FINAL REPORT

AAIU Report No: 2010-008
State File No: IRL00908045
Published: 15/07/2010

In accordance with the provisions of SI 205 of 1997, the Chief Inspector of Air Accidents, on 27 May 2008, appointed Mr. Graham Liddy as the Investigator-in-Charge to carry out a Field Investigation into this Serious Incident' and prepare a Report. The sole purpose of this Investigation is the prevention of aviation Accidents and Incidents. It **is not the purpose of the Investigation to apportion blame or liability.**

Aircraft Type and Registration:	Airbus A319-132, D-AGWK
No. and Type of Engines:	2 x IAE V2524-A5
Aircraft Serial Number:	3500
Year of Manufacture:	2008
Date and Time (UTC):	27 May 2008 @ 11.45 hrs
Location:	30 nm east of Dublin
Type of Flight:	Scheduled Public Transport
Persons on Board:	Crew–6 Passengers - 119
Injuries:	Crew- Nil Passengers - Nil
Nature of Damage: Commander's	None
Licence: Commander's Details:	ATPL
Commander's Flying Experience:	Male, aged 34 years
Notification Source:	8,200 hours, of which 8,000 were on type
Information Source:	Dublin Air Traffic Control (ATC)
	AAIU Field Investigation

SYNOPSIS

The aircraft had departed Dublin and was climbing towards cruising altitude when the Purser reported to the Captain that another Cabin Crew Member (CCM) appeared unwell and that passengers appeared to have fallen asleep quickly after take-off Following a discussion the flight crew went on oxygen, declared an emergency and returned to Dublin where the aircraft landed without further incident. No defect was subsequently found on the aircraft. The report of the Investigation makes three safety recommendations.

[1] This event has been classified as a serious incident, as ICAO Annex 13 defines an event requiring the emergency use of oxygen by the flight crew as a serious incident.

1. FACTUAL INFORMATION

1.1 History of the Flight

Prior to the event flight, the aircraft had flown from Cologne to Dublin on a scheduled public transport flight. Earlier in the day it had flown from Cologne to Munich, and then returned to Cologne, prior to the departure to Dublin. The same crew operated on all these flights. No defects or concerns were noted on any of these flights. The tum-round at Dublin was routine. De-icing was not required to be performed on the aircraft.

The event flight was a scheduled public transport flight, returning to Cologne with the same crew and a total of 119 passengers, including two infants. Preparations for the flight were routine and no abnormalities were reported. Following departure at 11.33 hrs[2], the aircraft climbed on an easterly heading. During the climb Auto Pilot 1 (API) was engaged, as was the Auto Throttle. The selected altitude was Flight Level (FL) 230 and speed was 290 kts, and the maximum vertical speed recorded was 4,656 ft/min.

As the aircraft passed FL100 (10,000 ft) the Purser called the cockpit on the intercom and reported that something was wrong, that almost all the passengers had fallen asleep, and that the CCM near her appeared unresponsive. In the course of this exchange, she also referred to a previous pressurisation event that had occurred to a sister aircraft a few weeks previously **(Other Information – Section 1.7.1)**.

The Cockpit Crew discussed the Purser's input. The Captain remarked that he was also feeling somewhat unwell and he later recalled a tingling sensation in his right arm, comparable with the arm "falling asleep". At this point (11.45 hrs) the aircraft was now approaching FL 200 (20,000 ft). The Cockpit Crew's initial concern was a possible pressurisation problem. A check of the Electronic Centralised Aircraft Monitor (ECAM) page showed no warnings or failures. At some point the Captain noted the cabin altitude indication of 1,700 ft. A decision was made to don oxygen masks, declare an emergency and descend. At 11.41.18 hrs the aircraft declared to Manchester ATC that they had to return to Dublin and descend immediately. This was approved by Manchester ATC. Shortly thereafter the aircraft was handed back to Dublin ATC as it re-entered Irish airspace. At 11.43.03 hrs the aircraft made a Mayday call to Dublin ATC. Once the Cockpit Crew donned their oxygen masks, their symptoms disappeared. No Public Address (PA) announcement was made to the passengers at this time. Based on information received from Dublin ATC, the Dublin Airport Fire Officer (AFO) declared an Aircraft Distress. This precipitated a full call out and response by all the relevant emergency agencies.

The aircraft landed normally at Dublin at 11.57 hrs, without further incident. By this time the Garda Sioch~na' had been alerted. A decision was made to hold the aircraft at a remote ramp position, Stand 89T. The aircraft was later towed to terminal stand (11 lL) at 12.56 hrs. The Air Accident Investigation Unit (AAIU) was also alerted and an investigation team was dispatched immediately. The AAIU team arrived on scene at 13.08 hrs, shortly after the aircraft had been towed in from the remote stand.

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[2] All times in this report are in UTC, which, at the time of the occurrence, was Irish Local time–1 hour and German Local time–2 hours.

'An Garda Sioch~na is the national police service of Ireland

Following an initial debriefing of the Cockpit Crew, and discussions with An Garda Sioch~na and the airport authorities, it was agreed that the passengers should be allowed to disembark. The passengers were then disembarked and escorted to a secure area in the terminal. The crew and passengers were asked if they required medical attention. Nobody requested such assistance. Passengers were invited to come forward to describe any ill effects they may have experienced during the flight and a sample of passengers was then interviewed. The only medical services available were first response emergency personnel. No medical practitioner attended, as none was available at the airport. Following discussions with An Garda Sioch~na, the passengers' carry-on baggage was not searched. The reasoning was that this had already been checked during the normal passenger screening. The contents of the baggage hold were examined as detailed in **Section 1.5** below.

