PART 1.4 – FINDINGS

Methodology

1.4.1 **Accident Factors.** Each finding by the Panel is attributed the following accident factors[1]:

a. **Cause.** Factors that led directly to the accident.

b. **Contributory.** Factors that did not directly cause the accident, but made it more likely.

c. **Aggravating.** Factors that did not cause the accident but made the final outcome worse.

d. **Other.** Factors that were none of the above but could contribute to, or cause, a future accident.

e. **Observations.** Factors that, whilst not germane to the accident and not thought likely to influence a future accident, were considered important aviation safety-related issues worthy of comment.

1.4.2 **Human Factors Modelling.** Prof James Reason offers a well recognised and widely employed technique to identify multiple hierarchical, socio-technical and interrelated factors that influence an occurrence. Known colloquially as the 'Swiss Cheese' model (Reason, 1997), the Panel has exploited the work of Reason in its analysis of the accident involving XW211 by assessing evidence across the following categories[2]:

a. **Unsafe Acts.** Fact-based non-judgemental statements aimed purely at categorising potentially unsafe acts of an individual (or team), whether intentional or unintentional; the aim being to clearly identify specific error types so that a correct assessment can be made of human performance issues relating to cited accident factors. Grouped as[3]:

(1) **Unintentional Acts.**

(a) **Slips.** Error by commission; where a well practiced skill, requiring little cognition, is carried out incorrectly.

(b) **Lapses.** Error by omission; where a well practiced skill, requiring little cognition, is not carried out.

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[1] Aviation Safety Information Management System (ASIMS) User Guide, V3.1.

[2] ASIMS exploits a similar methodology.

[3] Note for the purpose of this SI, the Panel considers an error has occurred when the individual (or team) fails to achieve what a given situation required (whether a consciously planned action or not).

(2) **Intentional Acts.**

(a) **Mistakes.** Deficiencies in judgement and/or failing to formulate the right plan based on flawed knowledge and/or incorrect comprehension of rules.

(b) **Violations.** Deliberate and conscious departures from established rules/procedures, although often with no intent to cause harm.

b. **Error Promoting Condition (EPC).** The psychological, physical/mental limitations and physiological factors that can influence human performance, i.e. capacity, fatigue, etc.

c. **Organisational Influences.** The broader (often indirect and latent) influences that a higher organisation brings to bear on those involved in an occurrence, and which are beyond those individuals control in terms of resources, climate, etc.

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

1.4.3 **Causation.** Key to the Panel's exploitation of Reason's HF model was a coherent and consistent approach to understanding accident causation. This in turn facilitates a clear understanding of short-comings within each category, for which the Panel can consider appropriate intervention strategies; thereby delivering recommendations targeted at preventing or reducing the likelihood of recurrence.

1.4.4 **Available Evidence.** The Panel had access to the following evidence:

a. Interviews with the crew of XW211 and other witnesses.

b. Formal statements from witnesses.

c. CVR, providing cockpit voice and area microphone recordings of the final 2 hours of the sortie.

d. Photography from various sources.

e. Relevant orders, TORs and documentation including flying logbooks, ac documentation, sortie planning and briefing materials.

f. Wreckage of XW211.

g. Ac technical report by MAAIB LAI.

h. Technical reports by 1710 NAS MIG, QQ and DfT AAIB.

i. A detailed review of XW211 documentation conducted by QA&S at RAF Benson.

j. Reports provided by RAFCAM.

k. Flying (simulated) assessment by the Aircrew Member.

l. All flight safety related material, including ASIMS and Puma PT reports.

m. Previous BoI Reports.

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

a. The Panel were unable to determine how many hours as HP had been flown by either pilot.

b. All information drawn on crew maps found in the aircraft, which were wiped clean due to fuel contamination. Exhibit 9

1.4.6 **Services.** The Panel was assisted by the following personnel and agencies:

a. MAAIB.

b. RAFCAM.

c. Specialist technical support from 1710 NAS MIG, DfT AAIB and QQ.

d. MSHATF.

Factors Considered by the Panel

1.4.7 The following factors were considered by the Panel, from which accident factors have been determined along with relevant categories from Reason's HF model:

a. **Pre Accident.**

(1) Crew composition.

(2) Crew readiness.

(3) Authorisations & qualifications.

(4) Aircraft maintenance history & preparation for flight.

(5) Sortie details & preparation.

(6) Supervision.

(7) Sortie execution.

(8) Discrepancy in hydraulic levels.

(9) MRGB Sliding Cowling.

(10) 'One Flight Only' Authorisation.

b. **Accident.**

(1) Aircraft technical.

(2) Crew handling of the emergency.

c. **Post Accident.**

(1) Survival aspects.

(2) PCM.

(3) Salvage operations.

(4) Costs of damage to aircraft & civilian property.

(5) Organisational Risk Management.

Analysis of Factors

Pre Accident

1.4.8 **Crew Composition.** The Panel found that the crew were on duty, current and competent for the planned sortie, and therefore crew composition was **not a factor** in the accident. Exhibits 1, 2, 3, 4 & 7

1.4.9 **Crew Readiness.**

a. The NHP and CM were on their 9th consecutive day at work having been deployed on an exercise the previous week. Both had worked 4 duty periods of night flying from 1200-0200 before starting at 1000 to fly a day sortie, recovering back to RAF Benson by 1900 on Tue 4 Jul. Within the immediate 24 hours prior to the day of the accident, all 3 crew were found to be within CRP limits as regulated by the JHC FOB. Exhibit 12 Annex B

b. Whilst cognisant of the potential for circadian de-synchronisation derived from the previous working period, and having considered RAFCAM evidence, the Panel did not consider fatigue to be a significant factor in this accident. However, the Puma Force planning cycle resulted in a protracted period of duty that led to minimum rest that could have affected crew readiness and was therefore an **organisational influence**. As ineffective management of crew readiness could influence a future accident, the Panel found this was an **other factor**. Annex B

1.4.10 **Authorisations and Qualifications**. The following authorisations and qualifications were identified:

a. **Aircrew.**

(1) **Crew of XW211.** The crew were correctly qualified on the Puma HC1 and were in current flying practice with no outstanding training deficiencies. The crew of XW211 were also in-date for competency checks and authorised for AFS. All crew were in-date for drills. The Panel therefore found crew authorisations and qualifications were **not a factor** in the accident. Exhibits 1, 2, 3, 7, 11, 28, T16 & T17

(2) **DA.** The DA had completed the Flying Authoriser's Course, shadowed a current DA through 2 duties, read his TOR and received a brief from the Sqn Cdr. There was no requirement to record this training and, whilst his name with appropriate powers of authorisation had been added to the F1575C, an unsigned copy was present in 33 Sqn on the day of the accident. The Panel found the DA's authorisations and qualifications were **not a factor** in the accident but made the **observation** that the authorisation process may not fully assure an individual is SQEP as no formal competency assessment was in place, and thus an **organisational influence**. Exhibit 17

Witness 23

(3) **DFC.** There is no formal training or written authority for those undertaking the duty of DFC since the appointment was implicit through the appointment of Sqn Flt Cdr. Although a TOR existed for 33 Sqn DFCs, they were in the process of being written for 230 Sqn DFCs. The Panel found the DFC's authorisations and qualifications (and absence of a TOR) were **not a factor** in the accident but made the **observation** that the authorisation process may not fully assure an individual is SQEP as no formal competency assessment was in place, and thus an **organisational influence**. Exhibit 16

Witnesses 17 & 23

(4) **Recording of First Pilot Hours.** JHC Regulation J401.105.1 required qualified pilots to record hours flown as First Pilot unless occupying the centre seat; in which case they were to log Second Pilot time. The Panel found that the recording of First Pilot hours was **not a factor** in the accident but made the **observation** that the JHC FOB stipulated a number of flying currency requirements that did not state whether they are to be flown as P1 or P2. As a consequence, and therefore an **organisational influence**, the Panel were unable to determine the numbers of hours flown handling the ac and how this translated into currency (for either the HP or NHP). It was noted that, to aid supervision, 230 Sqn recorded (on STARS) the number of hours flown handling the ac. Exhibit 28

