



Air Warfare Centre



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## QinetiQ Review of RTI/Nimrod/212B - Nimrod Enhanced Systems Integrity Checks

Originated by: X X X X X X

### 1 Introduction

#### 1.1 Background

1.1.1 Following the XV230 Board of Inquiry, the Nimrod Team introduced Routine Technical Instruction (RTI) RTI/Nimrod/212 (Nimrod Enhanced Systems Integrity Checks) to consolidate and rationalise a number of previous RTIs. RTI/Nimrod/212B [1] consolidated three previous RTIs, increased the pressure used within the pressurized fuel system checks to 50 psi and introduced a pipe security check (as a result of the findings from the Ageing Aircraft Systems Audit (AASysA) Teardown of XV236). RTI/Nimrod/212C [2] was subsequently released taking into account the initial findings of this assessment. RTI/Nimrod/212 [1] included the following activities:

1. an examination of the aircraft fuel system between port and stbd No.3 ribs;
2. a leak check of the No.3 tank 4-way trunking;
3. an integrity check of the refuel pipes in the port and stbd Engine Change Unit (ECU) compartments;

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4. an electrical wiring inspection in specific zones;
5. a pipe security check.

1.1.2 The Nimrod Team requested that QinetiQ conduct an independent review of RTI/Nimrod/212B [1] and provide recommendations for improvement.

## **1.2 Evaluation conduct**

1.2.1 QinetiQ's review of RTI/Nimrod/212B [1] focussed on the clarity of visual inspections required to complete the RTI and the estimated manhours and frequency of the instruction.

1.2.2 In order to understand the intent and extent of the visual inspection, the following extract from the RTI is included:

*(20) Using a strong light source and mirror, examine as far as possible zones 133, 134, 147, 148, 153, 154, 413, 423, 433, 443, 511, 512, 513, 514, 524, 611, 612, 613, 614, and 624 for:*

*(a) Evidence of leaks (fuel, hydraulic fluid, oil and water) around fairleads and brackets utilised to secure pipes.*

*(b) Signs of leaks, as per 5a(20)(a) above, around the fairleads and attachment points utilised to secure pipes.*

The QinetiQ assessment inspected pipework containing these fluids, ducting and the electrical looms, connectors, terminal blocks and components within the zones specified.

1.2.3 A team of QinetiQ evaluators was detached to RAF Kinloss on 8 June 2009 to conduct RTI/Nimrod/212B [1] on a retired Nimrod MR Mk2 (tail number XV254). The aircraft inspection was carried out by aircraft engineers using standard aircraft engineering practices to identify observations. These observations were then assessed to determine if they should have been captured from the instructions within RTI/Nimrod/212B [1].

1.2.4 The MOD Form 700 documentation recorded that the aircraft had been subjected to the RTI five times at Forward maintenance. The aircraft was retired from service in April 2009 and all four engines and other components had been removed to support the in-service fleet. QinetiQ presented the initial findings from the RTI visual inspection to representatives from the Nimrod Team, RAF Kinloss and 2 Gp at a meeting held on 2 July 2009. It was decided from the meeting that the visual inspection needed to be repeated on a Forward-Fleet representative aircraft to ensure that the results of the inspection on XV254 had not been adversely affected by the removal of the aircraft's engines or other components. Therefore, a team of QinetiQ evaluators was detached to RAF Kinloss on 7 and 8 July 2009 to carry out the inspection on XV229, which had flown the previous day and been subjected to RTI/Nimrod/212B [1] during Depth maintenance and Forward maintenance (on 8 June 2009). As requested by the Nimrod Team, QinetiQ presented the preliminary findings of the inspection to representatives from the Nimrod Team, 2 Gp, Forward and Depth on 8 July 2009.

## **2 Results of the assessment**

### **2.1 Visual inspection of XV254**

2.1.1 During the visual inspection of XV254, a total of 311 observations (131 mechanical and 180 electrical) were made throughout the specified zones. 278 of those observations (98 mechanical and 180 electrical) had not been affected by the removal of the engines or other components, and would be directly identifiable from RTI/Nimrod/212B [1]. As shown in Appendix A, these

observations were sorted by observation 'type' and Sentencing Panel category (examples of the findings of the visual inspection are shown in Appendix B).