1.2 Witness Interviews

1.2.1 Purser

The Purser was seated in the forward left position. After take-off she started to feel unwell. She noted that many passengers were falling asleep, which she considered to be unusual so early in a flight. She looked across to her colleague seated in the front right seat. He did not appear to be normal. She asked him if he was OK and queried him about how he was feeling. He appeared to be unresponsive. She called the Captain on the interphone and discussed the situation. After about 10 seconds the Captain said they were returning to Dublin and told her to use the portable oxygen cylinders. She passed this instruction onto the three other cabin crew members. About three minutes before landing, around the time the landing gear was lowered, she made an announcement to the passengers that they were returning to Dublin. She said that after landing the passengers *"were kind and relaxed"*. At the time of the event she had 4½ years experience as a CCM, and was a purser for the previous two years.

1.2.2 CCM No 2

CCM No 2 was sitting on the forward right position. He said that he was feeling tired after take-off and felt he may have been unable to perform his cabin service task. He recalled that when the Purser was talking to him, he did not respond and felt somewhat unwell.

1.2.3 CCM No 3

CCM No 3 was sitting at the rear of the aircraft. He stated that after take-off he felt very tired and wanted to sleep and described feeling dizzy. When the Purser told him to go on oxygen he queried her instruction and then complied.

1.2.4 CCM No 4

CCM No 4 was also seated at the rear to the aircraft and had only three weeks experience as a CCM at the time of this event. She recalled that her companion CCM at the rear had reported that he was feeling tired. She also felt tired and somewhat unwell.

1.2.5 Passengers

Passengers seated in various areas of the cabin were interviewed. A small number of passengers, mostly at the older end of the age spectrum reported that they felt drowsiness. No passengers reported feeling unwell or any loss of sensation. Many passengers stated that they had not noticed anything unusual or any feeling of drowsiness or lack of well• being. Many said their first indication of anything unusual was when they noticed that the aircraft was descending. They stated that no PA announcement was made at this stage. A few minutes prior to landing the Purser did announce that the aircraft was returning to Dublin as there was a technical problem, the nature of which was not understood. After landing the Captain made a PA announcement that they were feeling dizzy in the cockpit and this was the reason for the return. The announcement invited any passengers that were feeling unwell to bring this to the attention of the cabin crew.

1.3 Cockpit Voice Recorder (CVR)

The aircraft was equipped with a two hour duration digital solid-state CVR. This recorded the entire event flight and a significant part of the previous flight. An initial appraisal of the event flight showed a very relaxed and jovial environment in the cockpit, up to the point where the purser expressed her concerns. This jovial environment initially caused the Investigation concern that the crew may have been affected by a contaminated atmosphere in the cockpit. A significant portion of the previous flight, to Dublin, was found on the CVR recording. Analysis of this portion of the CVD record showed that a similar mood was present in the cockpit during the previous flight when no ill effects were reported. Inquires among colleagues indicated that both Cockpit Crew members were of an outgoing, good-humoured, disposition. The Investigation noted that once an emergency had been declared, the Cockpit Crew focused completely on the task in hand, with a professional approach. The cockpit voice recorder did not show any comments by the Cockpit Crew relating to feeling unwell prior to the call from the Purser.

1.4 Meteorological Information

The conditions at Dublin Airport did not require the aircraft to be de-iced during the turn• round. On departure from Dublin, the aircraft did not pass over any industrial or other area that might have been discharging noxious fumes. The wind was easterly, i.e. from the sea.

1.5 Test Results

Dublin Airport Fire Service completed an air composition check in the aircraft cockpit, cabin and hold, using a Crowcon Gas detector. This detector checks for a variety of gases including methane (CH_4), hydrogen sulphide (H_2S), carbon monoxide (CO) and oxygen (O_2). With regard to carbon monoxide, the unit triggers at levels above 30 parts per million (ppm). With regard to oxygen, the unit triggers if the oxygen levels falls below 17% or exceeds 23%. The unit did not detect any abnormal levels. The baggage hold was then emptied and a specialist team examined the baggage. Nothing suspicious was found. At this point the passengers and their belongings were released. More detailed interviews were conducted with the aircraft crew. A thorough examination of the aircraft cabin was then conducted. Again nothing suspicious was found.

The aircraft was later removed to a maintenance facility. The following day a series of tests were conducted on the aircraft, including running the engines, APU, galleys and other services. Swabs were taken from several points on the aircraft, particularly at air outlet points. These tests lasted several hours. Particular attention was paid to the possibility of oil from the engines or APU getting into the cabin air supply. No such evidence was found. It was noted that the APU oil level was correct and that no oil had been added to the APU since the aircraft had entered service a few weeks before the event. The aircraft manufacturer provided a list of items to be checked. This list was accomplished without anything unusual being found.

At one point during these tests, two members of the inspecting team, which numbered up to 15 people, reported a strong smell in the cabin. However the other members of the teams reported nothing unusual.

As these tests failed to reveal any reasons as to why crew and passengers might have felt unwell, these tests were repeated using specialist test equipment. The tests included running the engines at high power settings and a variety of air conditioning system settings. Again nothing abnormal was found. After three days of testing it was decided, in consultation with the operator and the aircraft manufacturer, that the aircraft be flown to the manufacturer's facility at Toulouse for further tests. The flight to Toulouse was flown, unpressurised, at 10,000 ft operated by two pilots from the operator and an AAIU Inspector in the jump seat. The handling pilot remained on portable oxygen for the entire flight. Towards the end of the flight the pilot monitoring (PM) started to feel slightly unwell and went on oxygen briefly. His feeling of being unwell disappeared after taking oxygen. The AAIU Inspector, who was not on oxygen, reported no ill effects.

On arrival at Toulouse the aircraft was subjected to six days of extensive tests, including flight tests. No abnormalities were found. In particular it was found that the air supply and air condition systems were working to specification. It was subsequently agreed to return the aircraft to service. Over an extended period of service since this event, no recurrence of crew or passengers feeling unwell on this aircraft has been reported.

