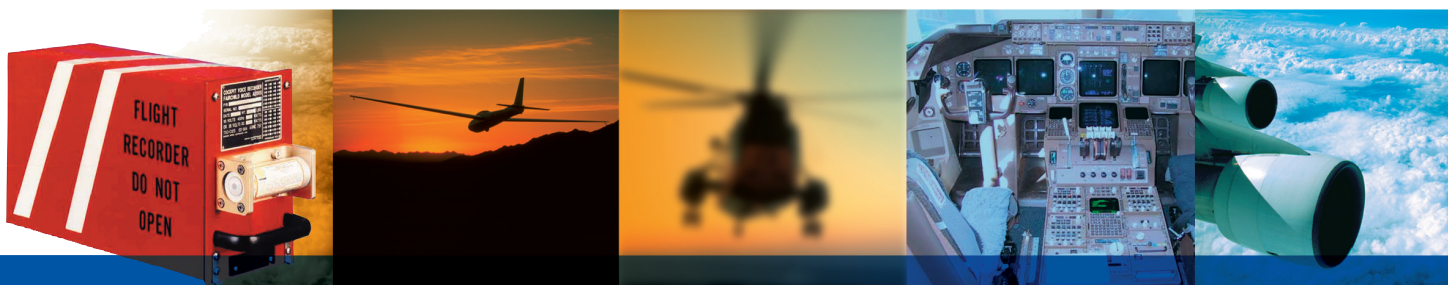




Air Accident Investigation Unit Ireland

INCIDENT REPORT
Boeing 737-8AS, EI-ENB
Kerry Airport (EIKY), Co. Kerry, Ireland
21 December 2010



**An Roinn Iompair
Turasóireachta agus Spóirt**

Department of Transport,
Tourism and Sport

AAIU Report No: 2012-004

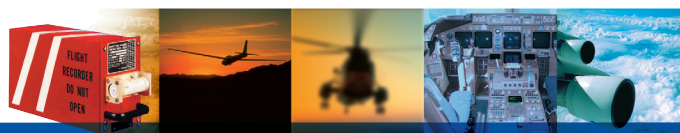
State File No: IRL00910128

Published: 29/02/2012 In accordance with the provisions of SI 460 of 2009, the Chief Inspector of Air Accidents, on 22 December 2010, appointed Paddy Judge as the Investigator-in-Charge to carry out a Field Investigation into this 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:	Boeing 737-8AS, EI-ENB
No. and Type of Engines:	2 x CFM56-7B
Aircraft Serial Number:	40289
Year of Manufacture:	2010
Date and Time (UTC):	21 December 2010 @ 09.13 hrs
Location:	Kerry Airport (EIKY), Co. Kerry, Ireland
Type of Flight:	Public Transport, Scheduled
Persons on Board:	Crew - 7 Passengers - 170
Injuries:	Crew - Nil Passengers - Nil
Nature of Damage:	None
Commander's Licence:	JAA ATPL(A) ¹
Commander's Details:	Male, aged 47 years
Commander's Flying Experience:	13,000 hours, of which 6,100 were on type
Notification Source:	ATC Duty Manager Shannon
Information Source:	AAIU Field Investigation AAIU Report Form submitted by Commander

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1 Joint Aviation Authorities Air Transport Pilot Licence (Aeroplane)



SYNOPSIS

Shortly after landing, smoke was observed in both the cockpit and cabin. The aircraft was stopped, the engines were shut down and an evacuation was carried out. No technical defect was found during the subsequent examination. It is probable that the smoke was caused by the engines ingesting granular urea, which had been used to de-ice the runway during a very cold weather period.

NOTIFICATION

The Air Accident Investigation Unit (AAIU) was first informed of the occurrence by the Air Traffic Control (ATC) Station Manager at Shannon. An AAIU Response Team of two Inspectors dispatched by rail in moderate snow to EIKY and arrived at 18.30 hrs.