2.1.2 The analysis showed that over half of the observations noted were attributed to either corrosion or clearance, with contamination to the electrical wiring being the next prominent category. The majority of the observations were identified in the bomb bay zones, followed by the intake and rib 1 compartments.

2.1.3 It was concluded from the visual inspection of XV254 that RTI/Nimrod/212B [1] provided adequate instructions to identify any faults that were present; however, it was evident from a review of the Mod Form 700 that a significant number of the observations made by QinetiQ had not been recorded or rectified when RTI/Nimrod/212 was last carried out on the aircraft. It is therefore recommended that the reason for the recordable faults, identified during the QinetiQ assessment, not being recorded by the Maintenance Organisations are established. Furthermore, physical and documentation quality assurance checks should be conducted within the fleet to ensure that RTI/Nimrod/212B [1] is being complied with to the required standard.

## 2.2 Additional observation from XV254 inspection

2.2.1 Although not directly related to RTI/Nimrod/212B, it was observed when entering the bomb bay area that the cross feed ducting shroud half clamps were incorrectly orientated as shown in Figure 2-1 below. The half clamps are removed and inspected during every After Flight Maintenance (Servicing) under RTI/Nimrod/235A [3]. The correct orientation of the half clamps allows any fluid contamination to drain from the shroud and away from the hot cross feed duct. It is therefore recommended that physical and documentation quality assurance checks are conducted within the fleet to ensure that RTI/Nimrod/235A [3] is being complied with to the required standard.

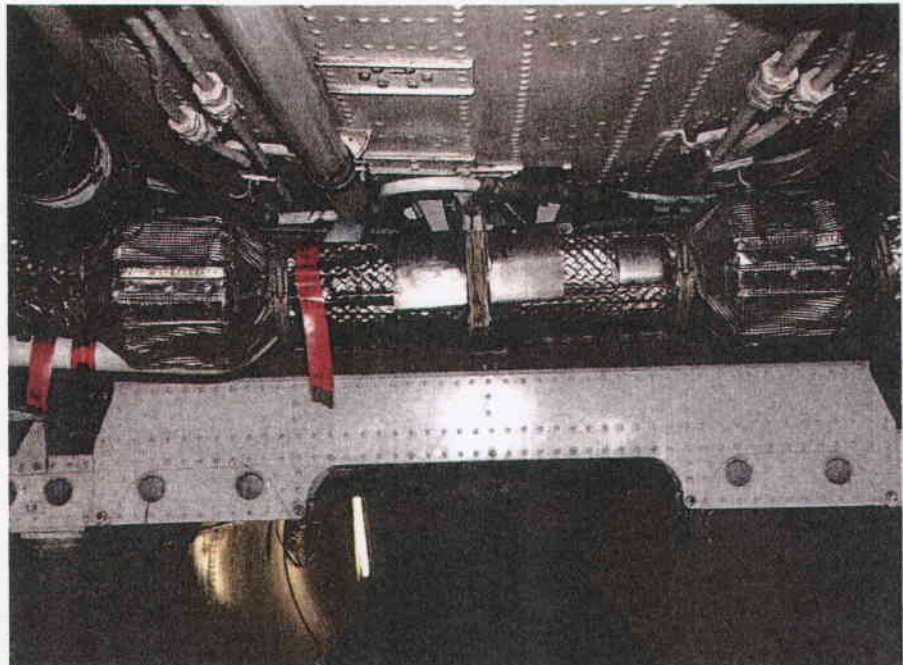


Figure 2-1; Cross feed duct shroud half clamp seams incorrectly orientated on XV254

