BAE SYSTEMS *BAe 146/RJ*

SERVICE INFORMATION LEAFLET
21-146-RJ-536-1

AIRCRAFT TYPE: 146/RJ

ATA CHAPTER: 21

SUBJECT: Cabin Air Quality Troubleshooting Advice and Relevant Modifications

Suggested Operator Distribution

☑ Engineering ☐ Head of Maintenance ☐ All Maintenance Staff
☐ All Ground Staff ☐ Maintenance Planning

Summary

This SIL describes modifications related to the subject of cabin air quality, best practice available for troubleshooting and recommended actions after a cabin air quality event. This e SIL is a direct replacement for SIL 21-45 issue 4, dated Nov 2006.

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(Form ref. CSTS.0008A)

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Introduction

The BAe 146/RJ cabin air quality has been tested to confirm that airflow rate and contamination levels are good compared to the relevant airworthiness regulations, and in respect of contaminants, internationally accepted safe norms. This SIL provides helpful data on operator experience, troubleshooting and modifications so that an acceptable standard and reliability of cabin air quality can be maintained. Additionally, regular maintenance recommendations are made in Section 1 which are designed to ensure early detection of aircraft bleed system oil contamination.

Possible Sources Affecting Cabin Air Quality

The following is a list of air quality issues that can affect many aircraft types and should be considered when diagnosing an air quality report;

- Underfloor hydraulic system leaks
- Ingestion of De-icing fluid into APU inlet
- Galley ovens (Ref Maintenance Review Board item 21-1D task which cleans the forward galley oven extraction grille every “A” check)
- Damaged electrical wiring or components
- Inappropriate or excessive use of CO_2 (dry ice) by caterers (see AOM 99/020V)
- Toilet fluid spillage, leakage and also unapproved mixing of different disinfectant fluids within the toilet.
- Leakage of the rain repellent system or rain repellent contamination within the cabin or flightdeck.
- Spillage’s within baggage bays.
- Items stowed in overhead baggage bins.
- Although not directly related to the issue of cabin odours, ECS pack temperature control problems can worsen the cabin environment. On some aircraft it has been found that the ducting from the avionics cooling fan and both the flight deck and cabin ECS air temperature sensors had become crushed. Crushed ducting can lead to low airflow over the sensors and therefore erroneous temperatures being sensed. This has the effect of causing the ECS air delivery temperature to be inappropriate with respect to the cabin conditions.
- Contamination of the ECS, see Section 2 of this SIL.
- Engine or APU bay leaks.
- Engine or APU oil leaks.

The trouble-shooting chart in Attachment 1 can be used as a guide to ensure that a logical process of elimination is performed.

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Section 1 – Bleed Air and ECS Scheduled Maintenance Recommendations

In order to ensure early detection of aircraft bleed system oil contamination, the following scheduled inspections are recommended. Also note that whenever a cabin air quality problem is reported or suspected whether intermittent or persistent, the inspection stages listed below should be used to provide an initial step in subsequent troubleshooting and rectification. Continue down the list of checks until the extent of the contamination is determined.

1. Inspect the associated engines and also the APU in accordance with the instructions given in the relevant CMM and Section 2 of this SIL. These inspections will include ;
    - Engine oil gallery diffuser pipe.
    - Engine shaft seal leakage at No 1, 2 and 9 bearings.
    - APU shaft seal leakage.
    - Evidence of ingestion of APU bay contaminants.

2. Periodically inspect the air-conditioning pack regenerative air duct at the point it enters the reheater/condenser (“swan neck” ref AMM 21-50-17 Fig 201 Items 22 and 24) for evidence of **wet oil**. Be careful not to confuse deposits of dirt with wet oil contamination.

The recommended periodicity for completing this check is every 500 flights or as operator experience dictates based on satisfactory findings.

If wet oil contamination is discovered during this check or contamination is suspected, the following checks should also be completed to further investigate the source of the contamination.

3. Aircraft rectification actions required following confirmation of aircraft bleed system oil contamination are contained in Section 4 of this SIL and include;
    - Removal and cleaning of the ECS packs.
    - Cleaning of contaminated bleed/ECS ducting.
    - Replacement of cabin air filters (when fitted).

Section 2 - Troubleshooting (Identification of Source)

This section addresses contamination of the ECS. The possible sources of oil contamination of the air conditioning system are described below and detailed in Table 1. Operators are directed to the Mandatory actions required by ISB 21-150 and 21-156.

Be Careful Diagnosing the Source of Contamination

The majority of reports associated with oil contamination coincide with or closely follow one of the following crew actions: -

- Initiation of the APU bleed air supply.
- Large change in power lever angle (PLA), i.e. top of descent, with engine bleed air already selected ON.

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In these instances the air conditioning packs are subjected to changing bleed air inlet flow, pressure and/or temperature conditions. It should also be noted that the temperature of the APU bleed air supply is higher than the engine air supplies (downstream of the pylon pre-cooler). The generally higher APU air temperatures make it more likely that any existing contamination that is present within the air conditioning system will produce smells. Therefore, a report following initiation of the APU bleed air supply does not necessarily mean that the APU is the cause of the air conditioning contamination from which the smell can originate. Similarly, a smell report following a large change in engine power lever angle when APU AIR is OFF, does not necessarily mean that one or more of the engines is the cause.

In all instances of reported smells both the APU and engine bleed air supplies should be checked for evidence of contamination. Remember that the APU can contaminate both ECS packs, whereas Engines 1 and 2 can only contaminate ECS Pack 1, and Engines 3 and 4 can only contaminate ECS Pack 2. The process of determining the contamination source can be managed by use of a proforma /questionnaire as shown in Table 2. Details of oil contamination identification methods can be seen in the following tables. Additionally for the main engines, Honeywell CMM Chapter 72-00-00 contains details of oil leakage identification methods.

Engine Sources

Operator experience indicates that the most likely sources are;

- Oil contamination of the engine bleed air supply owing to ;
    - Engine oil gallery diffuser pipe failure.
    - Engine shaft seal leakage – No 1 bearing seal.
    - Engine shaft seal leakage – No 2 bearing seal.
    - Engine shaft seal leakage – No 9 bearing seal.

