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MINISTÉRIO DAS OBRAS PÚBLICAS, TRANSPORTES E COMUNICAÇÕES

GABINETE DE PREVENÇÃO E INVESTIGAÇÃO DE ACIDENTES COM AERONAVES

GPIAA

FINAL ACCIDENT INVESTIGATION REPORT

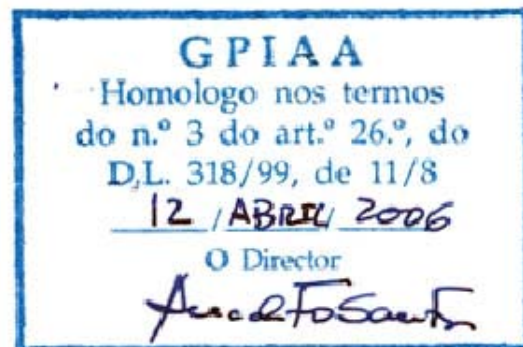
IBÉRIA

AIRBUS A346-600

EC-IZX

Lisboa International Airport

November, 11th 2004



REPORT Nr. 37/ACCID/2004

FOREWORD

This report expresses the technical conclusions determined by G.P.I.A.A. Investigation Commission about facts and causes involved in this occurrence.

According to Annex 13 to the International Civil Aviation Organization Convention (Chicago 1944), to the Council Directive nr. 94/56/EC (21st November 1994) and to nr. 3, 11th article of Decree-Law 318/99 (11th August), it is not the object of this report to determine blame or liability but solely to identify causes and deficiencies capable of undermining flight safety and to gather information for preventing further occurrences of similar circumstances.

Following ICAO Recommendation, Chapter 6, §6.7 (Note), this report has been prepared in English.

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SYNOPSIS

The Lisbon Airport Operations Service notified the occurrence to the *Gabinete de Prevenção e Investigação de Acidentes com Aeronaves (GPIAA)* at 03:44 UTC hrs on 11th November 2004. The investigation began that same day and the Commission of Investigation consisted of:

Mr. Anacleto dos Santos (GPIAA – Director-General)
Mr. Artur Álvaro Pereira (GPIAA - Investigator-in-Charge)
Mr. António Augusto Alves (GPIAA – Investigations Department)
Mr. José Ramón Sala (CIAIAC – Investigations Department)
Mr. Bernard Bourdon (BEA – Investigations Department)
Mr. Romain Bevilard (BEA – Engineering Department)
Mr. Jean-Claude Vital (BEA – Engineering Department)
Mr. Stéphane Ly (BEA – Engineering Department)
Mr. Joaquin M. Pardina (IBERIA – Maintenance)
Mr. Vicente Alvarez (IBERIA – Maintenance)
Mr. Julian Perez (IBERIA – Maintenance)
Mr. Albert Urdiroz (Airbus – Flight Safety Manager)
Mr. Ludovic Lehmann (Airbus – Engineering Department)
Mr. Gilles Cadet (Airbus – Engineering Department)
Mr. Emmanuel de Traversay (Matsushita – Technical Manager)
Mr. Sylvain Bauguil (Matsushita – Engineering Department)



On 11th November 2004, the AIRBUS A346-600 registered EC-IZX from IBERIA, en route from Madrid to City of Mexico with 15 crew and 289 passengers on board, when was cruising DETOX at 02:12 hours, had a *FWD Compartment Smoke* warning and a *Land ASAP* indication displayed in the ECAM.



The flight was diverted to Lisbon Airport where the aircraft made an emergency landing without incidents. However, when the aircraft was leaving the runway and beginning to roll on S1 taxiway, the flight crew noticed some smell of smoke and shortly afterwards the Chief Cabin Attendant entered the cockpit stating that there was a “smell” of smoke “*all along the cabin*”.

The Commander decided to stop the aircraft and to order an emergency evacuation.

Passengers’ evacuation has been made under the emergency type parameters and the doors escape slides have been used, except the inoperative one, blocked by the crew before the takeoff.

During the evacuation process, a passenger suffered a broken ankle and four others had minor injuries.

1. FACTUAL INFORMATION

1.1 History of the flight

On 19th November 2004, the aircraft AIRBUS A-346 from IBERIA, registered marks EC-IZX, was scheduled to fly from Madrid to the City of Mexico and took off at 01:00 hours¹ with 15 crew members and 289 passengers on board. There were three pilots in the cockpit: the Commander (CM-1), the Co-pilot (CM-2) and an additional First Officer (CM-3) as a relief pilot.

The crew requested FL340 and was initially cleared to climb to FL330.

At some point, the presence of the pilot in command was requested in the passenger cabin because a passenger was not feeling well. The passenger had suffered a low blood pressure state and it seemed he had fainted. It was called whether there was a doctor on board. Later on, the passenger felt better and it was decided to continue the flight to Mexico.

When the Commander returned to the cockpit, where both first officers were seated, he was told that some spurious warnings have been felt. They were described like flicker indication of smoke warning of so minimum duration that they couldn't find out the origin. The elapsed time between every warning was inconstant.

A few minutes later, a warning of smoke warning flashed again but this time the crew was able to identify that it was an "*IFE smoke*" warning. The pilots waited for some time and it appeared again, and therefore they accomplished the procedure and switched off the "*PAX SYS*".

After a while, an "*Avionics Smoke*" warning appeared, and they intended to apply the corresponding procedure, but the warning disappeared suddenly. They decided to review the procedure to be prepared just in case the warning was displayed again.

The first officer CM-3 went downstairs to the avionics bay - in the lap time between the very first spurious and the first "*ECAM ACTION*" - to check the status of the equipment. Nothing anomalous (abnormal high temperature, smoke or fire evidences) was perceived before he came upstairs.

After some time, the "*FWD Cargo Smoke*" warning was displayed and, from that moment on, an acid smell with irritating itching effects on the eyes of the crew was noticed. They donned the oxygen masks and applied the procedure of *Cargo Compartment Smoke Checklist*, including the discharge of the fire extinguisher bottles.

¹ All times in this report are UTC (UTC = Local time).



They asked the cabin crew for a report on the situation. The pilots were told that in the passenger cabin everything was normal.

The ECAM displayed the “Land ASAP” warning in red (at 02:55 hours) and the Commander declared emergency condition to the ATC, reported the intention to divert from the point where he was – DETOX – to Lisbon airport and requested descent, in the event of any smoke evacuation procedure was needed and also to burn more fuel.

During descent, they were dumping the fuel. At some point during that descent – when about crossing FL110 descending -, the First Officer CM-3 moved his mask to readjust the goggles and noticed that the smell had disappeared.

In contact with ATC, the flight crew told the controller that if everything was normal during the landing, they would proceed normally to the apron. Otherwise, if the smoke or the emergency appeared again, they would stop the aircraft where needed and would order an emergency evacuation.

At Lisbon Airport, the adequate means of emergency assistance have been deployed.

The ILS approach was normal and so it was the touchdown on RWY 03, at 03h13 hours, as well the landing roll. However, when they were leaving the runway entering S1 taxiway, the flight crew noticed some smell of smoke and shortly afterwards the Chief Cabin Attendant entered the cockpit stating that there was a “smell” of smoke² “all along the cabin”.

The Commander decided to stop the aircraft just there and to order an immediate passenger evacuation. The emergency evacuation was performed accordingly with the required parameters for this kind of emergency and the slide ramps have been inflated.

Cabin crew was expedite and proceeded to all passengers’ evacuation within 40 to 50 seconds. Among the 304 occupants, four passengers received minor injuries. One female passenger was seriously injured during the emergency evacuation for being immobilized at the end of the slide ramp, due to a broken ankle, and of being hit by other passengers.

When the evacuation was completed, the Commander went to the rear part of the cabin to check that every passenger had left the aircraft, and it was difficult for him to progress because of the itching he was feeling in the eyes. He also noticed a kind of thin fog in the cabin through the emergency lighting.

² “Huele a humo” (“smells to smoke”).