Witness 17

b. **Engineering.** All but one of the on-duty engineers from 230 Sqn, involved in preparing XW211 for flight and assisting with fault diagnosis of the hydraulic issue at MW, were found qualified and authorised iaw JAP100A-01. The on-duty 230 Sqn JEngO was under training and not authorised; he was fulfilling the role of on-duty JEngO under supervision from the on-duty FS Eng. The Panel found that whilst local engineering management were fully aware of this situation, the pooling of engineers across the Puma Force meant that 33 Sqn aircrew were unaware that the JEngO was a trainee. Notably, the JEngO was seen by the aircrew as directly involved in the decision making process when a 'one flight only' authorisation was discussed (see para 1.4.18) and thus over-reliance on the trainee JEngO was evident. The Panel found it unlikely that the JEngO directly influenced the accident but made the **observation** that confusion amongst aircrew was a potential **organisational influence**. Overall, the Panel found engineering authorisations and qualifications were **not a factor** in the accident.

Exhibit T17

Witness Crew Part 1

Witness 9

1.4.11 **Aircraft Maintenance History & Preparation for Flight.**

a. A full QA of ac maintenance documentation was conducted, from which the Panel found no significant concerns. It was noted that the aircraft had suffered 4 UFCMs for control in yaw and a bird strike that may have contacted the MRBs and TRBs, since Jan 11. All events were found to have been correctly investigated, iaw JAP100A-01 and RAF Benson AESOs.

Exhibits T15 & T21

b. The planned sortie was a pre-CR training flight at MAUM but the ac was re-rolled at short notice since the sortie profile was changed. The Panel found XW211 documentation was correctly amended to reflect changes and correctly certified for flight with a valid FSC and 'travelised' MF700C.

Exhibits 4, 13, T3 & T15

Witness 12

c. The Panel found aircraft maintenance and preparation for flight was **not a factor** in the accident.

1.4.12 **Sortie Details & Preparation.**

a. The Puma Force planning cycle meant that the NHP had just returned home from a week-long exercise and, as a consequence, felt under some pressure to start preparing the next day's sortie. The Panel found the lack of preparation time was an **organisational influence** that did not contribute directly to this accident, but may influence a future accident and was therefore an **other factor**.

Witness 1

Annex B

b. The planned sortie was amended at short notice due to a requirement for the QHI to conduct an air test on another aircraft. Without himself, the QHI decided that the MAUM sortie should not be flown by the LCR pilots so he elected to have the aircraft weights removed and allowed a GH sortie to take its place. Required bookings were amended on STARS and since the original sortie brief had been attended by the QHI, the DA was content to take a revised

Exhibits 5, 6, 9 & 10

Witnesses 1, 2, 3, 9 &12

out-brief from the 2 captains. The Panel found that the amended sortie, which was correctly planned, briefed and authorised (including STARS entries), was therefore **not a factor** in the accident.

1.4.13 **Supervision.**

a. **Aircrew.** The crew of XW211 conducted an SOP18 pre-sortie brief with the QHI, prior to the sortie change. The removal of the aircraft MAUM weights necessitated minor re-planning, after which the crew briefed again in the presence of the QHI. Both the DA and DFC were aware of the amended sortie (DFC was consulted by the DA prior to the sortie change) and were both content that the crew composition was correct and that the pre-sortie brief was conducted in the presence of the QHI. Whilst the QHI was aware of tasking undertaken by the aircrew over the previous 9 days, the DFC and DA were not aware. When questioned about fatigue (a potential **EPC**), the Panel made the **observation** that the QHI stated aircrew should raise fatigue (or other human performance factors that could affect safety) during the SOP18 brief. The Panel agreed aircrew had a duty to report fatigue issues but considered flying supervisors should also elicit such safety-related information. Therefore, the Panel found ineffective supervision of potential fatigue issues was a **breached defence**, and an **organisational influence** as the SOP18 brief did not ensure that those supervising flying were aware of human performance factors (such as fatigue) that could affect the safe conduct of flying. As this aspect of aircrew supervision could make a future accident more likely, the Panel found this was an **other factor**.

Exhibits 11, 17, 24 & 28

Witnesses 9 & 12

b. **Engineering.** Engineering management (on-duty FS Eng and JEngO) were aware of a hydraulic issue on XW211 at MW (see para 1.4.15) and had been consulted by the DA (via the Line Controller) prior to the approval for the crew to return to RAF Benson. The Panel found no evidence of any direct engagement between engineering management and the DA and/or crew of XW211. Despite the on-duty FS Eng and JEngO being aware that the DA was looking to authorise a direct flight back to RAF Benson, they remained remote and relied upon the Rects and Line Controllers to translate information relating to a potential airworthiness issue. It was the Panel's expectation that engineering management should have been more involved and thus be in the position to brief the aircrew on documentation requirements; thereby highlighting the correct actions to secure the MRGB cowling. The Panel considered the lack of effective supervision of the engineering effort was a **breached defence** and **organisational influence**. As this could make a future accident more likely, the Panel found engineering supervision was an **other factor**.

Witnesses 4, 6, 8 & 13

1.4.14 **Sortie Execution.** Analysis of the CVR indicated that the crew executed the first phase from RAF Benson to MW as planned and briefed. The initial departure from MW was also uneventful and executed as authorised. Therefore, up until the start of the accident, the Panel found sortie execution was **not a factor** in the accident.

Exhibits 5, 18 & 30

Witness 9

1.4.15 **Discrepancy in Hydraulic Levels.** The MAAIB technical investigation found no evidence to suggest the hydraulic system on XW211 was not functioning correctly at the time of the accident. Ground crew stated that the reservoirs were topped-up to the max fill levels during the previous BF and the NHP did not recall noting a discrepancy during his walk round at RAF Benson. Therefore, the Panel considered it most likely the reservoir was overfilled during the BF. After consultation with the Puma PT, the Panel determined the discrepancy in hydraulic levels was **not a factor** in the accident as there was no airworthiness risk from overfilling hydraulics. Thus, the Panel made the **observation** that the max fill line appeared redundant, which was an **organisational influence** due to ac design.

Exhibits 21, T1, T2 & T6

Witnesses 1, 2, 3, 6, 25 & 26

1.4.16 **Fluid Expansion.** The Panel found some evidence existed from senior Puma aircrew who stated that it was not unusual to find the hydraulic level in the No2 reservoir to vary between before and after flight. Therefore the Panel conducted a trial which found that, on occasion, there was a noticeable variation in the Hyd 2 level as a consequence of flight. The Panel made the **observation** that this was most likely to be expansion in the system as a result of heating effects and therefore an **organisational influence** due to ac design.

Exhibit T12

Witness 17

1.4.17 **MRGB Cowling Security.**

a. **Ac Documentation.** To aid fault diagnosis, the crew elected to open the MRGB cowling. The CM queried the need to raise paperwork as he was aware that the MF705(Puma) required an entry to be made in one of the blank 'spare' boxes to record an independent check for 'cowls'. The crew discussed this requirement and recalled the entry was made when all cowlings were opened during an AF/BF. As only the MRGB cowling was to be opened, the crew decided that they would not make an entry on the MF705(Puma) but ensure the independent check was 'covered' when securing the cowling. Whilst all crew were in-date for AFS training and authorised, the crew stated they were not aware that AP101C-0801-2R1 (Leaflet 200) existed, which mandated the documentation and independent check requirements when a MRGB cowling is opened. Assessment of AFS training revealed that all crew had signed for reading Leaflet 200 on their individual MF4820 (Technical Record Card), which records a list of 22 safety-related documents for aircrew to read and sign for. This formed part of the audit trail for the SEngO to deem the crew competent and be authorised to conduct flight servicing. Looking more widely across the Puma Force, none of the aircrew interviewed by the Panel were aware of Leaflet 200 despite all having signed that they had read it. The Panel found no measures were in place to assure the MF4820 reading list was actually read and understood, and therefore an **organisational influence**. The decision to by-pass mandated safety documentation was a **breached defence**, transacted via an **intentional unsafe act** (mistake) as the crew decision was based upon a lack of knowledge of Leaflet 200 and flight servicing requirements. The Panel therefore found the crew's decision to not raise any paperwork for the MRGB cowling was a **contributory factor**.