See below for diagnostic methods and Section 5 for related modifications.

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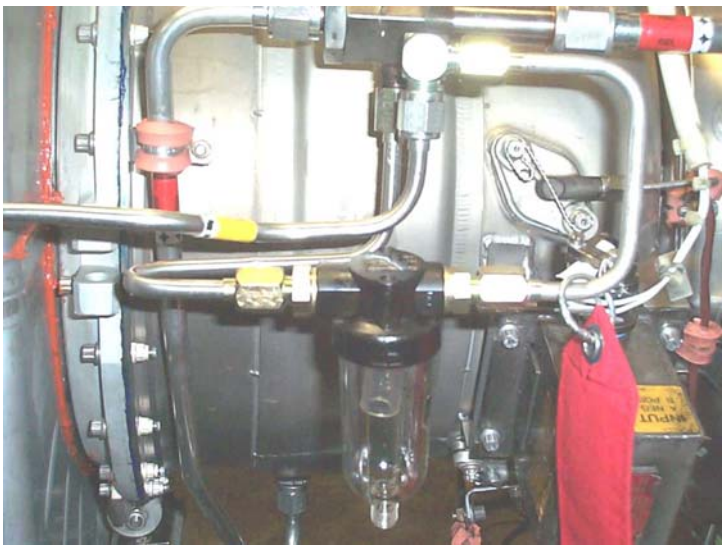
Cause	Identified by
Engine oil gallery diffuser failure	**Oil leaks in this area** may be evident by smoke in the exhaust on shutdown or draining/leaking/venting from the combustor drain valves.
No 1 Engine bearing/seal failure	**Oil may appear in the bleed band area** Check for oil wetness in the HP compressor. With reference to the EMM 72-00-00 Inspection/Check section, a boroscope examination can be performed to view oil telltale marks in the No1 bearing area.
No 2 Engine bearing/seal failure	**Check for heavy venting from the breather** , leakage at the diffuser/combustor split line and for evidence of oil drainage from the combustor chamber drain valves. No 2 seal leakage may also be evident by high bearing scavenge temperature
No 9 Engine bearing / seal failure	**Oil may appear in the bleed band area** Evidence of oil streaks from the fan exit guide vane weep hole and oil puddles at the '6 o'clock' position on the supercharger air seal

APU Sources

APU source diagnosis is impaired for aircraft operating with the GTCP36-150M APU fitted with the ejector system modification (listed in Section 5). The ejector system reduces oil leakage into the bleed air system, limiting fumes entering the cabin. Honeywell have developed a sight glass tool P/N 3212902-1 (ref eSIL 49-146-RJ-467-1) to be fitted into the ejector system during ground investigation checks when APU is suspected of leakage.



See below for diagnostic methods and Section 5 for related modifications.

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APU Shaft Seal Leakage

Cause	Identified by	APU Type
Failure of APU compressor seal. When the APU is running, smoke in the cabin or flight deck can result from oil leaking across the APU compressor seal.	Compressor seal failure should be suspected if smoke is witnessed in the aircraft cabin. Confirm by boroscope in accordance with Honeywell CMM 49-20-00.**	Honeywell
Failure of APU compressor seal resulting in oil leakage. Should be no smoke in the cabin as a result of this for those APU's fitted with the ejector system.	Fitting APU Sight Glass Tool (ref eSIL 49-146-RJ-467-1) to APU ejector system.	Honeywell
Oil system not correctly de-primed/primed. During shutdown the deprime valve must be energised for 16 seconds to remove oil from the oil system. Selecting APU to STOP will remove power from ESU and "de-oiling" will not occur.	N/A	Hamilton Sundstrand

****** Ref. ISB 21-150 & 156: Since it is not possible to gain direct access to the Compressor Seal area, it is recommended that a Black Light is used in the inlet area to establish if there is evidence of oil in preference to the Boroscope inspection procedure.

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APU Inlet Ingestion of APU Bay Contaminants

Cause	Identified by	APU
APU inlet plenum chamber seal leakage	Check integrity of the sealing of the inlet plenum chamber to the APU. With the Honeywell APU it may be possible to see staining and witness marks inside the APU at the Inlet flange interface by using a 4mm boroscope inserted through the compressor plenum drain outlet.	All
APU load control valve stub duct failure	Visual inspection of the stub duct for cracks and signs of failure or deterioration	Honeywell
APU oil fill point leaks	Visual inspection of **oil fill point area for oil leakag**e	Honeywell
APU Generator Cooling Fan leakage. Oil leaking past the cooling fan assembly seal can enter the APU inlet plenum and mix with the APU bleed air	Honeywell: Excessive oil consumption. Check the internal condition of the flexible duct connecting the APU cooling fan outlet to the oil cooler matrix for visible signs of oil deposits. In the case of high leakage**, traces of oil will be evident on the outside of the airframe at the oil cooler matrix orifice.** Hamilton Sundstrand: Excessive oil consumption. Oil deposits within the APU bay adjacent to the oil cooler air outlet.	All
APU exhaust flange seal failure. This can result in the leakage of APU exhaust gasses into the APU bay.	Sooty oil deposits within the APU bay. **Check the APU exhaust flange duct seal area for oil traces.**	Honeywell
Gearbox vent air containing oil mist can discharge into the APU bay	Oil deposits within the APU bay. **Check the APU gearbox vent pipe outlet area for oil traces**.	Hamilton Sundstrand
Oil cooling fan drain position. Existing fan drain position can lead to oil draining into the vicinity of the fan exhaust, which then propels oil mist throughout the APU bay.	Oil deposits within the APU bay adjacent to cooling fan oil drain and adjacent to the fan air outlet.	Hamilton Sundstrand
Gearbox vent tube obstruction can cause oil leakage through labyrinth seal.	Check gearbox vent tube for blockage	Hamilton Sundstrand

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Section 3 - Crew Medical Tests

BAE SYSTEMS have obtained medical advice about which medical checks should be carried out after an event. Where crew report any impairment, it is recommended that affected crew should be subject to medical examination as quickly as possible after reporting such symptoms to ascertain if the cause can be identified.