Swabs taken from the air conditioning ducts on the aircraft did not show the presence of any synthetic oil residue.

The cabin air recirculation filters were removed and were found to be in good condition as would be expected with a new aircraft[4]. This was the first removal of the filters since the aircraft was delivered from the manufacturer. The filters were sent to a specialist laboratory for analysis and were found to be free of any significant contaminant. Analysis of the filters showed levels of possible contaminants that were around the levels that would be considered as trace levels and therefore were far below the levels that would be a cause for any concern.

The maximum carbon monoxide level recorded in the Dublin tests was 2 ppm and less than 3 ppm during the flight test at Toulouse.

Levels of carbon dioxide of 400 to 600 ppm were found during the ground tests at Dublin and again during the flight tests at Toulouse.

[4] This aircraft flew for the first time on 15 April 2008, 6 weeks before this incident.

The detailed examination of the cabin air conducted at the Toulouse facility detected carbon dioxide levels that were 3% of the acceptable limit. The highest level of carbon monoxide detected was less than 3 ppm. Very small traces of Toluene, Ethybenzene and Styrene were found. In each case the maximum concentration found was only a very small fraction of that permitted under the various standards **(Appendix A).** These substances are typically found in aircraft exhausts. The induction of exhaust gases while the aircraft was on the ground is the probable explanation for the presence of very small quantities of these substances. The most toxic substance found in the analysis process was nicotine, and this was only found in very low concentrations. Traces of Volatile Organic Compounds (VOC) were found, but again the levels were far below exposure limits.

The Investigation identified the oil being used in the aircraft engines and APU and the oil manufacturer supplied a detailed analysis of this product. The contracted laboratory specifically tested for traces of this oil in the cabin air and did not find any.

1.6 Technical Information

The air supply of the A319 is shown in **Appendix B.** Compressed bleed air is taken from the engine and/or APU compressors. The air passes through the air conditioning packs and then into the mixing units where it is mixed with air drawn from the under-floor area of the aircraft. The mixed air then enters the passenger cabin through ceiling vents distributed along the top of the cabin and, via a separate supply, into the cockpit. Air is then drawn out of the cabin via ducts at floor level into the under-floor area and then though the recirculation filters and then back into the mixing unit. Half the air extracted from the cabin is discharged out of the aircraft via an outflow valve and the remainder is re-circulated into the cabin. The airflow rate is such that the cabin air is changed every two and a half minutes, or 25 times per hour. Data supplied by the aircraft manufacturer indicates that the average air consumption by a seated passenger is 0.24 cubic feet per minute (cfm) and the aircraft's supply system provides 20 cfm per passenger, and consequently the supply is approximately 83 times the normal consumption. While economics are partially the reason for using a 50/50 ratio of re-circulated air, the use of 100% fresh air would cause very low humidity problems, as the external air at cruising altitude holds very little moisture. Very low humidity levels can result in passenger discomfort and dehydration.

1.7 Other Information

1.7.1 About three weeks before this event, a sister aircraft operated by the same operator, which had also recently entered service, experienced an uncommanded deployment of the main cabin oxygen masks while operating at cruising altitude. Initial examination showed that there was no loss of pressurisation and found no explanation for the mask deployment. Subsequently it was determined that a faulty controller caused the deployment of the masks. This event appears to have been the subject of widespread discussion among the operator's aircrews. At the time of the event to D-AGWK, the crew were not aware that the cause of the previous event had been determined.

1.7.2 Apart from passenger baggage, no cargo was carried on D-AGWK. In particular dry ice (a solid form of carbon dioxide) was not carried on the aircraft.

The crew of D-AGWK, including the CCM's, had come on duty between 03.15 hrs and 03.45 hrs on the morning of the event. They had been working the previous day, ceasing work at various times between 13.00 hrs and 17.00 hrs.

The dizziness, and other symptoms reported by the crew disappeared quickly after they went on oxygen. Consequently, none of them requested medical attention when so offered.

No indications of smoke, burning, visible fumes, or unusual smells were reported throughout this event. The aircraft ECAM did not report any relevant malfunction.

The Investigation did consider testing the crew for carbon monoxide. However the Investigation noted that most of the crew were cigarette smokers and had smoked shortly after the Investigation team arrived on site. As smoking would have raised their carbon monoxide levels, it was decided that such testing would not be conclusive.

When the Investigation team arrived on scene, neither passengers nor crew indicated that they were feeling unwell. They appeared to have recovered from any adverse symptoms they may have experienced. Furthermore, they had been held in the aircraft at a remote stand on the ramp for an hour, and the majority were very anxious to continue their journey. No passengers or crew member expressed any desire to be subjected to a medical examination, when offered this facility. In these circumstances, it was inappropriate for the Investigation team to detain them for an extended period.

Two days after the event, while the tests on the aircraft at Dublin Airport were ongoing, the Investigation sought the assistance of the Toxicology Unit at Beaumont Hospital, the State Laboratories, the Public Analysis Laboratory and the Environmental Protection Agency. None of these organisations were able to assist the Investigation. The State Laboratories did suggest the use of a private laboratory facility and the Investigation subsequently contracted this laboratory to assist in the testing of the aircraft.

1.7.3 The aircraft operator uses FAID software to monitor aircrew fatigue. The Investigation was provided with data from this system for the duty rosters of all six crew members. The data showed that the Captain, the First Officer or the Purser did not have any exposure to excessive fatigue in the month prior to this incident. Two of the other cabin crew had a slightly elevated fatigue exposure (i.e. closer to the Tolerance Level) for a one-day period more than two weeks before the incident.

1.7.4 The Investigation obtained the assistance of the German Accident Investigation Board (BFU) with the replay of the CVR, as the inter-crew discussions were conducted in German. The BFU provided a transcript of the relevant portions of the CVR.

