Air Accident Investigation Unit Ireland

SYNOPTIC REPORT

SERIOUS INCIDENT
Airbus, A320-214, EI-GAL
Cork Airport

2 November 2017

An Roinn Iompair
Turasóireachta agus Spóirt
Department of Transport,
Tourism and Sport

Foreword

This safety investigation is exclusively of a technical nature and the Final Report reflects the determination of the AAIU regarding the circumstances of this occurrence and its probable causes.

In accordance with the provisions of Annex 13[1] to the Convention on International Civil Aviation, Regulation (EU) No 996/2010[2] and Statutory Instrument No. 460 of 2009[3], safety investigations are in no case concerned with apportioning blame or liability. They are independent of, separate from and without prejudice to any judicial or administrative proceedings to apportion blame or liability. The sole objective of this safety investigation and Final Report is the prevention of accidents and incidents.

Accordingly, it is inappropriate that AAIU Reports should be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

Extracts from this Report may be published providing that the source is acknowledged, the material is accurately reproduced and that it is not used in a derogatory or misleading context.

[1] **Annex 13**: International Civil Aviation Organization (ICAO), Annex 13, Aircraft Accident and Incident Investigation.
[2] **Regulation (EU) No 996/2010** of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.
[3] **Statutory Instrument (SI) No. 460 of 2009**: Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009.

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In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No 996/2010 and the provisions of SI No. 460 of 2009, the Chief Inspector of Air Accidents on 2 November 2017 appointed Paul Farrell as the Investigator-in-Charge, assisted by Kate Fitzgerald, Inspectors of Air Accidents, to carry out an Investigation into this Serious Incident and prepare a Report.

Aircraft Type and Registration:	Airbus, A320-214, EI-GAL	
No. and Type of Engines:	2 x CFM56 – 5B4/3	
Aircraft Serial Number:	3789	
Year of Manufacture:	2009	
Date and Time (UTC)[4]:	2 November 2017 @ 13.00 hrs	
Location:	Cork Airport (EICK)	
Type of Operation:	Commercial Air Transport	
Persons on Board:	Crew - 6	Passengers - 143
Injuries:	Crew - Nil	Passengers - Nil
Nature of Damage:	Minor	
Commander's Licence:	Airline Transport Pilot Licence (ATPL), Aeroplanes (A)	
Commander's Age:	45 years	
Commander's Flying Experience:	13,581 hours, of which 9,281 were on type	
Notification Source:	Duty Manager at EICK, and the Operator	
Information Source:	Field Investigation AAIU Report Form submitted by the aircraft Commander	

[4] **UTC**: Co-ordinated Universal Time. All timings in this report are quoted in UTC. At the time of the incident UTC and local time were coincident.

SYNOPSIS

Following a diversion due to fumes in the cockpit, the Airbus A320 aircraft landed at Cork Airport (EICK) at 13.00 hrs on 2 November 2017. Emergency services met the aircraft on the runway and after a short assessment, the aircraft taxied to stand. When the aircraft was parked on stand the Commander directed the passengers to disembark the aircraft immediately. The Commander had intended that an expedited disembarkation be performed. However, some of the passengers opened the emergency overwing exits and disembarked using the escape slides[5]. There were no injuries, but a passenger later became unwell and was taken to hospital.

NOTIFICATION

The AAIU was notified by the Duty Manager at EICK, and the Operator.

1. FACTUAL INFORMATION

1.1 History of the Occurrence

1.1.1 Previous flights

On 2 November 2017, the subject aircraft was scheduled to undertake two return flights between EICK and London Heathrow (EGLL). During the first descent of the day into EGLL, the flight crew noticed a burning smell. The Commander switched off the cockpit floor heaters, suspecting that they may be the source of the fumes. The fumes appeared to dissipate and the aircraft continued to EGLL without further incident. On landing, the Commander entered the occurrence into the aircraft's Technical Logbook. In accordance with the aircraft TroubleShooting Manual (TSM), the aircraft Auxiliary Power Unit (APU) ducting, avionics bay and air conditioning were checked by maintenance personnel at EGLL, but no fault was identified. The fumes did not recur during the return flight to EICK.

1.1.2 Occurrence Flight

At 12.34 hrs, the aircraft departed EICK for the second time that day bound for EGLL. On passing Flight Level (FL) 260 the Flight Crew again noticed the fumes, which this time, were strong and persistent. The Flight Crew donned oxygen masks, declared a MAYDAY and decided to return to EICK. During the diversion the Flight Crew carried out the '*SMOKE/FUMES/AVNCS SMOKE*' checklist from the aircraft Quick Reference Handbook (QRH). This checklist involved initial troubleshooting to try to identify the source of the fumes. The Flight Crew were unable to identify the source and moved on to the second part of the checklist which requires them to put the aircraft in an emergency electrical configuration; the Flight Crew de-powered the main aircraft generators and powered the aircraft using an emergency generator known as a RAT[6].

[5] **Escape Slide:** Also commonly known as evacuation slide or emergency evacuation slide.
[6] **RAT:** Ram Air Turbine – a small wind turbine which is deployed from the aircraft fuselage during flight and is used to provide power to aircraft systems in emergency situations.

Whilst the aircraft was in emergency electrical configuration, it had to be flown manually, in this case by the Commander, and the flight directors[7] were not available. The fumes did not dissipate during the descent towards EICK.

In accordance with the QRH checklist, the aircraft generators were switched back on shortly before landing, restoring some of the flight instruments. It was noted by both Pilots that this was not a complete restoration; the Commander still had to fly the aircraft manually and flight directors were not restored. The aircraft landed safely on Runway (RWY) 35 in EICK.

1.1.3 Post Landing Assessment and Disembarkation

On landing in EICK, the flight crew assessed the state of the aircraft, and when they were satisfied that it was safe to continue, they requested permission to taxi off the runway and onto a stand. The airport emergency services were waiting at taxiway 'C'; when the aircraft began to taxi, they entered the runway and followed the aircraft onto the parking stand.