The aircraft was immobilized at the RWY 03 and TWY S1 intersection, interfering with the traffic, so the runway was closed until 06:50 hours.

1.2 Injuries to persons

INJURIES	CREW	PASSENGERS	OTHERS
FATAL	-	-	-
SERIOUS	-	1	-
MINOR	-	4	-
NONE	15	284	

1.3 Damage to the aircraft

None.

1.4 Other damage

None.

1.5 Personnel information

1.5.1 Pilot in command (CM-1)

Identification	Sex Age Nationality	Male 51 years Spanish
License details	License held / Nr. / Validity	ATPL (A) / JAA E00004024 / 16/05/2006
Ratings	Aircraft	A340
Experience	Total flying hours Total hours on type Hours in last 90 days Hours in last 30 days Hours in last 7 days Hours in last 24 hours	10.502:00 hours 793:00 hours 187:11 hours 37:00 hours 02:30 hours 02:30 hours
Medical Certificate	Class Issued by / Validity Limitations	1 DGAC de España / 05/04/2005 VNL



1.5.2 Co-pilot on duty at the moment of the occurrence (CM-2)

Identification	Sex Age Nationality	Male 33 years Spanish
License details	License held/Nr: First issued Expire date	CPL (A) / JAA E00017665 DGAC de España 20/01/2008
Ratings	Aircraft	A340
Experience	Total flying hours Total hours on type Hours in last 90 days Hours in last 30 days Hours in last 7 days Hours in last 24 days	7.167:00 hours 3.167:00 hours 198:00 hours 60:40 hours 02:30 hours 02:30 hours
Medical Certificate	Class Issued by Expire date Limitations	1 DGAC de España 27/07/2005 NIL

1.5.3 Relief co-pilot (CM-3)

Identification	Sex Age Nationality	Male 47 years Spanish
License details	License held/Nr: First issued Expire date	ATPL (A) / JAA E00020618 DGAC de España 03/07/2008
Ratings	Aircraft	A340
Experience	Total flying hours Total hours on type Hours in last 90 days Hours in last 30 days Hours in last 7 days Hours in last 24 days	5.035:00 hours 2.964:00 hours 135:20 hours 64:25 hours 02:30 hours 02:30 hours
Medical Certificate	Class Issued by Expire date Limitations	1 DGAC de España 28/10/2005 VNL

1.6 Aircraft information

Airframe	
Maker/Delivery date	AIRBUS – 06 October 2004
Model	A340-642
Serial nr.	601
Nationality and registration marks	EC-IZX
Registry certificate nr.	7091 – DGAC España
Registered owner and operator	IBERIA - Líneas Aéreas de España
Airworthiness certificate nr.	5623, DGAC España - 21/12/05, Validity: 06/10/06
Radio license nr.	5623-04-01– DGAC España
Insurance certificate nr.	85/10/40, Validity: 30/11/06
Time since new	630.79 hours
M.T.O.M.	365.000 Kgs
Maximum POB (Crew/Pax)	3+8 / 352
Engines	
Maker	ROLLS ROYCE
<u>Engine # 1</u>	
Model	RB 211 Trent 556-61
Serial nr.	71240
Total time	630.74 hours
<u>Engine # 2</u>	
Model	RB 211 Trent 556-61
Serial nr.	71233
Total time	640.04 hours
<u>Engine # 3</u>	
Model	RB 211 Trent 556-21
Serial nr.	71235
Total time	640.74 hours
<u>Engine # 4</u>	
Model	RB 211 Trent 556-21
Serial nr.	71242
Total time	639:54 hours
APU	
Total time	169:30 hours

1.7 Meteorological information

At the time of the occurrence, the meteorological conditions were:

Wind calm, sky clear, visibility >10 km, QNH 1027 mbs.



1.8 Aids to navigation

Not relevant to the investigation.

1.9 Communications

Communications were clearly established and within standard phraseology. The Commission of Investigation (CI) accessed to its transcription through the CVR analyse performed by BEA laboratory.

1.10 Airport information

Lisbon airport information is not relevant to the evaluation of this occurrence.

1.11 Flight recorders

After the event, at GPIAA's request, the Digital Flight Data Recorder (DFDR), the Cockpit Voice Recorder (CVR) and the Quick Access Recorder (QAR) were disassembled and removed from the airplane by the French BEA to be analysed in Paris, in its own laboratory.

1.11.1 Flight Data Recorder (FDR)

The aircraft was fitted with a SSFDR (Solid State Flight Data Recorder) Honeywell P/N 980-4007-042.

The FDR examine results is reflected in chapter 2.1.1. iv.

1.11.2 Cockpit Voice Recorder (CVR)

The aircraft was equipped with a with a SSCVR (Solid State Cockpit Voice Recorder) Honeywell P/N 980-6022-001 that had 4 tracks for recording:

- Pilot communications, through the boom microphone, to track 1;
- Co-pilot communications, through the boom microphone, to track 2;
- Third occupant (jump seat behind the F/O) and/or the Public Address phone, depending on the selection at the Audio Control Panel number 3, to track 3 and
- Cockpit ambient microphone to track 4.

This CVR had 2 hours autonomy. The last 30 minutes were recorded in 4 individual files. The last hour and a half was recorded in 2 other files; one compiling tracks 1, 2 and 3, one for track 4.

The air/ground and between crew elements communications, as well the ambient sound recordings, allowed this CI to prepare the aircraft operations chronology since the IFE and smoke warnings until the moment of the engines shutdown, when the Commander decided the passengers emergency evacuation.

The recording begins at 5:00:42 hours and ended at 7:01:37 hours (CVR time³), consisting of about 2:00:55 hours of registered information.

From 6:17:18 on, the recorded data is of no relevancy to the investigation (time concerning the CVR recording reactivation when the APU was restarted to transfer the aircraft to the parking zone).

It was necessary to separate the different channels to have the communications audible.

The CVR recording registered three sounds corresponding to the times 6:12:15 (repeated gong sound), 6:12:30 (buzzer) and 6:13:29 (short beeps) that the Commission of Investigation was unable to identify and believed it was important to clarify. Airbus has been asked to identify them. The investigation findings are reflected on chapter 2.1.4 "Investigation of CVR sounds".

1.12 Wreckage and impact information

Not applicable.

1.13 Medical and pathological information

Not applicable.

³ There is a discrepancy between actual UTC hours and CVR UTC hours.

DFDR timing matches with ATC and captain reports, so the timing acquisition appears adequate.

CVR uses the FDIU UTC as DFDR does. This is due a factor 2 error while decoding data which turned hours to appear as 6 instead of 3.

1.14 Fire

There was no evidence of fire on the aircraft.

1.15 Survival aspects

1.15.1 Cabin Attendants' (CA) action

When "IFE SMOKE" warning came up to the ECAM, the Commander asked the CAs to look for possible sources of smoke in the cabin but nothing was detected. During the flight, there was no galleys failure. Nevertheless, the Cabin Crew applied the operational procedure 8.3.1 "Aviso de fuego/Fire Warning" as a prevention action and the CAs assigned to door 4L⁴ pulled out the CBs of their galleys, which justifies the "loss of power of the Recirculation Unit" indication reported in the PFR's message; the other CAs did not consider this action necessary because they perceived that the galleys have been already de-energized.

After Commander's decision to divert to Lisbon, the Cabin Crew have prepared the passenger cabin for a possible emergency landing. Two CAs occupied the seats close to the overwing emergency window exits. The left overwing window exit was inoperative, thus this emergency way out have been blocked for the landing. The other CAs took positions on the crew jump seats located next to each aircraft doors.

Some passengers have been moved to other seats due to the unfeasibility to straight up the back of the chairs, an eligible position to avoid obstacles which might compromise the passengers' evacuation flow.

Passengers have been instructed, in loud voice and in every aircraft sections, how to proceed in an emergency evacuation. Both tourist cabins were almost full but not the business cabin.

The landing was uneventful but during the landing roll, a smell of burnt was sent all over the passenger cabin by the entire Cabin Crew and some passengers, and this was transmitted to the Commander who, consequently, ordered the passenger evacuation⁵.

