appeared in the table of aircrew equipment assemblies approved for use. Section 2 of the Safety Case (Platform Applicability) referenced a RAFCAM report on the integration of the MK60/61(M) ACLP into the Lynx ac, which stated: Exhibit 181

- *"Rear crew are required to use a dispatcher's harness that is attached to the cabin floor (the floor attachment clearly makes the use of yoke harness impractical)."* Exhibit 183

1.4.107 The Panel made the **observation** that although the Safety Case refers to use of a yoke mounted harness for the Mk60 ACLP, the supporting Integration Report contradicts the practicality of this type of restraint when coupled with a floor attachment as shown by the bracketed section of the RAFCAM report extract above.

1.4.108 **Strop Snagging Hazard.** As part of the Panel's investigation into the strop arrangement it became aware of ASIMS reports relating to a potential snagging hazard. With the MK60(M) ACLP secured to an anchor point in the cabin floor the CM may have been required to move around the cabin. The Panel identified that there was potential for the karabiner connecting the two strops to snag on an open seat harness which had the potential to hinder egress in an emergency (see Fig 26 and Fig 27 below). The strop design (joining karabiner) was an **organisational influence** that in other circumstances might influence the outcome of another accident and was thus deemed to have been an **other factor**. Exhibit 250

Fig 26 – Karabiner 'Snagged'

Fig 27 - Karabiner 'Snagged' Close-Up

1.4.109 **Strop Release.** Having failed to operate the emergency release, the CM then unsuccessfully attempted to open the karabiner connecting the 2 strops (see Fig 22). His next action was an attempt to remove the jacket by unzipping the front, but he discounted this option when he realised the necessity to extricate himself from the integral leg straps. He eventually managed to open the karabiner attaching the ac strop to the cabin floor, using both hands. He had not considered the option of cutting the strop using the Mk1 Aircrew Cutter attached to the Mk60 jacket; however, the Panel found that when adjusted to the shortest length, there was no single-thickness webbing accessible and thus it would not have been possible to conduct an emergency cut-away. The strop design (accessibility of single thickness webbing) was an **organisational influence** that in other circumstances might influence the outcome of another accident and was thus deemed to have been an **other factor**. Witness 3 Exhibit 179

Other Service Personnel

1.4.110 There were no injuries to other Service personnel.

Civilian Personnel

1.4.111 There were no injuries to civilians.

Post Crash Management (PCM)

1.4.112 The Panel found that PCM was well handled; indeed, the INM identified the accident site facilities provided by 1 Regt AAC as representing best practice, suggesting that they should be referenced as such in future PCM training courses. The 1 Regt AAC PCM Report relating to XZ210 is at Annex E. Annex E

Salvage Operations

1.4.113 **Ac Recovery**. There were no significant issues with the recovery of the ac. The remains of XZ210 were recovered by road on 7 Dec 11 by JARTS under the direction of the MilAAIB. The airframe remains were delivered to storage at MW and the engines to RR Filton the following day. The CVR was delivered to QinetiQ for analysis. Annex F

1.4.114 **Site Search**. Although a search was conducted for smaller items of evidence, only small fragments of melted aluminium, which were considered to be burnt cowling, were discovered. Annex G

Safety, Health and Environment (SHE)

1.4.115 The Panel had no concerns over SHE (as detailed in JSP 375) in relation to the events of the XZ210 accident; however, it did note the following potential environmental hazards relating to the Salvage Operations:

a. The dust from the burnt debris could have posed a threat, but was contained by the damp conditions. Annex B

b. A small amount of aviation fuel had leaked from the ac but was localised and it was not believed to have contaminated the local water course or streams.

c. The main rotor blades had partially delaminated due to the fire but were sealed by JARTS personnel using plastic film to contain the exposed material prior to removal; the blades were later removed from the rotor head to aid recovery. Annex F

d. The ac battery was removed and, with MilAAIB approval, disposed of at Gütersloh's battery bay.

e. The ac fire bottles contained no BCF/Halon suppressant and the fact that it had discharged was reported to DE&S Director Helicopters, Safety Deputy Team Leader in order to comply with EC Regulation 1005/2009[14].

1.4.116 Site remediation was then handed over to the HQ Gütersloh Garrison Services Liaison Officer to deal with local authorities and settlement with the land owner of the crash site. Annex B

[14] The MOD has to provide information on the quantities of Halon installed, used and stored for critical users and the measures taken to reduce their emissions and an estimate of such emissions.

Costs of Damage to Ac & Civilian Property

1.4.117 XZ210 suffered Cat 5 (Comp) ac damage as a result of the accident. Costs were:

a. The depreciated cost of Lynx XZ210 was £1,718,896.66. Exhibit 279

b. Site remuneration at 2 Jul 12 is 48,706.04 Euros of which the UK share was 75% - (36,529.53 Euros); the remainder was paid by the German Govt. In addition, there was a possibility that pollution (resulting from fuel contamination) to a nearby stream would increase the above amount; however, at the time of writing this was still to be confirmed. Exhibit 215

Related Issues

1.4.118 During the course of the investigation, the Panel became aware of a number of issues related to the accident:

a. LP Fuel Pipe Modification.

b. Other Modifications.

c. 1 Regt AAC Wksp REME Manning.

d. EFD.