In order to reduce the possibility of external variables influencing the results of such examinations, crew movement details between the flight and the medical examination should be recorded.

Appropriate medical tests should include the following:

1. Take blood samples as soon as possible after landing: 10 ml in a lithium heparin pot and 2 ml in an EDTA pot for: a full blood count including haemoglobin, white blood cell count, packed red cell volume and platelets, c-reactive protein, temperature, carbon monoxide haemoglobin and cholinesterase activity in the blood.

   A clotted venous blood sample (10 to 20 ml) should be frozen at –20 deg C and stored for possible later testing.

2. Take and retain a urine sample, this should be chilled at 4 deg C and stored for possible later testing.

3. Ascertain personal medical history. This should include details of any drugs or medication taken, and details of any previous exposure to potentially toxic substances (e.g. hobbies, previous employment in other types of work or other activities involving exposure to paints or solvents etc.) Perform physical examination including neurological examination.

4. Record accurate and precise details of clinical symptoms: what symptoms were experienced? When during the flight did each symptom become apparent? How long did each symptom last? Was the symptom relieved by the use of oxygen? How were the onset of symptoms related to detected smell/odour? Were the symptoms related to any ECS system switch selections?

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Section 4 – Post Event Maintenance and Health Monitoring

Diagnosing Continuing Problems

Every attempt should be made to diagnose and fix reported problems. Use the questionnaire (Attachment 2) to help understand the crew report. Remember that seals wear and when they start to leak crews will report intermittent smells, usually associated with throttle changes, APU or air selection. Use this information to diagnose the cause. It may be difficult to reproduce the circumstances of the report during engine ground runs.

Aircraft Rectification

Following oil contamination of the aircraft bleed system and ECS, the system should be cleaned following removal of the contamination source, see Table 3, and then maintained in a clean condition.

NOTE : The practise of performing a “PACK BURN” (originally recommended in SIL 21/7 issue 1 to “burn” oil contamination from the ECS packs by elevating the conditioned air delivery temperature) is no longer recommended by BAE SYSTEMS. BAE SYSTEMS now recommend that if a pack becomes contaminated it is sent for cleaning.

ECS Pack Health Monitoring

Oil contamination of the air conditioning packs can lead to cabin odours even after the contamination source has been removed as well as premature failure of the ECS Packs. Prolonged use of the Pack when contaminated with oil can lead to carbon build-up on the Air Cycle Machine (ACM) foil bearings causing increased ACM torque. To avoid persistent cabin odours and in-service failures, effective cleaning procedures are available which enable “black or wet oil" contamination of the packs to be removed. Some operators have now adopted a periodic pack cleaning program or a pack monitoring procedure where the torque required to rotate the 3-wheel Air Cycle Machine (ACM) is periodically measured on the aircraft. The monitoring procedure not only enables planned, simplified and effective periodic cleaning of the packs to reduce the possibility of hot oil smells, but appears to reduce the major overhauls that are required when the ACM bearings, heat exchangers and water extractors have been subjected to prolonged oil contamination.

NOTE: The cleaning procedures outlined in this document address the problems caused by oil contamination of the air conditioning packs, It is important that the source of the oil is identified to prevent re-contamination.

The frequency of the periodic cleaning program or the torque check should be determined by in-service experience. These procedures should be used to compliment and not replace the checks recommended detailed in Section 1. It is not recommended to remove sub-assemblies from the ECS pack for local cleaning. Experience has shown that thorough cleaning and testing of the complete pack is important to ensure ongoing performance and reliability.

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Conduct a Torque Check (AMM 21-50-14)

To conduct a torque check refer to AMM 21-50-14. Disconnect the Jet Pump from the air conditioning pack and attachment clamp. Displace the Jet Pump sufficiently to one side to allow direct access to the retaining nut on the ACM turbine outlet fan. Carry out torque check using torque/cleaning tool P/N 2863T000 (or equivalent) and a suitable torque wrench, measure the torque required to rotate the ACM rotating shaft assembly in a clockwise direction when viewed from the conditioned air outlet end (i.e. when looking aft). If the measured torque exceeds 0.4 Nm (4 lbf ins), but is less than 2.26 Nm (20 lbf ins), then contamination is indicated and the pack should be removed for cleaning. Where the measured torque exceeds 2.26 Nm (20 lbf ins) or shaft rotation is not smooth, the pack should be rejected and returned to the vendor as the referenced cleaning procedures in this document may not alone deal with the suspected level of contamination.

Cleaning Procedure (See NGL CMM 21-50-30, 21-50-20 and 21-50-47)

- Remove the air conditioning pack from the aircraft in accordance with AMM 21-50-11.
- Remove the Jet pump from the aircraft in accordance with AMM 21-50-47 and clean in accordance with NGL CMM 21-50-35.
- Remove the Water Injector P/N 4342C000 from the aircraft in accordance with AMM 21-50-51 and clean in accordance with NGL CMM 21-50-30.
- Remove and clean the following components from the air conditioning pack in accordance with NGL CMM 21-50-20
  - Reheater/Condenser Heat Exchanger P/N 4684C000
  - Water Extractor P/N 4685C000
  - Air Cycle Machine P/N 1344D000
  - Primary B/Secondary Heat Exchanger P/N 4756C000
  - Primary A Heat Exchanger P/N 4754C000
  - Plenum assembly P/N 1430D000
  - Pack Ducts & Sleeves as required.
- Clean any traces of oil contamination from the inside of-the Ram air duct and also the stub duct at the jet pump connection at the rear pressure dome (frame 45) using Freon TF or Isopropyl Alcohol and a lint free cloth. If necessary, clean any traces of oil contamination from the air distribution ducts under the floor of the passenger cabin using Trichlorethene and a lint free cloth.
  NOTE: The flexible sound attenuator ducts (e.g. XC5349 at frame 44) cannot be cleaned satisfactorily and should be replaced if contaminated with wet oil.
- Refer to NGL CMM 21-50-20 and reassemble the air conditioning pack.
- Reinstall the Water Injector to the aircraft in accordance with AMM 21-50-51.
- Reinstall the Jet pump to the aircraft in accordance with AMM 21-50-47.
- Reinstall the Air Conditioning pack to the aircraft in accordance with AMM 21-50-11 and test the air conditioning system as detailed.