## 2.3 Visual inspection of XV229

- 2.3.1 During the visual inspection of XV229, a total of 358 observations (192 mechanical and 166 electrical) were made throughout the specified zones. 256 of those observations (95 mechanical and 161 electrical) would be directly identifiable from the RTI. As shown in Appendix C, these observations were sorted by observation 'type' and Sentencing Panel category (examples of the findings of the visual inspection are shown in Appendix D).
- 2.3.2 Although some of the fuel system pipework and ducts had been replaced, there were still a number of recordable defects relating to pipework and duct clearance between adjacent pipes and structure that should have been conceded at installation. However, the number of corrosion-related observations identified within the fuel system pipework and couplings was significantly lower than on XV254.
- 2.3.3 It was concluded from the visual inspection of XV229 that RTI/Nimrod/212B [1] provided adequate instructions to identify any faults that were present; however, it was evident from a review of the Mod Form 700 that a significant number of the observations made by QinetiQ had not been recorded or rectified when RTI/Nimrod/212 was last carried out on the aircraft. It is recommended that the reason for the recordable faults, identified during the QinetiQ assessment, not being recorded by the Maintenance Organisations are established. Furthermore, physical and documentation quality assurance checks should be conducted within the fleet to ensure that RTI/Nimrod/212B [1] is being complied with to the required standard.
- 2.3.4 There were a number of recordable faults identified that were outside the remit of RTI/Nimrod/212B [1]. It was considered that these faults should have been captured during this RTI [1] due to the proximity of the fault to the systems identified for visual inspection. Additionally, these faults could have been detected during other maintenance activities.

## 2.4 Build standard differences

- 2.4.1 From the inspection of XV254 and the subsequent inspection of XV229, it was observed that in some areas of XV229, the fuel system pipework had been replaced with new or reconditioned pipework and couplings as part of STI/Nimrod/922. This replacement pipework and coupling appeared to be in better condition and was therefore easier to inspect for defects, as illustrated in Figure 2-2 below.