Once on stand, the Commander set the aircraft parking brake and shut down the engines. The Commander and First Officer assessed the situation again and determined that the fumes were still present in the cockpit. The Commander spoke briefly to both the Cabin Crew and apron staff to ensure that they were prepared for the passengers to disembark. He then made an announcement to the passengers to initiate a *'Rapid Disembarkation'* (**Section 1.7.1**). Most of the passengers and crew exited the aircraft using the front and aft steps. However, passengers seated in the emergency exit rows opened the overwing emergency exits and approximately 32 passengers disembarked onto the aircraft wings. Half of these passengers used the escape slides. The other half returned to the passenger cabin and exited the aircraft using the front and rear steps.

1.2 Field Investigation

Two Inspectors of Air Accidents travelled to EICK immediately following the occurrence. At EICK they inspected the aircraft including the avionics bay blower fan. The aircraft Commander, Co-Pilot and Cabin Crew were also interviewed. Three of the aircraft passengers were subsequently interviewed by telephone.

1.3 Injuries to Persons

No injuries were reported to the Investigation. However, one passenger reported feeling unwell and was taken to a local hospital.

1.4 Personnel Information

1.4.1 Aircraft Commander

Personal Details:	Aged 44 years
Licence:	ATPL issued by the IAA
Medical Certificate:	Class 1, issued 9 May 2017
Total all Types:	13,581 hours
Total occurrence Type:	9,281 hours

[7] **Flight Directors:** Flight guidance indicator that is overlaid on the Attitude Indicator and shows the pilot of an aircraft the attitude required to follow a certain flight path.

1.4.2 First Officer

Personal Details:	Aged 37 years
Licence:	ATPL issued by the IAA
Medical Certificate:	Class 1, issued 3 March 2017
Total all Types:	2,862 hours
Total occurrence Type:	926 hours

1.5 Aircraft Information

The aircraft involved in this occurrence was an Airbus A320-214 powered by 2 x CFM56-5B4/3 engines. The aircraft was configured with 174 passenger seats. There were eight emergency exits, which included four overwing exits (two left and two right) located at rows 12 and 13. At the time of the occurrence, the aircraft was operating under a valid Airworthiness Review Certificate (ARC), which was issued by the Irish Aviation Authority (IAA) on the 5 May 2017.

1.5.1 Damage to Aircraft

The hatches from the overwing emergency exits sustained impact damage when they were ejected on to the wings and the ground beneath the aircraft. Following the occurrence, the upper surfaces of the aircraft wings were inspected, but no damage was found.

1.5.2 Avionics Bay Blower Fan

Maintenance personnel in EICK identified the avionics bay blower fan as the source of the fumes. This fan provides cooling air to the avionics bay. **Figure No. 1** shows the location of the blower fan in the avionics bay ventilation system and the route the air takes from the fan through the ventilation system to the forward, underfloor area of the aircraft. Once removed from the aircraft, the fan was examined by an approved maintenance organisation and an investigation report was produced. The report concluded that the root cause of the fan failure was wear of the rear bearing. The report noted that this failure mode was not unusual.

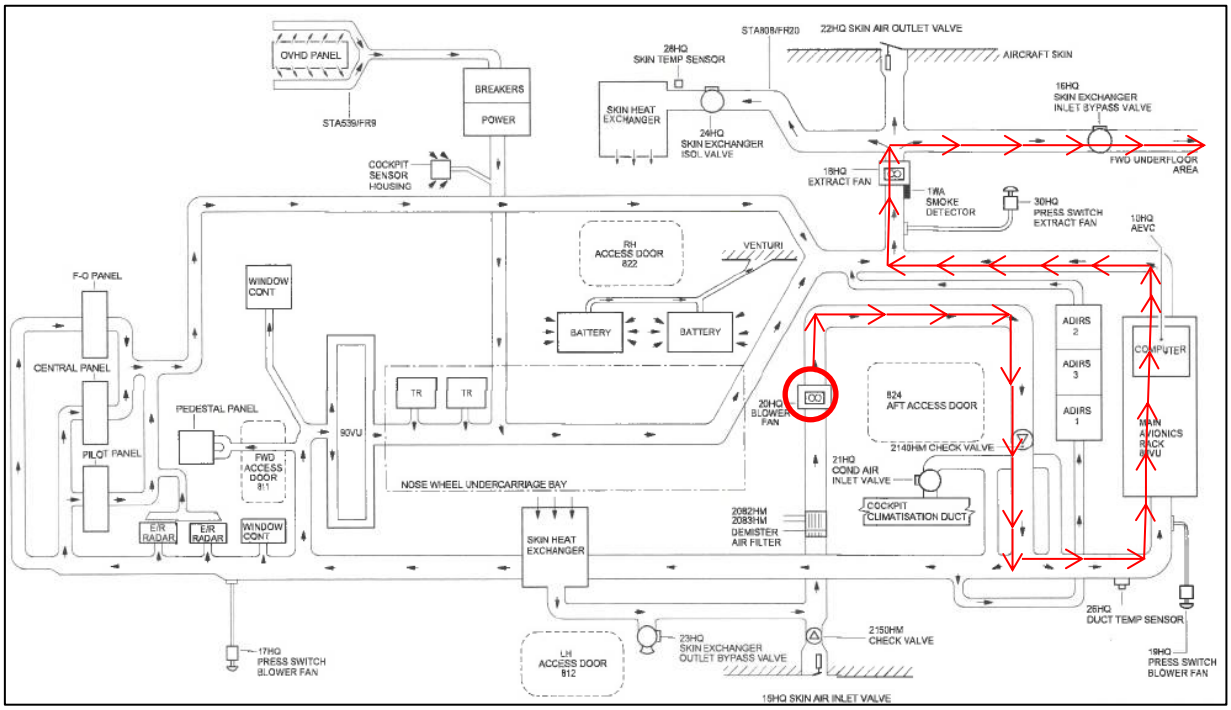

Figure No. 1: Avionics Ventilation System (blower fan circled*) (Airbus A320 Maintenance Manual)*

Historically, the avionics bay blower fan was operated on an '*on-condition*[8]' basis. In June 2005, the aircraft Manufacturer issued Service Information Letter (SIL) 21-141. This SIL informed operators that a new standard of avionics bay blower fan was available. The new standard had ceramic bearings and was expected to have improved service life. The SIL also advised operators of the possibility of a scheduled overhaul task between 8,000 and 12,000 Flight Hours (FH) which could reduce the risk of in-service interruptions. The SIL directed operators to consult the component maintenance manual (CMM) for details of the overhaul task.