Cabin and Flightdeck Filtration Monitoring (See AMM 21-20-51 and 21-50-55)

See Section 5 for details of the cabin air filtration system.

As the filtration system may mask the effects of an oil leak, regular checks are recommended to avoid system contamination. The filtration elements should be replaced when either;

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- Their absorptive capacity has been exhausted
  OR
- Excessive pressure loss across the filter installation owing to particulate contamination is measured or suspected.

The pressure drop across the cabin and flight deck filter installations will vary depending on the level of contamination of the filter elements. Measurements of the differential pressure across the cabin filter unit are made possible by the provision of pressure tappings upstream and downstream of the filter element. AMM 21-20-51 details full test and renewal procedure. AMM 21-20-55 details the renewal procedure for the flight deck filter.

The first cabin filter element pressure drop check should be carried out after 800 hours in-service, with subsequent checks made at 500 hour intervals until the element odour life has been reached or the pressure loss recorded is above the stated AMM limits.

Section 5 - Modifications

The current production standard of the 146-RJ has been shown to be effective in reducing reports of cabin mal-odours. Operators wishing to improve the standard of their aircraft with respect to cabin air quality may compare their aircraft standard against latest standard. The relevant modifications which form production standard are;

- **Engines**
  - Latest standard No 1 seal
  - Latest standard of No 2 seal
  - Latest standard of No 9 seal
  - Latest standard oil diffuser pipe
- **APU**
  - **General**
    - Intake plenum chamber improved sealing
  - **Honeywell**
    - Gearbox oil system ejector modification
    - Exhaust flange modification
  - **Hamilton Sundstrand**
    - Oil system de-oiling valve modification
    - Drains Modification
- **Bleed System and ECS**
  - ECS filtration system fitted
  - APU catalytic converter fitted

Refer to Table 1 for more detail including modification numbers and information on additional related modifications.

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Bleed System and ECS Modification Descriptions

ECS Filtration System

The Air Conditioning Filtration System was introduced in 1993 under Modifications HCM01316A&C (SB 21-72-01316A&C for retrofit to BAe 146) and HCM01316B (for production BAe 146-RJ Aircraft). The system is designed to remove excess oil and odour that, under certain failure conditions may exist within the air conditioning system.

The use of the cabin filtration system will reduce the effects of oil contamination in the cabin until the filter element capacity is full. When the filtration system is fitted the engine catalytic converters are not required and are therefore deleted. The APU catalytic converter has been retained to reduce the hydrocarbon burden on the filters.

Cabin Air Enhancement Modifications

Modifications are designed to enhance crew and passenger comfort by reducing toilet odours and to increase conditioned air movement in the aisle, galley, vestibule and toilet areas. The modifications, which are not current production aircraft standard have been fitted to a limited number of BAe 146 100, 200 and 300 series aircraft, and in summary comprise the following;

- Introduction of Air Extraction System for the Forward Toilet, 1R and 2R Galleys.
- Introduction of an Air Extraction System for the Rear Toilet, 3R and 4R galley.
- Introduction of additional air outlets in the Aisle.
- Re-distribution of conditioned air to introduce additional flow into the forward vestibule.
- Introduction of an additional conditioned air outlet into the rear vestibule.
- Introduction of an additional outlet louvre in the rear vestibule.
- Introduction of grille in the bottom of toilet doors.

Please note that the availability of the modifications is dependent on aircraft interior standard and configuration. Please refer to BAE SYSTEMS for more information if needed.

Other Airframe modifications

In addition to the modifications already mentioned the following modifications are also available; Whilst not being specifically developed in response to the cabin odour issue these modifications have a generally positive effect on the cabin environment and are therefore included.

- Galley fume extraction - HCM50095A
- Introduction of air outlets in the forward toilet – HCM40002M
- Introduction of warm air outlets in aft vestibules – HCM65188
- Introduction of improved duct joints in the bleed air supply – HCM01343A
- Introduction of duct clamp assembly – HCM01627A
- RJ Cabin temperature sensor relocation and ducting improvement – HCM30506F, HCM30507F and HCM30508F depending on series.

New Generation Oils

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In recent years engine oil manufacturers have been developing engine oils to reduce engine wear, coking and toxicity. BAE SYSTEMS recommends that you contact your local engine oil supplier to take advantage of these developments. BP, Mobil and Shell have modern products that you should consider using.

Operators are directed to Honeywell SB A72-1075 issued 24 July 2002. The SB removes approval to use Mobil 291 due to incompatibility with certain components in the engine oil system and oil system coking (see also All Operators Message 02/02 dated June 2002).

NOTE; Air BP purchased the Exxon Turbo Oil business in January 2001 and all products formerly labelled and marketed as Exxon are now identified as Air BP products.

Oil Change Over Method

Honeywell currently permit the mixing of oils within the same type i.e. type 1 can be mixed with type 1 and type 2 can be mixed with type 2. Honeywell recommend that when changing from a conventional type 2 oil to a 3rd or 4th generation oil the “top off” method is used rather than the “drain and flush” method. Experience has shown that the new generation oils act as detergents within the engine oil system. Any deposits left by the conventional type 2 oil will be “cleaned”. The top off method is more likely to result in a slow release of these deposits rather than a potential fast release of deposits when using the drain and flush method. A quick release of deposits is more likely to result in engine oil filter blockage and subsequent oil filter bypass indications.