All operative exits opened easily and the emergency slides also deployed quickly. The evacuation orders have been loudly transmitted to the passengers. Some passengers tried to collect their personal belongings from the overhead bins but they were firmly told to leave their stuff and to quickly jump and went away the aircraft. Some of them achieved their inten-

⁴ Door 4 Left.

⁵ This episode is coincident with the "Avionics Smoke" warning displayed on the ECAM when the aircraft was leaving the runway to roll on S1 taxiway (as mentioned in "History of the Flight").

tions and jumped out the plane with the personal objects the CAs, positioned at the doors, couldn't grasp at the last moment.

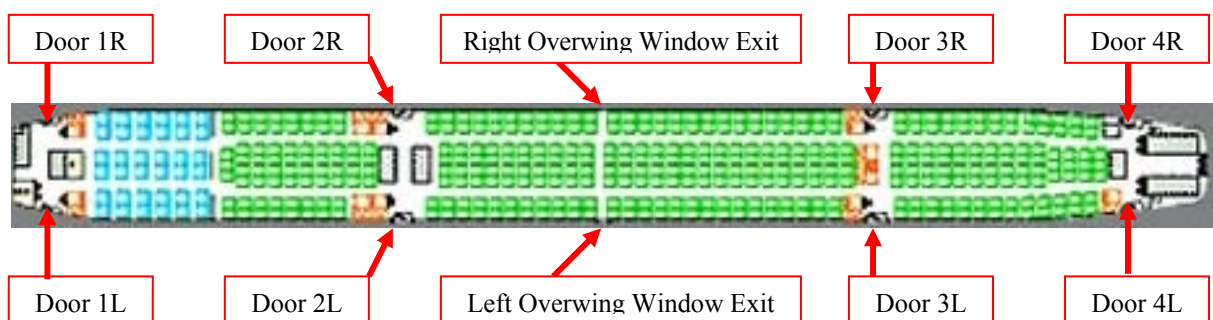
Anytime a queue of passengers has been observed at a given door, the CAs immediately directed the people to another cleared exit.

All emergency ramps deployed in 4-5 seconds (CAs estimate time) and were sufficiently illuminated except at the end of the slides where the illumination was virtually none, difficulting the passenger's perception of the aircraft surrounding ground conditions. The most part of the passengers did not show fear to jump to the emergency slide ramps. CAs estimated that these slide ramps have a slope of about 30 degrees⁶ and that the passengers reached the ground at high speed. Some of them suffered burns due to the scrape of the skin with the rough material of the ramps. One passenger broke ankle at the end of the slide down and she was evacuated to the hospital, together with some other minor ones, after being medical assisted on site.

The firemen, also in attendance near the aircraft during all the evacuation process, did not interfere, being the medical teams to make the assistance to the injured passengers.

Although the Cabin Crew cannot precise what was the exact evacuation time, the CAs estimated it in between 40 and 50 seconds.

The passengers quickly moved away the aircraft after the evacuation. It took quite a long time to have all the passengers, dispersed along the adjacent zones, together and drive them to the airport lounge.



Passenger Evacuation Diagram

Door 1L: The Chief Cabin Attendant was controlling this door during the evacuation. This exit enabled the evacuation to 10 to 15 passengers, what happened in approximately 10 seconds.

⁶ The escape ramps slopes are: Door #1 = 23°, Door #2 = 26°, Door #3 = 27,8, and Door #4 = 29,4° (AIB information).

Door 1R: It was impossible to establish how many passengers leaved the aircraft through this exit. One of the passengers broke an ankle at the end of the slide down. The CA assigned to this door, after having her exit cleared, went along the aircraft and deviated passengers crowded at doors 2R and 3R to make them exit through other doors.

Door 2L: About 50 to 60 passengers used this door. The evacuation was quick and uneventful. Some passengers have been deviated to door 1R and three firemen helped the passengers to move away.

Door 2R: The number of passengers that used this exit is unknown and also imprecise is the evacuation time but thought to be short. Some passengers carried personal belongings at the moment of the exit but they have been taken away as much as possible. No passenger showed fear; only a child had to be helped during the evacuation. Some passengers queued at this door were directed to Door 1R.

Door 3L: About 50 to 60 passengers left the aircraft through this exit. Many passengers want to leave the airplane with personal belongings being opposed in their intentions by the CAs. Some passengers were scared; others seated at the beginning of the escape slide and had to be pushed.

Door 3R: The number of passengers was unknown at this door but the evacuation was fast. A few passengers were scared and it was necessary to insist to two of them to jump to the escape slide. Some passengers were carrying their personal things and the CA controlling this door withdrew as much objects as possible. People were crowding against the exit and thus some were directed to door 2R, free at the time. A passenger rolled at the end of the slide and another one fell over her.

Door 4L: 30 to 40 passengers used this door to exit the aircraft in about 30 to 35 seconds. Again some passengers tried to leave the airplane with their belongings. Nobody required assistance except one passenger that remained in his seat all the time.

Overwing Exits: Passengers on 22A and 22L have been previously moved from these to other seats. Two CAs occupied these seats to be seated near the overwing emergency exits to operate the windows and to permit the passenger's evacuation. Passenger on seat 22J was told he would be the first to leave the airplane and instructed to help the other passengers at the bottom of the escape slide. This passenger carried no personal objects but the following ones were carrying handbags.

The Cabin Crew was unanimous in considering insufficient the illumination of the evacuation slides, especially at the end of the ramp, where an illuminated area beyond the end of the slides would be useful, in order to allow the passengers to see the zone where they leave the ramp and start to run away from the aircraft.

The CAs also referred it was difficult to know if the slide of the overwing exit was inflated due to the lack of visibility of the ramp from inside the airplane and because there wasn't any sign of "slide inflated" available.

1.16 Tests and research

Following the event, GPIAA asked to the different related authorities the usual cooperation for this kind of situation. A multidisciplinary Investigation Commission, consisting of Spanish, French and Portuguese elements belonging to the respective Investigation Departments, (IBERIA representatives, AIRBUS and MATSUCHITA AVIONICS SYSTEMS CORPORATION engineers), has been formed and leaded by GPIAA.

1.16.1 On site investigation

After being towed to position M2, close to apron J, where it remained parked due to its wing-span, IBERIA maintenance inspected the electronics and the Cargo compartments and removed the detachable panel of the cargo compartment forward wall which isolated these two compartments. There were no smoke or fire traces.

Based on the crew inputs and on data collected from the CMS (Central Maintenance System), the Airbus investigation team has focused on IFE (In-Flight Entertainment), CIDS (Cabin Intercommunication Data System), Smoke detection, bleed and air conditioning and galleys:

1. *Post Flight Report (PFR)*

A PFR print-out was collected to be analysed.

2. *Smoke Detection Control Unit Built-in Tests Equipment (SCDU BITE)*

The SCDU was checked to be P/N RAI281 1M0103, S/N Q09450005204. SCDU BITE print-outs were recovered for an afterwards evaluation.

3. *Smoke systems tests*

Smoke systems were completed as per Aircraft Maintenance Manual (AMM). All were passed with no anomaly. In addition, the investigator checked the correct response of

the detectors in the forward cargo by approaching a cigarette from detectors. The relevant warnings were triggered.

4. *In-Flight Entertainment (IFE) system*

Airbus investigators made a detailed visual check and test of the in-flight entertainment systems, considering the cockpit crew report of IFEC smoke warning, with no finds.

The IFE system was found in a status consistent with manual switching off before landing.

IFE VCC (Video Control Center) and IFE racks, as well its structure and wiring, have been visually inspected by AIRBUS and MATSUSHITA investigators with no evidence of smoke, fire, overheat or contamination.

The air intake filters of the IFE rack 2 have, however, been noticed to be dusty. Some dust and a filter have been collected by the Commission of Investigation to be analysed in laboratory.

Functional tests have been carried out on each zone individually, from zone 1 to zone 11, and were completed with no faults found.