Exhibits T3, T4 & T16

Witnesses 1, 2, 3, 16, 17, 19, 20, 21 & Crew Part1

b. **Cowling Closure.**

(1) The primary locking handle was found in the locked position at Accident Site 2. There was no evidence to suggest the handle had suffered mechanical failure in flight, and as far as could be reasonably determined, the handle was fully serviceable at the time of the accident. Therefore, the CM either forgot to lock the primary handle prior to flight or the locking mechanism failed in flight. Based upon technical evidence, the Panel considered it most likely that the CM did not secure the primary handle correctly. The Panel therefore found the failure to secure the primary handle was a **breached defence** and **contributory factor**. Exhibits T1 & T2; Witness 2

(2) All components of the secondary locking device were found still attached to the ECU cowling, undamaged and fully serviceable. Therefore, the CM either forgot to secure the secondary locking device (bolt and pin) or secured it incorrectly. Since he recalled struggling to secure the bolt and pin, and the NHP watched him carry out this task, the Panel found it most likely the CM secured it incorrectly. The Panel therefore found the failure to secure the secondary locking device was a **breached defence** and **contributory factor**. Exhibit T1 & T2; Witness 2

(3) Whilst closing and securing the MRGB cowling, the CM stated he was under no pressure to depart MW but frustrated with the difficulty he had securing the bolt and pin; he struggled with the routing of the lanyard and insertion of the bolt through the bushed hole in the sliding cowling. During this period, the CM recalled the NHP watching him whilst also discussing that the HP had already 'strapped-in' to his seat before the cowling was secured. Believing he had completed the securing of the cowling, the CM proceeded to stow the aircraft ladder and left the NHP to 'cover' the independent check. Annex B; Witness 2

(4) The operation of closing and securing the sliding cowling, whilst not routine, was very familiar to the CM and he was well practiced and experienced in this operation. The Panel determined that a combination of **EPCs** may have influenced his performance: low arousal (familiar skill-based task requiring little cognition); overconfidence (trust in team); frustration (struggled with pin); and distraction caused by the NHP. This, in turn, resulted in both contributory factors (cited above) occurring due to **unintentional acts** (slips) by the CM. Annex B

c. **Lanyard.** The Panel made the **observation** that the CM did not correctly route the lanyard for the bolt and pin, iaw AP101C-0801-1D3. Instead, the CM routed the wire lanyard under the cowling rather than through the cowling's access hole. As the incorrect routing was not considered to affect the safety or security of the MRGB cowling, the Panel found the incorrect routing of the lanyard was **not a factor** in the accident. Exhibit T22

d. **Independent Check.**

(1) The NHP watched the CM close the MRGB cowling whilst he was positioned at the stbd cabin doorway with the CM stood on the aircraft ladder attached to the stbd side. The NHP stated he did not observe the locking of the primary handle but did note that the CM had some difficulty securing bolt and pin. The CM stated that he assumed that the NHP was independently checking his work as agreed earlier by the whole crew. When checking the cowling, the NHP recalled that he observed the primary handle was in the horizontal position, visually checked the bolt and pin, and physically pulled back on the cowling; believing this constituted a sufficient check, although he did not regard himself responsible for the independent check. Leaflet 200 mandates an independent check is required and states that the person carrying out the independent check is not to be involved in the last closure of the cowling. Additionally, the Puma Training Cell stated that aircrew are trained to conduct a visual and physical check of the primary handle plus bolt and pin, iaw AP101C-0801-5B1A. When reviewing this document, the Panel found there was potential for varying techniques due to ambiguity in the text.

Exhibits T4 & T5

Annex B

Witness 22, Crew Parts 1 & 2

(2) Despite agreeing to conduct an independent check when discussing the need for ac documentation, none of the crew believed they were responsible for the check. As the CM closed and secured the cowling, the independent check had to fall to either the HP or NHP. Since the NHP knew the HP had already strapped-in, the independent check should have fallen to him. Throughout, it was evident that the crew experienced 2 **EPCs**: a break down in communication; and a strong sense of trust may have caused overconfidence (in that they were sure one of them would ensure the cowling was closed and secured correctly). In turn, this may have resulted in the NHP suffering expectation bias when watching the CM struggle with the bolt and pin, satisfying himself the cowling 'must have been' secured correctly. The Panel found the NHP's failure to carry out an independent check was a **breached defence**, transacted through an **intentional unsafe act** (mistake) as he did not recognise his cowling check should have constituted an independent check and he was not aware of the requirements mandated by Leaflet 200. Additionally, the Panel found the quality of the check conducted by the NHP to have been influenced by his AFS training (AP101C-0801-5B1A), and therefore an **organisational influence** as there was potential for varying techniques. Overall, the Panel found the failure to carry out an independent check was a **contributory factor**.

Annex B

Witness Crew Parts 1 & 2

e. **Pre-sortie Brief.** An authorisation to return to RAF Benson was received from the DA and, as the sortie profile had changed from that originally briefed, an amended brief was required. The HP did not conduct an amended pre-sortie brief and therefore the Panel found this to be a **breached defence**, transacted via an **unintentional unsafe act** (lapse) as interviews with the crew showed that the HP knew a brief was required but forgot to carry it out; most likely due to inexperience (**EPC**). The lack of a pre-sortie brief missed the opportunity to review their situation. Since this should have provided an opportunity for the HP to confirm the MRGB cowling had been secured and independently checked, the Panel found the absence of an amended pre-sortie brief was a **contributory factor**.

Witness 9 & Crew Part 1

f. **External Checks.** Post lunch, the HP commenced external checks in preparation for a HTGR, which was expected to precede a return to RAF Benson. Starting adjacent to the No2 hydraulic sight glass (see Part 1.3 Figure 3), the HP made his way around the front of the aircraft to the port cabin door. The HP recalled making a final check of the No1 hydraulic reservoir, for which it was most likely the cowling had been closed as the HP was able to see the sight glasses through the cowling inspection holes. He then proceeded to 'strap-in' and commence his cockpit checks. At this time, the CM and NHP were still securing the MRGB cowling and the rear of the aircraft had not been checked. The manner by which the external checks should be completed is given in the Puma OCF ISG, SSG and FRCs. Puma OCF training covers the checking of the cowling during external checks (normally completed by the HP). The MRGB cowling should have been secured and independently checked prior to the ac capt's external checks. This was understood by the HP but he could not recall why he did not conduct a full walk round or check the cowling for security. The Panel could **not positively determine** the reason but found a combination of **EPCs** may have influenced his mental model (situational awareness): his relative inexperience as ac capt; task interruption (started external checks prior to lunch); and desire to solve the hydraulic issue. Overall, the Panel considered the failure to complete mandated external checks was a **breached defence,** transacted via an **unintentional unsafe act** (slip) that missed the opportunity to fully ascertain the serviceability of the aircraft (missing a cowling check and inspection of ac rear). The Panel therefore found the failure to conduct external checks correctly was a **contributory factor**.