1.7.5 In response to a request from the Investigation, the UK Civil Aviation Authority (CAA) conducted a search of their Mandatory Occurrence Reporting (MOR) database, seeking similar events with A320 family aircraft over the last ten years. No case of poor cabin air quality was found where the contamination source was not readily identified.

[5] FAID is a proprietary software product designed to monitor personnel fatigue.

1.7.6 The American Society of Heating, Refrigerating and Air-Conditioning Engineers has published a new standard (161-2007, Air Quality Within Commercial Aircraft), which addresses aircraft cabin air quality. At this point in time, this standard has not been adopted by the International Civil Aviation Organisation (ICAO), or by the various aircraft certification authorities, such as the US Federal Aviation Agency (FAA) or European Aviation Safety Agency (EASA).

1.7.7 Being aware that EASA has an ongoing programme in the field of cabin air quality, the Investigation invited EASA to summarise their current work programme in this area. The following reply was received from EASA:

"An EASA Rulemaking 25.035 task on the topic of Cabin environment – air quality, was launched in January 2009. Subsequently A-NPA 2009-10[6] was published in September 2009.

The issue of cabin air contamination has been triggered based on engine or APU oil seal or bearing failure, engine or APU maintenance error/irregularities, or design deficiency, engine or APU oil, hydraulic fluid, fuel, de-icing fluid and the corresponding pyrolysis products may contaminate the bleed air, which then enters the cabin air supply and can be inhaled by the aeroplane occupants.

The objective of the A-NPA 2009-10 is to communicate the EASA's current understanding of the issue, outline potential safety concerns and invite stakeholders (Civil Aviation Authorities, Flight/Cabin crews, Manufacturers...) to provide any factual information relevant to the subject.

Relevant research activities are being conducted in the UK (in-flight testing by Cranfield University for Department for Transport) and in the U.S. (ACER, ASHRAE, OHRCA projects). These research studies are expected to help in answering some important questions related to safety and health (e.g. what toxic substances can be found actually in the cabin air after an in-flight "fume event" and in what levels?).

Based on the feedback from consultation of this A-NPA, if the result of the research studies and the A-NPA consultation provide enough factual evidence of a safety case or a threat to health, a rulemaking activity will be initiated. Such rulemaking activity would follow the EASA rulemaking procedure with the publication of an NPA (Notice of Proposed Amendment) and the involvement of all stakeholders. This might lead to the revision of CS-25, as well as to other measure deemed necessary."

1.7.8 The international guidelines for the provision of medical services at airports are given in ICAO Doc 9137 Airport Services Manual, Part 7, Appendix 3 **(Appendix C)**. In the Manual of Aerodrome Licensing, Chapter 10 **(Appendix D)** the Irish Aviation Authority (IAA) has incorporated many of the provisions of ICAO Doc 9137. Section 10.A.1.4 of this Manual does lay down the specific IAA requirements with regard to the medical services at an aerodrome.

[6] A-NPA means Advance Notice of Proposed Amendment

[7] A-NPA 2009-10 can be found at http://hub.easa.europa.eu/crt/docs/viewnpa/id_81

2. ANALYSIS

2.1 General

No evidence of fire or smoke was reported or found. Therefore fumes from a fire can be discounted in this event. No evidence of oil loss from the engines or APU was found, and therefore the passage of oil into the air conditioning system can also be discounted in this case. As the aircraft was not de-iced prior to the flight, de-icing fluid could not have contaminated the cabin air intake ducts. Passenger carry-on baggage had been subjected to the normal thorough screening. The hold baggage was examined and no evidence of any hazardous or suspicious substance was found. The sensor test by the airport fire service, conducted before the passengers disembarked, found nothing abnormal. A detailed search of the aircraft interior, including the under-floor area, found nothing of significance.

2.2 Results of Air Tests

All the subsequent tests conducted on D-AGWK found only minute trace quantities of substances that could be considered to be in any way harmful. Typically the levels were much less than 1% of accepted exposure limits. The only exception was Styrene, which was measured at 2.3% of the German Workplace Expose Limits Standard (BAuA TRGS-900, 2008). This value is therefore well within safety limits and is explained by the off-gassing of the cabin furnishings in this aircraft, which was very new. The tests did not produce any evidence of the existence of a substance or contaminant that might explain why members of the crew felt unwell or why any passenger may have prematurely gone to sleep.

US FAR 25.831 states that levels of Carbon Monoxide above 50 ppm are hazardous. The maximum recorded levels of less than 3 ppm during the tests of D-AGWK are well below this limit. With regard to Carbon Dioxide, the normal outdoor levels are approximately 400 ppm. The level of Carbon Dioxide normally associated with causing some drowsiness is 10,000 ppm. The recorded test levels of 400 to 600 ppm are therefore very close to normal outdoor conditions and are far below the levels where any drowsiness could be expected.

The case of the Pilot Monitoring (PM) not feeling well on the subsequent flight to Toulouse was examined. He had a senior management role in the Operator's company. He had to personally deal with several administrative and management aspects of the aftermath of this event, travel at very short notice to Dublin, where he did not get a good night's sleep, and ate irregularly in the period prior to the flight. Furthermore he was a cigarette smoker. Taking all these factors into account, his tolerance of exposure to unpressurised operations at 10,000 to 11,000 ft for a period of hours may have been reduced.

The cause of the smell reported by two of the 15 personnel (approximately) involved in the ground tests at Dublin was not determined. The smell may have been associated with those normally found in a new aircraft, caused by the previously mentioned off-gassing of the new interior furnishings.

2.3 Aircraft Crew

The fact that the symptoms reported by all the crew disappeared rapidly after they went on oxygen would indicate that some form of food poisoning was not a factor in this event.

Similarly, it must be considered unlikely that breathing pure oxygen would immediately cancel the effects associated with an intake of toxic gases or vapours.

