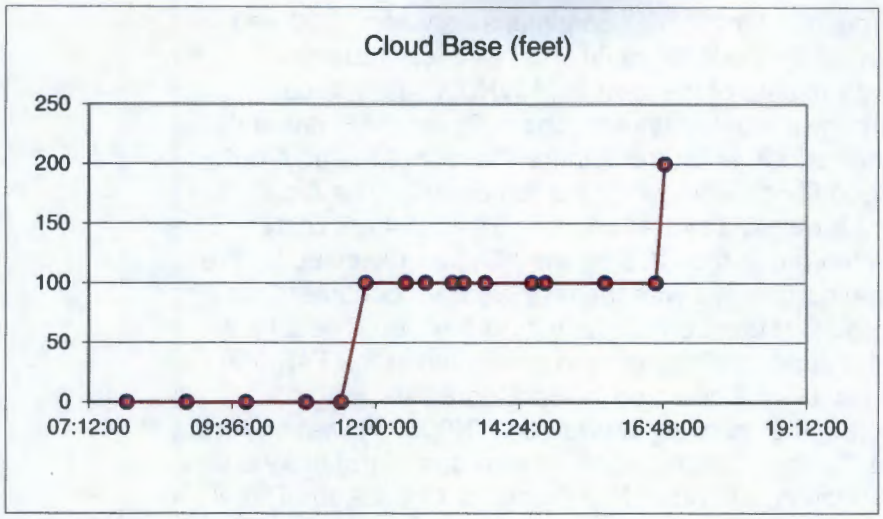


Exhibit 22

Exhibit 23

**Figure 22 - BDN Actual Surface Visibility 2 Nov 15**

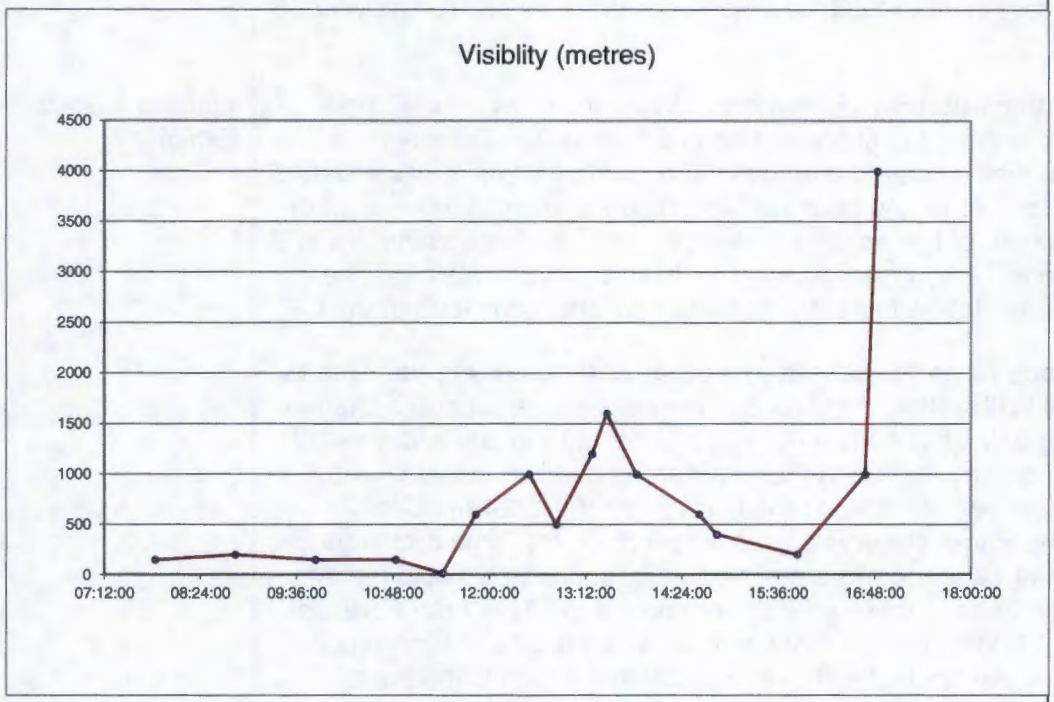


Exhibit 22

Exhibit 23

**Figure 23 - BDN Actual Cloud Base 2 Nov 15**

**Analysis of Met Considerations**

1.4.5.10. **Compliance with Regulatory Articles**. The Panel established that the crew had received a sufficiently detailed Met brief to satisfy the requirements of RA 2305. The Panel also found that the Captain and AO had satisfied the above requirements of RA 2115 and RA2306, outline at Para 1.4.5.5.

Exhibit 117

Witness 1-4

1.4.5.11. **Accuracy of Met Forecast**. The Panel has established that the products briefed at the Morning Brief at 0800hrs forecast RED conditions for the morning, with moderate improvements in the afternoon. The 0700 and

0730 TAF forecast an improvement to YLO2[60] conditions between 1300 and 1500 hrs, a forecast supported by the BDN initial cross-section and Area Forecast. However, around the time of the launch of WK006, the forecast improvement for the afternoon was being revised; the 1101 hrs TAF stated that it was likely that the RED conditions would remain for the rest of the day, with only a low probability that conditions would improve temporarily. The Area Forecast issued at 1105 hrs forecast a similar picture. The 1124 hrs BDN Cross-Section had been taken out to the GCS by the AO, and reviewed by the Captain; the Panel understands that this was the only weather document available and reviewed by the Captain during the flight of WK006. The Cross-Section illustrated a more favourable situation than presented in the TAF and Area Forecast. Viewed in isolation, it could be interpreted as showing a significant improvement during the recovery window of WK006. However, the Panel is of the opinion that Cross-Sections only form one part of the story and should be reviewed in conjunction with other Met products. Overall, the Panel concluded that the Met Forecast products available to the crew reasonably portrayed a day dominated by low cloud and poor visibility, with an initial forecast for an improvement to YLO2 conditions being reconsidered as WK006 got airborne.