LP Fuel Pipe Modifications - 498 (Engine) and 0908 (Airframe)

1.4.119 As stated earlier, the severed LP fuel pipe feeding the No2 engine was found to have caused the smoke which subsequently entered the ac interior, exacerbating the difficulties of dealing with the emergency. During the course of the Inquiry, the Panel became aware of a Lynx modification to re-route this pipe.

1.4.120 In the XZ256 (HMS Richmond) accident the release of the 1st stage FPT disc of the No1 ECU dislodged the LP fuel pipe from its location clip on the side of the engine case and fractured the LP fuel pipe at the FCU quick connect coupling, resulting in a fuel leak and large fire in the engine bay.

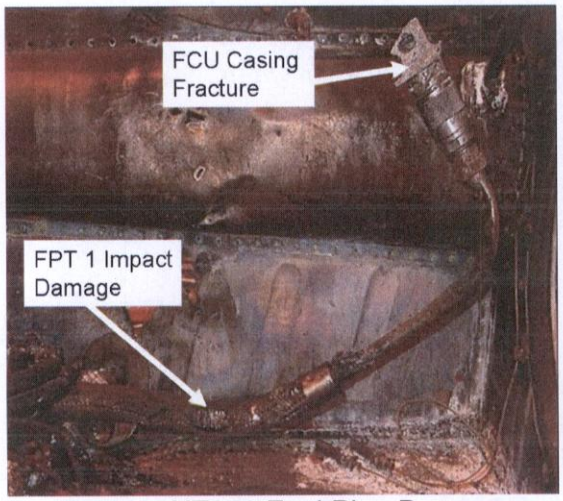

Fig 28 – XZ256 Fuel Pipe Damage

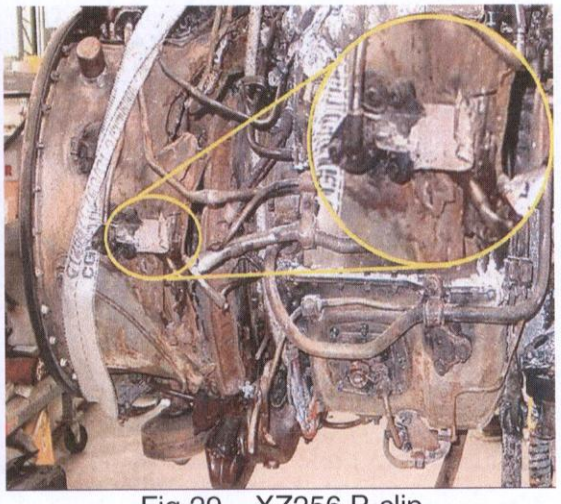
Fig 29 – XZ256 P-clip

The subsequent heat from this fire led to failure of the No2 engine and the ac ditched. The final accident report from XZ256 recommended that the original U-clip used to hold the LP fuel pipe in place was changed to a fully enclosed P-clip.

1.4.121 The XZ256 report was not released until Oct 05, but safety critical information was promulgated by the RN Flight Safety and Accident Investigation Centre (FSAIC) as the investigation proceeded. This led the Lynx Integrated Project Team (IPT)[15] to develop a modification to improve the security of the LP Fuel Pipe (Jul 03 – Mar 05) in order to reduce the likelihood of the pipe being dislodged from its engine attachment. Exhibit 211

1.4.122 During the modification development process, on-going Lynx survivability studies identified the possibility that an FPT failure might result in the FPT blades 'bursting' through the engine. RR were then tasked with mapping the potential 'burst' area danger zones.