Section 6 - Contacts

Further Information

Operators requiring more information or further advice should contact their regional Customer Support office or BAE SYSTEMS Regional Aircraft, Customer Liaison Engineering, at the following address;

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KA9 2RW
Scotland

Tel +44 (0)1292 675000
Fax +44 (0)1292 675700
Email : raengliaison@baesytems.com

Event Reporting

Any occurrences of crew incapacitation should be immediately reported to BAE SYSTEMS. All other reports of cabin odour events and subsequent findings should be reported to the Continued Airworthiness office at the following address;

BAE SYSTEMS Regional Aircraft
Prestwick International Airport
Ayrshire
KA9 2RW
Scotland

Tel +44 (0)1292 675051
Fax +44 (0)1292 675700
Email : david.houfe@baesystems.com

Table 1 – Oil Contamination Source Checklist

Oil Contamination of ECS Due to APU Ingestion of APU Bay Contaminants

Cause	Identified by	Rectification Action	APU
APU inlet plenum chamber seal leakage	Check integrity of the sealing of the inlet plenum chamber to the APU	Embody mod **SB 49-36-36019E** which introduces APU inlet plenum duct P/N DXA07175 in lieu of existing duct to improve the sealing the inlet chamber. SB mandated by UK CAA. Compliance is required at next scheduled APU removal or next aircraft C check, whichever is the earlier. *Note:. The SB is currently applicable to all APU installations.*	All
APU load control valve stub duct failure	Visual inspection of the stub duct for cracks and signs of failure or deterioration	Embody BAE SYSTEMS modification **SB 49-32-36127A** which introduces an improved design of stub duct P/N BA7154	Honeywell
APU oil fill point leaks	Visual inspection of oil fill point area for oil leakage	Review oil servicing procedures, particularly pressure refill. Ensure oil is replenished to the correct levels in accordance with AMM 12-10-49. Honeywell SB **GTCP36-49-6595** introduces a modified oil level dipstick to aid oil level inspection. Replace oil dipstick O-ring P/N S9143-015 if seal deterioration is evident.	Honeywell

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Cause	Identified by	Rectification Action	APU
APU Generator Cooling Fan leakage. Oil leaking past the cooling fan assembly seal can enter the APU inlet plenum and mix with the APU bleed air	Excessive oil consumption. Check the internal condition of the flexible duct connecting the APU cooling fan outlet to the oil cooler matrix for visible signs of oil deposits. In the case of high leakage, traces of oil will be evident on the outside of the airframe at the oil cooler matrix orifice (for Honeywell).	Embody Honeywell **SB GTCP36-49-6641** which introduces an improved cooling fan seal & rotor. Embody Hamilton Sundstrand **SB 4501690-49-21,** introduction of an improved fan seal runner**.**	All
APU exhaust flange seal failure. This can result in the leakage of APU exhaust gases into the APU bay.	Sooty oil deposits within the APU bay. Check the APU exhaust flange duct seal area for oil traces.	Replace APU exhaust flange duct seal P/N HC498H0004-202 if signs of seal deterioration are evident. Embody BAE mod **SB49-30-36115B** which introduces large special washers to clamp the APU exhaust flange. Embody mod **SB GTCP36-49-6573** which introduces a stiffened exhaust flange. These mods reduce the possibility of distortion of the flange.	Honeywell
Gearbox vent air containing oil mist can discharge into the APU bay	Oil deposits within the APU bay. Check the APU gearbox vent pipe outlet area for oil traces.	BAE SYSTEMS mod **SB 49-54-36190A** introduces a new fuel drain pipe (P/N CXA20293), plenum drain pipe (P/N HC490H0053-000) and gearbox vent pipe (P/N CXA20292) which relocates these pipes to discharge overboard.	Hamilton Sundstrand
Oil cooling fan drain position. Existing fan drain position can lead to oil draining into the vicinity of the fan exhaust which then propels oil mist throughout the APU bay.	Oil deposits within the APU bay adjacent to cooling fan oil drain and adjacent to the fan air outlet.	Hamilton Sundstrand mod **SB 4501690-49-14** will inspect the fan assy for correct oil drain location and reposition the oil drain/vent where necessary (new fan assy P/N 4502904).	Hamilton Sundstrand
Gearbox vent tube obstruction can cause oil leakage through labyrinth seal.	Check gearbox vent tube for blockage	If required, clear blockage and ensure at lease 3mm (0.125”) between vent tube outlet and the APU bay door drain cup	Hamilton Sundstrand

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Table 1 – Oil Contamination Source Checklist (Continued)

Oil Contamination of ECS System Due to APU Shaft Seal Leakage

Cause	Identified by	Rectification Action	APU
Failure of APU compressor seal. When the APU is running, smoke in the cabin or flight deck can result from oil leaking across the APU compressor seal.	Compressor seal failure should be suspected if smoke is witnessed in the aircraft cabin. Confirm by boroscope in accordance with Honeywell CMM 49-20-00.	On all GTCP36-150M APU's, embody Honeywell **SB's GTCP36-49-6661, GTCP36-49-6591 and GTCP36-49-6910** and BAE SYSTEMS mod **SB 49-38-36153A**. This modification introduces an improved bellows type compressor shaft seal & ejector system.	Honeywell
Oil system not correctly de-primed/primed. During shutdown the deprime valve must be energised for 16 seconds to remove oil from the oil system. Selecting APU to STOP will remove power from ESU and "de-oiling" will not occur.	Wetness around compressor seal.	BAE SYSTEMS **mod SB49-55-36189B** maintains power to the ECU after APU stop is selected to allow correct "de-oil" to occur. Use overspeed test shutdown on ground to shut the APU down.	Hamilton Sundstrand

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Table 1 – Oil Contamination Source Checklist (Continued)

Oil Contamination of the ECS System due to Engine Shaft Seal/Oil Gallery Diffuser Leakage