1.4.5.12. **Crew Interpretation of Weather**. Whilst the crew and AO had differing recollections about the chance of an improvement in the afternoon weather conditions, they all stated that they were aware that the day's weather was dominated by low cloud and poor visibility. The Panel established that the Captain was fully aware of the weather conditions, had re-checked the WK RtS for weather limitations[61] following the Morning Brief, and was aware that he would probably need to follow the FRC procedure to land with cloud at the CP.

Witness 1,3,4,5
Exhibit 44

1.4.5.13. **Bty procedures for passing weather updates to crews**. Due to the long duration of WK sorties, the forecast and actual weather could change considerably during a WK flight. The Bty had a procedure in place for the AO to brief the Captain on any update to the weather, as detailed in Para 1.4.5.5 The AO stated that he verbally briefed the Captain on the 1124 hrs Cross-Section update. The Panel **observed** access to formal, real-time met products in the GCS was limited and therefore believe that best practice would have been for the Captain to have received a paper copy of the TAF, Area Forecast and Cross-Section. Additionally, in other long endurance UA's, it is common for crews to be in regular contact with Met Forecasters directly, and have access to real-time weather information. Due to the current fragility of UAs in certain weather conditions (cloud, icing, etc), it is extremely useful for the crew to be kept appraised of the changing forecast and conditions which may occur whilst airborne.

**Met Findings**

1.4.5.14. The Panel found that:

[60] YLO2 conditions are defined as the lowest cloud base (SCT or more cloud) between 200 and 300ft, with surface visibility between 800 and 1600 metres

[61] The environmental limitations that were in force, including those in the RtS, for the operation of the WK system are covered in Section 1.4.2.

a. The accuracy and interpretation of the Met brief was **not a factor**

b. The Flying Supervisor, AO, Captain and Crew had received detailed met products prior to the launch of WK006. They had carefully considered the implications of the weather and ensured they were launching in compliance with extant regulations and policies. The Panel established that they complied with the Regulations laid down in RA 2305, RA 2115 and RA 2306 but a real-time feed of weather information into the GCS would have improved their situational awareness.

1.4.5.15. **Recommendation. The Panel recommends that the Head of the Unmanned Air Systems Team considers the provision of real-time weather information in the Ground Control Station.**

**Sortie Planning and Briefing**

**Regulation, Policy and Orders**

1.4.5.16. **Regulation – MAA RA2115 - Responsibilities of Aircraft Commander**. RA 2115 stated that an Aircraft Commander should ensure that all necessary flight planning has been carried out in accordance with the ADS. Exhibit 117

1.4.5.17. **Regulation – MAA RA 2305 - Supervision of Flying**. RA2305 required Aviation Duty Holders and Commanders to define specific responsibilities for the supervision and co-ordination of all mission planning and aircrew briefing being conducted at units within their Area of Responsibility. Guidance material required that the briefing of aircrew before flight was essential and should be conducted in a thorough and professional manner. The RA provided a list of 13 topics, from aircraft details, to emergency procedures, which may be covered, when appropriate, during sortie briefs. Exhibit 117

1.4.5.18. **Regulation – MAA RA 2305 Aircrew Briefing**. Under Acceptable Means of Compliance, RA 2305 stated all flying units should have suitable aeronautical planning and briefing facilities to include at least the following[62]: Exhibit 117 Exhibit 104

a. *'A facility close enough such as not to invalidate time-sensitive mission planning e.g. NOTAMS and METARS'.*

b. *Adequate accommodation to prepare flight plans without distraction and in reasonable comfort, with access to all necessary flight planning material and information, including warning's.*

1.4.5.19. **BDN WK SOPS – Planning and Preparation**. The BDN WK SOPs contained a detailed overview of pre-mission planning and preparation, and is shown at Figure 24. It provided a detailed schedule of how personnel should work together towards launch of the UA. Also contained within the SOPS was a template 'Sortie Brief' and an 'Authorisers Out Brief checklist' and 'In Brief checklist'. The sortie brief was used by aircrew to plan the sortie and Exhibit 108

[62] JHC FOB J2305.115.3 also stated this requirement.

was updated in flight to record significant occurrences. The Authoriser's Out Brief checklist enabled the AO to review critical aspects of planning and preparation, and if content, to authorize the flying activity.

Day 2 WK Battle Rhythm

| | Prep Activity | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Air Notices, Met forecast | | | | | | | | | | | | | | |
| | NOTAMS, Update Pilots-to-see | | Prep Morning brief | | Morning brief | | Ring BCE Ops | | | Call SPTA AirOps | | | | | |
| | Site and Set up GCS/GDT | | Prep Msn brief | | Morning brief | | Crew Brief + Auth | UAS-c sign GCS&GDT 700 | Crew GCS | | Acq AV + Uploads | Datalinks Check | | | |
| | Msn pre-planning | | | Sign UA 700 (Capt) | | | | | | | | | | | |
| | UIU fitted (Assump) | GDT Power up (Alt Crew) | GCS Power Up (Alt Crew) | | | | Alt Crew Sign 700 | | | | | | | | |
| | | | | | Morning brief | | | | | | | | | | |
| | ATOLS, PATE, Arrestor DFS (Valid 24hrs) | | | FLSCU 1st Pde | PATE (AVBFS) | | | | | | | Tow to E | Arrive Threshold | LAUNCH / Clear 23 N | |
| | Assump 700s stay in FLSCU during daily Ops | | | | ATOLS | | | | | | | | Deploy Arrestors | | |
| | ATOLs, PATE, Arrestor TFS (Valid 7 days) | | | | | | | | | | | | | | |
| | UA DFS (Valid 24hrs) | | Confirm Eqpt Avail and prep UA 700 | | Morning brief | | | | | | | | | | |
| | UIU fitted (Assump) | Out briefs to GCS/GDT Set up crew | | | ATOLS, PATE, Arrestor Co-ord | | | UA, GCS, GDT 700 co-ord | | | | | | | |