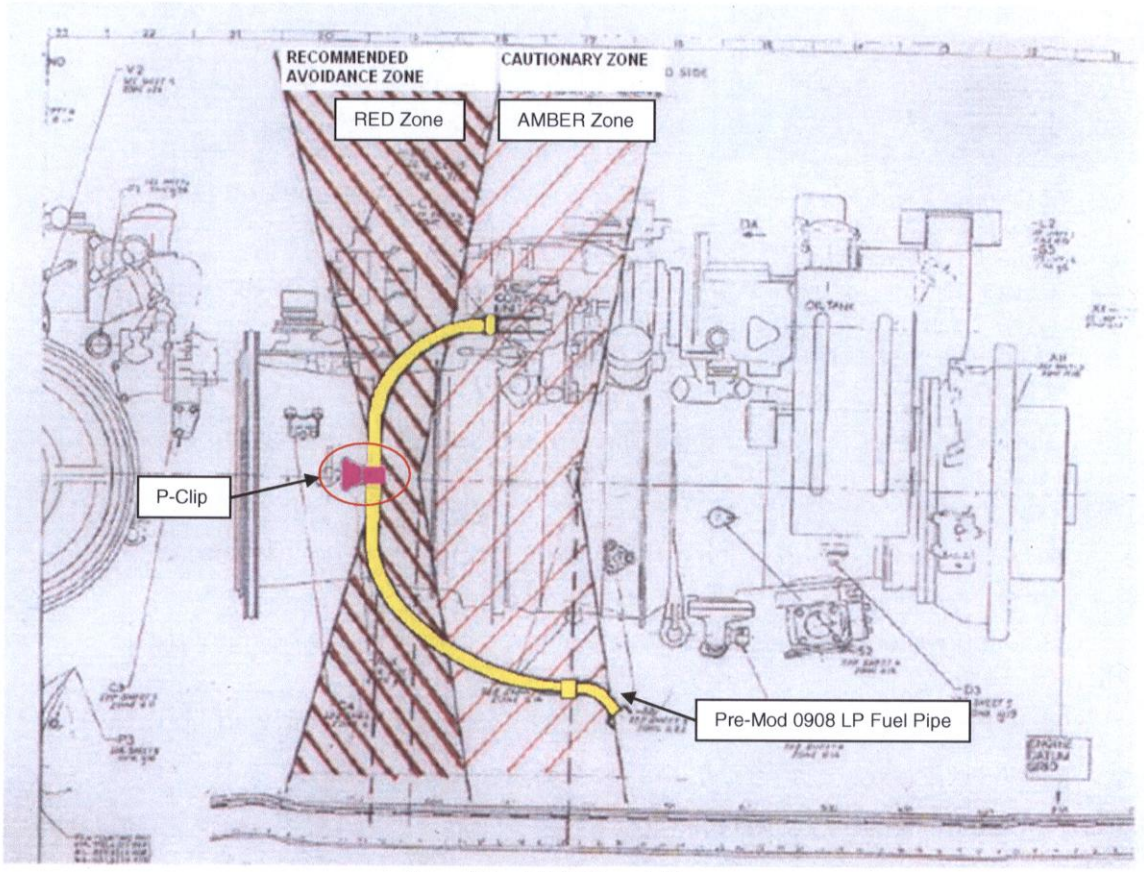

Fig 30 - FPT Burst Zones

1.4.123 Following the RR study, a subsequent Westland Helicopters Limited (WHL) report produced in Mar 05 identified that the LP fuel pipe was in the 'RED' zone. As a result, the Lynx IPT initiated the development of Lynx Mod 0908 and the Helicopter Engines IPT initiated GEM Mod 498 (the modification was specific to the RR Gem Engine and therefore not relevant for Lynx Mk9A), with an initial request to WHL and RR to produce a proposal issued in Jul 05. Exhibit 146 Exhibit 211

a. **Mod 0908**. Re-routed the port and starboard LP fuel pipes to reduce the risk of fire. To achieve this, new port and starboard fuel-feed hoses were introduced.

b. **Mod 498**. The re-routing required a new bracket to support the Mod 0908 hoses.

[15] PTs were known as Integrated Project Teams (IPTs) until 2009.