The fact that the Cockpit Crew did not make any PA announcement to the passengers was noted by the Investigation. It should be noted that the aircraft was quite close to Dublin when the emergency was declared. Thus the crew had to tum round the aircraft, perform a steep descent, configure the aircraft for a return to Dublin, liaise initially with Manchester ATC and then with Dublin, and prepare for an imminent landing in Dublin. All this had to be accomplished while wearing oxygen masks. Normally the wearing of such masks, arising out of a pressurisation event, could be dispensed with at 10,000 ft. However in this case, the concern related to the possibility of a contaminated air supply. Consequently the masks were worn for the remainder of the flight. The use of the PA handset is not feasible when wearing oxygen masks. The use of the PA via the headset, while wearing oxygen masks, tends to distort the announcement, which could increase passenger anxiety. When all the foregoing factors are taken into account, the absence of a PA announcement by the Cockpit Crew is considered to be understandable, even appropriate, in the circumstances.

The Investigation was unable to find any evidence of contamination of the aircraft air supply, which might have caused fatigue, sleepiness, dizziness or any other symptoms of feeling unwell among the flight crew. Neither can the Investigation explain why only some of the passengers complained of any symptoms and that the symptoms of the effected passengers were limited to drowsiness, i.e. no passengers reported feeling unwell. The fact that those who reported the symptoms recovered rapidly after landing would indicate the absence of any toxic contaminant. The failure to detect any abnormal residues within the aircraft after the event would also suggest the absence of toxic contaminants.

The Purser's action in alerting the Cockpit Crew regarding her concerns was positive and proactive. The inclusion in the discussion between the Purser and the Cockpit Crew of the previous cabin mask deployment event in a sister aircraft would have heightened the cockpit crews' concern, as this previous event was unexplained at the time of this event. It should be noted that the subsequent investigation of these two events showed there was no connection between them.

There are some indications on the cockpit voice recorder that one of the Cockpit Crew may have been suffering from an upset stomach prior to the event. This was not discussed on the recorded section of the incident flight or the previous flight.

2.4 Discounted Factors

The Investigation is satisfied, particularly from the records of the FDR and CVR, that there was no loss of pressurisation in this event.

There were no meteorological factors involved in this event.

The FAID data indicated that roster-induced fatigue was not a factor in this incident.

2.5 Medical Services

The availability of medical doctor during the initial examination of the aircraft and passengers would have been of assistance to the Investigation. Unfortunately no such resource was available at Dublin Airport.

The Investigation noted that the passengers and crew were left at a remote stand, inside the aircraft for nearly an hour. If the aircraft had been proven to contain dangerous contaminants, this delay would have resulted in unnecessary exposure for the passengers and crew. The Investigation believes that the presence of suitable medically qualified personnel, in the initial response emergency services response, would have led to an earlier resolution of this situation.

2.6 Discussion

2.6.1 Cabin Air Quality

Poor cabin air quality has been an on-going issue in commercial air transport operations. A number of recurring faults and defects have found to be the cause in many cases. A common cause is leaks in the engine or APU oil seals that permit oil, oil mist or oil vapour to enter the air conditioning system. This can be discounted in this case as no evidence of oil loss for either the engines or APU was found. Furthermore, contamination by such oils will normally leave detectable traces within the aircraft. No such traces were found in this case.

Another frequent cause of poor quality cabin air is fumes emanating from the galley ovens. Fumes are caused by overheating due to failed temperature controls, the failure to remove packaging from food before heating, or similar reasons. In this case the ovens were not in operation and thus this cause can also be discounted.

Leaking gas from air conditioning cooling systems has also been known to cause a deterioration of cabin air quality. The discharge of gaseous fire extinguishers can also introduce a noxious substance into the cabin air supply. In this case, no evidence was found of any type of gaseous discharge.

Smouldering electrical systems and/or wiring can cause a significant deterioration in cabin air quality. But again no evidence of such an occurrence was found in this case.

During the tum-round at Dublin, the aircraft was not the subject to any maintenance or heavy cleaning, other than the standard visual turnaround inspection and cabin tidy-up. The fact that no problem was reported on the earlier flight from Germany indicated that there were no significant residues from previous maintenance or cleaning.

It is noteworthy that during the exhaustive and prolonged tests undergone by this aircraft, no re-occurrence of the problem was found. Furthermore the aircraft has subsequently returned to service for an extended period, and no re-occurrence of the problem has been reported during this time.

The Investigation noted that in the months that followed this event, three further cabin air quality events, relating to fumes in the cabin, cabin crew reporting feeling unwell, unusual smells etc, were reported to the AAIU. In each case, different operators and aircraft types built by different manufacturers were involved. In none of these cases was a definite source of the reported problem identified.

Certain aircraft types have a higher incidence of reported cabin air quality issues. This is detailed in EASA A-NPA 2009-10. The Airbus A319, or the extended A320 family, is not included in these aircraft types.

2.6.2 Possible Contamination Sources

In cases of poor cabin air quality, there are, broadly speaking, two types of sources of contamination. The first type of contamination is associated with solid or liquid particles, such as the product of combustion or smouldering, or suspended droplets of substances such as oil and fuel. The generation of gaseous by-products, associated with the production of such particles is a particular feature of this type of contamination. This type of contamination can be subsequently detected by the deposited residue of the particles or droplets. Subsequent detailed examination of the aircraft will normally find evidence of such particles or droplets. The other source of cabin air contamination is by highly volatile substances or gases. A feature of such substances is that because of their nature, they are unlikely to leave any residue and will be dispersed by the air conditioning system and exit the aircraft via the outflow valve. The presence of such volatile substances usually requires the use of absorption filters to detect their presence. The difficulty with this method of detection is that it does not give real time warning of the presence of such contaminants.