**Figure 24 - Day 2 WK Battle Rhythm from WK BDN SOPS.**

## Planning and Briefing Sequence of Events on 2 Nov 15

1.4.5.20. Personnel followed the Battle Rhythm on the morning of 2 Nov 15 as follows: Witness 2

a. **Morning Brief**. The Crew, AO, Flying Supervisory, REME maintainers, Launch and Recovery Det and Bty support personnel all attended the Morning Brief at 0800 hrs. Following the Met Brief, the Ops brief covered airspace allocations for the day, crew constitution, sortie objectives, and identified equipment which would be used. Witness 3,4

b. **Crew Planning and Sortie Brief**. The Pilot and Payload Operator carried out the majority of the pre-flight mission preparation, as described in Part 1.3. The Captain liaised with BDN ATC and Main Ops to ensure they were content with WK launching in RED conditions. When planning was complete, the Pilot delivered the Sortie Brief to the Captain and Payload Operator. The Flying Supervisor also attended this brief. Witness 1,2,3,4

c. **Authorising Officer Brief (WK Out Brief)**. The Pilot gave a brief to the AO, who subsequently authorized the sortie. The crew then departed from the ops building to configure the GCS. Witness 1, 4,7

## Analysis of sortie planning and briefing

1.4.5.21. **Compliance with Regulatory Articles**. The Panel established

that on 2 Nov 15, personnel followed extant sortie planning and preparation procedures, ensuring that the requirements of RA2305 were met. Furthermore, the Panel established that the Captain planned the sortie in accordance with the ADS, thereby satisfying the requirements under RA2115.

1.4.5.22. **Pre-flight schedule**. As shown in Figure 24, the Bty had a comprehensive overview of the tasks requiring completion prior to launch. The Panel found that personnel had followed the BDN SOPs, and were not time constrained. Whilst the Pilot stated that the crew 'walked' to the GCS a little later than ideal, due to the extra time required to consider the weather, none of the crew stated that they rushed procedures, preparation or briefing. The Panel established that the pre-flight schedule on 2 Nov 15 reflected normal procedures and apart from the extra discussions and emphasis with regards to weather met the required timeline. The Panel, therefore, concluded that the pre-flight schedule was appropriate and was **not a factor.** Witness 1,2,3,4 Exhibit 108

1.4.5.23. **Ops Personnel.** The Panel considered whether the Ops Personnel were Suitably Qualified and Experienced Personnel (SQEP).

a. **External Assurance by JHC**. Two previous external inspections highlighted concerns over the limited availability of Ops SQEP. An inspection in Apr 15 by AAvn Sds stated that 'Ops Room personnel were not able to deliver comprehensive and effective Ops Room functions. Planning boards were not kept updated with the correct information and in some cases publications were out of date'. The inspection also found that the availability of SQEP was contributing to a situation which had a 'significant effect on flight safety'. A JHC Air Safety Assurance Visit for 1ISR Bde in Jun 15 also highlighted that the WK Ops staff at BDN were not SQEP as they had not completed the recognised Shawbury delivered Flight Operations Army Rotary Cse[63]. Exhibit 105 Exhibit 128

b. **Panel Analysis**. The CALF[64] document displayed in the Bty was over 4 months out of date on 2 Nov 15. Additionally, the Panel established that the NOTAM LFC[65] Map in the Planning and Briefing Room showed no record of CALFs being included (Figure 25). Whilst the Panel identified that the limited availability of Ops SQEP was in the process of being addressed by JHC and mitigations had been put in place, such as Army personnel being seconded to BDN Main Ops, the Panel **observed** that WK Ops personnel were not sufficiently SQEP, with potential implications on the safe operation of WK. Exhibit 129 Exhibit 130

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[63] There was no bespoke UAV Flight Operations Cse in existence at the time of the crash of WK006.

[64] The Chart Amendment Low Flying (CALF) is produced every 28 days. It provides an amendment service for the paper LFC charts and is available in paper or can be downloaded from the AIDU MilFLIP website.

[65] Low Flying Chart.

Exhibit 130


**Figure 25 - NOTAM display in Bty Planning/Briefing Room**

1.4.5.24. **Recommendation. The Panel recommends that the Delivery Duty Holder should:**

a. **In the short term, ensure that WK Operations personnel attend an existing Flight Operations Course.**

b. **Consider, in the longer term, developing a bespoke Flight Operations Course, to ensure Operations personnel are qualified to support WK flying operations.**

1.4.5.25. **Crew readiness and fatigue**. The sortie had been programmed towards the end of the previous week. The crew were aware that they were programmed to fly on Monday and were rested following the weekend. The crew had rest breaks during the flight, and were well within the stated crew duty limits in the JHC FOB. The Panel therefore consider crew readiness and fatigue was **not a factor**.