Exhibits 28 & T20

Annex B

Witness 3

g. **Pre-take Off Checks.** A final check for cowling security was carried out by the CM as required by pre-take off checks. The CM clearly recalled carrying out this check by visually inspecting the primary handle and only pushing on the bolt (he did not physically check the pin was gated). He then reported 'MRGB cowling handle locked and bolt pinned' to the HP. The Panel found that the FRCs simply state 'check bolt and pin' whilst the quality of OCF training varied; in that the manner in which the pre-take off check is to be conducted is not prescribed in any training material. The Panel found this was an **organisational influence** as confusion could

Exhibits 27 & T20

Witness 2

exist over whether a physical and/or visual check was required. The Panel found the pre-take off check was ineffective and thus a **breached defence**, transacted via an **unintentional unsafe act** (slip) due to a perceptual error exacerbated by technique. The Panel also considered the increased potential for error due to fatigue or time pressure to depart MW but found no significant evidence. The Panel therefore found the failure to conduct an effective pre-take off check was a **contributory factor**.

h. **Cowling 'Pushed Forward'.** Whilst awaiting further advice from RAF Benson, the crew took lunch at MW. Prior to leaving the ac, the CM slid the cowling forward (approximately 5 cm short of being fully closed). The Panel found Leaflet 200 also mandates that the MRGB cowling was to be left either in the fully open or fully closed position. Leaving the cowling pushed forward over lunch was therefore a **breached defence**, transacted via an **intentional unsafe act** (mistake) as the CM was not aware of the rule in Leaflet 200. This the Panel found was an **organisational influence** as no measures were in place to assure the MF4820 reading list was actually read and understood by the CM (see para 1.4.17a). However, as the CM later re-opened the cowling to assist with fully closing it, the Panel did not consider this was cause or contributory to this accident but as it could influence a future accident, the Panel therefore found this was an **other factor**.

Exhibit T4

Witness 2

i. **Cowling Design.**

(1) **Locking Device.** The understanding amongst the crew of XW211, and wider Puma Force, was that the bolt and pin on the MRGB cowling was a 'secondary locking device'. The Panel found the bolt and pin described as a 'locking pin' in AP101C-0801-5B1 and 'secondary lock pin' or 'sliding cowling safety lock' in AP101C-0801-1D3. This may lead to a false expectation that there are 2 mechanisms to keep the MRGB cowling closed (primary handle and locking device). The Puma PT confirmed that this device was a 'locking indicator' and not designed to keep the cowling closed if the primary locking handle failed. When considering the function of the locking indicator, the Panel noted that the cowling cannot be closed against the ECU cowlings if the primary locking handle is already in the 'locked' position when offering-up cowling faces. Here, a gap of around 3.5 cm exists as the MRGB cowling hooks butt against the rollers on each ECU cowling. In this condition, the locking indicator cannot be physically secured through the bushed hole in the MRGB cowling and this will alert the operator to check the primary handle. The Panel considered that the locking indicator was redundant in all other scenarios, as it provided no indication that the cowling had been closed and locked; only that the cowling was aligned correctly. The Panel found the wording of the locking indicator as a secondary locking device was **not a factor** in the accident but made the **observation** that it was an **organisational influence** that could yield a false expectation.

Exhibits T5, T6, T8 & T22

(2) **Potential for Error.** Analysis of ASIMS showed 34 reported occurrences of the sliding cowling not secured correctly due to operator error (9 cowlings detached in flight, including XW211). To understand the risk from human error, the Panel examined several MRGB cowlings. It was found that the primary handle could easily be perceived as locked when it was not. As highlighted at Figure One, the primary handle could be near to the locked position (and therefore appear locked) but not be positively secured; thereby promoting perceptual error. Additionally the Panel managed to inadvertently leave a locking indicator un-gated when the device was examined, again through perceptual error (despite the obvious focus on the task) as shown at Figure 2. This incorrect perception (**EPC**) was found to make an **unintentional act** (slip) more likely. The Panel considered the MRGB design was mechanically fit for purpose but sufficiently prone to human error that overall airworthiness could be inadvertently comprised. The Panel found this was a **contributory factor** in the accident and an **organisational influence** due to its design.

Exhibits T13 & T14

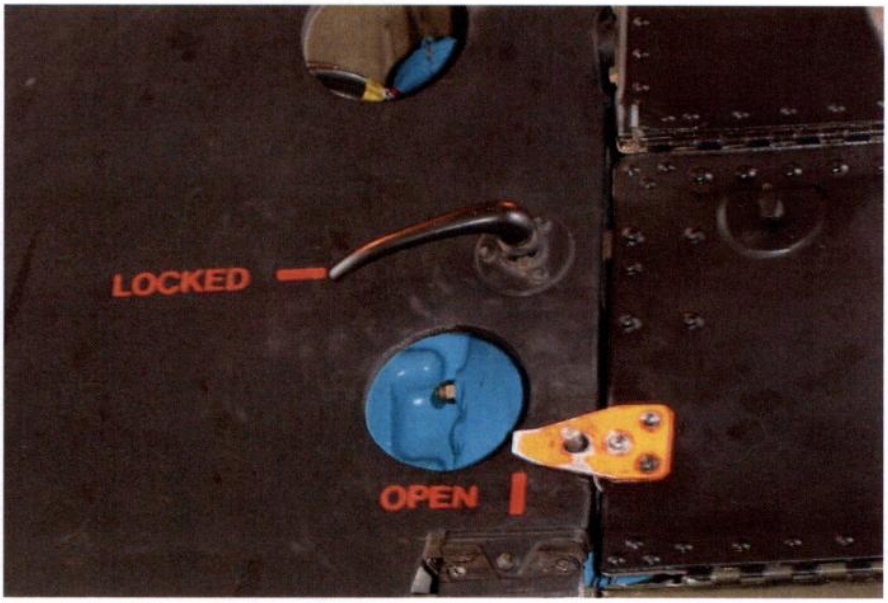


Figure 1 – Primary Handle Unlocked

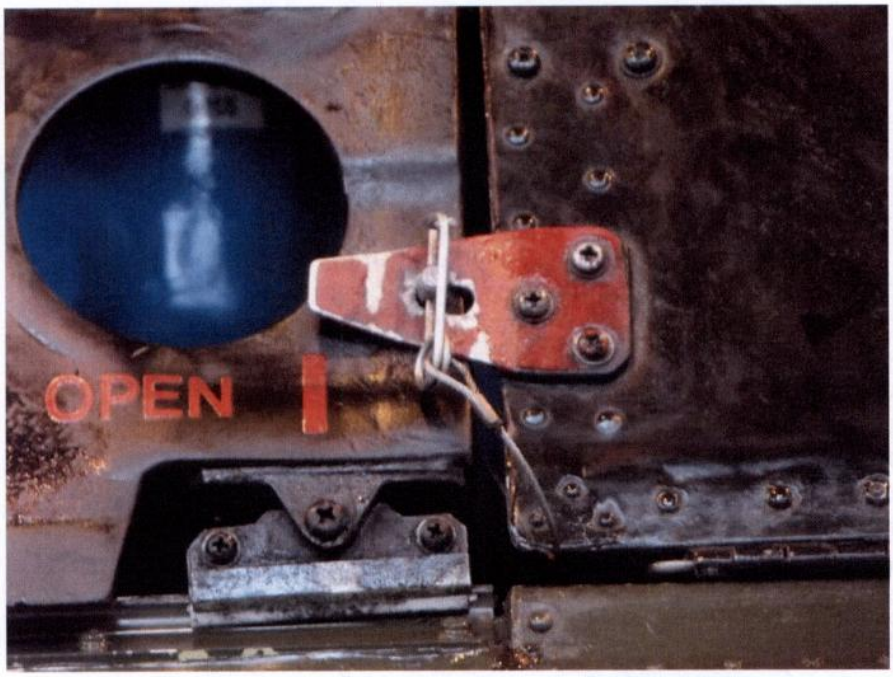


Figure 2 – Un-gated Locking Indicator Pin (Lanyard Routed Incorrectly)

Considering all the factors surrounding the security of the MRGB cowling, the Panel found the **cause** of the accident was loss of control; initiated by an incorrectly secured MRGB cowling that departed in flight and struck the MRBs/TRBs.

