Re Incident on Nimrod XV249:

Overview:

There had been a small to very small fire. This had been burning on the cross feed duct over a length of ~ 0.5m from a point roughly in line with the starboard side of the antenna superstructure to about 100mm outboard of the port Refrasil 'muff'. In other words the fire had extended further to port side than to the starboard side. The fire had been typical of those that burn on the surface of liquid fuels i.e. a turbulent, heavily sooting, luminous, diffusion flame with combustion products rising through natural convection. The liquid fuel had been located mostly on the underside of the ducts (indicated by crusty/cokey deposits) and lighter smoke deposition over the upper side of the ducts. Smoke deposits on the pressure hull surface and other fittings showed 'netting' typical of turbulent smoke deposition. Wakes behind obstacles indicated flow of combustion products around the curve of the hull and then down the aircraft skin almost to the 'Fire-wire' on the port side. There was evidence of flow forwards of the plane of the duct that had left smoke deposits on the split flap Servodyne unit.

There substantial evidence of paint damage typical of hydraulic fluid contamination on bay doors below the duct and splashing onto the RAM panels. This was most evident in areas below the antenna superstructure. There was also evidence of liquid flow out of the plunged hole in the antenna superstructure above a white wire bundle with damaged yellow sleeving.

Recent kerosene contamination of the forward end of the Pannier bay (from the rib 1 area) has been stated. *(we need dates and statements for this)* There no evidence of soot deposition on the wire bundle or the sleeving and only very minor sooting on the adjacent braided cable.

There was no sign of thermal damage to any component except for a binding wire tie on the XXXXX that had been immersed in the fire and had become brittle.

Discussion:

The following arguments are intended to cover what is known and what possibilities need to be considered:

1) Auto-ignition

There was a small fire,
The fire was stabilised on the cross feed ductwork (CFD),
The auto-ignition temperature (AIT) of OX87 is >300°C
The AIT of kerosene (AVTUR) is >240°C
The temperature of the CFD was less than 180°C
∴ The fire was not started by auto-ignition of OX87 or kerosene
It could have been started by something with an auto-ignition temperature less than 180°C. (measure AIT of grease – note that some paraffin waxes have an AIT of ~ 130 °C)

2) Auto-ignition
There was a small fire,
The fire was stabilised on the CFD,
The auto-ignition temperature (AIT) of OX87 is >300°C
The AIT of kerosene (AVTUR) is >240°C
∴, in spite of subsequent measurements, the temperature of the CFD was greater than 240°C or 300°C

3) Electrical ignition of 'fuel' spray
There was a small fire,
The fire was stabilised on the CFD,
There is no evidence of directed sprays of hydraulic fluid or kerosene that could have prepared fuel suitably for electrical ignition. If there had been such sprays they would have been local to the CFD and directed exactly onto it.
A spray would create anomalous flow directions in the soot flow witness
A spray would have led to evidence of the location of a separate fire
∴ it is very unlikely that there was a spray that was co-incidental with two other, known, splashing leaks.

4) Electrical ignition of fuel vapour
The flash point temperature of OX87 is 91°C
The flash point temperature of kerosene (AVTUR) is 38°C
∴ the cross feed duct was in use when the fire started (in order to prepare flammable vapour for ignition) *(we need very accurate information about the operations of the CFD from several days before the discovery of the fire including what occurred on test flight(s)*

5) Electrical ignition of fuel vapour
The flash point temperature of OX87 is 91°C
The flash point temperature of kerosene (AVTUR) is 38°C
∴ there was a co-incidentally a hot electrical sparking/arcing fault - i.e. plug, connector, amplifier etc.
(this could have been helped by the OX97 that I have measured to have a conductivity of < 1MΩ) (do we have a conductivity for OX87?)

6) All the signs are of a slow burning pool fire with a slowly convective rise of combustion products. There are no signs of explosive combustion of a vapour cloud that could have brought ignition to the CFD from a remote ignition site.
∴ Any 'remote' ignition source, either electrical or thermal, needs to be very close to the seat of the fire on the CFD. *(Re-examine possible nearby ignition sources)*

6) 'Foreign object' initiation.
There are no signs of point ignition on the CFD due to solid materials 'foreign' to the scene. I.e. such as fabrics, pyrotechnics, cable ties etc. and the scene was well enough preserved that such signs would have been visible.

7) The hydraulic drain leading from the aileron bay in the pressure hull exits has now been shown to be leaking. This leak flows into the superstructure above the antenna. It is reasonable to assume that leaking fluid would also flow along the underside of the PVC drain-pipe towards its' exit on the port side. This tube runs more or less above the CFD and has several low points where drips would occur. This leak has most of the properties need to account for the fire, the distribution of the fire and the pool of liquid found in the port side 'muff'. It therefore seems unlikely that we need to find some other, co-incidental leak/spray/fuel source. On the other hand it seems unlikely that the drain fitting spontaneously leaked when the aircraft was stationary on the ground. Therefore we need to consider whether the leak resulted from a change of aircraft attitude in flight. And whether the CFD did, in fact reach > 300°C during flight trial(s)