5. *Cabin Memory Expansion Unit (CMEU)*

MATSUCHITA representatives downloaded the reboot log and BITE memory of the CMEU in order to complete the review of the system for subject flight.

The CMEU BITE did not exhibit anomalies that may have contributed to the event.

6. *Cabin Intercommunication Data System (CIDS)*

As some of the CAs reported smell over the passenger cabin at the economy class area, AIRBUS performed an inspection of the CIDS for any indication of overheat.

AIRBUS also performed a CIDS interface and power-up test. Functional tests have been carried out successfully in the entire cabin and the CIDS systems did not exhibit anomalies that may have contribute to the event.

Due to a caution light illuminated on the Forward Attendant Panel (FAP), the recorded data was accessed. The items there recorded (three PISAS⁷ were detected as fault and the slide bottle pressure was detected low) were representative of the aircraft condition, i. e. slides deployed.

7. Bleed and Air Condition systems

Engine bleed is ingested in the air-condition ducts to adjust the temperature in each different compartment. The following tests were made for investigating the possible engine bleed contamination as origin for the reported acid smell and stinging eyes in the cockpit and the smoke smell in the passenger cabin:

- BITE check of the Ventilation Controller (VC);
- Engine run with packs 1 and 2 running under engine 1, 2, 3 and 4 bleeds.

There were no faults found on both tests.

8. Galley systems

The PFR showed 2 messages related to the galley systems:

- 2:12 GALLEY RCCB(23MC)/ECMU2(1XM2);
- 2:13 RU ELEK (3800ML1)

The first one pointed to a spurious indication due to the fact the aircraft had not the galley feeder 4 installed and AIRBUS already reflected this matter in a Service Information letter where recommendations were made to filter this message;

The other one, related to a lack of communication between the Air Recirculation Unit and the Ventilation Controller, was consistent to the action taken by the Cabin Crew as a preventive measure (R/U CB pulled) against potential galley originating smoke.

Although this fault occurred in the time frame when FIREX were being discharged, no particular link could be found between the failure of this pump and the event under investigation.

1.16.2 Actions in Madrid before the aircraft return to service

1. The filters of all re-circulation fans, PACK 1 & 2 and IFEC were sampled for further detailed investigation by the Commission of Investigation. IFE filters have been sent to the "Centre d'Essais des Propulseurs", in Saclay, Paris surroundings, where the suit deposit located in these filters has been analysed. The filters have been subjected to destructive tests and there were no evidences found related to the occurrence.

⁷ PISA (Passenger Interface and Supply Adapter) is a panel grouping the "Fasten Seat Belt" sign, the "No Smoking" indication and the reading light.



2. The TSM task related to the air chiller system was accomplished and the findings reported later on to the Investigator-in-charge showed no evidences related to the episode.
3. Also the TSM task related to the RCCB fault message triggered at 2:12 was accomplished and the findings reported later on to the Investigator-in-charge confirmed no relationship to the event.
4. ILM (IBERIA Line Maintenance) performed troubleshooting in accordance with AIB recommendations as well as tasks for restoration of serviceability. For this purposes, ILM issued the Engineering Order A340-600-26/00003 Rev 0 and informed there were no finds.

1.16.3 Statement of passengers

Four passengers were willing to write their statements. They made reference to the existence of a smell of smoke after the landing and during the evacuation.

1.16.4 Other tests and research actions

1. The Occupational Safety and Health Administration (OSHA) indicates that the halon Permissible Exposure Limit (PEL) is 0.1% (1.000 parts per million) on an 8-hour Time Weighted Average (TWA) exposure. FIREX contains 33% of halon. The LRE (List of Radioactive and Hazardous Elements) refers that "Halon 1301 (a gaseous flooding agent) leave no residue and is remarkably safe for human exposure." ⁸
2. The spurious smoke warnings registered in ECAM were already known by AIRBUS, due to recurrences verified in same other models, and the manufacturer carried out a modification to eliminate the malfunction.
3. This modification was scheduled to be introduced on EC-IZX on Monday 22-11-2004 but the occurrence took place on 19-11-2004. After the modification has been introduced to the EC-IZX, this airplane returned to service on Monday 22nd November 2004 and operated 6 flights on 22nd, 23rd, 24th, 25th and 26th November with no reports of malfunction or defects in the systems related to the 19th November's one.
4. Making reference to this event, AIRBUS issued an Operator Information Telex (OIT) to all AIRBUS operators in order to remind them the necessity of embodying the SCDU PN RA12811M0104 modification;

⁸ <http://www.h3r.com/halon/faq.htm#q1>



5. There were no dangerous or other goods on board that could have been related with the circumstances of the event.

1.17 Organizational and management information

Not applicable.

1.18 Additional information

None.

1.19 Useful or effective investigation techniques

None.

2. ANALYSIS

The review of all facts gathered, as described in the previous paragraphs, leads to the following considerations:

2.1 Technical

2.1.1 Investigation of smoke warning occurrences

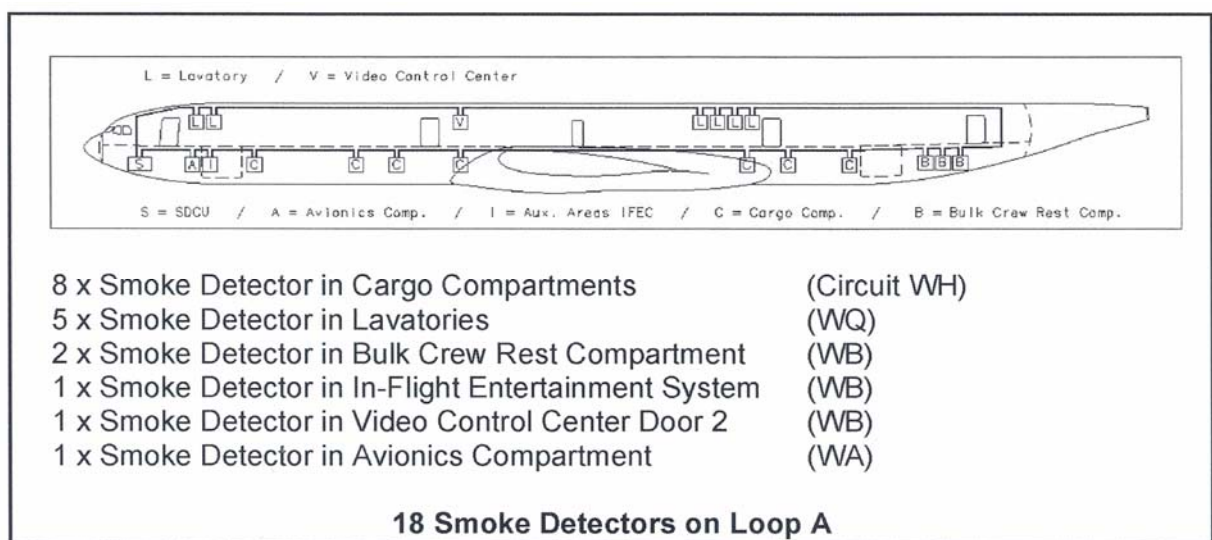
i. Architecture and components of the smoke detection system

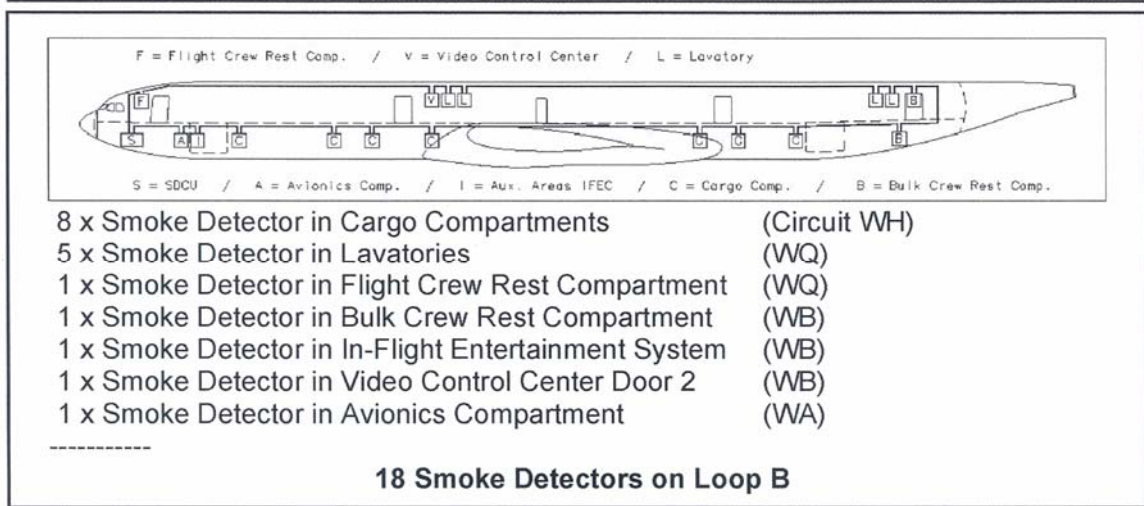
SDCU was checked to be P/N RAI2811M0103, S/N: Q09450005204.