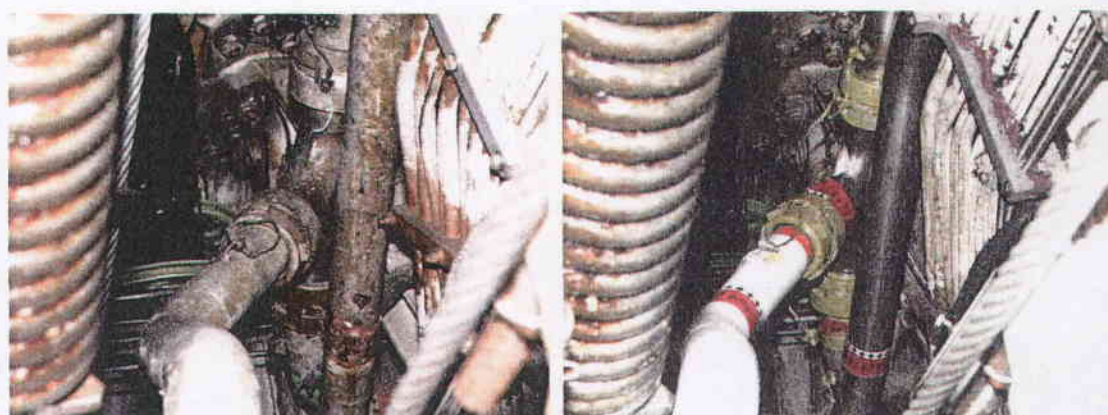


Figure 2-2; Illustration of the fuel system pipework on XV254 and XV229

## **2.5 Review of RTI/Nimrod/212**

- 2.5.1 The review of RTI/Nimrod/212B [1] concentrated on the visual inspection element of the instruction. The instruction stated in para 5a(20)(a) to inspect for "*Evidence of leaks (fuel, hydraulic fluid, oil and water) around fairleads and brackets utilised to secure pipes*". However, this was not clearly stated in the Reason paragraph of the instruction, it is recommended that RTI/Nimrod/212B [1] be amended to explicitly state which systems need to be inspected, in the opening reasoning paragraph on the RTI.
- 2.5.2 RTI/Nimrod/212B [1] requires a minimum clearance of 13 mm between adjacent pipes and ducts; however, it does not specify a minimum clearance between the pipes and structure. Nevertheless, an inspection of the general condition of the fuel pipework is required that should identify areas where the pipework was either interfering with, or being damaged by the aircraft structure. RTI/Nimrod/212C [2] addresses this by including a minimum required clearance of 2 mm between pipes and structure.
- 2.5.3 The number of tradesman man-hours estimated to complete the inspections was not detailed in RTI/Nimrod/212B [1]. RTI/Nimrod/212C [2] indicated that 40 man-hours would be required to complete the inspections. The level of inspection carried out by the QinetiQ team would suggest that a total of 48 hours (24 hours each for A Tech M and A Tech Av tradesmen) would be necessary to complete the instruction. Taking into account aircraft-type experience, the time required for the Nimrod Line Squadron to complete the instruction would be lower than that of the QinetiQ team. In light of this experience, it is recommended that the number of man-hours estimated to conduct RTI/Nimrod/212 be reviewed to ensure that sufficient time is planned for the inspection.
- 2.5.4 Additionally, the variation in interpretation of the RTI within the maintenance community led to components and zones that are required to be inspected being excluded. It is probable that the evolution of the instruction, together with the man-hours being utilised has led to this situation.

## **3 Conclusions**

- 3.1 It was concluded from the visual inspections of XV254 and XV229 that RTI/Nimrod/212B [1] provided adequate instructions to identify any faults that were present; however, it was evident from a review of the Mod Form 700 that a significant number of the observations made by QinetiQ had not been recorded or rectified when RTI/Nimrod/212B [1] was last carried out on the aircraft. It was concluded from a review of RTI/Nimrod/212B [1] that some improvements to the instruction could be made to assist in ensuring that inspections are carried out effectively.

## **4 Recommendations**

- 4.1 The reason for the recordable faults identified during the QinetiQ assessment not being recorded by the Maintenance Organisations should be established (see Paras 2.1.3 and 2.3.3).
- 4.2 Physical and documentation quality assurance checks should be conducted within the fleet to ensure that RTI/Nimrod/212B [1] is being complied with to the required standard (see Paras 2.1.3 and 2.3.3).
- 4.3 It is recommended that RTI/Nimrod/212B [1] be re-issued in two parts: an initial, detailed inspection to capture all recordable faults, with subsequent periodic inspections limited to specific components and areas (See Para 2.5.4).
- 4.4 RTI/Nimrod/212B [1] should be amended to explicitly state which systems need to be inspected (see Para 2.5.1).

- 4.5 The number of man-hours estimated to conduct RTI/Nimrod/212 should be reviewed to ensure sufficient time is planned for the inspection (see Para 2.5.3).
- 4.6 Physical and documentation quality assurance checks should be conducted within the fleet to ensure that RTI/Nimrod/235A [3] is being complied with to the required standard (see Para 2.2.1).

	Technical Approval	Release Authority
Signature		
Name	X X X X X X	X X X X X
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		Date 28 August 2009

5 **References**

- 1. *RTI/Nimrod/212B – Nimrod Enhanced Systems Integrity Checks*, 22 October 2008
- 2. *RTI/Nimrod/212C – Nimrod Enhanced Systems Integrity Checks*, 10 July 2009
- 3. *RTI/Nimrod/235A – After Flight Examination of the Cross Feed Ducting Shroud Assemblies including the Support Half Clamps*, 12 November 2008

**A**      **Observation Tables for RTI/Nimrod/212B on XV254**

Sentencing Panel Category	Definition	Number of Mechanical Observations	Number of Electrical Observations
A1	Potential airworthiness issue requiring possible Technical Servicing Instruction SI(T) action across the Fleet	0	0
A2	Potential airworthiness issue requiring immediate rectification but not Fleet-wide	3	0
A(Inv)	Potential airworthiness issue requiring further investigation	1	0
E1	Serious engineering issue requiring immediate action	15	0
E2	Engineering issue requiring rectification	11	4
E3	Minor rectification	11	6
E(Inv)	Possible engineering issue requiring immediate investigation	35	16
M	Minor issues requiring assessment / possible ADF action	22	114
SC	Surface Corrosion	0	0
H	Husbandry	0	40
<b>Total</b>		<b>98</b>	<b>180</b>