1 FACTUAL INFORMATION

1.1 History of the Flight

The flight departed from Stansted Airport (EGSS) in the U.K. and flew directly to EIKY. The cockpit crew consisted of a Commander, who was an instructor pilot, a newly qualified First Officer (FO), who was making his first landing with passengers on board and a Safety Pilot (SP) occupying the jump seat. The FO was the Pilot Flying (PF) and the Commander was the Pilot Non-Flying (PNF).

The weather conditions were good for the approach and the runway surface was reported dry. The descent, approach and landing were reported normal. After landing reverse thrust was selected. As the aircraft decelerated the SP reported smoke on the right hand side of the cockpit. The aircraft was turned off the runway and brought to a halt on the taxiway adjacent to the ramp. Shortly afterwards the Cabin Services Supervisor (CSS) also reported smoke in the cabin.

The engines were shut down and an evacuation was immediately commenced following which the passengers walked to the airport terminal building, a short distance away.

1.2 Commander

The Commander reported that after an uneventful landing by the FO on Runway (RWY) 26 he took control of the aircraft at about 60 kts, as per normal procedure. At about 50 kts the SP reported smoke on the right hand side of the cockpit. This was followed by a call from the CSS that there was smoke in the cabin. At the time the aircraft was turning off the runway onto the taxiway.

He reported that the smoke continued to thicken on the flight deck and he told the FO to don his oxygen mask as the smoke was dense on the right hand side of the cockpit. On hearing the call from the cabin he asked the SP to answer it and to open the cockpit door to view the cabin. He stated that he was unable to see the back of the cabin clearly due to "*grey/blue slightly acrid smoke*". Based on this assessment he decided to immediately evacuate the aircraft, this being the safest option. He then shut down the engines and carried out the evacuation procedures.

1.3 Safety Pilot (SP)

The SP stated that ATC had reported that the runway was dry for landing. The landing, which was conducted with flaps at 40 and auto-brake setting at 3, was smooth and normal reverse thrust was used.

During the landing roll he saw blue/violet smoke on the right hand side of the flight deck, which he reported. The smoke or mist was acrid and affected the back of his throat.

He answered a call from the CSS who told him that there was smoke in the cabin. When the aircraft had stopped he opened the door and looked back down the cabin. He stated that he could see about half-way down the cabin.

He made a "PAN²" transmission to ATC and said that the Fire Services reacted very promptly to this call. He stated that the Auxiliary Power Unit (APU) was not started after shutdown.

1.4 Cabin Services Supervisor (CSS)

The CSS reported that when he observed vapour like steam all over the cabin after landing he called the cockpit. He said that the vapour appeared very dense in the flight deck when the cockpit door was opened and that it seemed to be getting denser in the cabin at the time.

He said that he had never seen this amount of vapour in the cabin before but that he had heard that an incident of a similar nature had happened to a company aircraft some weeks previously, which he believed might have been due to de-icing fluid. He had tried to communicate this to the SP who answered his call from the cockpit.

Following the Commander's order to evacuate, which was given over the public address (PA) system, he and the crew immediately commenced an evacuation using all exits.

He stated that during the evacuation all four door slides were used as well as three of the four over-wing exits and that the evacuation was completed in about 30 seconds. The CSS reported that a passenger had been unable to open one over-wing exit, which was therefore unused. However, it was subsequently found to be serviceable when checked. The over-wing exits were not manned by the cabin crew but a passenger close to each had been earlier briefed on how to open it.

He reported that it was very difficult to deal with those passengers who brought carry-on baggage with them during the evacuation, even though they had been told not to bring anything. He said that it was not possible to remove hand baggage from individuals during the evacuation without disrupting the evacuation flow and reducing the rate of egress of passengers. He stated that crowd control outside the aircraft was difficult, even though he used a loud hailer.

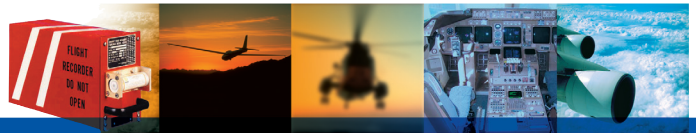
1.5 Injuries to Persons

No injuries were reported to the Investigation.

1.6 Damage to Aircraft

The aircraft was not damaged.