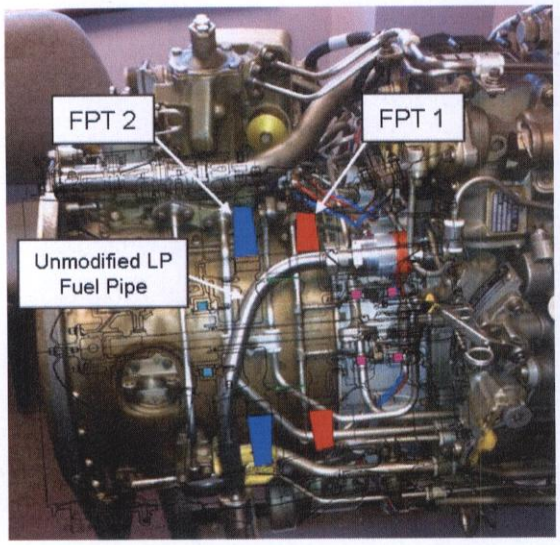

Fig 31 - RR Gem Engine Pre-Mod 0908

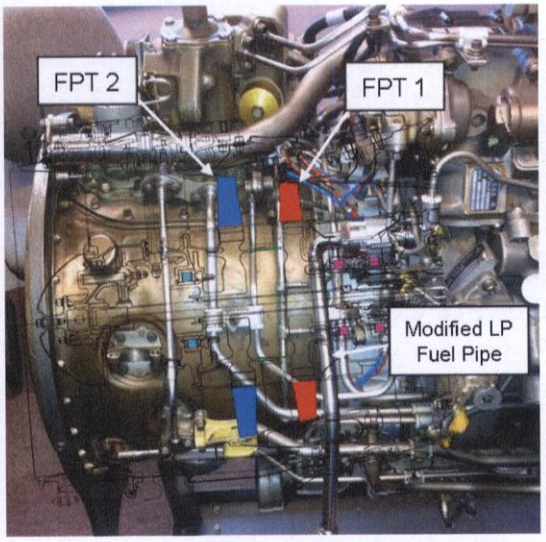

Fig 32 - RR Gem Engine Post-Mod 0908

1.4.124 At the Lynx Crashworthiness Progress Review meeting in Dec 05 the original plan was for the design concept to complete its Test Installation (TI) by Apr 06; however, the proposed solution was not presented to the IPTs until Oct 06 and production drawings for the respective designs not completed until Mar 07. The TI was not completed until Feb 08. Exhibit 211 Exhibit 149

1.4.125 The Panel considered why the modification had not been embodied on XZ210, more than 9 years after the XZ256 (HMS Richmond) accident. The Panel's investigation included:

a. How the classification of the modification affected the priority afforded to the modification.

b. How long it took for the embodiment of the modification to be carried out.

c. How the recommendation from the XZ256 accident was followed-up.

d. How the risk associated with the modification was managed.

e. The actual modification state of XZ210.

1.4.126 **Modification Classification**. The Panel noted that the modifications were not classified as those that would enhance flight safety. At the time, modification embodiment was governed by JAP100A-01, which stated that ac would generally be modified during Depth maintenance; repairable components would generally be modified during repair or reconditioning. Modifications would not normally be embodied Forward unless warranted by flight safety or operational requirements. Mods 0908 and 498 were approved at the respective IPT Modification Committee (MC) meetings, both held in Oct 08: Exhibit 201 Exhibit 211 Exhibit 149

a. **Mod 498 Classification**. Because of the engineering processes necessary for the installation of the new LP fuel pipe bracket on the engine, it was decided that Depth was the most suitable level for embodiment. The view was that to carry out the work at Forward would have introduced

[16] Class B – High priority modifications, the non-embodiment of which imposes operational limitations or reduces maintenance efficiency. Parts will be made available as soon as practicable and embodied forthwith during reconditioning or repair. The MC may also authorize delay in the delivery of any ac or equipment being produced in order to ensure embodiment and/or the scrapping of pre-mod parts.
[17] Class A – Modifications essential for safety and must be embodied irrespective of the delay involved. The absence of a Class A modification may involve the grounding of the ac, a flight limitation or a limitation of its operational role.

increased risk of damage to the ECU which outweighed potential benefits of more expedient embodiment.

b. **Mod 0908 Classification**. As the re-routed LP fuel pipe modification was intended to mitigate the effects of a potential technical failure rather than to prevent its occurrence, the Lynx PT considered it to have been an ac survivability issue rather than flight safety. This assessment meant that the highest classification that could have been applied (against the JAP 100A-01) was Class-B[16], with the default level of embodiment at Depth. Had the modification been assessed as flight safety related it would probably have been allocated Class-A[17] status, which would have enhanced the prioritisation of the modification, increasing the likelihood that embodiment would have been carried out at both Forward and Depth. Exhibit 188 Exhibit 189

1.4.127 Even though the modification was classified as a Class-B, there was provision within the JAP 100A-01 for the addition of a 'rider' or note to classification, which would have specified the timing or method of embodiment, common examples were: Exhibit 188 Exhibit 189

"On Removal of Unmodified Item – The modification should be embodied on the first occasion that the item itself is removed or some other part is removed which gives access. For example, on removal of engine or tailplane. "

"On Replacement of Unmodified Item – The modification should be embodied on the first occasion that the item becomes unserviceable and is replaced, subject to a modified item being available."

1.4.128 Lynx PT considered that none of the riders were appropriate in this instance. Exhibit 265

1.4.129 Although these modifications were designed to mitigate another failure rather than prevent one, they delivered an obvious safety benefit. The Panel made the **observation** that the decision to treat the LP fuel pipe modifications as survivability rather than flight safety related (**organisational influence**) contributed to length of time required to effect their embodiment. The Panel also made the **observation** that the XZ210 accident occurred 9 ½ years after the HMS RICHMOND accident and 6 ½ years after the decision to re-route the LP fuel pipe. Exhibit 211

1.4.130 **Modification Embodiment Schedule.** The Panel investigated the rate at which the modifications were embodied, after the decision to re-route the fuel pipe had been taken. After the TI in Feb 08, it took a further 2 years for the Mod 498 kits to arrive at ERS at Yeovilton. The first engine was modified by ERS in Jun 10. To ensure that there were sufficient ECUs in the system to enable Mod 0908 LP fuel pipes to be embodied on ac at Depth, the Lynx PT decided that the modification would be put on hold until a pool of 30 ECUs had been modified with the Mod 498 engine bracket. This figure was chosen as the threshold based on the knowledge of ECU rejection rates and supportability and to minimise the impact on continued fleet availability. Exhibit 201 Exhibit 211