1.4.18 **'One Flight Only' Authorisation.**

a. Despite extensive fault diagnosis, the discrepancy in the No2 hydraulic level was not resolved and the DA elected to verbally authorise the crew to fly back directly to RAF Benson. Prior to his decision, the DA sought engineering approval for a 'one-flight' back from the on-duty JEngO and FS Eng. Witness evidence indicated that communication broke down, as the engineers understood the aircrew were looking to provide an authorisation to the crew at MW but stated that they offered advice only and any 'one flight only' authorisation did not originate from them. The Line Controller was employed as a 'runner' by the DA thus there was no direct engagement with the on-duty JEngO and FS Eng; as a result, the DA believed he had asked the JEngO to 'OK' a one flight (this being the response he got from the Line Controller) whilst both the JEngO and FS Eng believed that they stated 'if the aircrew are happy then we are happy' for the aircraft to return to Benson. The crew of XW211 were not aware of the internal discussions and understood they had been given an explicit 'one flight only' authorisation from the DA. Exhibit 21 Witnesses 12 & 17

b. A review of the term 'one flight only' showed the only reference was in the JAP100A-01 but without any clear description of how the term is to be authorised and documented. A straw-poll across Puma Force engineers (and wider) cited a 'one flight only' was an

airworthiness risk management tool that required an MF703 Limitation to be entered in the aircraft MF700C. Aircrew cited that it was a general term that they employed when authorising a flight; after seeking engineering advice. Whilst the authorisation to return home was not considered to have been an unsafe decision, the Panel found confusion existed across the Puma Force over the term 'one flight only'. As an aviation risk management function, the Panel found that the lack of understanding and control of the use of the term 'one flight only' was an **organisational influence** that could lead to an **intentional act** (mistake) due to poor comprehension (**EPC**) of the term. The Panel found this could impact upon a future accident and was therefore an **other factor**.

Accident

1.4.19 **Aircraft Technical.** Technical examination of XW211 found the following:

a. **MRB.** Debris recovered from Accident Site 2 consisted of parts from at least 2 MRBs and the MRGB cowling. Reconstruction of a recovered MRB showed the leading edge survived the impact but the outer 2.8m (40%) of honeycomb structure disintegrated; causing the severe vibrations experienced by the crew. Exhibits T1 & T2

b. **MRGB Cowling.** MIG reconstruction of the MRGB cowling debris determined that the cowling moved backwards under vibration and airflow, prior to detaching from its airframe rails. The cowling then lifted from its port side and was struck 3 times on the port side and once on its forward face by the MRBs. The MRGB cowling primary locking mechanism consists of 3 locking hooks that are operated by a single handle on the RHS of the cowling. Apart from damage caused by the accident, the absence of any trauma to the hooks or securing rollers on the ECU cowlings indicated the primary locking mechanism was not engaged correctly at the time of the accident. All components from the locking indicator were found still attached to the ECU cowling at Accident Site One with the lanyard, locking 'bolt and pin' all serviceable and undamaged. The metal plate (or tang) attached to the stbd ECU cowling through which the locking bolt passes was also found still attached and was unstressed. Exhibit T2

c. **CVR.** An unusual pulsing sound was identified (calculated as approx '1R' type frequency of 4.7Hz) at around 2:30 minutes prior to the start of the severe vibration. Spectral analysis was conducted on this sound and a previous recording, made from XW211, was reviewed. Additionally, a flight was arranged to try and replicate the pulsing frequency but no equivalent sound was identified; thereby discounting any sounds attributable to open cabin doors, loose equipment or open windows. Despite considerable effort, the nature of the unusual pulsing frequency was **not positively determined.** Exhibits T1, T2 & 30

d. **AVAD Master Caution.** During the descent, the AVAD Master Caution triggered repeatedly. The Panel could **not positively determine** why it triggered but it was most likely due to the MRGB Exhibits T1 & T2

pressure reducing below 0.8 bar (MGB pressure warning) brought about by negative g; as a consequence of severe vibration. The Panel found that the AVAD Master Caution alert was **not a factor** in the accident.

e. **TR System.** Civilian witnesses close to Accident Site 2 were initially alerted to the emergency affecting XW211 by a loud bang. XW211 was then sighted in a rapid descent with changes in heading and some rolling and pitching, for which the aircrew recalled difficulty controlling yaw. The TR was reported as turning slowly by a witness and the cowling behind the main rotors was missing. The Panel considered the lack of reported heading control was due to one of the following: Exhibits T1 & T2; Witnesses 10, 11, 14 & 24

(1) Loss of yaw authority due to flying control failure.

(2) Failure of the HP to control yaw.

(3) Aerodynamic effects due to MRB/TRB damage.

(4) TRDS failure in flight.

f. **Flying Control Failure.** The MAAIB LAI found the TR controls intact with no evidence that the ac suffered TR control failure. The Panel therefore found lack of yaw control due to control failure was **not a factor** in the accident. Exhibits T1 & T2

g. **Failure to Control Yaw.** When considering the potential lack of yaw control by the HP, the Panel determined that positive control was made on the cyclic and collective. Whilst the HP could not recall his pedal inputs, the Panel thought it was most likely that the HP would have instinctively input the associated pedal. The Panel therefore found it was unlikely the HP failed to input pedal to control the yaw and thus was **not a factor** in the accident. Witness 3

h. **Aerodynamic Effects.** All 5 TRBs were found attached to the TR hub and had suffered varying degrees of damage. MIG forensic evidence determined that 2 of the TRBs were struck by MRGB cowling debris and several blades struck the tail boom but none had contacted the ground under power. The MAAIB accident report supported the MIG findings, which indicated the ac may have experienced difficulty with yaw control due to unstable aerodynamic effects caused by severely disrupted airflow from damaged TRBs/MRBs. The Panel made the **observation** that this aerodynamic effect may have led to the reported difficulty to control yaw but the full extent of this effect could **not be positively determined**. Exhibits T1 & T2

i. **TRDS Failure.** In an attempt to determine the point of TRDS failure, the Panel compared MIG forensic evidence with a similar accident that occurred to XW212:

(a) MIG evidence determined debris from the MRGB cowling Exhibits T2

pierced the TRDS cowling and damaged the No3 TRDS, although the TRDS continued to operate until XW211 crashed. At this point, a torsional failure of No3 TRDS occurred approx 500mm from the No1 BH and an overload failure occurred between No2 & No3 shafts, causing a 600mm section to come detached from the ac, which was found 5m from the ac. Additionally, the tail boom detached during the crash, causing an overload failure of the No6 TRDS whilst TR control cables and hydraulic pipelines remained connected.

