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Nimrod IPT

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Your Reference:

Our Reference:
DE&S(Wyt)11/1/2/235
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XV235 AAR FUEL SYSTEM TRIAL WITH TRI-STAR AC AT RAF KINLOSS 30 NOV 2007

BACK GROUND.
XV235 reported a fuel leak in the bomb bay during AAR. Nimrod Ground Engineers investigated the fault, using MP41-41/1 and could not replicate the fault. The ac was returned to its OOA MOB and engineers re-investigated the fault, again the fault could not be replicated on the ground. The Nimrod IPT, was charged with investigating the fault. Xv235 was returned to RAF Kinloss.

IPT Investigation Work Strands:
2. The identified work strands are as follows.
   a. 3D Survey of AAR pipe work within the bomb bay. (Task via BAES)
   b. NDT X-Ray of the Avimo and FRS fuel system couplings within the bomb bay. (RAF Kinloss Regional NDT Team).
   c. Tasked QinetiQ to carry out a non-invasive instrumentation of the AAR fuel system within the bomb bay.
   d. Ground trial of Nimrod AAR fuel system with a Tri-Star Tanker at RAF Kinloss.
   e. Forensic Analysis of the Seals fitted within the Avimo and FRS couplings.

Actions:
3. **3D survey**:
As a precursor, target rods were fitted along the AAR fuel gallery within the bomb bay. The 3D survey was carried out in two stages.

   a. First stage – base line readings with the bowser hose attached to the AAR probe were taken.
   b. Second stage – fuel delivery from the bowser at 50psi was initiated (MP41-41/1) via the AAR probe and a second survey carried out. The interim results from the survey show that the maximum deflection on the pipe was 2.1mm(Y-axis). All other reading were of a lesser magnitude.

4. **NDT X-Ray**:
The Avimo and FRS couplings fitted to the AAR fuel gallery within the bomb bay were x-rayed. The results showed that one of the Avimo coupling was not assembled IAW the ac Topic 1. No other issues were noted from the x-rays. It must be understood that the x-rays could not provide information on the condition of the seals.

5. **Non-Invasive Instrumentation of the AAR Gallery within the Bomb Bay**:
A contract was placed on QinetiQ to carry out a non-invasive instrumentation of the AAR gallery within the bomb bay. The QinetiQ team arrived at Kinloss 26th November, and started planning the instrumentation.
The instrumentation was to include the following:

a. Camera cover of all the couplings.

b. Temperature sensors.

c. Accelerometers – Vibration monitoring.

d. Ultra-Sonic sensor – Fuel flow monitoring.

6. **Ground Trial of the Nimrod AAR Fuel System Engaged to a Tri-Star Tanker ac**:
It was decided to replicate the AAR on the ground using a Tri-Star Tanker ac. This was programmed for the week beginning 10th December. A change to the programme time table brought this element of the trial forward. A Tri-Star tanker was requested and arrived at Kinloss on the 30th November.

7. The Ground testing was initiated. The Tri-Star was positioned on ac dispersal 14>17. The Nimrod was brought in behind the Tanker and the in-flight refuel hose was connected to the Nimrod AAR probe. The transfer was planned to exactly follow the actions detailed with in the Incident Report (IR). The flight refuelling hose was primed. The Nimrod fuel tank cocks were set as per the IP. Fuel transfer from the tanker was then initiated again replicating the profile identified in the IR. See Table 1.

Pump	Prime	1	2	3	4	5	6	7	8	Carter
Pressure	22	12	12	15	17	20	22	22	22	33
Flow Rate (Kgs/min)	-	500	500	600	700	800	850	900	1100	1700
Highest pressure = 49psi, recorded when the refuel valve closed.										

Table 1

NB: Three cameras were fitted during the fuel transfer. They were focused on the suspect Avimo coupling, FRS coupling fitted forward of the 'Y' split and the FRS coupling fitted where the fuel pipe starts to cross over the bomb bay heating mixing chamber. Two observers were also in the bomb bay through out the AAR activity to monitor the AAR gallery.

The AAR was completed. The two observers did not observe leaks or any movement of the gallery. However, post trial run through of the camera footage showed that the Avimo coupling did move, no fuel leaks detected. This is in line with the movement noted during the 3D survey.

The tanker was disengaged from the Nimrod and the cameras removed. This strand of the investigation was closed.

8. **Summary**:
The trials work to date has been informative and has high-lighted that there is a fault with one of the Avimo couplings fitted on XV235.It has also shown that under high flow rates that there is rear wards movement of the Avimo coupling / gallery. This may just be a direct consequence of the incorrect

coupling assembly. However, it has not provided conclusive proof of where the observed in-flight leak originated.

9. **Recommendations**:

a. Remove the seals from the Avimo and FRS coupling in the AAR gallery for forensic analysis by QinetiQ. This needs to be adopted before instigating paras 9 c and d.

b. Replace ALL Avimo (x3) and FRS (x3) coupling assemblies fitted to the AAR gallery in the bomb bay. Ensure that the set-up of the couplings is IAW the Topic 1/ RTI/NIM/224 and 225.

c. Place a task on QinetiQ for flight capable non-invasive instrumentation of the AAR gallery.

d. On completion of 9 (c), carry out a two stage in-flight trial.

i. Nimrod trails a Tri-Star NO contact for data capture.
ii. Nimrod makes a wet contact on completion of 9 (d) i.

NB: Suggested time lines for 9 (d) i and ii, is twenty minutes.

On successful completion of 9 (d) XV235 should be returned to normal operations.

Original Signed

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NIMROD IPT