The IBERIA A340-600 MSN 601 had the following smoke detection system configuration:

- Avionics compartment: 1WA and 2WA;
- IFE Centre: 3WB and 4WB;
- FWD LDCC (Lower Deck Cargo Compartment): 1WH, 2WH, 3WH, 4WH, 41WH, 42WH, 43WH and 44WH;
- AFT LDCC: 45WH, 46W, 5WH, 6W1-1, 7WH and 8WH;
- BULK LDCC: 9WH and 10WH;
- BCRC: 22WB, 23WB and 24WB;
- Lavatories:
 - o VCC: 7WB and 8WB;
 - o FCRC (Flight Crew Rest Compartment): 28WQ.

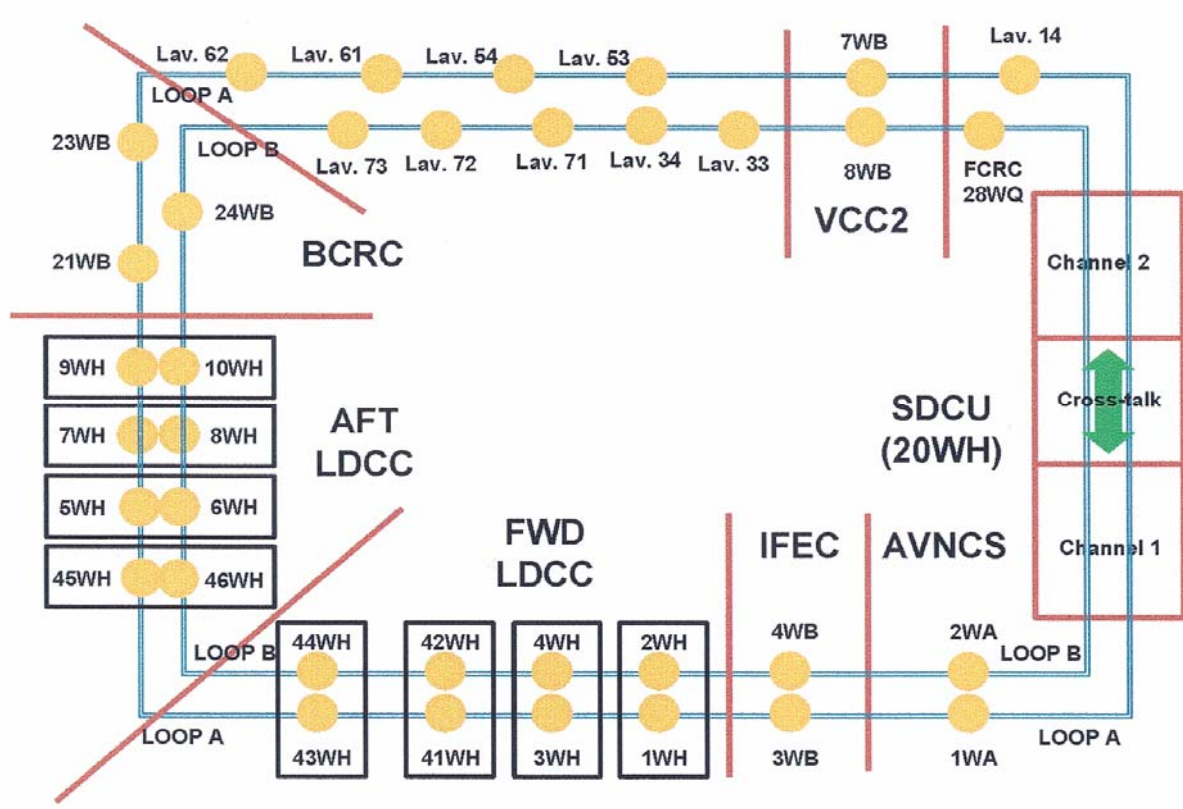
They are distributed over the cabin and segregated in 2 loops A and B as follows:





All the smoke detectors are connected in series in the order illustrated in the following sketch:

- Loop A: Channel 1, 1WA, 3WB, 1WH, 3WH, 41WH, 43WH, 45WH, 5WH, 7WH, 9WH, 21WB, 23WB, Lav62, Lav6l, Lav54, Lav53, 7WB, Lavl4, Channel 2;
- Loop B: Channel 1, 2WA, 4WB, 2WH, 4WH, 42WH, 44WH, 46WH, 6WH, 8WH, 10WH, 24WB, Lav73, Lav72, Lav7l, Lav34, Lav33, 8WB, 28WQ, Channel 2.



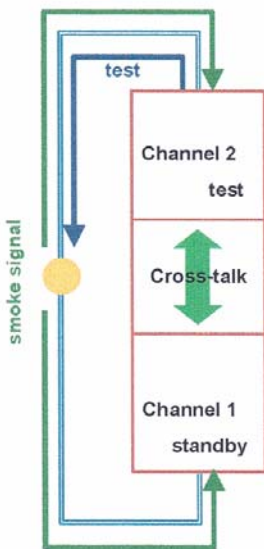
ii. SCDU in-service experience

The SCDU may trigger spurious smoke detection E/W when one or some smoke detectors are detected electrically disconnected from the control loop. In such case, the E/W would involve smoke detectors at the loop opposite to the one the faulty detector(s) belong(s). In such circumstances, the E/W are spuriously triggered in response to an automatic test on detectors groups because channels 1 and 2 are desynchronized.

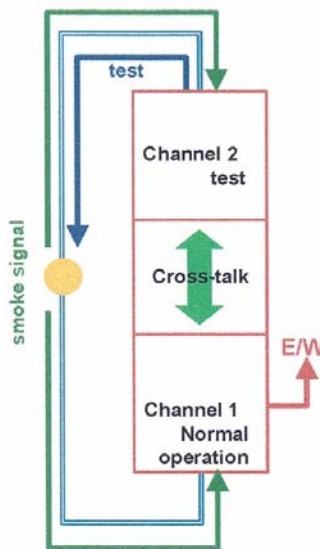
Tests are test launched every 30 minutes. There are 6 groups of detectors, which means there is a test launched every 5 minutes. As a consequence, there may be sequences of spurious E/W occurring every 5 minutes and repeating every 30 minutes.

There are 2 modes of desynchronization that are detailed in the following sketches. Type 1 would result in triggering of spurious E/W. Type 2 would result in triggering of spurious E/W and of smoke detector faults.