2 **PAN:** When a "PAN-PAN" radio transmission is repeated three times it indicates that an urgent message about the safety of the aircraft is being transmitted.



1.7 Licences

The Commander's licence was a Joint Aviation Authorities (JAA) Airline Transport Pilot Licence (ATPL), issued by the Civil Aviation Authority (CAA) UK.

His licence, type rating and Class One medical certificate were valid. He had a total of 13,000 flying hours of which 6,100 hours were on the B737-800 type.

The SP held a JAA ATPL licence, issued by the Irish Aviation Authority (IAA). His licence, type rating and Class One medical certificate were valid. He had a total of 2,600 flying hours of which 2,300 hours were on the B737-800 type.

The FO held a JAA Commercial Pilot Licence (CPL), issued by the IAA. His licence, type rating and Class One medical certificate were valid. He had a total of 322 flying hours of which 2.5 hours were on the B737-800 type.

The training record for each cabin crew member was found to be current.

1.8 Hand Baggage

Airport security cameras recorded that the first Fire Service appliance arrived at the aircraft 22 seconds after the aircraft came to a halt. One minute and five seconds later the port doors opened, the slides inflated and passengers immediately began to leave the aircraft. The security cameras (**Photo No. 1**) recorded that a significant number of the passengers carried hand baggage as they walked towards the airport terminal building.



Photo No. 1: Passengers after emergency evacuation.

The International Civil Aviation Organisation (ICAO) Training Manual, Document 7192, Part D-3 contains procedures regarding carry-on/hand baggage. However, the National Transportation Safety Board (NTSB) of the United States, in a Safety Study³ of 46 emergency evacuations published in 2000, identified that nearly 50 per cent of passengers who brought carry-on luggage on board attempted to remove a bag during emergency evacuations. Reports issued by other investigative authorities on other evacuations have found that some passengers have resisted the removal of carry-on baggage by cabin crew, thereby disrupting orderly evacuation.

1.9 Weather

The weather report for EI-KY at the time of the incident was that the wind was calm; the visibility was in excess of 10 km. There was some cloud at 3,000 ft with a temperature of -9° C and a dew point of -11° C.

The month of December 2010 in Ireland, during which the incident occurred, was the coldest since weather records commenced, consequently the normal supplies of runway de-icing fluid had been exhausted.

The Airport informed the Investigation that although snow had been expected during the early morning period this had not occurred.

1.10 Site Inspection

The aircraft was inspected and no defect or technical anomaly was found which could explain the presence of smoke during the landing roll.

The runway and taxiway were inspected by the Investigation the following morning. These had been swept clear of snow, which had been removed to the sides of the runway. The centre section of the runway was bare and clear but found to be lightly covered by significant amounts of granular urea that had been spread on the runway by a mechanical spreader.

1.11 Runway Anti-Icing Agents

1.11.1 General

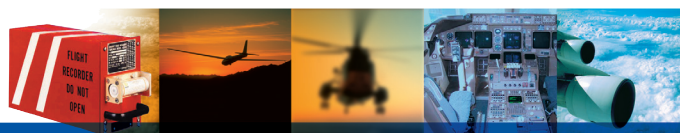
Older runway de-icing/anti-icing methods, such as the application of urea or glycol, are no longer used as they have been replaced by more modern methods that are more environmentally friendly in the main. In addition, chloride salts, commonly used on roads etc., cannot be used where aircraft move due to their corrosive effect on aircraft structures and systems.

1.11.2 Urea

Urea granules are colourless, odourless and have a melting point of 132.7°C. A sample of the granular urea used on the runway was obtained, which was heated using hot air. It initially melted to a clear liquid that subsequently boiled with an acrid and pungent smell (ammonia is released on contact with the water vapour in the air). A grey hue was observed in the air and a powdery residue remained after the liquid had evaporated.

When urea is used as an anti-ice formation agent, precipitation (snow or rain) falling on the urea dissolves it. The resulting mixture has a lower freezing point. Though effective down to -9.5 °C it is of limited use at temperatures below -4°C.