In August 2013, the fan manufacturer issued SIL 34554HC-21-520, which informed operators that although the fan met guaranteed reliability rates, there were still between five and ten occurrences per year causing in-flight turn backs or diversions. In order to address this issue, the fan manufacturer had updated the CMM to include a scheduled overhaul task with an advised threshold of 10,000 FH. The aircraft manufacturer did not re-issue SIL 21-141 at this time.

The avionics bay blower fan installed in the occurrence aircraft was of the standard which included ceramic bearings. It had accumulated 15,745 FH since new and 8,636 FH whilst installed on the subject aircraft. At the time of the occurrence the Operator had elected to carry out a fleet-wide maintenance campaign on the avionics bay vent fans. During the campaign all fans of this type in the Operator's fleet would be rotated through the maintenance shop and overhauled. Once overhauled, the fans were to be operated in line with the manufacturer's SIL.

[8] **On-condition:** This means that the component does not have a scheduled maintenance interval. The actual condition of the component is monitored and maintenance is carried out as required.

Further to issuing the SIL, the fan manufacturer has designed a Ball Bearing Health Monitoring (BBHM) system which can be retrofitted to the current avionics bay blower fan and has also developed a new fan design. The BBHM was scheduled to become available to operators in May 2018 and the new fan design is scheduled to be available in 2019. The Aircraft Manufacturer has communicated this information to operators using a 'Technical-Follow-Up' document. They informed the Investigation that they will publish further documentation to operators once the new fan is available.

1.6 Recordings

1.6.1 Cockpit Voice Recorder (CVR)

The aircraft was fitted with a Honeywell solid state CVR. This unit recorded the final 30 minutes of the flight on three channels; the Commander's microphone, the First Officer's microphone and a Cockpit Area microphone. A review of the CVR by the Investigation showed that during the final 30 minutes of the flight the workload for the flight crew was high. There was no extraneous conversation between the pilots; they were focussed on the tasks of flying the aircraft, troubleshooting the problem and ensuring that the Cabin Crew, the Passengers and Air Traffic Control (ATC) were briefed on the situation.

When the aircraft was parked on stand, the CVR recorded a brief discussion between the Commander, the SCCM (Senior Cabin Crew Member) and ramp staff relating to disembarkation of passengers. The SCCM called the cockpit and asked if they (the Cabin Crew) could open the doors. The Commander responded that they could, and that he intended to make a PA (Public Address) and disembark the passengers. Before the SCCM could open the doors, the Commander asked her to wait for a second. He then had a conversation with ground staff, which confirmed that they could receive the passengers on the ramp.

When this conversation was completed, the Commander gave the Rapid Disembarkation instruction in accordance with the Operator's Standard Operating Procedure (SOP), "*Attention, attention, this is the Captain. Disembark the aircraft immediately, disembark the aircraft immediately."* This instruction was followed by a further direction from the SCCM; "*Ladies and gentleman, please leave all cabin baggage behind you and make your way to the nearest exit, thank you."* The passengers began to disembark with some passengers choosing to use the overwing emergency exits. When the Cabin Crew realised that the overwing exits had been opened, a second announcement was made by the SCCM; *"Ladies and gentleman, please remain calm and please exit the aircraft through the back doors and the forward doors."* Both of the SCCM's announcements were in accordance with the Operator's SOP which states that, *"Additional PA announcements can be made by the SCCM to encourage passengers to disembark quickly if required".*

1.6.2 Flight Data Recorder (FDR)

The aircraft was fitted with a Honeywell solid state FDR. In normal flight, this records 25 hours of data on a continuous loop. The FDR was operational during the occurrence flight, but did not record data for the complete flight due to the fact that it was not powered when the aircraft was in emergency electrical configuration. The Investigation confirmed that the data for the occurrence flight shows that the emergency electrical configuration was activated during the flight and that the aircraft generators were restored for the approach and landing.

Following the occurrence, the Co-pilot informed the Investigation that the flight director bars were not restored when the original electrical configuration was reinstated. The Investigation confirmed that this was reflected in the FDR data and requested an explanation from the aircraft Manufacturer. The aircraft Manufacturer stated that when emergency electrical configuration is active, Inertial Referencing System (IRS) No. 2 and No. 3 are de-powered. When the original configuration is restored IRS No. 2 and No. 3 are re-powered, but they do not provide any data to the Flight Management and Guidance Computer (FMGC). The FMGC cannot compute a guidance control law from IRS No. 1 alone. This results in Autopilot (AP) 1 and 2, Flight Director (FD) 1 and 2 and Autothrust (ATHR) remaining inoperative.

When the FDs are inoperative red flags are displayed on both Primary Flight Displays. The inoperative status of AP 1 and 2 and ATHR is displayed in the cockpit on the Electronic Centralised Aircraft Monitor (ECAM) status page for five minutes after the emergency electrical configuration is selected and for five minutes after the original electrical configuration is restored.

1.6.2.1 Flight Data Recorder - Alternate Power Source (FDR-APS)

Current European Aviation Safety Agency (EASA) regulations do not require FDRs to be powered when the aircraft is in emergency electrical configuration. Therefore, there will be occasions when data relating to an accident or serious incident is lost. This is a known issue and has been the subject of several safety recommendations to relevant authorities.