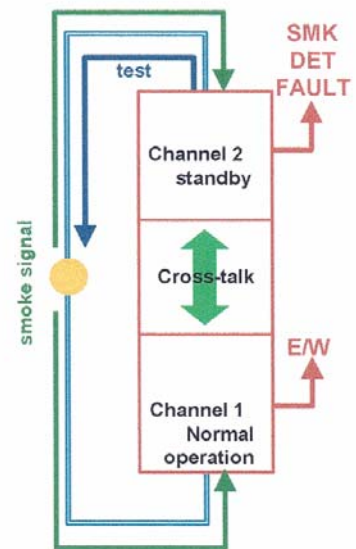
Normal operation during test sequence:
 -Channel 1(2) launches the tests
 -Channel 1(2) awaits smoke test answer from detector
 -Channel 2(1) switches to standby mode
 -No E/W and no SMK DET FAULT



Desynchronization type 1 during test sequence:
 -Channel 1(2) launches the tests
 -Channel 1(2) awaits smoke test answer from detector
 -Channel 2(1) remains in normal operation monitoring and triggers a **spurious E/W** upon reception of SMK DET signal



Desynchronization type 2 during test sequence:
 -Channel 1(2) launches the tests
 -Channel 1(2) switches to standby mode and triggers a **SMK DET FAULT** upon reception of signal
 -Channel 2(1) remains in normal operation monitoring and triggers a **spurious E/W** upon reception SMK DET of signal



Illustrations: Test launched by channel 2 (IB6401 scenario)

iii. Investigation of SDCU BITE

The SDCU BITE reports were analyzed with the following findings. At:

1:00 – Engine Start – SMK DET FWD LDCC (3WH)/WRG: SMOKE LOOP A (Class 2)

→ This message is typical of 3WH disconnection from the smoke detection loop A.

1:41 – Cruise – SMOKE AVNCS VENT SMOKE (red warning)

1:41 – Cruise – SMOKE FWD CRG SMOKE (red warning)

→ Triggered by 2WA, 2WH and 4WH (loop B - Channel 1 only)

→ Consistent with a desynchronization type 1. Involved smoke detectors belong to loop B, while 3WH indicated as disconnected belongs to loop A.

1:46 – Cruise – SMOKE IFEC SMOKE (red warning)

→ Triggered by 4WB (loop B - Channel 1 only)

→ Consistent with a desynchronization type 1. Again the involved detector belongs to loop B. This message was triggered 5 minutes after the ones triggered at 1:41, consistently with the interval in between 2 automatic tests.

2:11 – Cruise – SMOKE AVNCS VENT SMOKE (red warning)

2:11 – Cruise – SMOKE FWD CRG SMOKE (red warning)

→ Triggered by 2WA, 2WH and 4WH (loop B – Channel 1 only)

→ Consistent with a desynchronization. These messages are identical to the ones triggered at 1:41 and were triggered 30 minutes after them, consistently with the interval in between 2 identical automatic test sequences.

2:12 – Cruise – SMK DET AVIONCS (2WA) (Class 2)

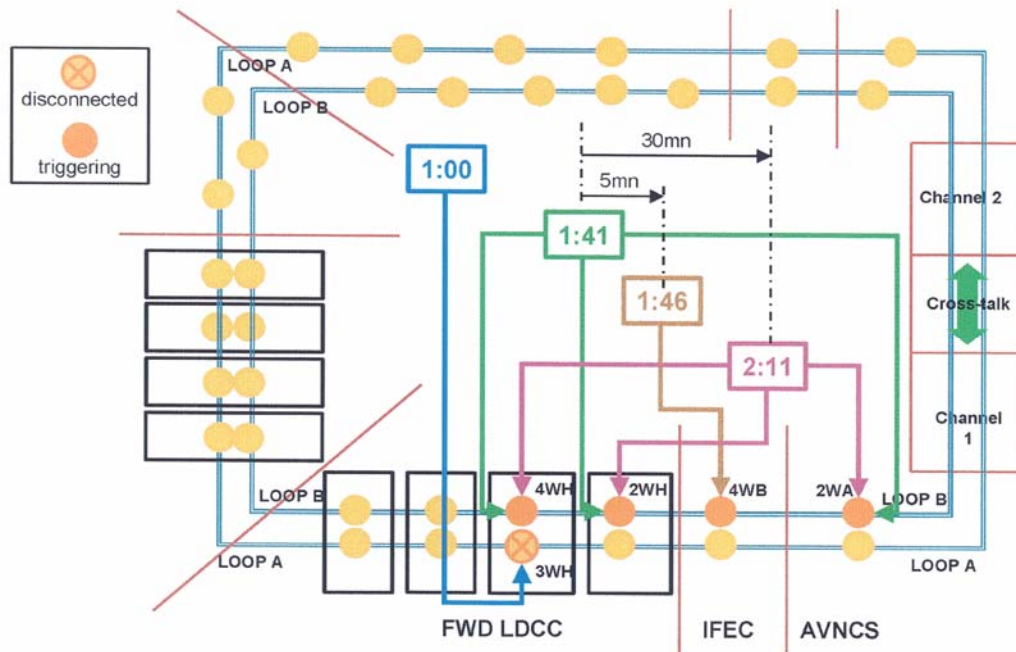
2:12 – Cruise – SMK DET FWD LDCC (2WH) (Class 2)

2:12 – Cruise – SMK DET FWD LDCC (3WH) + SMK DET FWD [DCC (4WH) (Class 1)

→ Triggered by 2WA, 2WH and 4WH (loop B - Channel 2 only)

→ Together with events that occurred at 2:11, consistent with issue (1) of paragraph 3.2 with a desynchronization type 2.

This sequence of messages, reflecting the spurious E/W triggered up to 2:11, is illustrated in the following sketch:



iv. Investigation of FDR

The analysis of the SDCU BITE revealed that the avionics and the forward cargo smoke warnings were triggered first at GMT 01:51, followed 5 minutes later by an IFEC smoke warning, and finally 25 minutes later by again the same avionics and forward cargo smoke warnings.

FDR also brought some information as for the duration of these warnings.

The first avionics and forward cargo smoke warnings, and the IFEC smoke warning lasted 16 seconds, from GMT 01:41:56 to 01:42:12, and from 01:46:58 to 01:47:14 respectively. This duration corresponds to the time for the SDCU to confirm the status change from “SMOKE” to “NO SMOKE” status.

The second avionics and forward cargo smoke warnings were latched till the end of the flight. During this specific sequence, the status of smoke detectors triggering smoke signal were frozen at the SDCU software level. Consequently, the SDCU software announced smoke signals from these detectors to the FWC, until the end of the flight, whereas the smoke detector units were not in “SMOKE” status. At the cockpit, E/W were thus displayed until the end of the flight.

During the lab testing of the SDCU M0103, it has been confirmed that the smoke detector status could be frozen at the SDCU software level, due to a deviation of the channel cross-talk function. This specific deviation has been cleared on next SDCU standard M0104.

2.1.2 Investigation of the events that occurred after FIREX discharge

i. In-service experience linked to FIREX discharge.

The first issue relevant to this event was the triggering of smoke warnings upon FIREX discharge. Indeed, optical smoke detectors are sensitive to the haze that builds up when FIREX is spread out as illustrated in this picture:



Some occurrences of smoke detectors, coming at fault upon the temperature drop resulting from the FIREX discharge, have also been experienced.

ii. Investigation of the SDCU BITE

2:14 – Cruise – CRG BTL 2 SQUIB (4013WX) EWD/SDCU (Class 1)

2:14 – Cruise – CRG BTL 3 SQUIB (4023WX) FWD/SDCU (Class 1)

2:14 – Cruise – CRG FIRE BTL 1 LO PR (4005WX) /SDCU (Class 1)

➔ Consistent with a FIREX discharge commanded by the crew at 2:12.