*Table A-1; RTI/Nimrod/212B - XV254 recordable faults by provisional Sentencing Panel Category<sup>1</sup>*

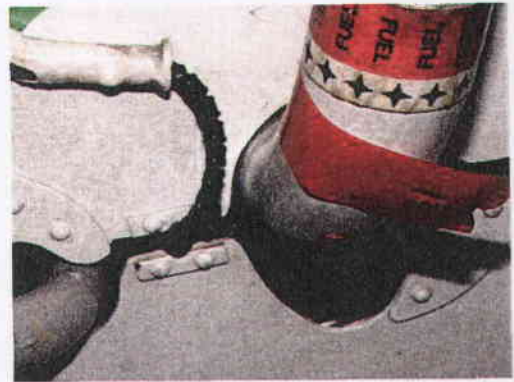
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<sup>1</sup> Sentencing Panel categories are those used in the Nimrod ALTI and the AASysA Teardown of XV236.

Observation type	Number of Mechanical Observations	Number of Electrical Observations
Assembly	0	1
Chafing	2	18
Clearance	49	7
Contamination	0	18
Corrosion	27	88
Damage	0	9
Dent / distorted	5	2
Leak	2	0
Loose	1	3
Misalignment	1	9
Loose article	0	0
Wrong component	1	10
Perished/deteriorated	5	12
Missing	2	2
Wrong id on component	1	0
Wrongly fitted component	2	1
<b>Total</b>	<b>98</b>	<b>180</b>

*Table A-2; RTI/Nimrod/212B - XV254 recordable faults by observation type*

**B**            **Examples of the Findings from the Visual Inspection of XV254**  
**B.1**          **Provisional A category recordable faults**



*Figure B-1; A2, Clearance, Zones 133/134, No 5 tank, Cell 1 pipe clearance with panels*



*Figure B-2; A2, Chafing, Zones 133/134, No 5 tank Cell 2 pipe chafe apparent from panel ridge trim*



*Figure B-3; A2, Clearance, Zones 147/148, No 6 tank cell fuel pipe in contact with panel ridge*

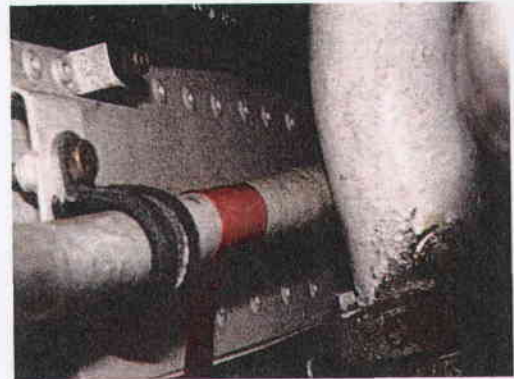


Figure B-4; A(Inv), Clearance, Zone 512, Fuel pipe hard against adjacent fuel pipe