Witness 3 (A8), Witness 4 (A34), Exhibit 104

1.4.5.26. **WK Infrastructure at BDN**. In Apr 15, an inspection by AAvn Stds raised concerns about the WK infrastructure at BDN. The Panel established that improvements had been made between publishing the inspection report and the accident involving WK006. By the time of the accident, aircrew had been given a separate office for planning and briefing purposes (Figure 26), and were able to plan and brief without distraction, a requirement of MRP 2305. However, the Panel:

Exhibit 105

a. Established that at the time of the accident, DII connectivity at BDN was intermittent and slow, therefore potentially limiting access to time-sensitive material, important to the safe operation of WK. This had been highlighted by AAvn Stds prior to the crash of WK006. The WK BDN SOPs stated that the Bty was to receive Met products from the BDN Met Office via a civilian email address. The Panel **observed** that the DII computer infrastructure was

Exhibit 131

Exhibit 108

inadequate to support flying training operations.

b. **Observed** that the planning and briefing facilities were inadequate. The room available to plan and brief (Figure 26) was extremely limited in size considering the number of crew involved. Additionally, the Bty Ops set up did not follow recognised best practice by providing a dedicated flight authorisation area. Exhibit 131

Exhibit 132

**Figure 26 - Planning and Briefing Facility for WK at BDN**

1.4.5.27. **Recommendation. The Panel recommends that the Head of Capability Combat Support should ensure that:**

a. **The information infrastructure at WK operayting locations is sufficiently robust to support safe WK flying.**

b. **The planning and briefing facilities are improved to enable crews to safely plan WK sorties without undue distraction.**

**Conclusion**

1.4.5.28. The Panel believe that the personnel involved in the operation of WK006 on 2 Nov 15 planned and briefed for the sortie to a sufficient standard. In the context of the need to continue the training of the Pilot and PO, and in the absence of any formal limitation in the ADS, which would have precluded flying in the meteorological conditions of the day, the Panel believe that it was a reasonable decision to launch WK006 on 2 Nov 15.

## SECTION 1.4.6 – SUMMARY OF FINDINGS

1.4.6.1. **Causal Factors**. A Causal Factor is a factor which, in isolation or in combination with other factors and contextual details, led directly to the accident. The Panel identified 3 causal factors, which are as follows:

a. Use of the laser altimeter height at the CP to open a *Ground Touch identification time window* (Paragraph 1.4.1.34.a).

b. Cloud at the CP (Paragraph 1.4.1.34.b).

c. Flawed VMSC software logic (Paragraph 1.4.1.34.c).

1.4.6.2. **Contributory factors**. A contributory factor is a factor which made the accident more likely. The Panel identified 11 contributory factors, which are as follows:

a. Limited UK understanding of the technical issues concerning the recovery of WK (Paragraph 1.4.2.62).

b. Paucity of information on the landing phase within the ADS (Paragraph 1.4.2.92b).

c. The absence of cloud and visibility limitations for the recovery phase in the RtS (Paragraph 1.4.2.92c).

d. The UAS TAA was not informed of the weather restriction in place at WWA (Paragraph 1.4.2.92d).

e. The absence of role specific AO training (Paragraph 1.4.4.80).

f. Normalisation of the use of the Low Cloud Recovery Procedure (Paragraph 1.4.2.85).

g. The decision to operate when low cloud was forecast during the planned recovery period (Paragraph 1.4.1.45).

h. Pursuing attempts to land with cloud at the CP (Paragraph 1.4.1.48).

i. The decision making process that led to the premature selection of MO (Paragraph 1.4.1.57).

j. Selection of MO (Paragraph 1.4.1.54).

k. The pitch down manoeuvre to intercept the glideslope following the CP (Paragraph 1.4.1.37).

1.4.6.3. **Aggravating factors.** The Panel did not identify any aggravating factors.

1.4.6.4. **Other factors.** An other factor is a factor which was not a causal, contributory or aggravating factor, but was noteworthy in that it may cause or contribute to future accidents. The Panel identified 2 other factors. They were:

a. Deviating from FRC guidance without sufficient justification

(Paragraph 1.4.1.74).

b. The Captain and the AO did not meet all of the currency requirements stated in the 1 ISR Bde FOB (Paragraph1.4.4.73).

1.4.6.5. **Observations.** The Panel made 39 observations, which were not relevant to the accident but worthy of consideration to promote better working practices. These are as follows:

a. WK did not have a crashworthy FDR (Paragraph 1.4.1.76).

b. WK did not have a GCS playback capability (Paragraph 1.4.1.77).

c. A number of the expected CVR files were either missing or corrupt (Paragraph 1.4.1.78).

d. There was no stated requirement to formally respond to the Safety Advice issued by DG MAA (Paragraph 1.4.2.49).

e. The ADS did not clearly specify areas personnel should remain clear of during WK launch and recovery operations (Paragraph 1.4.2.51).

f. Safety Case assumption T85 may not be valid regarding the use of observers to ensure the landing site remains clear or personnel (Paragraph 1.4.2.51).

g. The UAST was functioning without an active ISA from the end of Jan until May 15 (Paragraph 1.4.2.54).

h. The lack of information in the RtS relating to ATOL requirements, could contribute to the level of operator appreciation about limitations and therefore capabilities (Paragraph 1.4.2.65).

i. There was no ODM for WK (Paragraph 1.4.2.67).

j. The IETP did not provide a suitable platform to act as an Aircrew Manual. (Paragraph 1.4.2.69).

k. There was insufficient information within IETP v7.1 relating to the landing phase (Paragraph 1.4.2.69).

l. There were inconsistencies within the FRCs and between the FRCs and IETP (Paragraph 1.4.2.71).

m. Limited availability of SQEP in AAvn Stds and the reliance on Thales UK could have reduced the effectiveness of the verification and assurance process for the FRCs (Paragraph 1.4.2.72)

n. Inconsistent procedures within the ADS could confuse operators and undermine the safe operation of the platform (Paragraph 1.4.2.92e).