1.4.131 Due to a combination of Desk Officers' (both airframe and engines) advice and the final classification of both Mods 498 and 0908, Lynx and Helicopter Engines PTs considered Depth to be a suitable means of embodiment. However, recognising that modified Gem engines (those with the new bracket attached) may be available to the FLCs, Lynx PT issued Lynx General Message (Lx GM) 638 to enable Front Line Commands the flexibility to embody Mod 0908 on an 'opportunity basis'; notably, when a post-Mod 498 engine was allotted to a Unit which had the capacity to embody Mod 0908. However, the original Depth embodiment plan was still deemed valid. Exhibit 141 Exhibit 201 Exhibit 265

1.4.132 The first ac to have the full modification (Mod 0908 and 498) on both ECUs embodied at a Forward unit was XZ652 in Feb 11 (at 9 Regt AAC at Dishforth). By 1 Dec 11, of the 46 Lynx AH Mk 7s in the Fleet, 6 ac had the full modification embodied on both engines and a further 7 ac had been partially modified (one engine with both Mods). Exhibit 211

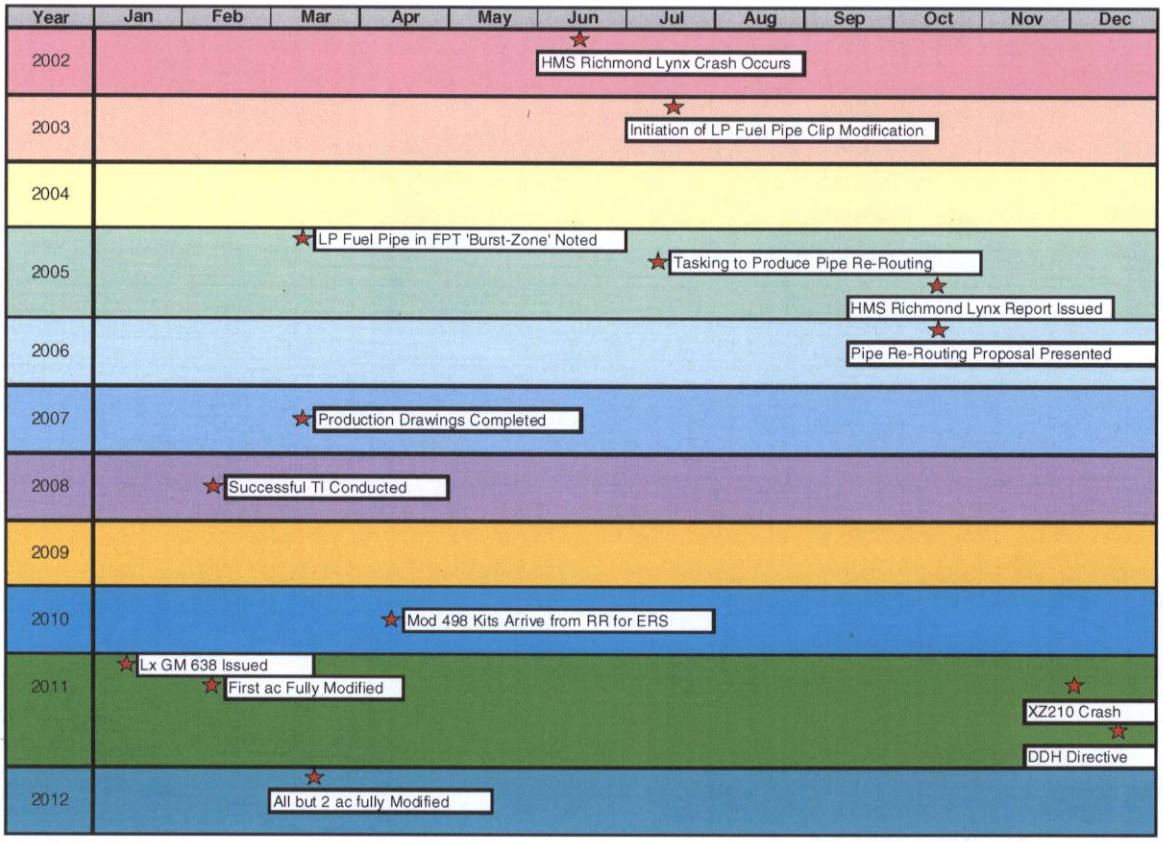

Fig 33 - Graphical Representation of Mod 0908 / 498 Timeline

1.4.133 Following the accident, the Lynx PT issued further direction (Lx GM 767) on 6 Dec 11 for the embodiment of Mod 0908 to be completed on 'installation or lift' of an ECU which had Mod 498 embodied. This removed the flexibility of 'opportunity basis' that was previously stated in Lx GM 638. Additionally, the Helicopter Engines PT conducted a trial on 8 Dec 11, to ascertain the ability of Forward units to embody Mod 498 with ECUs in situ. This trial proved successful and authority was granted by the Gem Engineering Authority for Mod 498 to be carried out at Forward to ECUs whilst installed on the ac. Exhibit 142 Exhibit 211