In the environment of a modem passenger aircraft, the list of potential cabin air contaminants is large. Given this vast spectrum of possible culprits, the task of detecting possible contaminants is daunting. Many possible contaminants are of a volatile nature. Volatile Organic Compounds (VOC's) are particular challenging contaminants from the point of view of detection. These compounds evaporate and are pumped overboard by the aircraft's air conditioning system, and so disappear, without leaving a trace, in a relatively short period of time. The investigation of this event demonstrated the difficulties of finding evidence of contamination after a reported event, in spite of significant resources available to, and utilised by, the Investigation. The issue of cabin air quality has been the subject of much debate and research by a wide variety of agencies and other organisations, including EASA, FAA, CASA, many research organisations, aircraft crew representative bodies and voluntary organisations.

2.6.3 Cabin Air Monitors

Many of the studies into the problem of cabin air contamination have identified the need for an on-board monitoring system that would alert a crew to a deteriorating cabin air environment. Such an alert would permit the crew to take rectifying action, such as the use of independent (and safe) oxygen supplies. An important aspect of such a system is that the crew would need to be alerted to the hazard before their faculties suffered possible deterioration due to the presence of the contaminant, which would in tum diminish their capacity to deal effectively with the situation. Unfortunately, an alerting system that could detect a significant range of the potential contaminants, never mind all of them, has yet to be devised.

Even cabin air monitoring on an on-going basis poses difficult technical challenges. Monitoring for the presence of a VOC is normally performed by fitting absorption filters. These filters absorb the VOC's over the period they are installed in an environment. The absorption filter must then be analysed to determine the VOC level. The result is a total count, over the test period, of the VOC level.

Unfortunately, this technique can't differentiate between a low level contamination over a long period, or a short level of exposure to a high (and possibly dangerous) level of contaminant. Some progress has been made in the production of test equipment for industrial applications that can monitor VOC on a real time basis. However, the design, production and certification of such equipment that could be realistically fitted in public transport aircraft has yet to be accomplished.

The standards for cabin air quality laid down in the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Standard (161-2007, Air Quality Within Commercial Aircraft), are comprehensive. However the monitoring of cabin air in accordance with criteria laid down in this standard poses severe technical challenges and current thinking within the aviation industry is that the technology required to implement this standard does not yet exist or is not sufficiently mature to operate in the aviation context. Consequently this standard has not been adopted by the major aircraft certification agencies.

2.6.4 Medical Services

The aerodrome medical standards laid down in the IAA Manual of Aerodrome Licensing applies to a wide spectrum of licenced aerodromes, from grass strips to major international airports, such as Dublin Airport. While the Manual states that the medical supplies and equipment should be appropriate to the category (size) of the aerodrome, no stipulation is made with regard to the provision of medical personnel or their level of expertise. The ICAO guidelines **(Appendix C)** in paragraph 29 of Appendix 3 states that *"Generally, it may be recommended that an airport medical clinic be available when the airport employees number 1000 or more....."*. Given that the employed population of Dublin Airport exceeds this figure by a large margin, best international practise indicates that a medical clinic should be provided at the airport. Furthermore paragraph 34 (i) of the same document says that *"In general it is recommended that during principle hours of airport activity at least one person trained to deal with ..... basic measures for treatment and protection of spills or leaks of radioactive materials, toxic or poisonous substances."* The experience of this Investigation is that this event could have been dealt with more effectively if such expertise was available at the scene.

2.6.5 EASA A-NPA No 2009-10[8]

This document provides a useful overview of the scope and complexity of Cabin Air Quality issues. It is worth noting that the document, on page 9, provides flight crews, cabin crews and operators of category CS25[9] aircraft with a confidential facility to report cabin air quality events to EASA, which can be used by EASA in developing a fuller understanding of the frequency and extent of cabin air quality events. This Investigation recommends that flight crew, cabin crew and aircraft operators report such events using this facility.

As EASA already have an ongoing work and research program in the area of cabin air quality, as described above, the Investigation saw no benefit in making safety recommendations to EASA with regard to this event.

[8] Available at http://hub.easa.europa.eu/crt/docs/viewnpa/id_81

[9] CS 25 is the EASA Certification Specifications for Large Aeroplanes, which includes the Airbus A319

3. CONCLUSIONS

(a) Findings

1. The Crew declared an emergency and returned to Dublin, due to concern regarding cabin air quality.

2. The Investigation was unable to find any evidence of contamination of the aircraft air supply, or of any contaminant in the aircraft.

3. The Investigation was unable to find any evidence of a restricted, poor quality or inadequate air supply to the cockpit or cabin.

4. The reports of more serious symptoms (loss of sensation in limbs) appear to have been limited to the aircraft crew. Some passengers reported drowsiness. Many passengers reported that they did not experience anything unusual.

5. While no evidence of contamination, or poor air quality, was found, all six members of the aircrew reported adverse symptoms. These symptoms disappeared when the individual crew members in question went on oxygen.

6. There was no evidence whatsoever of any loss of pressurisation.

7. There was no on-site medical doctor at Dublin Airport after this event. Such a presence would have been useful to the Investigation.

8. Current IAA standards do not specify the provision of medical centre at major international airports, and thus fail to meet ICAO recommended guidelines.

9. There was a significant delay in making a decision as to how the situation should be handled, which resulted in the passengers and crew being detained in an aircraft, which could possibly have contained dangerous contaminants.

(b) Probable Cause

The probable cause of the adverse symptoms reported by the aircraft crew and some passengers could not be determined.