(b) A similar accident to XW212 that occurred on 8 Mar 75 was reviewed by the Panel. Here, the MRGB cowling was found to have detached from the ac in flight and impacted the TR, causing a torsional break of the No4 TRDS at a similar distance from the No1 BH on XW211. XW212 remained airborne for a further 25 secs, during which little damage occurred to the surrounding structure. Applied to XW211, the Panel considered it plausible that the TRDS failed in flight, which would support the witness statement and the crew's inability to control the aircraft in yaw. However, the Panel found this contrary to MIG forensic evidence and thus concluded the point of TRDS was **not positively determined**. Notably, if the ac had been fitted with an FDR, technical attributes associated with the accident would have been more readily available. The Panel found that the lack of safety related information, due to the absence of an FDR, was **organisational influence** and therefore an **other factor**. Exhibit 29

j. **Damage Cat.** The crash landing resulted in Cat 5 (Comp) damage to the aircraft, which is described in detail by the MAAIB accident report. Exhibit T2

1.4.20 **Aircraft Technical Summary.** The MAAIB accident investigation found no evidence of any technical faults with the aircraft prior to the start of the accident. The Panel therefore found that ac technical failure was **not a factor** in the accident to XW211 and whilst the cause of some aspects of the aircraft damage was **not positively determined**, it was not believed further technical investigation would provide greater clarity or safety value. Exhibit T1

1.4.21 **Crew Handling of the Emergency.**

a. The crew reported a loud bang and an immediate onset of very large vibration. Simultaneously, a single low NR tone was noted on the CVR, indicating a rapid drop in NR to 255 RPM followed by an immediate recovery into the governed range. The Panel considered this transient reduction in NR was most likely as a result of the MRGB cowling impacting the MRBs. Exhibits 30, T1 & T2; Witnesses 1, 2 & 3

b. Initially, the crew assumed their emergency was based upon a mechanical failure associated with a hydraulic malfunction. The Panel considered this understandable because of the earlier focus on hydraulic levels at MW, which had injected an element of mental pre-conditioning. Witness 3

c. Due to vibration and difficulty in maintaining control, the HP selected a field and commenced an immediate descent. This descent was flown at high speed (approx 135 kts) and at a high RoD (averaging 1640 ft/min over the period of the descent). Notwithstanding the damage, it is thought that initially the MRBs were close to an autorotative state given the engine-hunting found during CVR analysis. The associated low torque reaction, and the directional control derived from high airspeed, meant that track was maintained despite damage to the ac. — Exhibits 15, 25 & T2

d. The speed started to reduce at 500 ft AGL, which would have had 2 effects on heading: a reduction in directional stability derived from the fin; and a reduction in autorotative effect such that, to maintain NR, the MRH was driven by the engines (with a consequential increase in torque). These factors led to the left yaw witnessed as the ac approached the A303. Furthermore, any application of collective pitch would have increased the amount of yaw. Application of right pedal should have corrected this yaw but the Panel considered the damage to the TR system would have prevented further directional control. — Exhibit 25; Witnesses 3 & 24

e. The HP maintained track towards the field by applying right cyclic. This application of cyclic reduced the rate of yaw due to the keel effect from the fuselage. However, the ac continued to yaw slowly left until it was facing back up the approach direction; the latter stages of flight towards the field having a rearwards component. This was overcome by the HP applying forward cyclic as the ac achieved the overhead of the field. The final rate of yaw was reported as low. The Panel judged that this was because the ac was now heading into-wind and had a low power setting (evidenced from the impact damage commensurate with a high RoD), which reduced the torque reaction. — Exhibits 15 & T1; Witnesses 3 & 24

f. The ac descended rapidly towards the ground in a port side low attitude and with slow forward movement. The HP's application of collective pitch was unable to arrest the descent before the ac hit the ground. As far as can be determined from the NR droop heard on the CVR, the Panel determined that the application of collective pitch had been timely. Notwithstanding this, it was considered that it would have been considerably less effective than usual due to the damage to the MRBs. It was also thought that the application of collective pitch provided a short-term increase in lift, which enabled the ac to lift briefly after impact and turn left before coming to rest on its stbd side. The MRH continued to turn for a few seconds until the ac engines shut down due to fuel starvation arising from the closure of the fuel shut-off levers by the NHP, who then closed the throttles; the port throttle was found fully closed and the stbd throttle partially closed. — Exhibits T1 & 30; Witnesses 1 & 3

g. Shortly before impact with the ground, the HP recalled a simulator sortie during which undemanded yaw had been stopped by throttle closure; he therefore called for 'throttles'. However, the NHP — Exhibits 27 & 30

elected to close the fuel-shut off levers first, because they were easier to reach and move. The timing of the decision to shut down the engines pitted against the time for the engines to be starved of fuel by closure of the fuel-shut off levers rendered the decision irrelevant by the time of impact. The FRC action for TRDS failure stipulates throttle closure before fuel-shut-off levers but, given the rapidity with which events were unfolding, the Panel found that this would not have influenced the accident and was therefore **not a factor** in the accident. Witnesses 3

h. The CVR indicated that a fire warning was activated when the aircraft rolled onto its side (the CM recalled seeing a small amount of smoke). As none of the crew were aware of the fire warning, most likely due to task focus (**EPC**), they did not act iaw FRCs. The Panel considered this lack of response to the fire warning was an **unintentional act** and **breached defence**. Whilst no fire occurred, the Panel found this was an **other factor** due to the potential to influence a future accident. Exhibits 27 & 30

Witnesses 1, 2 & 3

i. Overall, witness statements and technical evidence indicated that the crew were confronted with an unusual, very challenging and unpractised emergency; the damage to XW211 was such that they experienced extremely limited control, severe vibration and a high RoD. Throughout, the HP gave clear intentions to his crew who assisted him well throughout the emergency. Representative profiles were flown by the Panel in the simulator. Although it was not possible to explore fully the extent of the emergency due to simulator limitations, the Panel was able to inject a series of scenarios such as MRH vibration, TR ineffectiveness and TR failure. As a result, the Panel considered the crew handling of the emergency was sufficiently effective for the unusual situation and their actions did not aggravate the accident. Therefore, the Panel found that the crew handling of the emergency was **not a factor** in this accident. Exhibits T1, T2, 30 & 31

Witnesses 3 & 24

1.4.22 **Brace Position.** The CM called 'brace' correctly, and assumed his brace position. The HP was flying so could not brace for the impact and the NHP also did not brace as he was following through on the controls. The Panel found that, across the Puma Force, there was no prescribed brace position for the NHP and thus an **organisational influence**. As this could impact upon a future accident, the Panel therefore found this was an **other factor**. Annexes A & B

Post Accident

Survival Aspects

1.4.23 **Crew Injuries.** All crew members evacuated the aircraft without assistance and received on-site medical attention from Paramedics before being transferred to Basingstoke and North Hampshire Hospital; 2 of whom were released the following day with the 3rd released on 14 Jul. Two of the crew suffered major injuries and one was uninjured: Annex A

a. **(S40)**

b. **(S40)**

c. **(S40)**

1.4.24 **Medical Statement. (S40)** Annex A

1.4.25 **Egress.**

a. **Escape Route.** Post impact, the front crew unfastened their QRFs and were released from their restraint harnesses without difficulty. Each GFL was in the unlocked position and the PSPs remained in the cockpit seat. The HP, followed by the NHP, climbed out of their seats and passed through the companionway into the rear cabin where they made their exit by climbing up through the port cabin door. The CM had also exited via the port cabin door and all crew made a rendezvous at the aircraft's 12 o'clock position. The Panel found crew egress was **not a factor** in the accident. Annex B

b. **External Ladder.** The Panel found that the Puma external ladder was not stowed correctly, resulting in it coming free during the crash. The CM stated that he could not fully secure the ladder with the 2 securing pins as the ladder and airframe stowage pin holes would not align; one pin could not be inserted and the other could only be partially inserted. The Panel found this was a **breached defence**, transacted via an **intentional unsafe act** (violation), but influenced by the situation. The serviceability of the ladder stowage could not be fully determined due to accident damage. However, the CM cited that it was not unusual for the holes to not align and when the Panel examined 3 aircraft at RAF Benson, all 3 ladder stowages were found unserviceable. Additionally, the MAAIB LAI considered the ladder stowage was not of a robust construction. Therefore, the Panel found this was an **organisational influence** (ac design and/or servicing shortfall). Since the ladder was able to break free during the crash and potentially affect egress, the Panel found this as an **other factor** as this could influence a future accident. Exhibit T1 Witness 2

c. **Load Pole.** The aircraft load pole was not in use on XW211 and stowed using a locally approved technique of lashing it to seat racks using bungee cords. MAAIB evidence showed that this technique failed to keep the load pole secured during the crash due to its non-crashworthy stowage. The Panel found this was an **organisational influence** as there was no secure stowage for the aircraft load pole and the approved technique was ineffective. Since the absence of a secure stowage could influence egress or cause injury in a future accident, the Panel found this as an **other factor**. Exhibit T21

d. **Instrument Panel.** The instrument panel broke free from its 2 anti-vibration mounts. This allowed the panel to move vertically and impact the left-hand windscreen, causing it to crack. However, the instrument panel was retained by its hinged bar and 2 stays, and thus did not restrict the aircrew's egress from the ac. The Panel therefore found the movement of the instrument panel was **not a factor** in the accident but made the **observation** that its crash performance could **not be positively determined** due to unknown 'g' loading. Exhibit T1