o. The presence of environmental material in the main oil tank was most likely to be a result of poor maintenance practices (Paragraph 1.4.3.13).

p. The ATOLS fibre optic cable was reported to suffer poor serviceability (Paragraph 1.4.3.19a).

q. The L&R Det did not have fibre optic connector cleaning kits (Paragraph 1.4.3.19b).

r. The previous 90 days of Auth Sheets did not provide a comprehensive and accurate record of WK flying (Paragraph 1.4.4.9).

s. The logbooks reviewed failed to comply with RA2401 and the 1 ISR FOB (Paragraph 1.4.4.13).

t. Army Book 646 (Logbook) did not capture all WK flying data, including information relating to specific currency items (Paragraph 1.4.4.14).

u. Training records were not maintained to the required standard and did not follow the guidance issued by AAvn Stds (Paragraph 1.4.4.22).

v. There was not a reliable method for capturing individuals' currencies and providing an overview to the supervisory chain. (Paragraph 1.4.4.25).

w. The use of non-SQEP instructors, who were not qualified on WK, to deliver WK Level 3 Ground-school Trg, did not represent best practice (Paragraph 1.4.4.31).

x. The WK LCR qualification was listed as one the 3 experience and competency requirements to become qualified as a WK Captain, but was not awarded at the time of the accident (Paragraph 1.4.4.42).

y. The Form 3 for the Captain's C to I assessment was completed after the loss of WK006 (Paragraph1.4.4.49).

z. The C to I assessment conducted on the Captain was not independent, as mandated in RA2125 (Paragraph 1.4.4.49).

aa. The terminology in the 1ISR FOB, calling all WK Instructors 'C to I', was misleading and did not comply with higher guidance from JHC (Paragraph 1.4.4.52).

bb. The WK instructors had not received AI training at a 'recognised training unit', in contravention of RA 2125(1) (Paragraph 1.4.4.56).

cc. The WK instructors who awarded CQT to the Pilot and PO of WK006, had not been assessed as competent to do so by CFS, in contravention of RA 2125(1) (Paragraph 1.4.4.56).

dd. The reduced 'hands-on' live flying hours requirement of Instructors, did not represent best practice (Paragraph 1.4.4.63).

ee. The reduced 'hands-on' simulator flying hours requirement of Instructors, did not represent best practice (Paragraph 1.4.4.67).

ff. There was no record that the Captain and AO had attended a Unit or Bty Air Safety training day, or crew room discussion (Paragraph 1.4.4.71).

gg. The Flying Supervisor was not qualified on type (Paragraph 1.4.4.85).

hh. There was an inadequate level of flying supervision (Paragraph 1.4.4.87).

ii. There was a paucity of WK SQEP across 43 Bty, 1ISR Bde and JHC (Paragraph 1.4.4.89).

jj. There was no access to formal Met products in the GCS (Paragraph 1.4.5.13).

kk. WK Ops personnel were not sufficiently SQEP, with potential implications on the safe operation of WK (Paragraph 1.4.5.23)

ll. DII computer infrastructure was inadequate to support WK flying training operations (Paragraph 1.4.5.26a).

mm. The planning and briefing facilities on 43 Bty were inadequate (Paragraph 1.4.5.26b).

## PART 1.5 – RECOMMENDATIONS

| Recommendation | | Analysis Reference |
|---|---|---|
| 1.5.1. | **Introduction**. The following recommendations are made in order to enhance Defence Air Safety: | |
| 1.5.2. | **Director General, Defence Safety Authority should:** | |
| | a. Consider stating a requirement for the recipient to respond within a given timescale to Safety Advice issued. | 1.4.2.50 |
| 1.5.3. | **The Operating Duty Holder (ODH) should:** | |
| | a. Ensure that WK Flight Reference Cards are reviewed by Suitably Qualified and Experienced Personnel who are independent of Thales UK and have in-service military experience of operating WK. | 1.4.2.74 |
| | b. Ensure that Army Aviation Standards has suitably qualified and experienced personnel to act as Independent Assessors for WK training assurance purposes, as stipulated in the JHC Flying Order Book and mandated in RA2125. | 1.4.4.50 |
| | c. Review WK qualification and experience requirements to ensure there is a baseline of Watchkeeper suitably qualified and experienced personnel across JHC, 1ISR Bde and 47 Regt RA. Until this is achieved, consideration should be given to embedding personnel with manned aviation experience, across the WK organisation. | 1.4.4.90 |
| 1.5.4. | **Head of Capability Combat Support should:** | |
| | a. Ensure the information infrastructure at WK operating locations is sufficiently robust to support safe WK flying. | 1.4.5.27 |
| | b. Ensure the planning and briefing facilities are improved to enable crews to safely plan WK sorties without undue distraction. | 1.4.5.27 |
| 1.5.5. | **Head Unmanned Air Systems Team should:** | |
| | a. Ensure that the Vehicle Management Systems Computer landing mode software logic is modified to prevent a *Ground Touch* declaration and post landing actions being commanded whilst the aircraft is still airborne. | 1.4.1.35 |
| | b. Investigate and provide advice to operators on how to set up a recovery route to minimise the possibility of sensing a false *Ground Touch* as a result of a pitch down manoeuvre to intercept the glideslope after the Connect Point. | 1.4.1.38 |
| | c. Review the risks associated with incorrect laser altimeter readings and ensure they are adequately mitigated. | 1.4.1.44 |
| | d. Provide a reliable flight data and CVR audio recording and download solution, for the purpose of assisting accident and incident | 1.4.1.79 |