Cause	Identified by	Relevant Modification
Engine oil gallery diffuser failure	Oil leaks in this area maybe evident by smoke in the exhaust on shutdown or draining from the combustor drain valves	For LF507-1F engines **SB72-1035** Introduction of improved air diffuser assembly with new oil tubes and double clamping. For LF502 engines **SB ALF502R72-340** is available which introduces new air diffuser oil tubes **SB 72-1027** is applicable to all engine types and replaces the diffuser curl assembly due to incorrectly manufactured diffuser curls. SB 72-1058 - Introduction of improved air diffuser assembly clamps
No 1 Engine bearing/seal failure	Check for oil wetness in the HP compressor and in the bleed band area. With reference to the EMM 72-00-00 Inspection/Check section, a boroscope examination can be performed to view oil telltale marks in the No1 bearing area.	BAE Systems recommends the embodiment of **SB ALF/LF 72-1082** for the replacement of the No1 seal and seal faceplate with seal, p/n 2-313-076-01 and seal faceplate, p/n 2-313-084-01 at a suitable shop visit.
No 2 Engine bearing/seal failure	Check for heavy venting from the breather, leakage at the diffuser/combustor split line and for evidence of oil drainage from the combustor chamber drain valves. No 2 seal leakage may also be evident by high bearing scavenge temperature	**SB 72-1034** Introduction of an improved No 2 bearing, part number 2-303-998-01 **SB 72-1009** Introduction of an improved No2 seal assembly, part no 2-310-142-01 **SB72-1037** Removal of coke for oil passages and inclusion of a heat shield to reduce coke build-up
No 9 Engine bearing / seal failure	Evidence of oil streaks from the fan exit guide vane weep hole and oil puddles at the '6 o'clock' position on the supercharger air seal. Oil may also appear in the bleed band area	**SB72-1090** Introduction of an improved No9 seal, p/n 2-313-074-02 and No9 seal faceplate, p/n 2-313-075-01.

For further guidance please refer to;
EMM Special Procedures 72-00-00 Oil leakage isolation procedures and limits
Alert Service Bulletin 21-150
Alert Service Bulletin 21-156

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Table 2 - Contamination Source Troubleshooting Proforma (Ground Use Only)

Part 1 – Isolating ENGINE/APU/PACK as the contaminant source						
Date	**Notes**	**Pack 1**	**Pack 2**	**Engine Air**	**APU Air**	**Odour**
		OFF	ON	ALL OFF	ON	YES/NO
		ON	OFF	ALL OFF	ON	YES/NO
		OFF	ON	ALL ON	OFF	YES/NO
		ON	OFF	ALL ON	OFF	YES/NO
	Take-off config	ON	ON	ALL OFF	ON	YES/NO
	Landing config	ON	ON	ALL OFF	ON	YES/NO
	Landing config	ON	ON	ALL ON	OFF	YES/NO
Part 2 – Isolating Engine(s) as contamination Source						
Date	**Notes**	**Engine Air #1**	**Engine Air #2**	**Engine Air #3**	**Engine Air #4**	**Odour**
	APU Air OFF	ON	OFF	OFF	OFF	YES/NO
	APU Air OFF	OFF	ON	OFF	OFF	YES/NO
	APU Air OFF	OFF	OFF	ON	OFF	YES/NO
	APU Air OFF	OFF	OFF	OFF	ON	YES/NO

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Table 3 - Rectification of Contaminated ECS

Component	Check	Rectification Action
ECS packs P/N 4676C000	Perform a torque check of the air cycle machine P/N 1344D000. Inspect the internal condition of the duct at the reheater/condenser inlet P/N 4684C000 for visible signs of oil deposits	Clean packs in accordance with NGL CMM 21-50-20
ECS pack jet pumps P/N 4888C000	Remove the jet pump from the aircraft in accordance with AMM 21-50-11 and check the internal surface for evidence of oil deposits	Clean jetpumps in accordance with NGL CMM 25-50-35
APU Bleed air supply ducting downstream of the APU load control valve	Conduct a visual examination of the internal condition of the ducting for evidence of oil deposits	Clean contaminated metallic ducts using a Teepol/water solution. Wash parts in distilled or demineralised water and dry thoroughly
APU catalytic converter P/N HC495H009 (HCM35078A&B)	Conduct a visual examination of the condition of the catalytic converter. The converter should be dry, free of acrid odours and particulate contamination	Replace the APU catalytic converter in accordance with AMM 36-12-21
Cabin filter P/N AFA2531 (HCM01316A&C)	When mal-odours are evident in the cabin area the odour absorption capacity of the cabin filter has been exhausted	Fit replacement cabin air filter element P/N AFA2541-1 in accordance with AMM 21-20-51. Monitor times between the replacement of elements to determine typical in-service life.
Flightdeck filter P/N AFA2532 (HCM01316A&C)	When mal-odours are evident in the cabin area the odour absorption capacity of the flight deck filter has been exhausted	Fit replacement flight deck air filter element P/N AFA2547-1 in accordance with AMM 21-20-55. Monitor times between the replacement of elements to determine typical in-service life.