1.4.26 **Crashworthy Seats.** The Puma was not fitted with energy attenuating cockpit seats. The Panel found the absence of crashworthy seats may have exacerbated injuries to the front crew so was therefore an **organisational influence** and **aggravating factor**. Annexes A & B

1.4.27 **Personal AEA.** Each crew member carried the original analogue SARBE 7 beacon, and a single McMurdo Fastfind 406 digital beacon was carried in the aircraft. An **organisational influence**, the Panel found that the Fastfind was not integrated into crew AEAs and thus the crew stowed it elsewhere on the aircraft. The Panel therefore found this was an **other factor** as survival may be affected due to a lack of access to 406 beacons. Annex B

1.4.28 **Other Service Personnel.** There were no injuries to other Service personnel.

1.4.29 **Civilian Personnel.** There were no injuries to civilians.

Post Crash Management

1.4.30 The Panel did not find any significant issues with PCM. A separate report by the PCMIO offers a series of recommendations that are included at Annex D. Annex D

Salvage Operations

1.4.31 XW211 was recovered by road to MW on 7 Jul 11 by JARTS under the direction of the MAAIB LAI and stored with the DEME(A) at MW. Both accident sites were released to the DIO before recovery to the land owner. The Panel made the **observation** that much evidence lay hidden within the wheat field of Accident Site 2, which was recovered by conducting a bespoke ferrous/non-ferrous 'sweep' technique using the ESG from DIO. Exhibits T1 & T2

1.4.32 The MAAIB LAI found that the aircraft battery posed a safety hazard as it could not be isolated or removed from the ac until the CAFTS was defueled and removed. The Panel considered this was an **organisational influence** as the ac RTS permitted the CAFTS configuration in-use at the time of the accident. The Panel found the this could influence a future accident and thus was an **other factor**. Exhibits T1 & T6

Costs of Damage to Aircraft & Civilian Property

1.4.33 XW211 suffered Cat 5 (Comp) aircraft damage as a result of the Annex E

accident. Costs were:

a. The depreciated cost of Puma XW211 is £150,000.

b. Services and crop remuneration at Middleton and Portway (Accident Site One) is £5,395.33.

c. Crop costs for Balls Farm (Accident Site 2) is £15,178.26.

d. The QQ CVR costs were £13,912.02.

Organisational Risk Management

1.4.34 **Puma PT.**

a. In Feb 11, the Puma PT relocated from RNAS Yeovilton to DE&S Abbeywood. This relocation resulted in only 2 of the 6 civil servants, comprising the Safety Management Team, making the move to Bristol and thus this area was found under-resourced. The 2 civil servants that relocated were primarily focused on compiling the safety case for Puma 2. The Panel found the PT was actively seeking to address this issue and the absence of the civil servants was **not a factor** in the accident. Exhibit T6

b. The PT had a documented strategy for responding to in-Service incidents/accidents, for which the Mechanical Manager owned a locally produced ASIMS Log (Excel spreadsheet) to investigate, monitor and report on safety information generated from DFSOR reports. This Log was found to be actively managed and did not contain any outstanding issues relating to MRGB cowlings. The Mechanical Manager was correctly authorised via a LOA, having been deemed competent to hold the post via a formally assessed competency framework. Exhibits T6 & T18

c. The Puma PT SMS and Hazard Log (ECasandra) were available and reviewed by the Panel. ECasandra did not record a specific hazard for the MRGB cowling as it was considered under the following: Exhibit T7

(1) Ac component falls off that strikes the TRBs, leading to irrecoverable loss of control and loss of aircraft.

(2) Ac component falls off that strikes the MRBs, leading to irrecoverable loss of lift and loss of aircraft.

(3) Ac component falls off that does not cause ac damage but kills or injures a 3rd party.

d. Overall, the PT maintained a Hazard Log and were proactively managing ASIMS reports. However, the Panel made the **observation** that corporate knowledge of the risk posed by a MRGB cowling becoming detached in flight had been lost; the last reported event being over 10 years previously. Information management

within the PT resulted in an **organisational influence** whereby this risk was not actively considered (see para 1.4.37).

1.4.35 **In-Service Modifications.**

a. **Applicable to MRGB Cowling.** Eight in-Service modifications applicable to the MRGB cowling were found embodied on the Puma Mk1, for which the Panel found none to be a cause or contributory factor to this accident. Exhibit T6

b. **MRGB Cowling Visual Warning System.** The Panel noted that a cockpit visual warning system, to alert aircrew to an open cowling, was embodied (MOD S345) in 1978 but later removed under Puma PT authority due to poor reliability. Little audit trail exists for this MOD but minutes from CIM (D/DHP/31/4/3) showed that the UK opted to remove this MOD in 1981; a decision not supported by the manufacturer. Embodied as a safety feature, no evidence was found to mitigate the potential RtL with the warning system removed. The Panel could not identify any formal audit trail behind the decision to remove the warning system or mitigation to support its removal and thus found this was an **organisational influence**. As the crew may have been alerted to the unsecured cowling via a cockpit warning system, the Panel found its absence was a **contributory factor**. Exhibits T10 & T11

1.4.36 **ASIMS.** Data from ASIMS showed 34 reported occurrences involving the MRGB cowling not secured correctly, for which application of the Heinrich Ratio suggested there could be many more unreported occurrences. Particularly, 9 sliding cowlings detached in flight (including XW211) over the operating life of the Puma Mk1, which covers approx 500,000 flying hours. This equates to approx 2×10^{-5} events over 36 years of in-Service use (or 1 event every 4 years); suggesting a medium RtL, iaw RA1210. From analysis of ASIMS and the design of the MRGB cowling (see para 1.4.17 i), the Panel made the **observation** that the RtL may not have been sufficiently mitigated, through design or operating procedures, to ALARP. The Panel therefore found this was an **organisational influence**. Exhibit T13

1.4.37 **Accident Involving XW212.** A similar accident to that experienced by XW211 occurred to XW212 on 8 Mar 75. Here the RAF BOI found that the MRGB cowling was most likely not secured correctly prior to flight such that the cowling departed in flight, striking the TRBs and causing an emergency landing that resulted in the aircraft rolling onto its stbd side. Whilst the majority of the BOI recommendations were actioned, the Panel found that a recommendation to modify the MRGB cowling with a 'fail-safe' mechanism was not taken forward. As human intervention led to the cowling being left in an unsafe condition, the recommendation suggested either a 'stop' on the cowling rail to prevent the cowling sliding back (and detaching in flight) or fitment of a spring-loaded mechanism to prevent rearwards movement should the cowling not be locked correctly. Apart from the BOI report, no further reference to this recommendation was found. The Panel therefore found this was an **organisational influence** and a **contributory factor** as the absence of a fail-safe system made the accident to XW211 more likely. Exhibit 29

1.4.38 **SHE.** Relating to the events involving the accident to XW211, the Panel found no concerns over SHE, iaw JSP 375.