There are two industry working groups, FLIRECSWG[9] and EFRPG[10], dedicated to flight recorders, and each of these groups are developing position papers on the topic of FDR-APS for the International Civil Aviation Organization (ICAO) and EASA. A number of design challenges are associated with installing an FDR-APS to an aircraft. The FDR has larger power requirements than the CVR, as a data acquisition unit and dedicated sensors must be powered in addition to the recorder itself. Therefore, power to most of these components must also be protected. The power required is greater than the power that can be delivered by currently available RIPS[11] systems, which are used to provide back-up power to CVRs. Therefore, additional power supplies would be required.

[9] **FLIRECSWG:** Flight Recorder Specific Working Group.
[10] **EFRPG:** European Flight Recorder Partnership Group.
[11] **RIPS:** Recorder Independent Power Supply.

1.6.3 Closed Circuit Television (CCTV)

The Investigation was provided with CCTV footage of the aircraft landing at EICK, the subsequent taxi to stand and the disembarkation of the passengers. This footage indicates that the passengers could likely see the emergency services waiting for the aircraft at the side of the runway. The emergency services would also have been visible to the passengers when the aircraft was parked on stand. At this time the fire crew took up positions around the aircraft and manned fire hoses.

The CCTV footage shows that when the overwing emergency exits were opened both escape slides deployed and inflated correctly, maintaining inflation levels throughout the disembarkation process. **Photo No. 1** is a screenshot taken from the CCTV footage after all of the passengers had disembarked.

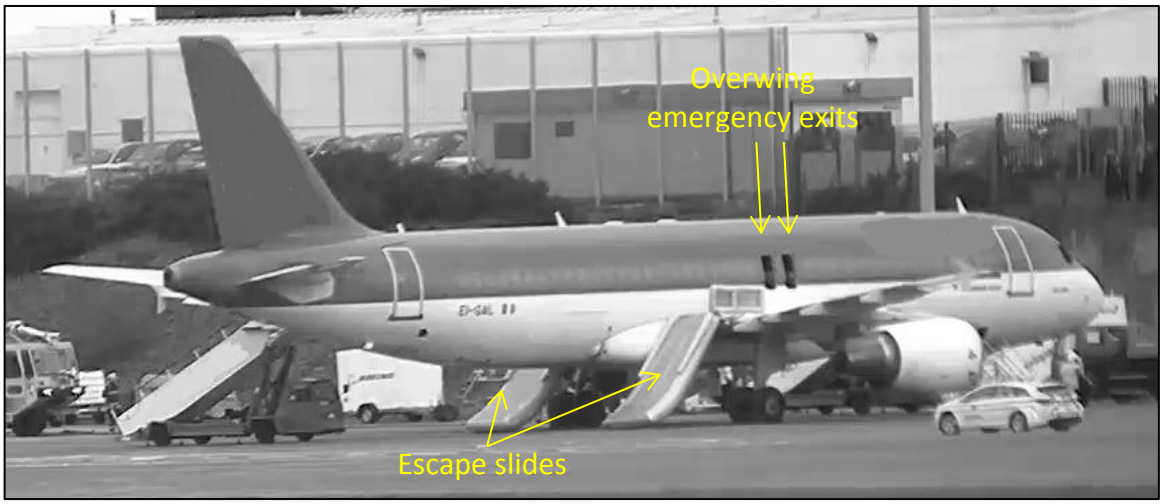

Photo No. 1: EI-GAL following the disembarkation of passengers (Operator's logo removed)

The Investigation used the CCTV footage to determine the sequence of events during the disembarkation of the passengers. **Table 1** below describes the sequence.

Time*	Event	Camera**
13:25:30	Post-landing assessment of aircraft carried out on runway.	3
13:28:37	Aircraft arrived at parking stand number 18.	2
13:28:40	Emergency vehicles arrived at parking stand.	2
13:30:51	Front passenger door opened.	1
13:30:59	First eight passengers disembarked.	1
13:31:08	Starboard side emergency exit doors opened and passengers began to disembark on to the aircraft wing and down escape slide.	2
13:31:11	Rear passenger door opened - passengers commenced disembarkation.	1
13:31:12	Fire fighter entered cabin through front passenger door.	1
13:31:14	Port side, emergency exit doors opened and passengers began to disembark on to the aircraft wing and down the escape slide.	1
13:31:39	Fire fighter exited aircraft through front passenger door.	1
13:32:42	Passengers stood on starboard wing returned to aircraft cabin.	2
13:32:46	Passengers stood on port wing returned to aircraft cabin.	1
13:36:47	Final passenger disembarked with assistance.	1

Table 1: Sequence of events taken from CCTV footage

*The timings in this table were derived from the time stamps of two different CCTV files.

** Camera 1 was mounted in the car park adjacent to Stand 18 and had a view of the port side of the aircraft.

** Camera 2 (from which Photo No. 1 was extracted) was mounted on the top of the airport multi-storey car park and had a view of the starboard side of the aircraft. Camera 3 was mounted on the south side of the airport terminal building and had a view of the runway.

1.7 Disembarkation

1.7.1 Rapid Disembarkation Process

The occurrence aircraft Manufacturer does not specify a '*rapid disembarkation*' procedure in the operations manuals for this aircraft type. It informed the Investigation that the reason for this was that specific operator procedures for both aircraft and ground activities were matters for the Operator to address.

The Rapid Disembarkation procedure used in this occurrence was a Standard Operating Procedure (SOP) developed by the Operator. The process is intended for situations where there is a requirement to expedite disembarkation, but the situation does not require a full emergency evacuation. Possible reasons for a rapid disembarkation include a security threat, smoke in the cabin or a threat of fire. In a rapid disembarkation, passengers are expected to leave luggage behind and exit through the normal exit doors at the front and rear of the aircraft. This is different from an emergency evacuation where the intention is to use ***all*** available exits, including emergency exits and escape slides.