3 NTSB/SS-00/01, titled *Emergency Evacuation of Commercial Airplanes*



1.12 Cockpit Voice Recorder (CVR)

The CVR was downloaded and was found to be of good quality, but it was difficult to decipher due to the sound of breathing subsequent to the FO donning his oxygen mask. The CVR confirmed the accuracy of the flight and cabin crew's recollections. However, it terminated while the engines were spooling down and did not record the subsequent evacuation order, PA announcements or the conduct of associated procedures.

The CVR electrical power source on this aircraft is from the 115V AC Transfer Bus No. 2. This Bus is de-energised when the engines are shut down unless the Auxiliary Power Unit (APU) is running with its generator on line or external power has been connected; in such cases the CVR will then run for an additional 5 minutes.

If neither external nor APU electrical power is available, the CVR ceases recording when the electrical power supply from the engines is lost during shutdown.

1.13 AAIB Safety Recommendation (SR) 2005-075

Following an investigation into an incident involving a United Kingdom registered aircraft in 2005 the UK Air Accident Investigation Branch (AAIB) issued Safety Recommendation No. 2005-075, which stated:

For newly manufactured aircraft, the Joint Airworthiness Authorities should require that the cockpit voice recorder and cockpit area microphone are provided with an independent 10 minute back-up power source, to which the cockpit voice recorder and cockpit area microphone are switched automatically, in the event that normal power is interrupted.

1.14 CVR Power Supply

The Investigation notes that, in response to AAIB SR 2005-075, the European Aviation Safety Authority (EASA) current Rulemaking Programme for 2012-2015, Task No. RMT.0268 proposes a revision of FDR and CVR certification specifications. However, no timing or work method for this Task is scheduled in the Programme.

The Investigation notes that the Federal Aviation Administration (FAA) 2010 Rule Option requires that CVRs of new B737 aircraft must have Option 2371B628B41 CVR Power – RIPS4, which provides for an independent power supply to power the CVR for an additional 10 minutes in the event that normal power is lost or interrupted. However this option is only mandatory for aircraft registered in the United States. There is no equivalent ruling in the European Union.

On 31 January 2011 the International Civil Aviation Organisation (ICAO) issued State Letters proposing that Annex 6 Part 1, (Commercial Air Transport – Aeroplanes), Section 6.3.4.1, incorporates a provision that an alternate CVR power supply engages for 10 minutes when normal power to the CVR is lost, whether by engines shutdown or by any other loss of power. This proposal would become mandatory for aircraft over 27,000 kgs for which the application for type certification is submitted on or after the 1 January 2018.

1.15 Previous Incident

A similar incident had occurred on one of the Operator's flights to Girona (Spain) three weeks previously. The pilot subsequently reported that during the landing roll blue smoke appeared in the flight deck accompanied by smoke in the cabin. A "PAN" call was made, but as the distance to the airport terminal was short the aircraft was taxied towards the stand. The smoke cleared and did not return.

When the aircraft arrived on stand the engines were shut down and the passengers disembarked normally. Following this the subsequent engineering investigation found no cause for the incident and the aircraft was released back to service. It operated thereafter normally with no further report of smoke.

1.16 De-icing and Anti-icing

IAA guidance on movement area de-icing/anti-icing to airport operators is provided in ALM 002 of which Section 7.3.12 refers to ICAO Airport Services Manual, Part 2 (Doc 9137). Chapter 7.1.1 of this document addresses the issues of snow and ice removal from the movement area and states:

It is impossible to decide, in advance, on the measures that should be adopted in order to improve the friction coefficient (μ value) on a movement area where ice, snow, slush, water and other contaminants result in impaired friction characteristics since, at a particular airport, the meteorological conditions can lead to a number of different situations demanding entirely different countermeasures.

In general liquid potassium acetate (KAc) is used at Irish Airports as an anti-icing agent. This can also be spread in conjunction with urea (hopper spread beforehand), in which case KAc dissolves the urea granules. Since supplies of KAc were exhausted by the time of the incident urea was used on its own.