1.4.134 On 14 Dec 11, Delivery Duty Holder (DDH) Army Lynx Force directed that all Lynx Mk7 ac that still required either of the modifications were to have them embodied before next flight. This followed the RN issued direction which set a backstop of Feb 12 to embody the modifications. Exhibit 123 Exhibit 211

	Mod 0908 Embodied*		
	Single	Double	Total
Jan 11 - Jun 11	9	4	17
Jul 11 - Nov 11	4	5	14
Dec 11 - Feb 12	13	62	137

*Table shows Mod 0908 embodiment for all Gem equipped Lynx (RN & Army)

1.4.135 In the 11 week period following the DDH direction, 40 Lynx AH Mk7 ac had the complete LP Fuel Pipe modification embodied (30 ac required the full mod on both Exhibit 223

ac bar one stored Lynx Mk3.

1.4.136 **Post Aircraft Accident Follow-Up (PAAFU) of Navy Lynx XZ256 (HMS Richmond) Safety Recommendations.** After the RNFSAIC accident report was published in 2005, the actions arising from the recommendations were transferred to the RN PAAFU Log (Report No 170). This Log was managed by the RN Flight Safety Centre (RNFSC) within FLEET. On review of the PAAFU Log Report No 170 after the accident, it was found that no entries had been made to the log since Nov 06. The Report was not transferred to the Log in 2006 during a system transfer (**lapse**) and the actions had not been pursued in the normal manner. The last log entry noted that: Exhibit 223

> *"Engine Fuel Pipe enclosed clip modification cancelled, replaced by a plan to move the fuel feed pipe out of the Red and Amber disc burst zone".*

1.4.137 Retrospective action was instigated by RNFSC on 9 Dec 11 to determine what had occurred and to ensure that the actions from Report No 170 were closed correctly. After further investigation it was agreed by the PAAFU Joint Chairs (Jun 12) that the actions taken had exceeded the original recommendation by replacing and re-routing the fuel supply pipe away from the ECU disc burst zones. The action was therefore closed. Exhibit 223

1.4.138 The Panel made the **observation** that not transferring the associated PAAFU report was a **lapse** which led to a loss of oversight of the recommendation from the XZ256 Lynx crash. This meant that there was no independent monitoring of progress of the modification embodiment programme, which may have had an influence on the modification timeline.

1.4.139 **Management of Risk associated with LP Fuel Pipe.** The Lynx PT had a documented safety strategy that included risk management. The Safety Management System and Hazard Log (ECassandra) were available and reviewed by the Panel. The PT Hazard Log was a database containing the ac hazard to accident sequence. It detailed 24 generic accidents, hazards and individual causes as well as the sequences connecting them; this Log was maintained by the Lynx PT Safety Manager. Exhibit 201

1.4.140 There were 2 x Gem engine hazards which were entered into the Helicopter Engines PT Hazard Log which were of relevance to FPT failure and fire: H1 uncontained failure, initially assessed as remote catastrophic and H2 uncontrolled fire, also initially assessed as remote catastrophic. It was noted that these hazards were the cumulative result of a number of causes, but that the driving cause was Zone 59 fire (the major factor in HMS RICHMOND accident). It was also noted that engine hazards were for single engines and therefore the risk assessed to Lynx was reduced due to the presence of 2 engines; i.e. the loss of engine power was mitigated at platform level by the presence of the second engine. In the case of uncontained failure, the risk on platform was therefore reduced to incredible catastrophic due to the presence of 2 engines. Exhibit 265

1.4.141 Although engine failure was detailed within the Hazard Log, high energy failures of the engine were not the primary engine failure mode that drove the top level safety assessment. The most likely hazard leading to a loss of ac due to fire or explosion in the PT model was a fuel leak. The PT considered that a catastrophic failure of the engine was considered to be $<10^{-6}$. As the risk of LP Fuel Pipe damage related to a secondary event, being dependent upon an FPT overspeed and blade burst, it would not have featured as a risk in the Lynx PT register. Exhibit 201

1.4.142 **Lynx XZ210 - 0908 & 498 Modification State.** 1 Regt AAC Wksp REME received the Lynx PT direction to incorporate the Mod 0908 LP fuel pipe modification on an opportunity basis (Lx GM 638) in Jan 11. The signal was placed in the Lx GM folders held within the Wksp. The Wksp did not carry out any Mod 0908 work until Exhibit 143 Exhibit 193 Exhibit 159

directed when the DDH issued his direction on 14 Dec 11 and no demands for Mod 0908 kits were placed by the Wksp until 19 Dec 11.