Aviation regulations do not require operators to have a Rapid Disembarkation process. However, it is noted that the International Air Transport Association (IATA), an industry group of which the Operator is a member, recommends a rapid deplaning procedure in their *'Cabin Operations Safety, Best Practices Guide, 3rd Edition'*. The IATA document states that:

'An abnormal situation may arise that has the potential to escalate into an emergency, and where passengers and crew need to deplane immediately and quickly as a precautionary measure. Such situations usually occur while the aircraft is parked at the gate or during taxi.'

Figure No. 1 below shows the procedure that is recommended by IATA. In this procedure, IATA recommends that the *'Command should be different from the evacuation command'*.

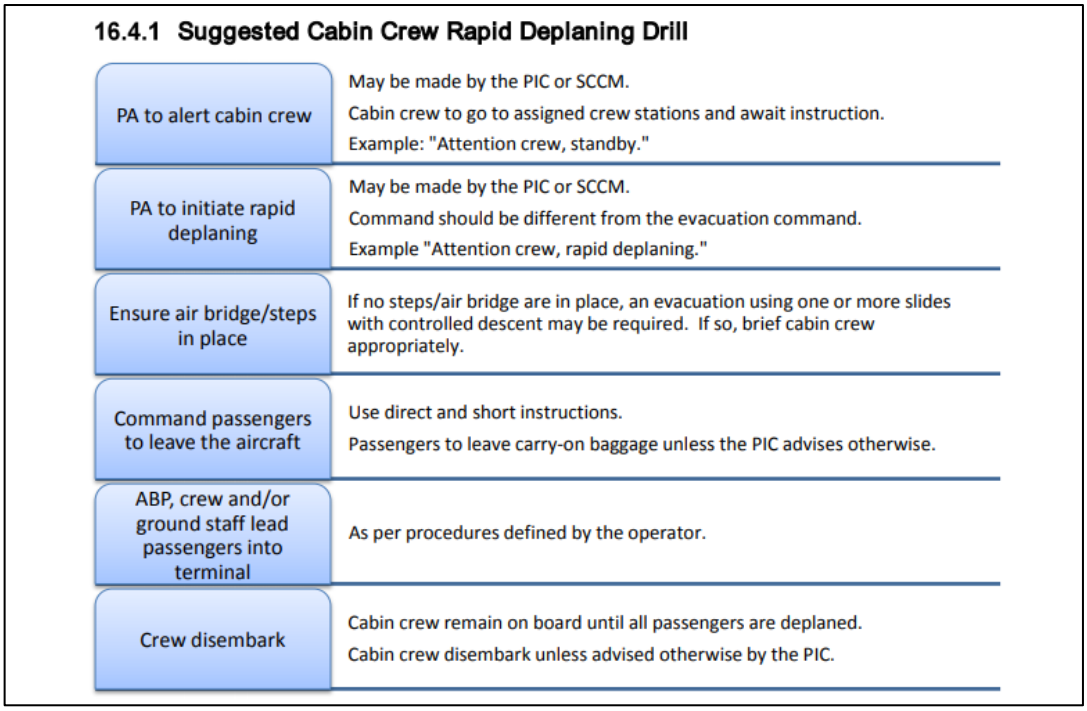

Figure No. 1: IATA Suggested Rapid Deplaning Procedure

The Rapid Disembarkation Procedure had initially been introduced by the occurrence Operator for use by cabin crews. It had recently been expanded to be used by flight crews following an occurrence in the USA, where ground equipment caught fire close to an aircraft when passengers were disembarking. The Operator promulgated the procedure to flight and cabin crews using internal memos known as Crew Instructions, and in recurrent training. Other operators have similar procedures which are designed to be used only when there is no immediate threat to passengers.

In the Operator's SOP, a Commander can initiate a Rapid Disembarkation using the call, "*attention attention this is the Captain, disembark the aircraft immediately*." The SOP also advised crews that, *"Additional PA* [Public Address] *announcements can be made by the SCCM* [Senior Cabin Crew Member] *to encourage passengers to disembark quickly if required."* For comparison, the call that would be used by the Operator in the case of an Emergency Evacuation would be *"Attention attention this is the Captain, evacuate the aircraft immediately."*

During the drafting process of this Final report, the Operator informed the Investigation that it had undertaken a review of its Rapid Disembarkation procedure and were satisfied that the communications specified within the procedure were appropriate for their mixed fleet and operation. The Operator stated that it had also re-examined the Rapid Disembarkation procedure in the context of a deteriorating scenario, i.e. where a Rapid Disembarkation escalates to a full Emergency Evacuation. In order to address this potential escalation, the Operator informed the Investigation that it intended to update the procedure with the following additional instructions:

*'If at anytime the situation deteriorates, an evacuation may be initiated and the **ON GROUND EMERGENCY PROCEDURE/ EVACUATION CHECKLIST** and associated procedures shall be completed.*

In this case when required the following PA shall be made:

"Attention, Attention, this is the Captain, Cabin Crew Re-Arm Doors and Evacuate the Aircraft, use all available exits"'.

The Operator informed the Investigation that it plans to communicate this update to their Flight and Cabin Crews using Flight Crew Instructions (FCI) and Cabin Crew Instructions (CCI).

1.8 Witness Interviews

Following the occurrence, the Flight Crew, Cabin Crew and three passengers provided accounts of the event.

1.8.1 Pilot-in-Command

The Commander informed the Investigation that the fumes in the cockpit initially occurred on the first flight of the day, during descent into EGLL. The fumes lasted no more than one minute and dissipated after the foot warmers in the cockpit were switched off. The aircraft was checked by engineers in LHR, no fault was found and the problem did not recur during the return flight to Cork.