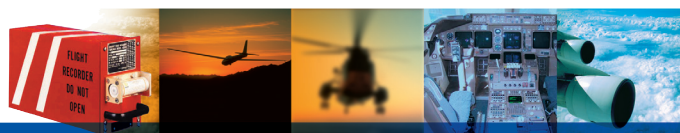
The IAA subsequently informed the Investigation that airports have increased their stocks of KAc to ensure they will have sufficient stock and it is not anticipated that urea will be used with any level of frequency.

2. ANALYSIS

2.1 General

The technical examination of the aircraft by the Investigation found no fault in the aircraft or its systems. The aircraft was later released to service and thereafter operated normally.

At the time of the incident the weather in Ireland had been unseasonably cold for the previous month. Because of this, the supplies of runway de-icing fluid had been exhausted at EIKY and, if airport operations were to continue, granular urea was one of the few alternatives available. This was spread on the runway as an anti-icing measure in order to allow continued safe operation of flights from the runway. In this case, although some snow had been expected, none had fallen and consequently the urea had not dissolved and significant amounts remained in granular form on the centre of the runway, which was bare and clear of snow.



After landing, the engines spooled up due to reverse thrust being selected, as per normal procedures. It is probable that the urea on the runway was then ingested into the engines and rapidly heated to a high temperature by engine compression before being dispensed by the air conditioning system throughout the flight deck and cabin.

This would have resulted in the acrid smoke observed in both the cockpit and cabin.

2.2 Evacuation Order

When smoke was reported in the cockpit, the aircraft was decelerating and approaching a short taxiway that led to the ramp. CCTV recorded the aircraft coming to a stop on the ramp and later the doors opening and the evacuation commencing. It is unclear at what point the order was made to evacuate the aircraft as the CVR recording stopped during engine shut down.

Although the SCM mentioned a previous incident to the SP, who answered his call, this information was not conveyed to the Commander. In any case, as no details of the cause of that incident were available, it is unlikely that it would have been a factor in the Commander's decision making had he been informed, as its relevance was unknown.

Fire in an aircraft is a most serious occurrence and if suspected must be addressed immediately. The first priority is the safety of passengers and crew; if they can be evacuated safely it is critical that this is done as soon as possible. Therefore when faced with acrid smoke in both the cockpit and cabin from an unknown source and possibly a fire, the Commander correctly decided to shut the engines down and order an evacuation.

The Investigation notes that, although a passenger close to each over-wing exit had been earlier briefed on how to open it; one over-wing exit was not opened during the evacuation. Nevertheless the other three exits were opened and, as these over-wing exits were not manned by the cabin crew, the evidence from this and other evacuations supports the importance of briefing passengers at such "self-help exits".

Historically urea was once commonly used as an anti-icing agent on runways and taxiways. Currently, it is rarely used and consequently its fumes and smell are not recognised when flight crew are exposed to its affects for the first time. Consequently, if it is spread on runway or taxiways, pilots should be advised accordingly and a Safety Recommendation is issued in this regard.

2.3 Passenger Hand Baggage

The airport CCTV recorded passengers leaving the aircraft and approaching the terminal building with hand baggage. The SCM reported that some passengers had brought their hand baggage with them during the evacuation even though they had been told not to do so in the evacuation announcement made by the cabin crew.

Passengers who take carry-on baggage off the aircraft during an emergency evacuation impede the evacuation because it restricts the evacuation flow rate, which is critical especially in the event of a fire or the suspicion of one. Furthermore, aircraft emergency slides are not designed to accommodate hand baggage and can therefore be damaged. There is also a significant risk that a passenger with hand baggage can lose balance while descending the slide and consequently suffer injury on contact with the ground. In addition, it delays the evacuee clearing away from the slide after descent. Finally, it negates the certification process that governs aircraft design and safe evacuation procedures.

The reasons given by passengers for taking off carry-on baggage include that valuables such as wallets, passports and keys are in the luggage. Although it can be argued that the four cabin staff could have forcibly taken the carry-on baggage from passengers during the evacuation, this was only possible at the passenger doors, where the cabin crew were located. However, previous investigations have shown that it would have reduced evacuation flow rates as passengers resisted and, bearing in mind the extent of the problem recorded in **Photo No. 1**, it would not have been possible to subsequently store it without blocking the opposite emergency exit. Therefore, it was not possible.