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| investigations. | |
| e. Provide a GCS playback capability to assist with crew debriefing and the investigation of faults, incidents and accidents. | 1.4.1.79 |
| f. Obtain a full and detailed functional description of the Flight Control System and all Vehicle Management System Computer logic and include this information in the Aircraft Document Set in sufficient detail to assist aircrew in dealing with unusual or emergency situations. | 1.4.1.87 |
| g. Commission a thorough review of the system logic to determine all circumstances in which a *Ground Touch* could be sensed by the aircraft whilst it is airborne. | 1.4.1.87 |
| h. Ensure a robust and auditable system is used for recording the consideration, sentencing and actioning of safety and airworthiness advice. The system should be capable of providing feedback to the originator to ensure that the intent of any such advice has been understood. | 1.4.2.21 |
| i. Ensure sufficient detail is included in the Aircraft Document Set to allow the Delivery Duty Holder to define appropriate safety distances for personnel during WK Launch and Recovery operations. | 1.4.2.53 |
| j. Ensure that the Project Team receives uninterrupted independent safety advice, to satisfy the requirements in Def Stan 00-56, RA1220 and the DE&S Safety and Environmental Handbook. | 1.4.2.55 |
| k. Ensure that the Project Team obtain and record independent technical evaluation when assessing technical information underpinning their Safety Assessment/Case. | 1.4.2.57 |
| l. Submit a Release to Service recommendation to the Release to Service Branch (Army) to include explicit ATOL procedures and limitations, including recovery set-up and operation, in the WK Release to Service. | 1.4.2.66 |
| m. Consider introducing a WK Operating Data Manual. | 1.4.2.68 |
| n. Introduce an Aircrew Manual for WK, which is readily accessible to crews, both in the Ground Control Station and for self-study. | 1.4.2.70 |
| o. Ensure that there is sufficient information in the Aircrew Manual to enable operators to deal with emergency/unusual situations. | 1.4.2.71 |
| p. Ensure that the Aircraft Document Set and all training material reflects the exact wording of all warnings, cautions and advisories that could be seen by WK operators. | 1.4.2.73 |
| q. Ensure that weather limitations relating to cloud and visibility during automatic take-off and landing phases of flight, are introduced into the Release to Service and Military Flight Test Permit and that | 1.4.2.93 |

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| | these limitations reflect the actual capability of the system. These limitations should be underpinned by comprehensive test and evaluation evidence. | |
| | r. Ensure that WK crews have unambiguous advice about operating WK should cloud develop at or below the Connect Point. | 1.4.2.93 |
| | s. Establish regular communication between Thales UK, the Unmanned Air Systems Team and the Army WK Organisation to ensure that pertinent safety information concerning the operation of WK is passed between organisations. | 1.4.2.93 |
| | t. Remove all references from the Aircraft Document Set and training material to WK being 'an all-weather system'. | 1.4.2.93 |
| | u. Review the design and use of the Automatic Take-Off Landing System fibre-optic cable to ensure its reliability in service. | 1.4.3.20 |
| | v. Provide fibre optic cable cleaning kits and appropriate training to ground crews. | 1.4.3.20 |
| | w. Consider the provision of real-time weather information in the Ground Control Station. | 1.4.5.15 |
| 1.5.6. | **The WK Delivery Duty Holder (DDH) should:** | |
| | a. Ensure that WK operators should, by default, follow FRC guidance and only deviate from the prescribed procedures and drills by exception. | 1.4.1.75 |
| | b. Review assumption T85 in the WK Safety Case to ensure that it remains valid. | 1.4.2.52 |
| | c. Provide WK flying units with bespoke Authorisation Sheets, suitable for accurately recording WK flying, including the key elements required for currency. | 1.4.4.10 |
| | d. Provide direction to WK flying units on how they are to formally record simulator training. | 1.4.4.10 |
| | e. Issue direction to WK flying units on how WK Auth Sheets are to be completed, to ensure compliance with RA2401 and ensure all relevant WK flying activity is accurately recorded. | 1.4.4.10 |
| | f. Ensure that WK crews and supervisors receive detailed direction and guidance to accurately complete a flying logbook. | 1.4.4.15 |
| | g. Provide a logbook that is suitably designed to record all WK flying activity, including essential currency requirements. | 1.4.4.15 |
| | h. Ensure subordinate units maintain flying records in accordance with extant direction, thereby satisfying the Regulatory requirements within RA 2401. | 1.4.4.23 |

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| i. Ensure aircrew, supervisors and those in support functions, receive appropriate training to ensure their aviation records are maintained to the required standard. | 1.4.4.23 |
| j. Ensure that aircrew flying records are readily accessible to the supervisory chain during flying operations. | 1.4.4.23 |
| k. Issue guidance to civilian contractors flying on Army WK units on how they are to record their flying history, qualifications and competencies, to enable the supervisory chain to have the suitable oversight. | 1.4.4.23 |
| l. Ensure that subordinate units are provided with a robust system to track currency information, such as Squadron Training Achievement Recording System (STARS). | 1.4.4.26 |
| m. Ensure that Certificate of Qualification on Type qualifications are accurately recorded in logbooks following successful completion of the prescribed training course, as directed in 1ISR Bde Flying Order Book U2041(2). The certificate should also be recorded on a Form 3 and placed in a Flying Record Folder. | 1.4.4.38 |
| n. Review the experience and competence requirements necessary to become WK Captains, pending the availability of the LCR competency. | 1.4.4.43 |
| o. Ensure that Instructor assessments are formally recorded at the time of the assessment and a suitable audit trail maintained in the Flying Record Folder, to provide Supervisory oversight and ensure compliance with RA2125. | 1.4.4.51 |
| p. Align the terminology used in the 1ISR Flying Order Book describing WK Instructors to the definition found in the JHC Flying Order Book. | 1.4.4.53 |
| q. Ensure that WK Instructor Training adheres to the Regulations stipulated in RA 2125, or seeks a waiver or an additional Acceptable Means of Compliance. | 1.4.4.57 |
| r. Review the reduced 'hands on' live flying requirement for WK Instructors. | 1.4.4.64 |
| s. Review the reduced 'hands on' simulator flying requirement for WK Instructors. | 1.4.4.68 |
| t. Ensure that units conduct mandated Air Safety Training days. | 1.4.4.72 |
| u. Introduce a robust governance structure to ensure WK pilot currency, both live and synthetic, is accurately recorded, tracked, maintained and assured. | 1.4.4.74 |
| v. Implement a bespoke WK Authorising Officer training package, to ensure individuals have the required knowledge, skills and experience to act as effective Authorising Officers. | 1.4.4.81 |