On departure from Cork for the occurrence flight the Commander noticed stronger fumes when the aircraft was passing FL260. The aircraft levelled off at FL270 and the Commander contacted Shannon ATC to inform them that the aircraft may have a problem and to ask ATC to stand by. The Commander then initiated the primary actions for the '*SMOKE/FUMES/AVNCS SMOKE*' checklist, which were memory items. The memory items carried out by the Flight Crew included donning oxygen masks. The Commander also made a MAYDAY call.

The Commander informed the Investigation that he requested a return to Cork which was the nearest airport. Following the MAYDAY call, the Flight Crew continued troubleshooting the problem in accordance with the aircraft QRH. They could not identify the source of the fumes and therefore, in accordance with the QRH checklist put the aircraft into Emergency Electrical Configuration. The Commander informed the Investigation that he also gave the SCCM a NITS[12] briefing and made a PA to the passengers.

The QRH recommends that flight crews restore Generator 2 and Emergency Electrical Generator 1 Line, shortly before landing in order to *'recover normal braking, while minimizing possible reactivation of a smoke source.'* The Commander informed the Investigation that this action was carried out on Base Leg[13]. The Commander noted that although some functionality was restored, he did not regain flight director bars and had to carry out a manual ILS (Instrument Landing System) approach to RWY 35 at EICK.

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[12] **NITS**: An Acronym used for an emergency briefing given by the Flight Crew to the Cabin Crew. N: Nature of the emergency, I: Intentions of the Commander, T: Time remaining to landing, S: Special Instructions, if any.

[13] **Base Leg:** The Base Leg is the section of a flight path before an aircraft turns 90 degrees on to final approach for the runway.

Once the aircraft had landed, the Commander brought it to a halt on the runway and made an announcement to the cabin requesting that everyone stay in their seats. The Commander informed the Investigation that he and the First Officer briefly removed their oxygen masks, but as the fumes were still present in the cockpit, they put the masks back on and opened the cockpit windows to try to dissipate the fumes. They carried out a brief assessment of the situation, and as there were no fumes in the passenger cabin, or any signs of fire on the aircraft, were cleared to taxi to stand.

The Commander stated that when the aircraft was on stand the fumes were still present and he therefore decided to disembark the passengers quickly, but not using the escape slides. The Commander gave the 'Rapid Disembarkation' command on the PA system and the passengers began to disembark.

The Commander noted that the emergency services were not aware of the presence of a Passenger with Reduced Mobility (PRM) on board the aircraft until a late stage in the occurrence.

1.8.2 First Officer

In addition to the flight details given by the Commander, the First Officer noted that:

He (the First Officer) was the Pilot Flying for the occurrence flight, but that once the aircraft was in emergency electrical configuration the Commander took over the flying role. This is standard procedure as the emergency electrical configuration results in many of the First Officer's instrument displays being de-powered.

After the MAYDAY call there were continued communications on the same frequency by ATC to other traffic in the area. The First Officer had assumed that after the MAYDAY call the frequency would have been reserved for their use so that they could have undisturbed communications with ATC.

When the Flight Crew returned the aircraft to the original electrical configuration, he did not get back all of the flight instruments he expected and that neither he, nor the Commander had operational flight director bars.

1.8.3 Cabin Crew

The Cabin Crew informed the Investigation that approximately 15 minutes prior to landing on the first flight of the day [to EGLL] the Commander had called the SCCM and asked if there were any fumes in the cabin. The SCCM reported that she could not smell anything at the front of the cabin and checked with the rest of the cabin crew that there were no smells at the back of the cabin.

During the occurrence flight a passenger in Row 29 reported a smell just as the *"cabin secure"* check was being made shortly before take-off. The SCCM called the Commander to report this and described it as being like fuel. The Commander suggested to the SCCM that the wind direction on the day could have led to external fumes being ingested into the air conditioning system.

Approximately 15 minutes after take-off, the Commander called the SCCM to enquire about fumes, and was informed that at that time there were no fumes in the cabin. The Commander said that they were getting fumes in the cockpit and that he would call back shortly to give the Cabin Crew a NITS brief. The SCCM then noticed a "*movement*" under her feet and what she described as a "*surge*" in power which seemed to cause the cabin lights to dim. The SCCM had been trying to call the rear cabin crew when this occurred but found that the interphone on the PA system would not work. At around the same time, the Cabin Crew in the #2 position noticed a strong, chemical smell as she walked forward past row 29 and this extended to the front of the aircraft. The SCCM then made a second attempt to call the rear cabin crew and this time the interphone worked.

After the Commander had given the Cabin Crew a NITS briefing, he made a PA to passengers to inform them that the aircraft had a technical problem and would be returning to Cork. The Cabin Crew informed the Investigation that a passenger in row 29 asked for more information about the problem as he could hear that the Commander was using an oxygen mask.

The Cabin Crew informed the Investigation that the landing was normal, the aircraft stopped on the runway and the Commander made a standard '*Remain in your seats'* call. The aircraft taxied on to stand, but the SCCM noted that neither the cabin lights nor the Flight Attendant Panel (FAP) were working. This meant that the SCCM had to contact the cockpit to confirm that certain checks could be carried out. The SCCM also noted that the seat belt signs at the front of the cabin were not working during the landing or taxi. However, the rear cabin crew confirmed that seat belt signs at the back of the aircraft were working. The SCCM also informed the Investigation that during the flight the '*Interphone all'* function was not working on the FAP so when the Commander directed the Cabin Crew to open the doors, the SCCM had to relay the message to the cabin crew at the back of the aircraft.

When the front door was opened, a Fire Officer entered the cabin and as the passengers were disembarking the Fire Officer shouted *'Passengers this way'* down the cabin. The SCCM informed the Fire Officer that there was a PRM confined to their seat and he tried to assist with the disembarkation of this passenger.