2:14 – Cruise – SMK FWD LDCC (41WH)

2:14 – Cruise – SMK FWD LDCC (43WH)

2:14 – Cruise – SMK EWD LDCC (42WH)

2:14 – Cruise – SMK FWD LDCC (44WH)

2:14 – Cruise – SMK EWD LDCC (1WH)

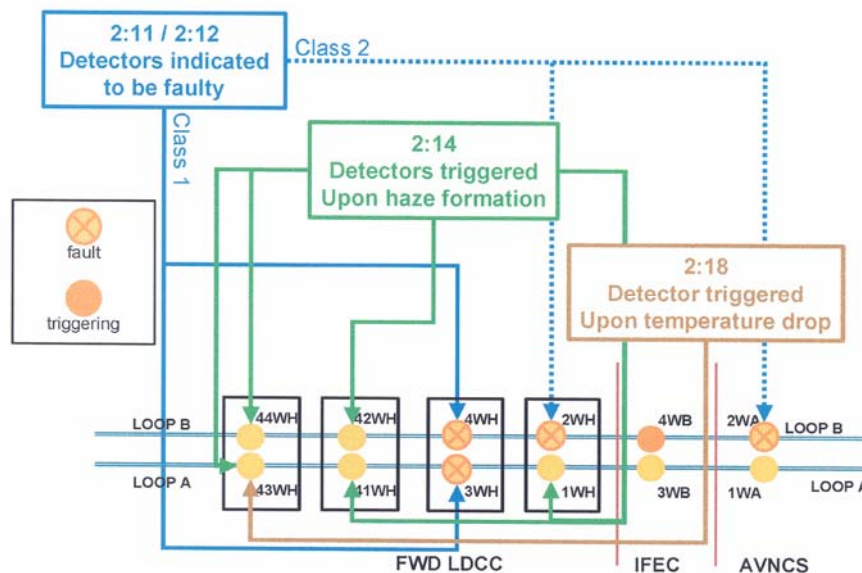
➔ Consistent with optical smoke detectors triggering upon haze formation at FIREX discharge;

- ➔ The smoke detectors already in fault (2WH, 3WH, 4WH) did not, as per design, trigger a smoke alarm;
- ➔ The fact that SDCU channel 1 recorded the triggering of 41WH and 43WH indicates that 3WH had reconnected to loop A.

2:18 – Cruise – SMK DET EWD LDCC (43WH)

- ➔ Consistent with optical smoke detectors coming at fault upon temperature drop.

According to this analysis, the following sketch illustrates which smoke detectors were indicated to have failed and which triggered upon halon discharge:



2.1.3 Investigation of reported tainted air

Because of the reported acid smell and stinging eyes experienced by the Commander and the First-Officer, the possibility of FIREX gas circulating to the cockpit was investigated.

This analysis was supported by a presentation that was given to the Commission of Investigation.

i. Air conditioning system description

The air conditioning system is such that the air injected in the different areas of the cabin is composed of outside air from packs, hot air from bleeds, and recirculated air from the under-floor.

As far as the forward cargo compartment is concerned, a Pressure Equalization Valve (PEV) allows circulation of air from the cargo compartment to the underfloor in case of slight overpressure in the cargo compartment. PEV opens transiently upon overpressure beyond 1.7 mbar and closes as soon as pressure is equalized.

Consequently, air from the cargo compartment may, for a very limited period of time, be recirculated in the cabin. This air would be equally distributed over the different areas of the cabin since going through the mixer unit.

ii. Possible halon recirculation upon FIREX discharge

During the event flight, the forward cargo compartment was reportedly full of containers.

Considering that, after the FIREX bottle discharge, the overpressure could be sufficient to possibly activate the PEV, the AIRBUS Investigator, integrating the Commission of Investigation, carried on an investigation to compute the concentration of Halon gas after being circulated from the cargo compartment to the passenger cabin.

Even based on quite penalizing hypothesis and considering the homogeneous distribution over the entire passenger cabin as well the exposure time, the halon concentration would be significantly lower than the permissible exposure limit⁹, and that it would have no effects and no burning odour.

For this reason, AIRBUS investigation considered that the eventual FIREX gas migration to the passenger cabin could not explain the crew report of stinging eyes and smell in cabin.

2.1.4 Investigation of CVR extracts

Upon the request from the Commission of Investigation, AIRBUS investigated 3 CVR extracts that were containing each a specific sound. The extracts were provided in the form of ".wav" files. They were identified making reference to a certain timing, respectively 6-12-15, 6-12-30 and 6-13-29. AIRBUS assessed these sounds as follows:

i. Sound at time 6-12-15

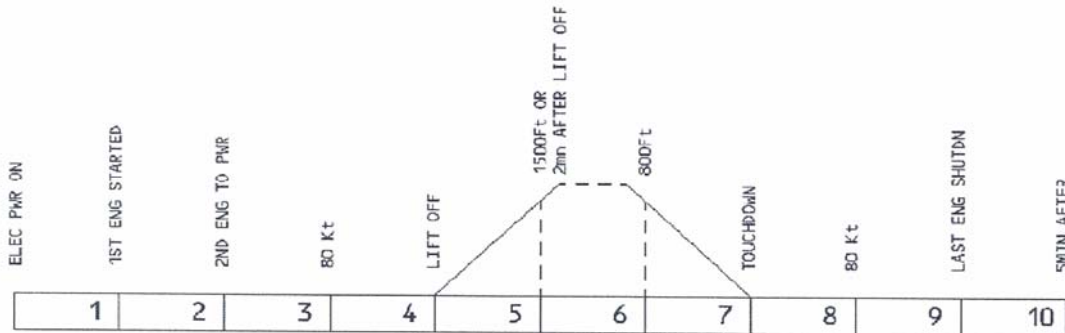
Occurrence 6-12-15 was a single chime. The occurrence time was about the touchdown plus 20 seconds and this cue has been transmitted to AIRBUS who reviewed the flight data re-

⁹ A Permissible Exposure Limit (PEL) of 0.1% (1000 parts per million) on an 8-hour Time Weighted Average (TWA) exposure, as referred in 1.16.3 - Other tests and research actions, § 1.



cordings and indeed found trace of a master caution, which accompanies most of single chime occurrences.

FDR indicated that the master caution triggered when aircraft speed was 80kt. This corresponds to the FWC computing the switching from phase 8 to phase 9. Indeed, flight phases are defined as follows:



AIRBUS examined the PFR looking for any event that would trigger both a master caution and a single chime, and found that the message “VENT EXTRACT FAULT” was triggered during approach at time 03:11. Approach corresponds to phase 7, i.e.; from 800ft to touch-down.

The triggering conditions for this message is provided with ECOM 1.21.30, page 11:

 IBERIA A340 <small>FLIGHT CREW OPERATING MANUAL</small>	AIR COND/PRESS/VENT	1.21.30	P 11
	VENTILATION	SEQ 210	REV 18

WARNINGS AND CAUTIONS

FFCS-01-2130-011-A210AA

E / WD: FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLT PHASE INHIB
BLOWING FAULT * Low cooling capacity detected by the CED.			NIL	NIL	4, 5, 7, 8
EXTRACT FAULT * Low extract flow detected by the pressure switch.	SINGLE CHIME	MASTER CAUT	CAB PRESS	EXTRACT FAULT light	3, 4, 5, 7, 8
OVBD VALVE FAULT Valve open at engine start, or not partially open after override.					
ONE CAB FAULT					

It indicates that the message is indeed annunciate with a single chime and a master caution, and also that it is inhibited during some phases among which 7 and 8. Consequently, the

event that occurred during approach (phase 7) was annunciate to the crew at switching to phase 9, i.e. 80kt.

The reasons for this occurrence were not investigated. Among the possible ones is a fan failure, or a ducting issue, or eventually a pressure sensor. IBERIA has not reported any similar occurrence with subject aircraft since this event.

In conclusion, single chime and master caution that triggered 20 seconds after touchdown were consistent with the detection of a VENT EXTRACT FAULT, which reason was not determined.

ii. Sounds at time 6-12-30 and 6-13-29

Occurrence 6-12-30 was the buzzer sound indicating to the cockpit crew that a cabin crew was calling them from the interphone.

Occurrence 6-13-29 was the buzzer sound indicating to the cockpit crew that a cabin crew was requesting access to the cockpit.

In order to sustain this statement, AIRBUS provided the Commission of Investigation with extracts of a training video document reflecting the buzzer sounds specific in these situations.

2.2 Operational

2.2.1 The Flight Crew handling of the Emergency

The crew was confronted by an incident of dubious diagnose, due to the different E/W inputs: first an IFE smoke warning, next an Avionics smoke warning and then a FWD cargo smoke warning. The first and second warnings were cleared by the relief pilot (CM-3) when he checked the avionics compartment for smoke/fire and by the CAs when they assured the integrity of the in-flight entertainment system and the passenger cabin, galleys and toilets compartments. The last warning (Cargo Smoke Warning) displayed on ECAM, reflecting a decisive demand – LAND ASAP –, directed the Commander to the prompt and correct decision to return to Lisbon Airport after complete the adequate emergency procedures.