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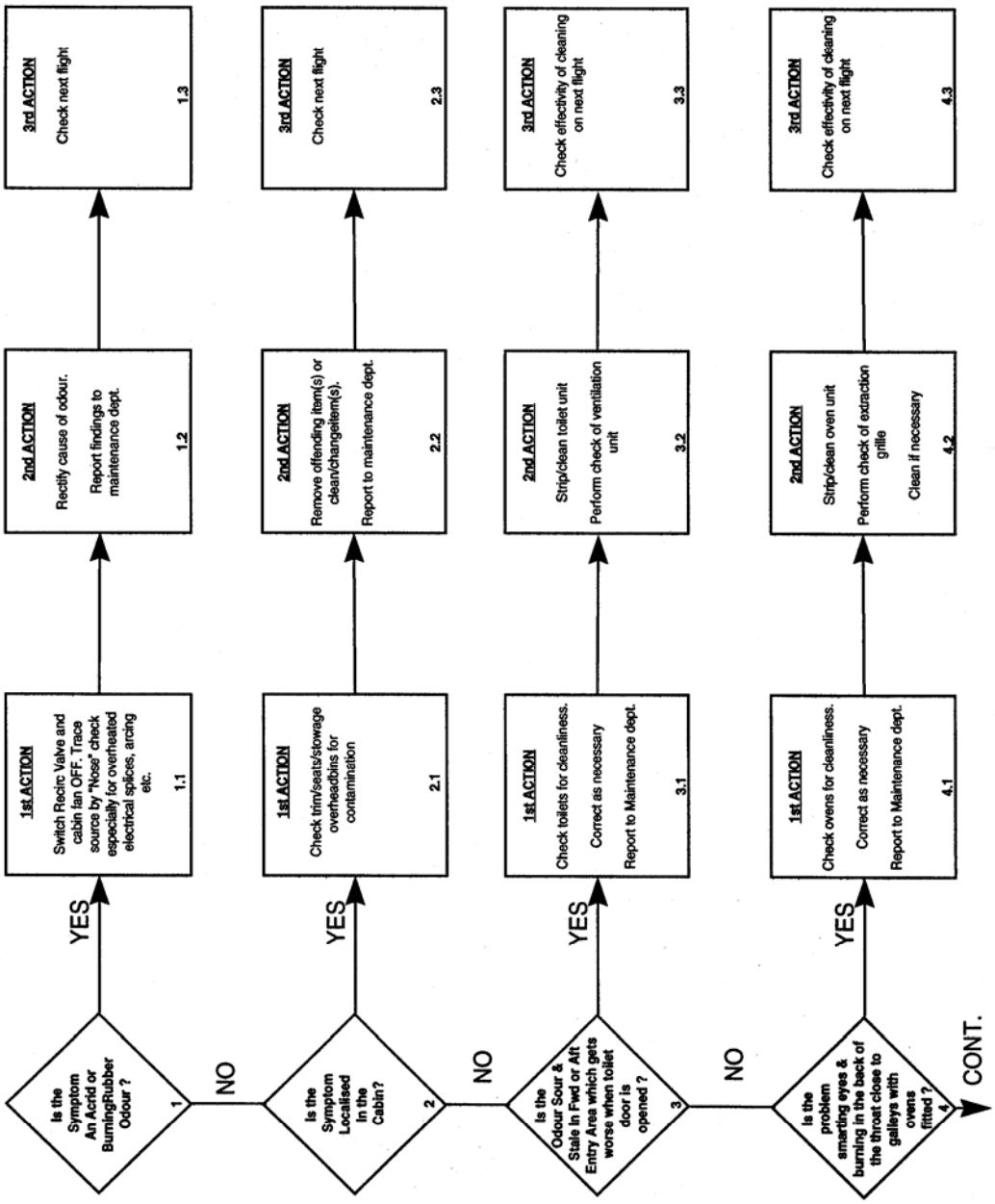
Attachment 1 - Troubleshooting Flowchart



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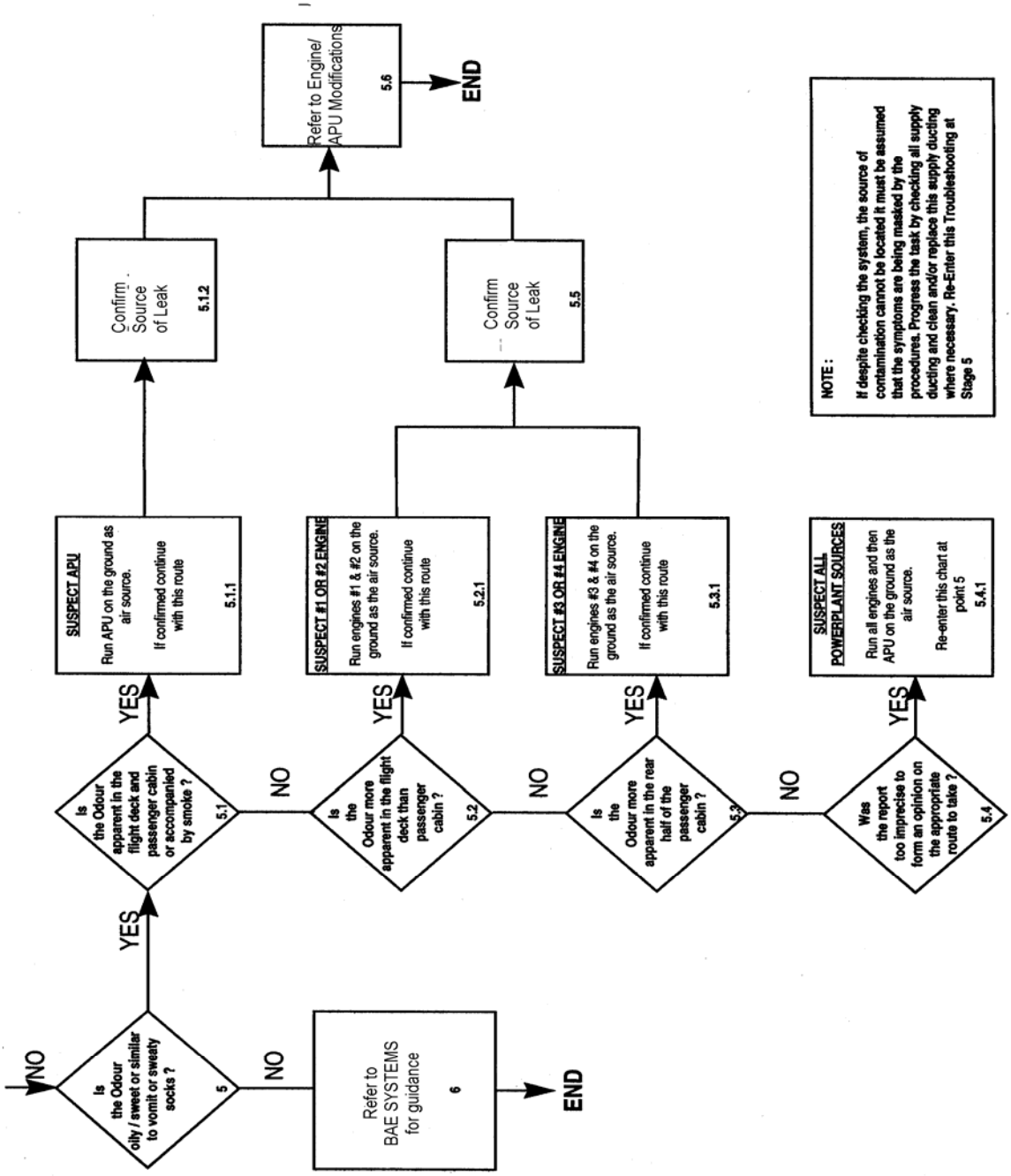
Attachment 1 - Troubleshooting Flowchart (Continued)



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Attachment 2 – Cabin Air Quality Questionnaire