During the interview with the Investigation the Cabin Crew members made several observations with regard to the passenger's cues and perception as the situation unfolded. The Cabin Crew noted that;

- When the aircraft was on stand, the fire crew manned hoses around the aircraft and this may have alarmed passengers.
- The PA system sounded louder because the pilots were wearing oxygen masks.
- The cabin was quiet at the time of the rapid disembarkation announcement.
- The Commander gave the 'Rapid Disembarkation' Instruction at the same time as the forward aircraft door was opened.
- A member of the fire service boarded the aircraft soon after the forward aircraft door was opened and began to direct passengers in a loud voice.
- Passengers wouldn't necessarily know the difference between a '*disembark*' and an *'evacuate'* instruction.

1.8.4 Passenger No. 1

Passenger No. 1 was seated in Row 18 which is aft of the overwing emergency exits. The Passenger informed the Investigation that the Pilot was *"excellent"* but that the disembarkation was "*chaotic"*. Passenger No. 1 stated that the emergency lights were not on, that the aircraft became "*stuffy"* and that his wife identified an unusual smell. The Passenger stated that he became trapped, unable to move to the front or the rear of the aircraft. A PRM was in the aisle in the forward part of the aircraft. The PRM was being assisted by a member of the cabin crew but for a time this prevented other passengers from accessing the forward aircraft door. Passenger 1 informed the Investigation that other passengers did not know what to do and some opened the overwing emergency exits. Passenger 1 disembarked through one of these exits and stood on the aircraft wing where two other passengers were assisting people in getting through the emergency exit. Passenger 1 stated that the escape slide looked almost "*deflated"* and he was instructed by a Fire Officer not to use the slide.

Passenger No. 1 informed the Investigation that the "*evacuation"* procedure was frightening. He stated that adults and children were upset which caused him to feel upset. Passenger No. 1 became unwell shortly after disembarkation and was taken to a local hospital.

1.8.5 Passenger No. 2

Passenger No. 2 was travelling with Passenger No. 1. She stated that they were directed to leave their seats and walk quickly. Passenger No. 2 did not observe any smoke in the cabin and noted that the slide appeared to be substantially deflated.

1.8.6 Passenger No. 3

Passenger No. 3 said he flew very frequently, had previously experienced aircraft emergencies, and was seated in an overwing emergency exit row on the starboard side of the aircraft. Passenger No. 3 stated that the boarding and early parts of the flight were normal and that he had been briefed in the use of the overwing emergency exit prior to take-off. Approximately 15-20 minutes into the flight he noticed the aircraft banking steeply. The Commander then announced that the aircraft was returning to Cork and Passenger No. 3 was aware from the sound of his voice that the Captain was speaking through an oxygen mask. Following this, Passenger No. 3 noticed a sharp drop in altitude and the aircraft banked. He stated that some passengers were alarmed by this.

Passenger No. 3 stated that the landing was normal. He could see the emergency services waiting on the airfield but when the aircraft reached the parking stand passengers were preparing to disembark normally. It was at this point that the Commander gave the instruction to disembark immediately and this heightened the tension in the cabin. A passenger seated in the row in front of Passenger No. 3 opened the emergency exit. Passenger No. 3 then felt obliged to do the same and opened an emergency exit next to his seat. He exited the aircraft and disembarked using the escape slide.

1.9 Emergency Services Response

When the Commander of the aircraft declared a MAYDAY and stated his intention to return to EICK, the Emergency Services response plan at EICK was activated. The emergency services vehicles took up positions at the side of the runway prior to the aircraft's arrival, monitored the aircraft when it was on the runway, followed the aircraft to stand, prepared to respond to a fire on the stand, and assisted passengers during disembarkation.

1.10 Electrical Problems during Landing and Taxi

Following the occurrence, the Operator investigated the electrical problems experienced by the Cabin Crew during the landing and taxi. Engineers were unable to replicate the problems experienced and confirmed that the cabin electrical system was operating as expected. The Operator informed the Investigation, from in-service experience, that temporary electrical issues can occur following an interruption to the aircraft's power supply and these are generally resolved when the relevant circuit breaker is reset.

1.11 Crew Training for Smoke / Fume Events

The Operator informed the Investigation that cabin crew are trained to deal with smoke / fume events as part of their recurrent training programme. This is accomplished by carrying out practical exercises in the Operator's cabin simulator. The Operator informed the Investigation that at the time of this occurrence the practical exercises also included simulating failures in cabin lighting. Since the occurrence, the Operator reviewed the capability of the cabin simulator and plans to upgrade it to simulate problems with the Cabin Intercommunication Data System (CIDS). The CIDS controls and displays cabin functions including cabin lighting, cockpit/cabin announcements, door status indications, emergency signals, cabin signs, smoke detectors, cabin temperature, water/waste tank capacity. This upgrade will allow the Operator to simulate intercommunication issues of the type that were experienced by the Cabin Crew in this occurrence.

The Operator also re-ran the scenario in an aircraft cockpit simulator with the occurrence Pilots. The Operator informed the Investigation that the Pilots noted some minor differences between the simulator and their 'real-life' experience, which they intend to address during flight crew training.

1.12 Use of Aircraft Escape Slides

Aircraft escape slides are intended to facilitate a high flow of passengers off an aircraft during an emergency evacuation. The EASA Certification Specification for Large Aeroplanes 25.803 requires aircraft manufacturers to demonstrate the ability to evacuate an aircraft in 90 seconds with half of the emergency exits unavailable.

In 2008, the US Airport Cooperative Research Program carried out an FAA-sponsored study, which evaluated the injuries caused by aircraft slide evacuations[14]. The study analysed occurrences on commercial aircraft between January 1996 and June 2006 where passengers were evacuated using escape slides. Of 142 analysed events, there were 441 minor[15] injuries and 35 serious[16] injuries during slide evacuation.

1.13 Regulation of Operators in EU member states

The EU civil aviation regulations are adopted by the EU Commission. Individual member states are responsible for auditing compliance with the regulations by operators within their own particular state. EASA informed the Investigation that it assists the EU Commission by monitoring the application of the Regulation, and of any delegated and implementing acts by the member states. The aim of the monitoring activities is to assist the member states in ensuring a uniform application of the Regulations and to share best practice.