**B.2 Typical examples of recordable faults**

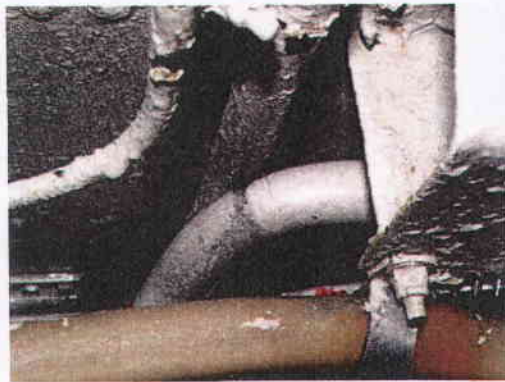


Figure B-5; Signs of damage and insufficient clearance between pipes

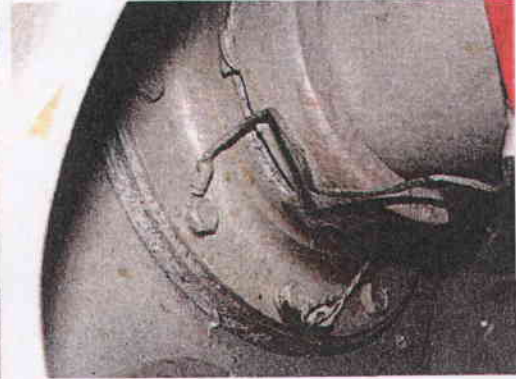
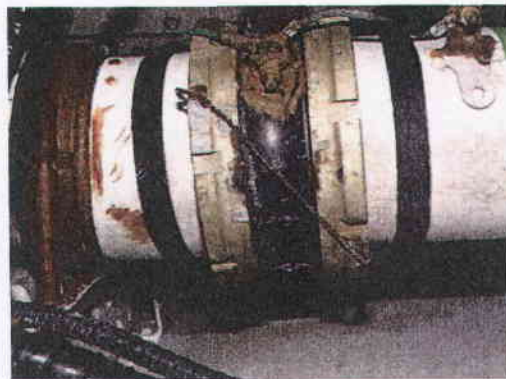


Figure B-6; Corrosion on fuel couplings



*Figure B-7; damage to electrical cables*

**C Observations Tables for RTI/Nimrod/212B on XV229**

Sentencing Panel Category	Definition	Number of Mechanical Observations	Number of Electrical Observations
A1	Potential airworthiness issue requiring possible Technical Servicing Instruction SI(T) action across the Fleet	0	0
A2	Potential airworthiness issue requiring immediate rectification but not Fleet-wide	0	0
A(Inv)	Potential airworthiness issue requiring further investigation	5	0
E1	Serious engineering issue requiring immediate action	7	3
E2	Engineering issue requiring rectification	18	26
E3	Minor rectification	24	62
E(Inv)	Possible engineering issue requiring immediate investigation	2	3
M	Minor issues requiring assessment / possible ADF action	25	7
SC	Surface Corrosion	9	23
H	Husbandry	5	37
<b>Total</b>		<b>95</b>	<b>161</b>

Table C-1; RTI/Nimrod/212B - XV229 recordable faults by provisional Sentencing Panel Category<sup>2</sup>

<sup>2</sup> Sentencing Panel categories are those used in the Nimrod ALTI and the AASysA Teardown of XV236.

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Observation type	Number of Mechanical Observations	Number of Electrical Observations
Assembly	1	5
Chafing	11	3
Clearance	45	18
Contamination	1	14
Corrosion	11	57
Damage	7	29
Dent / distorted	4	1
Leak	2	0
Loose	2	6
Misalignment	2	1
Loose article	0	0
Wrong component	3	9
Perished/deteriorated	5	9
Missing	0	4
Wrong id on component	0	0
Wrongly fitted component	1	5
<b>Total</b>	<b>95</b>	<b>161</b>

*Table C-2; RTI/Nimrod/212B - XV229 recordable faults by observation type*

D Examples of the Findings from the Visual Inspection of XV229

D.1 Provisional A category recordable faults

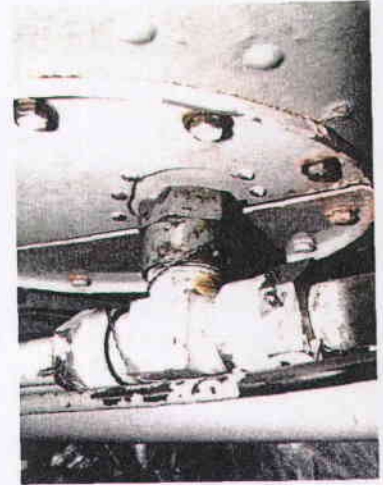


Figure D-1; A(Inv), Chafing, Zone 154, Fuel pipe from No 6 tank - chafe marks above union