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| | w. Ensure that WK Flying Supervisors hold a WK Certificate of Qualification on Type and are in current flying practice before they assume the role of Flying Supervisor. | 1.4.4.86 |
| | x. Review the pre-employment qualifications and experience to become a WK Flying Supervisor. | 1.4.4.88 |
| | y. In the short term, ensure that WK Operations personnel attend an existing Flight Operations Course. | 1.4.5.24 |
| | z. Consider, in the longer term, developing a bespoke Flight Operations Course, to ensure Operations personnel are qualified to support WK flying operations. | 1.4.5.24 |
| 1.5.7. | **Royal Artillery HQ Regimental Colonel should:** | |
| | a. Review Officer career development paths to grow UAS Troop and Battery Commanders with sufficient experience as UAS operators, to enable them to be effective supervisors. | 1.4.4.91 |
| 1.5.8. | **Chief Instructor Unmanned Air Systems, the Royal School of Artillery should:** | |
| | a. Ensure that ground school Instructors are suitably qualified and experienced to deliver WK Level 3 Training. | 1.4.4.32 |
| 1.5.9. | **The Delivery Duty Holder Chief Air Engineer should:** | |
| | a. Ensure that appropriate measures are adopted to ensure the risk of oil contamination is minimised. | 1.4.3.14 |

## PART 1.6 - CONVENING AUTHORITY COMMENTS

1. Watchkeeper number 006 (WK006) was the second Watchkeeper (WK) air vehicle to crash in just over 12 months, the first being WK031 at West Wales Airport in Oct 14. Both crashes were as a result of the Vehicle Management System Computer (VMSC) commanding post landing actions (V-tail deflection) whilst the vehicles were still airborne. In both cases, the VMSC sensed and latched a false Ground Touch, although the hazard entry condition in each case was different, WK031 being a gust of wind and WK006 a pitching manoeuvre (to capture the glideslope) both of which produced negative accelerations to the point of the VMSC registering Ground Touch. In both accidents the laser altimeters were reading erroneously during periods of the approach either due to fog below the air vehicle or a wet runway causing reflections. These conditions set the scene for the vehicle to believe it was on the ground during the semi-flare when it was in fact still airborne. It is of concern that further unforeseen technical hazard entry conditions existed which meant that mitigation of known system issues was insufficient to prevent reoccurrence. Accordingly, the Service Inquiry (SI) Panel believes the operation of WK with the flawed VMSC logic still carries an undefined safety risk, unless it can be shown that there are no other conditions that could lead to a false Ground Touch being sensed.

2. This has been a long and complex SI and I commend the Panel for their efforts in determining a whole range of significant matters surrounding the cause of this accident. I agree with their identification of the 3 causal factors, 11 contributory factors and 39 observations and I endorse the recommendations made which when complete will make the WK a safer and more effective platform. It will not be possible in this short précis to cover all of the issues in this SI in any substantial detail but I will try and give a feel for the main points. I would like to thank industry and the DE&S for their co-operation during this technically demanding investigation but would note that VMSC logic and flight control system is extremely complex and despite best efforts from all involved, the Panel never gained a sufficiently detailed understanding to be able to provide comment on the prospect of further hazard entry conditions existing. I suggest this is something that the Project Team may now wish to pursue. Finally, comment in this report is aimed entirely at the WK automatic landing sysem and not the wider WK capability which was clearly out of scope of this SI.

3. It is worth starting by trying to explain what lies at the heart of this and the previous WK accident. The WK automatic landing system appears to work as designed in good weather but in poor weather, including low-cloud, fog, gusts, precipitation or a combination of these conditions, anomalies in the system can make the air vehicle self-abort its approach to landing; for example, wind gusts or sudden vehicle manoeuvre can cause a combination of pitch rate and acceleration sufficient for Ground Touch to be sensed or the laser altimeters can register false height due to fog or low cloud below the vehicle or reflections off wet operating surfaces. Accordingly, the management of these events by the software in the VMSC will likely result in the vehicle aborting its approach. If the operator then wishes to force the vehicle to land, the selection of Master Override (MO) will remove the in-built safety protection which causes the abort and allows the vehicle to continue its approach unless a manual abort is commanded by the crew. Clearly, therefore, the decision to select MO is significant as it increases the risk of the air vehicle crashing. It is of course accepted that as a last resort the automatic protection might need to be overridden to force the vehicle to land, for example when it becomes low on fuel. In the case of WK006, decision making with regard to selection of MO had been influenced to varying degrees by airmanship, past experience from WK031 crash, weak supervision and a lack of crew understanding of the system. In mitigation, crews have not been helped in their decision-making by poor

documentation of procedures in Flight Reference Cards (FRCs) and other aircrew publications. This, combined with poor flying administration (logbooks, authorisation sheets and training records), training shortfalls, emergency procedure omissions and currency issues, has further compounded the possibility of air vehicle loss.