After landing, when the aircraft was leaving the runway and entering S1 taxiway, the “Avionics Smoke” warning was displayed and the Chief Cabin Attendant entered the cockpit stating that there was a “smell” of smoke¹⁰ “all along the cabin”. Some instants before, the Co-pilot re-

¹⁰ “Huele a humo” (“smells to smoke”).

ferred the same odour. The Commander ordered the emergency evacuation which, in the opinion of the Commission of the Investigation, was the right decision to take.

2.2.2 The Cabin Crew Action

An aircraft manufacturer, to get an aircraft¹¹ type or model certificate in order to introduce it in service, is required to demonstrate that the evacuation criteria required under the JAR 25.803 directions can be met.

These guidelines requires an actual demonstration to show the capability to evacuate, in less than 90 seconds¹², the full aircraft capacity, including the crewmembers, in a real or simulated night darkness situation, so the aircraft emergency lights should be the only illumination to the exit strips and the escape slides, using solely 50% of the exits¹³.

The reliability of an effective emergency evacuation lies on the cabin crew preparation where the crewmember is trained to be assertive in order to accelerate the passengers flow to the exits, dynamic and persuasive in their instructions to encourage the passengers to leave their seats to run away the aircraft and to redirect them to operative exits (in case of inoperative or crowded exits) using, if necessary, physical force to get the most reluctant passengers out of the aircraft¹⁴, assuring their security after leaving the airplane.

The Cabin crew acted accordingly to the standard evacuation procedures.

¹¹ If carrying more than 44 passengers.

¹² **Sec. 121.291 - Demonstration of emergency evacuation procedures.**

[...] each certificate holder must conduct an actual demonstration of emergency evacuation procedures [...] to show that each type and model of airplane with a seating capacity of more than 44 passengers to be used in its passenger-carrying operations allows the evacuation of the full capacity, including crewmembers, in 90 seconds or less. (Federal Aviation Authority Regulations).

¹³ *Demonstrate the effectiveness of its crewmember emergency training and evacuation procedures by conducting a demonstration, [...] in which the flight attendants for that type and model of airplane, using that operator's line operating procedures, open 50 percent of the required floor-level emergency exits and 50 percent of the required non-floor-level emergency exits whose opening by a flight attendant is defined as an emergency evacuation duty under §121.397, and deploy 50 percent of the exit slides. The exits and slides will be selected by the administrator and must be ready for use within 15 seconds.*

Use flight attendants in this demonstration who have been selected at random by the Administrator, have completed the certificate holder's FAA-approved training program for the type and model of airplane, and have passed a written or practical examination on the emergency equipment and procedures [...](Federal Aviation Authority Regulations).

¹⁴ *New Evacuation Techniques – Civil Aviation Training Conference – Lausanne, 1997 – by Anna Damsky (British Airways) and Laurie Richardson (Boeing Company).*

3. CONCLUSIONS

3.1 Findings

3.1.1 History of the event

- On the 19th of November 2004, while en route to Mexico, Iberia A340 MSN 601 registered EC-IZX experienced smoke warnings during cruise;
- At engine start, a smoke detector in the forward cargo compartment was electrically disconnected from the control loop of the smoke detection control unit. This unit was part number RA12811M0103;
- The first occurrence indicated smoke at the avionics and forward cargo compartment. It lasted 16 seconds;
- The second occurrence was experienced 5 minutes later. It indicated smoke at the in-flight entertainment compartment for 16 seconds;
- The third occurrence went 25 minutes after the second one, again indicating smoke at the avionics and forward cargo compartment. This warning was latched till the end of the flight;
- During post-flight investigations, there were no visible evidences of fire, smoke, overheat or contamination;
- There were no findings that would explain the crew report of stinging eyes and smell in the cabin.

3.1.2 Flight Crew

- The flight crew possessed airline transport pilots' licences and valid medicals issued by the appropriate authorities;
- Limits concerning crew time, flying time and rest time were complied with;
- The flight crew action was apposite facing the existing emergency, from the time the warning was displayed on ECAM to the end of the passengers' evacuation.



3.1.3 Cabin Crew

The cabin crew acted correctly, from the time they prepared the passengers' cabin to the time the emergency evacuation order has been given by the Commander, achieving the crowd control during the evacuation, redirecting the passengers to the nearest usable exit and maintaining a well balanced passenger flow out of the exits, thus minimising total evacuation time.

3.1.4 Aircraft

- The aircraft was a new unit and had a valid Airworthiness Certificate;
- The spurious smoke warnings were already known by AIRBUS and thus AIB had informed all operators and had launched a retrofit campaign in order to remind them the necessity of embodying the SCDU PN RA12811M0104 modification;
- It was IBERIA's intention to carry out this corrective modification, which was scheduled to be performed on Monday 22-11-2004 but the occurrence took place on 19-11-2004.
- After the modification has been introduced to the EC-IZX, this airplane returned to service on 22-11-2004 and no more spurious warnings were registered until the time being.

3.2 Cause of the occurrence

The cause of the spurious indications, before FIREX was discharged, was determined to be SDCU PN RA12811M0103 desynchronization upon smoke detector 3WH electrical disconnection from the control loop, since engine start.

4. SAFETY RECOMMENDATIONS

Considering that

1. At the time of the event, AIRBUS had already launched a fleetwide retrofit of SDCU P/N RA12811M0103 into P/N RA12811M0104, providing a final fix to the triggering of spurious smoke warnings in flight upon SDCU desynchronization;
2. Further to this event, AIRBUS issued an Operator Information Telex (OIT) to all AIRBUS operators in order to remind them of the interest of embodying SDCU PN RA12811M0104, making reference to the IBERIA's occurrence;
3. Immediately after the event, IBERIA installed SDCU PN RA12811M0104 on the subject aircraft,

this Commission of Investigation has no further safety recommendations to express either to the Manufacturer or to the Operator.

The Investigator-in-charge



Artur A. Pereira

At Lisbon, on 7th March 2006

ACRONYMS

ASAP	As Soon As Possible
ATC	Air Traffic Control
BEA	Bureau d'Enquêtes et d'Analyses
BITE	Built-in Test Equipment
CI	Commission of Investigation
CIDS	Cabin Intercommunication Data System
CMEU	Cabin Memory Expansion Unit
CMS	Central Maintenance System
CM	Crew Member
CRG	Cargo
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
ECAM	Electronic Centralized Aircraft Monitoring
ECMU	Electrical Contactor Management Units
FWC	Flight Warning Computer
FWD	Forward
GPIAA	<i>Gabinete de Prevenção e Investigação de Acidentes com Aeronaves</i>
ICAO	International Civil Aviation Organization
IFE	In-Flight Entertainment
IFEC	In-Flight Entertainment Compartment
ILM	IBERIA Line Maintenance
INAC	<i>Instituto Nacional da Aviação Civil</i>
LRE	List of Radioactive and Hazardous Elements
MEL	Minimum Equipment List
mbs	millibars
OIT	Operator Information Telex
OSHA	Occupational Safety and Health Administration
PAX	Passengers
PEV	Pressure Equalization Valve
PEL	Permissible Exposure Limit
PFR	Post Flight Report
QAR	Quick Access Recorder
RCCB	Remote Control Circuit Breakers
RPT	Regular Public Transport
RWY	Runway
SCDU	Smoke Detection Control Unit
SOA	<i>Serviços de Operações Aeroportuárias (Airport Operations Service)</i>
SSCVR	Solid State Cockpit Voice Recorder
SSFDR	Solid State Flight Data Recorder
SYS	System
TSM	Troubleshooting Manual
TWA	Time Weighted Average
TWY	Taxiway
UTC	Universal Time Coordinated
VCC	Video Control Center
VNL	Visual Near Lenses