1.4.143 XZ210 underwent a No2 ECU change in Sep 11 during its B1 servicing; the Panel considered why Mod 0908 had not been embodied at this time. The task supervisor responsible for the ECU change followed the procedure for removing/ installing a No2 ECU as detailed in AP101C-1307-1C1A Chap 40-12-00. The procedure made reference to Mod 0908 LP fuel pipe and so the task supervisor consulted the Modification Book to understand the relevance of the modification. Noting that the relevant modification leaflet stated that *"the modification will be embodied at Depth (D1/D2)"*, he did not embody the modification and re-installed the pre-Mod 0908 fuel pipe, which was still compatible with post Mod 498 engines. Exhibit 193 Exhibit 197

1.4.144 When Lx GM 638 was issued there was no instruction to update the modification leaflet with the revised direction (**organisational influence**). As a result, the 'Modification Book' only contained a copy of the original modification leaflet for Mod 0908; the Lx GM 638 was not referenced in it and no copy of the Lx GM was attached to either the modification leaflet or the removal/installation procedure. Additionally, there was no reference to Mod 0908 on the electronic ac activity schedule (GOLDesp[18]). On 6 Dec 11, when the Lynx PT re-issued their guidance (Lx GM 767) on fitting Mod 0908, it included direction to annotate GOLDesp with a D1/D2 servicing backstop for this modification. Exhibit 196 Exhibit 193 Exhibit 142 Exhibit 159

1.4.145 At the time of the accident, neither engine fitted to XZ210 had the full modification embodied: Exhibit 005

a. No1 ECU (A68304) was completely unmodified.

b. No2 ECU (A63169) only had Mod 498 embodied.

1.4.146 The Panel made the **observation** that if the modification leaflet had been amended or re-issued with the guidance contained within Lx GM 638, it was likely that the modification would have been incorporated as part of the engine change. This could also have been achieved if the original modification classification included a similar rider (see para 1.4.123). The Panel judged that the absence in Lx GM 638 of direction to amend the associated technical documentation resulted in the task supervisor's conclusion that he was not required to embody the Mod 0908 LP fuel pipe as part of the engine change process.

1.4.147 **Summary of Findings (LP Fuel Pipe Modification).** The unmodified LP fuel pipe was susceptible to an FPT blade burst, this was due to the ac design (**organisational influence**). The HMS RICHMOND Lynx (XZ256) accident in 2002 highlighted the potential dangers of an FPT blade burst and resulted in the LP fuel pipe modification. This design change was introduced to mitigate the subsequent secondary events following a breakout. The Panel made the **observations** that:

a. The assessment of the LP fuel pipe modifications as a survivability improvement as opposed to a flight safety consideration contributed to the lower prioritisation given for embodiment (**organisational influence**).

b. The XZ210 accident occurred 9 ½ years after the HMS RICHMOND accident and 6 ½ years after the decision to re-route the LP fuel pipe.

c. The loss of oversight (PAAFU) of the recommendation from the XZ256 Lynx crash was a **lapse** which meant that there was no independent

[18] GOLDesp provides maintenance management capability for the SH Force. The Maintenance module of GOLDesp provides airworthiness decision support and a paperless working environment. Maintenance tools are available to schedule and record maintenance actions, control and update configurations, and evaluate maintainability and reliability, down to the individual component level by part number and serial number.

monitoring of progress of the modification embodiment programme.

d. The absence in Lx GM 638 of direction to amend the associated technical documentation resulted in the LP fuel pipe modification not being carried out as part of the engine change process on XZ210 in Sep 11 (**organisational influence**).

1.4.148 The Panel found that if Mod 0908 had been fitted to the starboard side of XZ210 on 1 Dec 11, the FPT failure would not have severed the LP fuel pipe and the emergency would, in all probability, have been confined to a single engine failure with a hot gas leak. Accordingly, the lack of the LP fuel pipe modification to the starboard side of XZ210 was found to have been an **aggravating factor.**[19]

Other Relevant Modifications

1.4.149 **Mod 0821 (Crash Switches).** During the course of investigation, the Panel were made aware of a modification designed to protect aircrew in the event that they suffered a crash landing and were incapacitated. Mod 0821 (issued in Nov 00) introduced two inertia crash switches (ICS) and a tail cone hydraulic cut-off valve within the Lynx. In the event of a crash landing (6g load) the ICS would operate and would initiate the fire suppression system on both engines, close off the tail hydraulic cut-off valve and disconnect the electrical power supplies; however, the system was isolated on XZ210 in May 08 under Urgent Technical Instruction (UTI) 2045. Exhibit 270 Exhibit 255

1.4.150 Following an incident when a Sea King ICS system (similar to that fitted to Lynx) was activated by a 0.50" cal sniper rifle fired from the cabin door, the Lynx PT carried out an investigation. Subsequent instruction to disable the ICS during sorties where sniper weapons or M3M Heavy Machine Gun were to be fired was issued in Feb 08 (UTI 2042); however, following the discovery of an activated ICS switch during UTI 2042 compliance, UTI 2045 was issued in May 08 to isolate the system completely whilst a permanent solution was sought. Exhibit 213