The Investigation believes that the only practical option for cabin crew is to repeatedly and vigorously order passengers not to remove carry-on baggage during the evacuation.

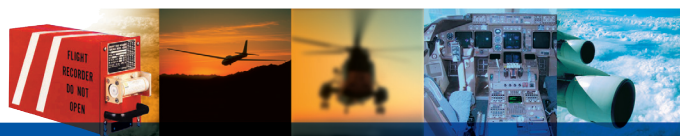
The Investigation is of the opinion that this issue applies to most Commercial Air Transport (CAT) aeroplane operations that have an unplanned emergency evacuation and the NTSB study in 2000 has shown that almost 50% of passengers with carry-on baggage take it with them during an emergency evacuation. The Investigation therefore considers that this issue should be examined by the international civil aviation community in order to prevent loss of life during a future emergency evacuation where speed of evacuation is essential. Although the ICAO Training Manual, Document 7192, Part D-3 indicates training requirements regarding carry-on/hand baggage, this is in the context of general operations. The Investigation is of the opinion that guidance regarding emergency procedures should also be given and consequently a Safety Recommendation is issued to the International Civil Aviation Organisation (ICAO) in this regard.

2.4 Cockpit Voice Recorder (CVR) Power Supply

Because the CVR recording stopped during engine shut down it was not possible to clarify what happened subsequently, as the CVR no longer recorded activities in the cockpit due to the failure of the electrical power supply from the engines. The Investigation notes that in 2010 the FAA introduced a requirement that a CVR should continue to record in the event of normal power failure for new aircraft registered in the United States. However, there is no such requirement for aircraft registered in the European Union.

The Investigation notes that, in response to a UK Air Accident Investigation Branch (AAIB) SR No. 2005-075 regarding CVR power supply, a task was allocated in EASA's current Rulemaking program but no time constraint or urgency is identified for this future work.

This Investigation believes this issue should be addressed and makes a Safety Recommendation to EASA accordingly.



3 CONCLUSIONS

(a) Findings

1. During deceleration following a normal landing, acrid smoke was observed in the cockpit and cabin.
2. The source of the smoke was not identified.
3. The aircraft was stopped on the ramp and the engines were shut down.
4. An emergency evacuation was successfully conducted.
5. Deposits of granular urea, which had been used as an anti-ice precaution, were found on the runway.
6. The flight crew had not been advised that urea was being used as an anti-icing agent.
7. The CVR recording ceased while the engines were shutting down.
8. Passengers took carry-on baggage off the aircraft during the emergency evacuation.

(b) Probable Cause

Ingestion of granular urea while using reverse thrust.

(c) Contributory Factor(s)

A prolonged spell of cold weather resulted in granular urea being used to anti-ice the runway after normal de-icing fluid stocks had been exhausted.

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4. SAFETY RECOMMENDATIONS

It is recommended that:

1. The Irish Aviation Authority should require airport operators to advise pilots, via NOTAM, ATIS or VHF transmission, when urea is being used as an anti-icing agent on runways or taxiways. **IRLD201202**
2. European Aviation Safety Agency (EASA) should introduce a requirement that the CVR should continue to record in the event of power failure. **IRLD201203**
3. The International Civil Aviation Organisation (ICAO) should examine the issue of passengers taking off carry-on baggage during an emergency evacuation and provide guidance for cabin crew in such situations. **IRLD201204**

-END-

**In accordance with Annex 13 to the International Civil Aviation Organisation Convention, Regulation (EU) No 996/2010, and Statutory Instrument No. 460 of 2009, Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulation, 2009, the sole purpose of these investigations is to prevent aviation accidents and serious incidents.
It is not the purpose of any such accident investigation and the associated investigation report to apportion blame or liability.**

A safety recommendation shall in no case create a presumption of blame or liability for an occurrence.

Produced by the Air Accident Investigation Unit

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**An Roinn Iompair
Turasóireachta agus Spóirt**

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