Airline		Report Ref No	

Introduction

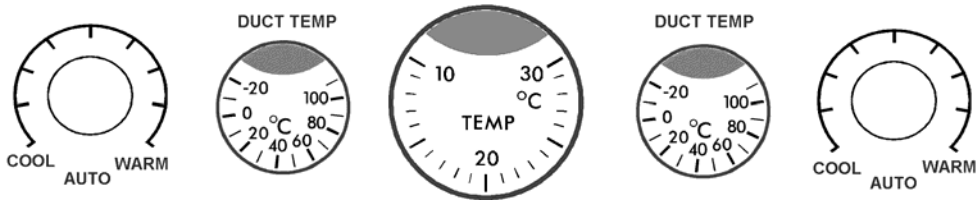
Purpose	This questionnaire has been produced as part of an ongoing study into cabin air quality. Its use will enable consistent information to be collected.
Protection of data	This information will be used for analytical / statistical purposes and may be freely shared by and between interested parties. The identities of individual respondents will not be disclosed.
Airworthiness reporting	This form supplements any national airworthiness reporting and is not intended as a replacement

Flight Details

Date			Aircraft Reg.	
From			To	
Aircraft Max Altitude	ft		Cabin max altitude	ft
Main engines started by	Electrical GPU	Diesel GPU		Aircraft APU

ECS settings at time of report

Mark control settings and resulting temperatures



Air Source at time of report

APU	Engines	Fresh	Recirc

Flight Deck Air Settings

Captain	First Officer

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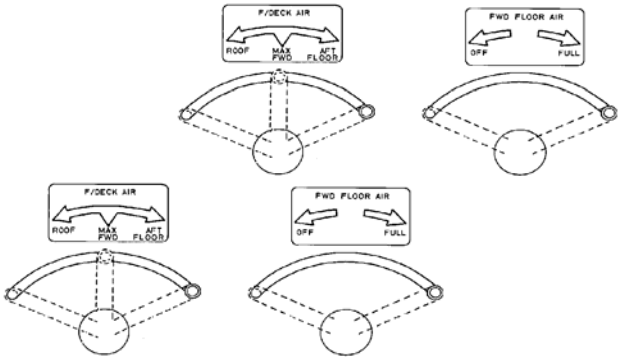

Air Isolation during flight

Was either pack switched off to isolate source	No / Yes Pack 1 / Pack 2
Were any engine air supplies turned off to isolate source	No / Yes Eng 1 / 2 / 3 / 4 / APU
Was the source identified	No / Yes Eng 1 / 2 / 3 / 4 APU Pack 1 / Pack 2

Rectification Post Flight

Any oil leaks found from main engines	No / Yes	Eng 1 / 2 / 3 / 4 Details:-
Any oil leaks from APU	No / Yes	Details:-
Any ECS problems discovered	No / Yes	Details:-
Other relevant information:-		

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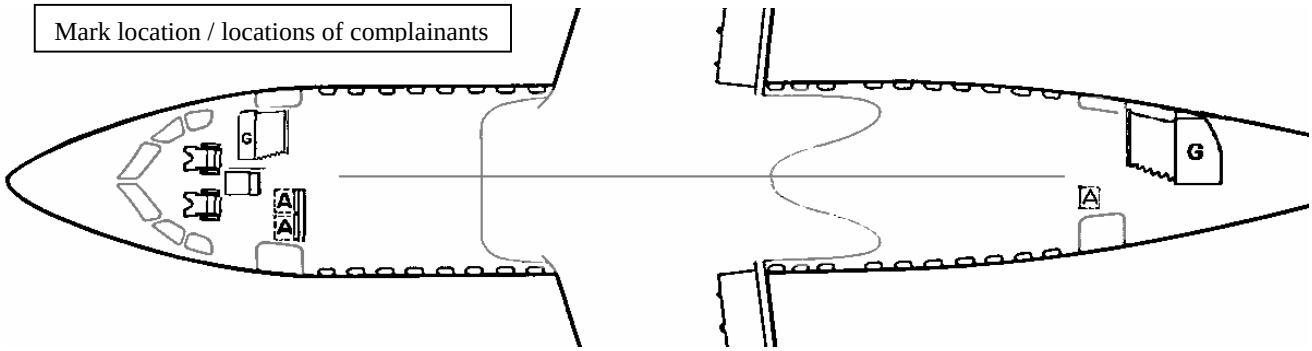
Attachment 2 – Cabin Air Quality Question (Continued)

Reporter Details - complete additional sheets for different people

Crew / Passenger	Male / Female	Approx age:-	Smoker / Non-smoker	Assessment of fitness: Good / Ave / Poor
Did you take any over-the –counter medication		analgesics	decongestants	Other:-
Are you taking any prescription medication if so what		No / yes details:-		

Location in Aircraft

Mark location / locations of complainants



Phase of flight	start	taxi	climb	At switch from APU to engine air	climb	cruise	descent	At switch to APU air	descent	Land & taxy

Symptoms	***The following reflects a range of possible symptoms, which might arise in a variety of circumstances, as well as individual terms used in previous reports. For <u>each</u> category, circle 'normal' <u>or</u>, all relevant 'descriptions' <u>or</u>, add a new description. Note that individuals may only show one or two symptoms in total, in this case, please indicate by circling 'normal' or ' none' as appropriate.***								
Head	normal	headache	light-headed,	pressure in head,	'moon-walking'				
General	normal	dizzy	faint	giddy	vague	lack of concentration	poor co-ordination		
Alertness	normal	fatigued	tired	sleepy	somnolent	exhausted			
Emotions	normal	relaxed	euphoric	elated	'drunk'	intoxicated	irritable	morose	pugnacious
Eyes	normal	dry	irritated	burning	streaming				
Nose	normal	dry	irritated	burning	streaming				

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Throat	normal	dry	irritated	burning			
Breathing	normal	shortness of breath	breathless	laboured breathing	rapid breathing	pressure in chest	
Stomach	normal	nauseous	vomiting				
Numbness or Tingling	none	scalp	hair-roots	nose	lips	fingers	toes
'Blueness'	none	lips	nail-beds	finger-tips			
Any other comments Consider general health							

Smells or Visible Fumes

Describe anything smelt or seen	

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