1.4.151 Following the receipt of an AW engineering paper on the ICS system, the Lynx PT launched a task (LH12176) through the Joint Modification Service in Apr 12 to design an ICS system which isolated a number of systems whilst retaining flight critical systems; the task also required the design of a warning and crew isolation switch in case of inadvertent activation of the system. The outline decision as to which systems were to be isolated and retained was decided by a suitably qualified and experienced panel; respective DDHs were involved in the modification development and approval process through participation at the Local Technical Committees. Exhibit 213

1.4.152 Although this direction **(organisational influence)** left the ac without the intended protection, the risk had been identified and was recorded on the JHC Unified Air Safety Risk Register (UASRR). The lack of crash switch functionality was not deemed to have affected the outcome of this accident as it was unlikely that the controlled landing was sufficiently heavy to have activated the 6g switching. However, the Panel did conclude that this might have affected the survivability of the aircrew under different circumstances and was thus deemed to have been an **other factor**. Exhibit 192

1 Regt AAC Wksp REME Manning

1.4.153 It was reported that in the weeks preceding the accident the workload demands on the 1 Regt AAC Wksp REME may have exceeded available resources.

[19] In the future this issue would be mitigated under the 2011 revision of Def Stan 00-970 Part 7/3 Sect 7 (Helicopter design/ installations) Chapter 700. *"The propulsion system design shall take into account the possibility of burst of engine compressor and turbine discs. An analysis of the effects of disc burst shall be made…[and] the design aim shall be to ensure that continued safe flight shall not be prejudiced and that no injury be caused to the air crew"*

The Panel investigated the manning situation within the workshop to try to understand the problems that the Wksp were facing. The investigation considered:

a. The manning at the time of the accident.

b. The reasons for the manning shortfall.

c. The supervisory gap that manifested itself.

d. The effect of the undermanning on ac engineering tasks.

e. Risk management associated with the undermanning.

1.4.154 **1 Regt AAC Wksp REME Manning Situation in Dec 11**. Manpower was reported to have been a continuous risk in 1Regt AAC Wksp REME dating from Aug 06, when it had been recorded on the Wksp Risk Register. Specifically, personnel stated that manpower shortages had affected their ability to carry out the REME training programme and had impacted on supervision effectiveness. The Wksp had a disproportionate number of inexperienced engineers compared to numbers of experienced and supervisory personnel. In addition to the shop-floor and training supervision issues there was also a reported shortage of experienced and qualified individuals for management and supervisory posts. To off-set the manpower and personnel factors, Wksp management had made some staffing changes within the structure. Exhibit 068

1.4.155 The specific effect that the operational requirements, associated workload and insufficient resources had on management performance was that the Wksp struggled to keep up with administration demands. Wksp personnel reported that as they were frequently working to maximum capacity they did not have the available resources to track and implement organisational changes, monitor flight safety reports and maintain an effective quality assurance process. In the case of XZ210, there were only 6 independent 'QA2' inspections carried out between May-Nov 11. These inspections should have been carried out weekly, rather than monthly, as detailed in AESP 0200-A-090-013 (DEME(A) Engineering Standards). Indeed, in the time preceding the accident the Wksp was reported to have been 6 months behind in its assurance process. Annex A Exhibit 194 Exhibit 194 Exhibit 280 Annex A

1.4.156 In one specific instance, an audit of the Tool Store had highlighted a significant number of adverse observations which were directly attributed to the lack of dedicated Tool Store personnel. The general undermanning issue had already been reported to JHC by the Regt as an 'objective' risk to output. As a result of the problems in the tool store the responsible officer, OC Wksp, had informed the operating authority (Lynx Force HQ and J4) that he would halt ac production temporarily if it was felt that the objective risk started to impact on air safety. Indeed, this happened for 1 week in Nov 11 when the Wksp ceased ac production to catch up on routine engineering admin and assurance tasks (with a further week planned in early Jan 12). Exhibit 216 Exhibit 172

1.4.157 **1 Regt AAC Wksp REME Manning - Background.** 1 Regt AAC Wksp REME manning had been determined as part of a REME study (REME Aviation Review (RAR)) into the required levels of manning within REME Aviation Wksps (Dec 10). The manning level was set to meet a specific Annual Flying Task, with the assumption of supporting 2 Sqns at 2 different locations concurrently. Exhibit 133 Exhibit 134

1.4.158 At the time of the accident, DEME(A) were unable to meet the REME aviation manning liability with available manning. While there was an approximate liability for 1000 positions, the available manning figure had been approx 850. This was exacerbated by a lack of supervisory ranks which, coupled with the significant number of Under Training (UT) personnel, created an imbalance across ranks. Exhibit 132

1.4.159 In particular, there was a significant shortage of WO2 (Ac Quarter Master Exhibit 170