4. SAFETY RECOMMENDATIONS

It **is recommended that**:

1. The Irish Aviation Authority (IAA) should review the licensing requirement of major airports in Ireland, as specified in the Manual of Aerodrome Licensing, to comply with ICAO guidelines for large airports and to ensure that the provision of adequate medical services are part of the licensing provisions. **(IRLD2010012)**

2. Dublin Airport Authority (DAA) should review the provision of medical services at Dublin Airport. **(IRLD2010013)**

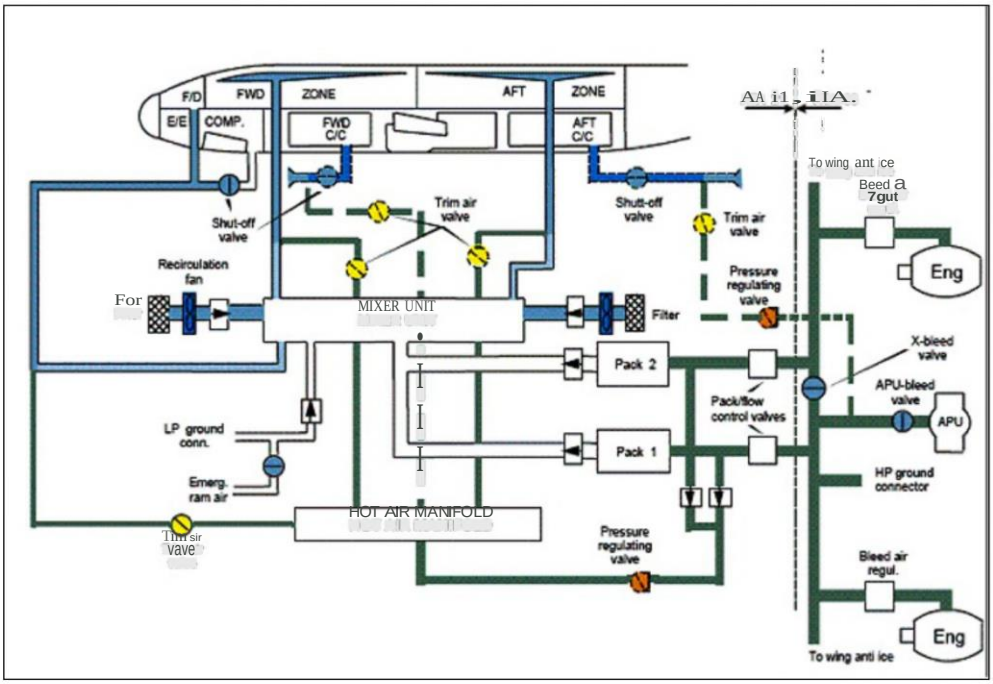
3. The DAA should review the response procedures to ensure that passengers and crew are not unduly detained in a potentially toxic environment, following cabin air quality events. **(IRLD2010014)**

Appendix A

	Toluene	Ethylbenzene	Styrene
prEN 4618, 2004 (Comfort limit) [mg/m³]	153		
SAE AIR 4766, 2007 (Cabin Supply Air Contaminant Limits) [mg/m³]	153	-	-
BAuA TRGS-900, 2008 (Working place exposure limit) [mg/m³]	190	440	86
Odour threshold [mg/m³]	5.8	0.013	0.6
Max. flight test measurement (charcoal tube #2) [mg/m³]	**0.4**	**0.02**	**2**
Measured value [% of TRGS-900]	0.21%	0.00%	2.33%

Levels of concentration of Toluene, Ethylbenzene and Styrene found in the cabin air, shown in red bold type, compared maximum tolerable level and laid down in various standards.

Appendix B



This diagram is a schematic layout of the air circulation system on the Airbus A319

Appendix C

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least one on-call ambulance for routine medical emergencies. Written agreements with off-airport based ambulances should be prepared to provide for emergency transportation services.

24. Airborne transportation equipment, i.e. helicopters and fixed wing aircraft, should be considered for emergency evacuation or for transport of medical services and equipment from hospitals to the accident site.

25. Since it may be necessary to transport many casualties to appropriate off-airport medical facilities, ambulances arriving at the scene should report to the rendezvous point or staging area and then to the designated transportation officer. This officer will be responsible for ascertaining the number of casualties who will need transportation, the number and type of ambulance units necessary, and the availability and capacity of each medical facility receiving casualties. In the event of a multi-casualty accident, the transportation officer (or members of the team) will also supervise the actual loading, recording of names and injuries of casualties, and routing of the individual vehicles and casualties to hospitals.

26. In major emergency situations, other means of transportation may be substituted for ambulances. Vans, buses, automobiles, station wagons or other suitable airport vehicles may be used. Immediate transportation for moving of the uninjured or apparently uninjured to a designated holding area should be available.

27. A grid map (with date of latest revision) of the airport and surrounding area should be provided for all rescue vehicles. All medical facilities should be depicted prominently on the grid map (See Chapter 7 -- Grid Map).

AIRPORT MEDICAL CARE FACILITIES (MEDICAL CLINIC AND/OR FIRST-AID ROOM)

28. General factors influencing need. There are many general factors which influence the need for an airport first-aid room or an airport medical clinic. Factors to be taken into consideration include:

a) the number of passengers served annually and the number of employees based on the airport;

b) the industrial activity on the airport property and in the surrounding community;

c) the distance from adequate medical facilities; and

d) mutual aid medical services agreements.

29. Generally, it may be recommended that an airport medical clinic be available when the airport employees number 1 000 or more and that a first-aid room be available at every airport. The airport medical care or first-aid room personnel and facilities should be integrated with the airport emergency plan.

30. The airport medical clinic, in addition to providing emergency medical care to the airport population, may extend emergency care to communities surrounding the airport, if these communities have no emergency facilities of their own.

31. The airport medical clinic may be included in the community emergency services organization and planning. In the event of a large-scale non-airport local emergency, the airport medical clinic may function as the co-ordination site for direction of incoming medical assistance.