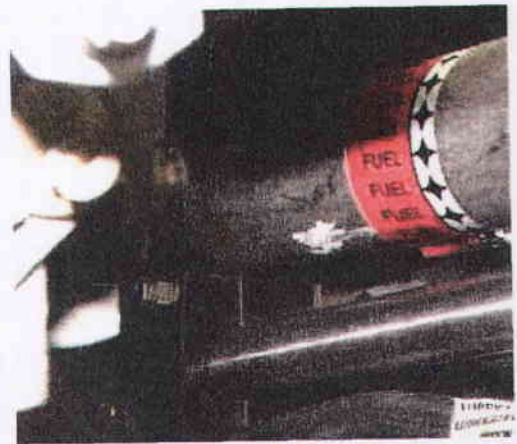


Figure D-2; A(Inv), Chafing, Zone 413, Fuel pipe hard against fairlead



Figure D-3; A(Inv), Clearance, Zone 514, APU fuel feed pipe and No 7 Tank Y branch possibly touching



Figure D-4; A(Inv), Chafing, Zone 514, APU fuel feed chafing on bulkhead and fairlead nut

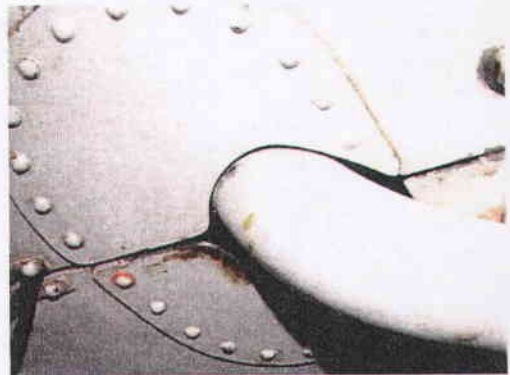


Figure D-5; A(Inv), Chafing, Zone 614, Fuel vent FRS coupling on air con v band clamp

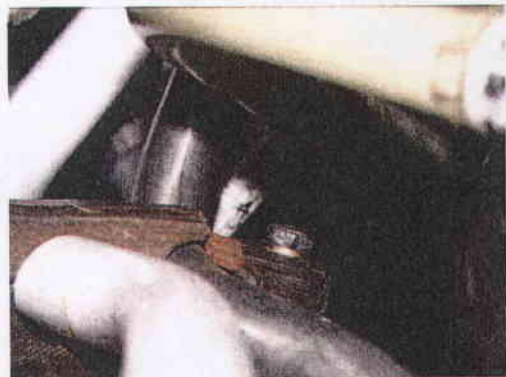
**D.2 Typical examples of recordable faults**



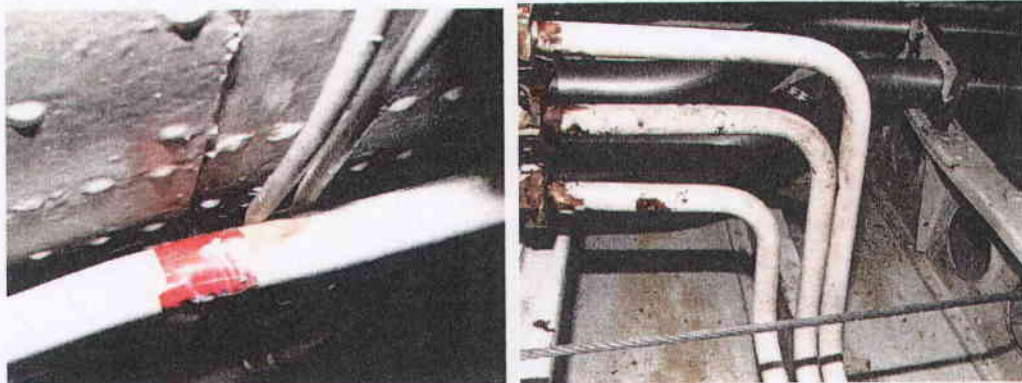
Figure D-6; Insufficient clearance between ducts and fuel pipes