4. Following 2 self aborts by the WK006 air vehicle due to fog, the crew selected MO which removed the safety measures protecting the air vehicle and which had led to the 2 initial aborted approaches. The Panel considered that the decision to select MO was premature considering that, with significant fuel available, options were available to hold, seek further advice or wait for an improvement in weather. In this case, following the selection of MO, on the final approach with fog at the Connect Point (CP), the laser altimeters reading less than one metre caused the VMSC to open the Ground Touch identification window at an altitude of 360 ft which was followed shortly afterwards by the vehicle manoeuvring to capture the 3 degree glidepath causing an acceleration and pitch rate which caused the Ground Touch to latch and declare that the aircraft was on the ground. Therefore, once the aircraft had reached the 22 ft semi- flare then all conditions were satisfied to allow the post landing actions to occur, with the V-tail deploying and the vehicle crashing in a 35 degree dive.

5. As with the WK031 accident, weather has played a significant part in the outcome. Neither the Release-to-Service (RtS), Interactive Electronic Technical Publication (IETP) or FRCs make any reference to weather limitations during aircraft recovery. Specifically, the IETP states that WK is an all-weather aircraft which is not true and has likely led to operators having expectations beyond its true capabilities. Importantly, the RtS contained no limitations or cautions about cloud or visibility limitations during recovery. Although unrelated to the issues described surrounding the landing logic, Thales UK had limitations in place at West Wales Airport regarding cloud at the CP since 2013, although, surprisingly, this had not been communicated to the MOD Type Airworthiness Authority or the Army operators at Boscombe Down. This was a missed opportunity. Overall, the Panel concluded that personnel operating WK006 at the time of the accident did comply with extant environmental (weather) orders and instructions which were reasonably available to them at the time. However, it is clear that these orders, instructions and documentation were woefully inadequate, misleading and difficult to determine. It is disappointing that the WK development community did not recognise or, even when they were identified, communicate these environmental limitations which were determined by the Panel to be contributory. It is unlikely that these shortcomings in understanding and communicating the weather limitations could have happened to one of our manned platforms, which is a strong indication that the governance and control arrangements at various levels were not fit for purpose. For example, no weather limitations (cloud base and visibility) were specified in the RtS even when the problem was known.

6. There are a wealth of aviation husbandry issues surrounding this accident which were largely observations by the Panel but in my view they reinforce a lack of aviation governance and flying ethos behind the operation of WK. Accordingly, the flying supervision was inadequate at the time of the accident. The Panel were unable to ascertain the live flying currency and simulator currency of both the Captain and the Authorising Officer (AO). Further, the Panel found it unlikely that either the Captain or the AO had completed the prescribed emergency or collective training. The Panel found that the Delivery Duty Holder (DDH) organisation was proactive and had a sound supervisory framework in place but that given the embryonic stage of the growth of the WK cadre in the Army, there was extremely limited availability of appropriately experienced supervisors. Of note, no officers in 1 ISR

Bde or JHC were qualified on type, with the reliance being placed on a few NCOs and Thales UK employees. The Flying Supervisor on the day of the accident was not qualified on WK and therefore had to rely on the AO and Captain with regard to launching the WK that morning in adverse weather conditions. Following the launch of the WK, the Flying Supervisor was not involved in the flight of WK006 again that day until it had crashed.

7. Following the accident of WK031 in Oct 14, the SI Panel issued Safety Advice regarding the software in the VMSC. The Project Team (Unmanned Air System Team (UAST)) appeared not to consider this advice to be a safety issue. The UAST judged that it was a capability issue with no increase in Risk to Life (RtL) as, in their opinion, the air vehicle would be likely to crash on the runway. They also considered that a repeat of the weather conditions which caused the first accident to be unlikely. I find this an interesting proposition for an aircraft safety case and consider that treating SI Panel Safety Advice as a capability issue and not a safety issue was an unusual judgement even after accepting that RtL in all probability remained low. The balance between this being a RtL and a risk to platform capability is for the Operating Duty Holder to decide and accept if the system is to remain airworthy. The Panel noted that the UAST considered other mitigation as an alternative to software modification. Thales UK suggested specific design improvements that could be considered including modification to altimeters, removal or modification of Ground Touch identification when MO was selected and the introduction of a physical weight-on-wheels sensor. It is accepted that there was no simple fix to implement the safety advice and eventually the activity stalled with the UAST electing to wait for the WK031 SI to report and Thales UK waiting for further direction from the UAST.

8. In summary, clearly the VMSC software needs to be fixed before WK is able to provide a reliable and credible capability in a range of weather conditions. I have no doubt that this can be done and the technical issues will be fixed. However, this accident and that of WK031 have again raised some disappointing organisational, control of activity and governance issues which will be less easy to put right. There is no doubt that while the programme has many people doing their best, it suffers from a lack of air or aviation mindedness at every turn. Flying remains safe when it is supervised, controlled and governed by aviators with the right experience who are able to apply judgement and airmanship where and when needed. I have made this comment before and these issues go back beyond the 2 WK crashes to include lessons from Hermes 450 in 2011. It is most welcome that CGS has directed that WK is placed under the command of the JHC which is a great step forward but this, on its own, will not provide an instant solution to some of the wider issues that we have seen. This move will need to be supported by a raft of through-life activity to inculcate appropriate air-mindedness into the WK cadre; this activity would need to include a review of training and personnel policies including the career management of WK operators and supervisors. It is proven that those who are not manned aircraft pilots can successfully fly and operate UAVs but this must be done within a framework that has its roots and ethos in aviation.

**DG DSA**