32. *Location of airport medical care facilities.* The facilities should be readily accessible to the airport terminal building, to the general public and to emergency transportation equipment (i.e. ambulances, helicopters, etc.). Site selection should avoid the problem of having to move injured persons through congested areas of the airport terminal building, while providing access to the facility by emergency vehicles by a route that as far as is feasible can bypass normal public access roadways to and from the airport. This suggests that the medical care facility be located so that access can be gained from the air side of the airport terminal building as this provides control over unauthorized vehicles interfering with emergency equipment.

33. *Airport medical care facility personnel.* The number of trained personnel and degree of expertise needed by each individual will depend on the particular airport's requirements. The staff of the airport medical clinic should form the nucleus for the medical services planning for the airport emergency plan (and be responsible for implementation of the medical portion of the plan). It is recommended that the airport first-aid room be staffed with at least highly qualified first-aid personnel.

34. In general it is recommended that during the principal hours of airport activity at least one person trained to deal with the following be on duty:

a) cardiopulmonary resuscitation (CPR);

b) bleeding from a traumatic source;

c) Heimlich manoeuvre (choking);

d) fractures and splinting;

e) burns;

) shock;

g) emergency childbirth and immediate care of newborn, including prematures,

h) common medical conditions which may influence the outcome of injury (allergies, high blood pressure, diabetes, pace-maker, etc.);

i basic measures for treatment and protection subsequent to spills or leaks of radioactive materials, toxic, or poisonous substances;

j) treatment of emotionally disturbed persons;

k) recognition and first aid for poisons, bites, and anaphylactic shock; and

l) transportation techniques for injured persons.

This person should have authority to order hospitalization and to arrange any needed transportation, if necessary

35. The airport authority should obtain the advice and direction of a consulting emergency medical care physician as to the allotment and design of equipment for the first-aid room commensurate with the anticipated needs of the particular airport.

36. The airport medical clinic equipment and the medical supplies have to be determined by the physician or the group of physicians in charge of the clinic. It should be remembered that responding to an aircraft emergency may be the main problem.

37. The airport medical care facility should be adequately equipped to handle cardiac arrest and other types of injuries and illnesses associated with industrial medicine. If drugs are maintained, provision should be made to ensure full security.

38. Sufficient emergency oxygen and respiratory equipment should be available to treat smoke inhalation victims.

39. Since the majority of non-accident related medical emergencies at airports involve coronary problems, advance life support systems including oxygen, oxygen regulators, and other elements for cardiopulmonary care should be readily available. In addition, first-aid kits (containing drugs, a wide selection of bandages and splints, blood transfusion equipment, and burn and maternity kits), chains, ropes, crow-bars, and metal cutters should be available.

AIRPORTS WITHOUT A MEDICAL CARE FACILITY

40. At airports without a medical care facility (medical clinic or first-aid room), the airport authority should make arrangements to have available sufficient personnel trained in advanced first aid to cover all active hours of airport operation. Equipment for first aid work at these airports should consist, at minimum, of an emergency medical care bag. This bag should be readily available to be carried on a designated airport emergency vehicle and should contain at least:

- one plastic sheet (1.80 m x 1.80 m) with four spikes;
- seven haemostats (one package of three, one package of four);
- two field dressings (one 45 cm x 56 cm, one 56 cm x 91 cm);
- ten abdominal pads (five packages of two);
- forty 10 cm x 10 cm gauze pads (four packages of ten);
- two tourniquets,
- one artificial airway;
- three disposable airways (one each No. 2, No. 4, No 5);
- one bulb syringe with two catheters (No. 12, No. 14 FR);
- two large bandage scissors;
- twenty disposable syringes with No. 25 GA 1.6 cm needle;
- twelve ace bandages (two 15 cm, four 7.5 cm, six 5 cm);
- twelve alcohol sponge packages;
- four rolls of gauze bandage (two 7.5 cm, two 5 cm);
- two rolls of adhesive tape;
- four vaseline gauze dressings (15 cm x 91 cm);
- box of 100 band-aids;
- one blood pressure cuff and gauge;
- two clipboards (22 cm x 28 cm);
- six pencil,
- sufficient supply of casualty identification tags (see Appendix 8);
- one set of inflatable splints;
- one resuscitube;
- one short spine board;
- one flashlight;
- two cervical collars;
- one bite-stick wedge;
- one disposable obstetric kit; and
- one immobilizing mattress.

Appendix D

10.A.1.4 Aerodrome medical services.

10A.1.4.1 All licensed aerodromes should be equipped with a nucleus of medical equipment on a scale appropriate to their category. First aid training should be undertaken by all aerodrome personnel likely to play an active role in rescuing or assisting persons involved in an aircraft accident. This is to ensure that in the early stages following an accident qualified assistance will be available. Under normal arrangements the 'Emergency Plan' will be activated and the initial effort will be supplemented by professional ambulance, medical and nursing assistance within a short time.

10A.1.4.2 The aerodrome authority should arrange to have sufficient medical supplies available on or in the vicinity of the airport and carried to the scene of the accident as quickly as possible. The type and quantity of such supplies, to treat the passenger and crew capacity of the largest aircraft nonnally using the aerodrome, should be determined by the aerodrome authority using the information available in the ICAO Airport Services Manual, Part 7. At remote aerodromes where off aerodrome medical support may not be immediately available additional medical supplies may be required.

10A.1.4.3 A list of medical supplies retained on or in the vicinity of the aerodrome should be made available to the Authority.

10A.1.4.4 The availability of ambulance and medical facilities for the removal and after-care of casualties arising from an aircraft accident should receive careful consideration and form part of the overall emergency plan.

10A.1.4.5 Buildings should be identified :

(a) for casualty reception;
(b) as temporary mortuary accommodation;
(c) for safeguarding recovered personnel effects;
(d) as a reception area for grieved and shocked relatives.

10A.1.4.6 Working in accident conditions without adequate lighting can be extremely difficult and supplementary lighting should be provided as required.

IAA Manual of Aerodrome Licensing, Chapter 10, Page 275

-END-