*Figure D-7; Fuel pipe interfering with structure and showing signs of damage*



*Figure D-8; Damage to fairlead*



*Figure D-9; Clearance between pipes not within the fuel system*



Figure D-10; Fuel pipe clearance to structure

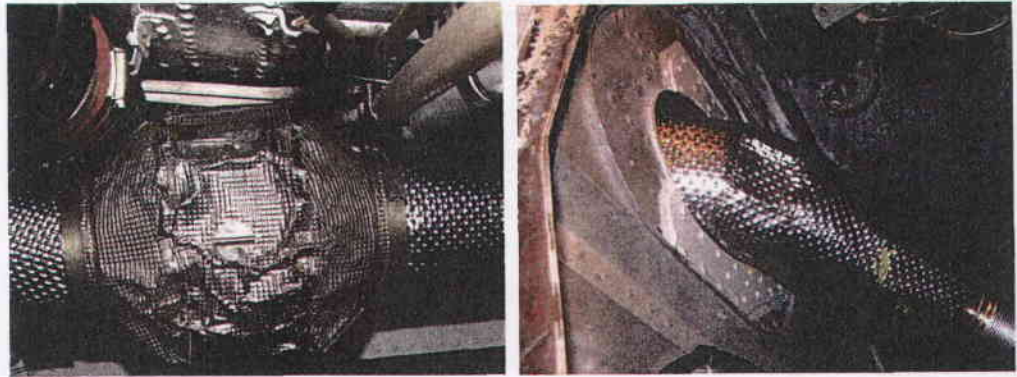


Figure D-11; Duct insulation crushed and clearance to structure

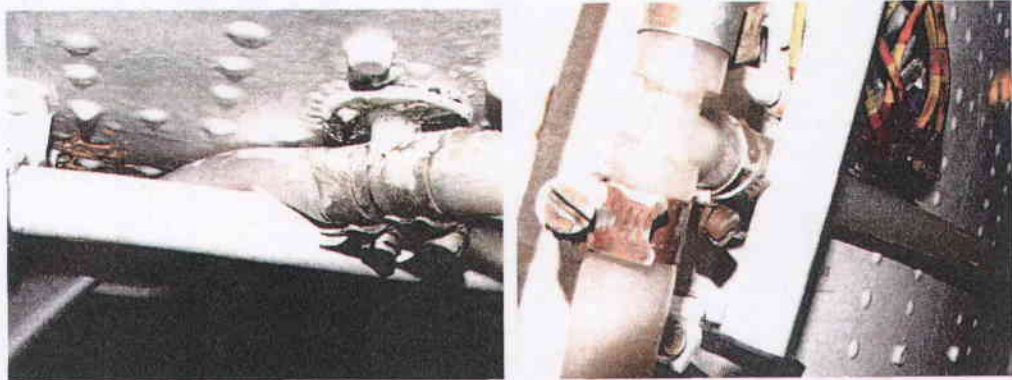


Figure D-12; Keel drain assembly issues



Figure D-13; Damage found on electrical cables



Figure D-14; Damage found on bonding leads

D.3 Observations identified on XV229 considered recordable but outside the inspection requirements of RTI212

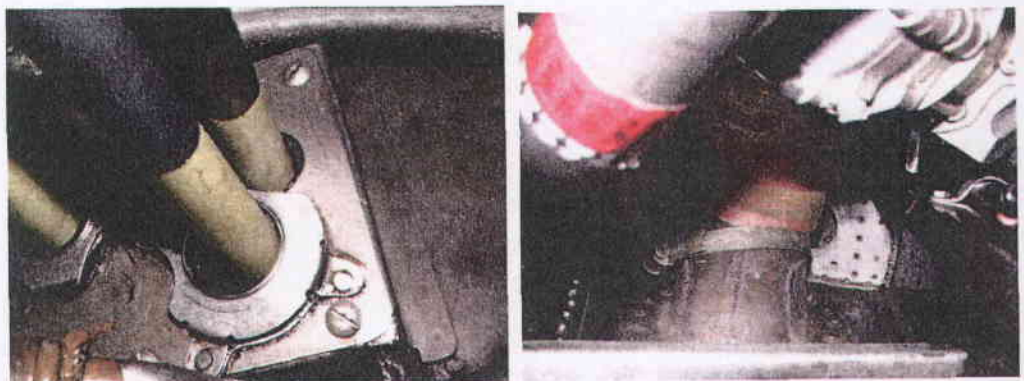


Figure D-15; Control rods and clearance to structure, loose component



*Figure D-16; Signs of overheating of protective coating*

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