Summary of Findings

1.4.39 **Cause.** The Panel found that the **cause** of the accident was loss of control; initiated by an incorrectly secured MRGB cowling that departed in flight and struck the MRBs/TRBs.

1.4.40 **Contributory Factors.** The Panel identified 10 factors that were contributory to the accident:

- CF 1 – Ac documentation not completed (Sliding Cowling).
- CF 2 – MRGB cowling primary locking mechanism not secured correctly.
- CF 3 – MRGB cowling locking device not secured correctly.
- CF 4 – Independent check not carried out correctly.
- CF 5 – Absence of pre-sortie brief.
- CF 6 – External check not completed.
- CF 7 – Pre-take off check not completed correctly.
- CF 8 – Cowling design.
- CF 9 – Absence of cockpit warning system.
- CF 10 – Absence of fail-safe.

1.4.41 **Other Factors**. The Panel identified 13 factors that could make a future accident more likely:

- OF 1 – Crew readiness.
- OF 2 – Sortie preparation (Planning Cycle).
- OF 3 – Aircrew supervision.
- OF 4 – Engineering organisation.
- OF 5 – Cowling 'pushed forward'.
- OF 6 – 'One flight only' authorisation.
- OF 7 – Response to fire warning.
- OF 8 – Lack of FDR.

- OF 9 – Brace position.
- OF 10 – Ladder stowage.
- OF 11 – Load pole stowage.
- OF 12 – Fastfind stowage.
- OF 13 – Battery access.

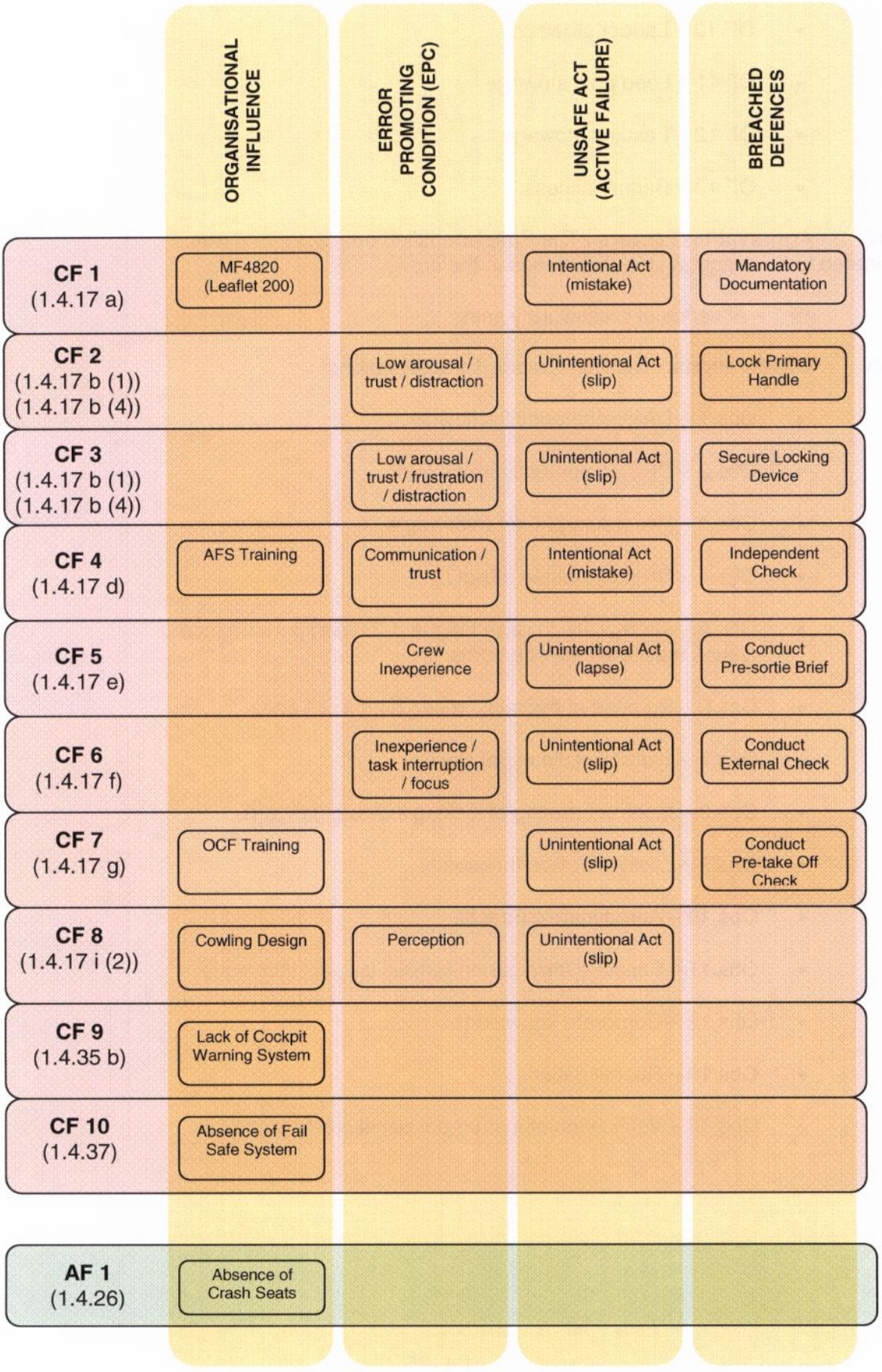
1.4.42 **Aggravating Factors**. The Panel identified one factor that was considered to have aggravated the injuries to the crew:

AF 1 – Absence of crashworthy seats.

1.4.43 **Observations**. The Panel made 14 observations:

- Obs 1 – DA competency framework.
- Obs 2 – DFC competency framework.
- Obs 3 – Recording of First Pilot hours.
- Obs 4 – On-duty trainee JEngO.
- Obs 5 – Aircrew are to raise fatigue or human performance issues that could affect a sortie.
- Obs 6 – Purpose of hydraulic reservoir max-fill line.
- Obs 7 –Hydraulic fluid expansion.
- Obs 8 – Incorrect routing of locking indicator lanyard.
- Obs 9 – Locking device function.
- Obs 10 – Aerodynamic Effects.
- Obs 11 – Bespoke ferrous/non-ferrous 'sweep' technique.
- Obs 12 – Corporate knowledge.
- Obs 13 – RtL mitigation.
- Obs 14 – Verification of instrument panel crashworthiness.

1.4.43 **Human Factors Model** (Observations not included).



	ORGANISATIONAL INFLUENCE	ERROR PROMOTING CONDITION (EPC)	UNSAFE ACT (ACTIVE FAILURE)	BREACHED DEFENCES
OF 1 (1.4.9 b)	Crew Readiness (planning cycle)			
OF 2 (1.4.12 a)	Sortie Prep (planning cycle)			
OF 3 (1.4.13 a)	Supervision (SOP18)	Fatigue		Effective Aircrew Supervision
OF 4 (1.4.13 b)	Engineering Organisation			Effective Eng Supervision
OF 5 (1.4.17 h)	MF4820 (Leaflet 200)		Intentional Act (mistake)	Cowling Open / Closed Position
OF 6 (1.4.18 b)	Lack of 'one flight'	Comprehension	Intentional Act (mistake)	
OF 7 (1.4.21 e)		Task Focus / distraction	Unintentional Act (lapse)	Fire Warning
OF 8 (1.4.19 i b)	Lack of FDR			
OF 9 (1.4.22)	Lack of NHP Brace Position			
OF 10 (1.4.25 b)	Ac Design / Servicing		Intentional Act (violation)	Correct Ladder Stowage
OF 11 (1.4.25 c)	Ac Design			
OF 12 (1.4.27)	Lack of Fastfind Stowage			
OF 13 (1.4.32)	CAFTS Clearance			