1.13.1 Regulations relating to Passenger Safety Briefings

Commission Regulation (EU) No 965/2012 (Air operations) states:

'CAT.OP.MPA.170 Passenger briefing

The operator shall ensure that passengers are:

(a) given briefings and demonstrations relating to safety in a form that facilitates the application of the procedures applicable in the event of an emergency; and

(b) provided with a safety briefing card on which picture-type instructions indicate the operation of emergency equipment and exits likely to be used by passengers.'

1.13.2 Acceptable Means of Compliance (AMC) & Guidance Material (GM)

EASA issues documents, known as Acceptable Means of Compliance (AMC) & Guidance Material (GM). EASA informed the Investigation that recitals from EASA Executive Director (ED) decisions published in 2019 define AMC & GM as:

*'**Acceptable Means of Compliance** are non-binding standards issued by EASA which may be used by persons and organisations to demonstrate compliance with Regulation xyz and the delegated and implementing acts adopted on the basis thereof.'*

***'Guidance Material** is non-binding material issued by EASA which helps to illustrate the meaning of a requirement or specification and is used to support the interpretation of Regulation xyz, the delegated and implementing acts adopted on the basis thereof, certification specifications and acceptable means of compliance.'*

The AMC & GM to Annex IV Commercial air transport operations (Part CAT) of Commission Regulation (EU) No 965/2012 includes a description of how an operator can comply with CAT.OP.MPA.170. The AMC states that:

[14] Motevalli, V., Monajemi, L., and Rassi, L. (2008), *'Evaluation and Mitigation of Aircraft Slide Evacuation Injuries*', Washington D.C., USA, Airport Cooperative Research Program.
[15] **Minor Injury:** In this study, minor injuries were defined as a sprains, strains, abrasions or contusions.
[16] **Serious injury:** In this study, serious injuries were defined as fractures, lacerations or major bruising.

'AMC1 CAT.OP.MPA.170 Passenger briefing

[...]

(a) Before take-off:

(1) Passengers should be briefed on the following items, if applicable:

(i) any cabin secured aspects, e.g. required position of seatbacks, tray tables, footrests, window blinds, etc. as applicable;
(ii) emergency lighting (floor proximity escape path markings, exit signs);

(iii) correct stowage of hand baggage and the importance of leaving hand baggage behind in case of evacuation;
(iv) the use and stowage of portable electronic devices;
(v) the location and presentation of the safety briefing card, the importance of its contents and the need for passengers to review it prior to take-off; and
(vi) compliance with ordinance signs, prctograms [sic] *or placards, and crew member instructions;*

[...]

(3) Passengers occupying seats with direct access to emergency exits not staffed by cabin crew members should receive an additional briefing on the operation and use of the exit.'

The AMC does not explicitly require an operator to include emergency evacuation commands (or any other expedited disembarkation procedure) in their pre-flight briefing. The Investigation asked EASA to clarify what was intended by *'compliance with ordinance signs, prctograms [sic] or placards, and crew member instructions.'* EASA informed the Investigation that the intended purpose was that crew members should explain to passengers that they must comply with any instructions given by crew members. The specifics of the instructions would depend on the nature of the emergency and associated procedures. This intent is further reinforced in *AMC1 CAT.OP.MPA.170 (e)(1) which states that:*

'(e) Emergency during Flight:

Passengers should be instructed as appropriate to the circumstances. '

However, the GM relating to the briefing of passengers seated in emergency exit rows does explicitly refer to emergency commands as follows:

'GM1 CAT.OP.MPA.170(a) Passenger briefing

BRIEFING OF PASSENGERS OCCUPYING SEATS WITH DIRECT ACCESS TO EMERGENCY EXITS NOT STAFFED BY CABIN CREW MEMBERS

(a) The emergency exit briefing should contain instructions on the operation of the exit, assessment of surrounding conditions for the safe use of the exit, and ***recognition of emergency commands given by the crew****.'* (Bold type added for emphasis).

During the drafting process of this Final Report, the Investigation discussed the purpose of AMC & GM documents with EASA in order to understand how EASA intended them to be used by National Competent Authorities and Operators. During these discussions EASA informed the Investigation that:

- AMC & GM documents are not intended to be prescriptive. This is due to the fact that these documents cannot cover every possible emergency scenario. Instead, the documents are intended to provide a framework to assist the operator in identifying and mitigating the risks associated with emergency scenarios for their own specific fleet and operation. EASA are now moving towards performance-based regulations.

- Operators demonstrate compliance with the technical requirements of Commission Regulation (EU) No 965/2012 (Air operations) relating to emergency and/or other evacuation procedures through their standard operating procedures and training syllabi for air crew. The scope of the SOPs and training syllabi should include full emergency evacuations, as well as procedures such as rapid disembarkation, that have been implemented at the Operator's discretion in order to address abnormal situations.

- National Competent Authorities are required to verify that operators comply with Commission Regulation (EU) No 965/2012. This verification should include a review of the operator's management system, which includes the emergency evacuation and rapid disembarkation (where applicable) procedures documented in an operator's Operations Manual, and all associated training syllabi.

EASA also informed the Investigation that the '*EASA Collaborative Analysis Group – Fixed Wing'*, is currently considering the topic of emergency evacuations as a *'Candidate Safety Issue.'* Selected *'Candidate Safety Issues'* are formally captured and analysed by EASA using data reported by member states. Scenario-based safety risk assessments and impact assessments are carried out on the '*Candidate Safety Issue'* and recommendations are made for actions to be implemented in the European plan for Aviation Safety (EPAS).

The Investigation noted that a potential difficulty in analysing the safety risks associated with emergency evacuations is that significant data must be provided by the passengers themselves. The data that is normally supplied by the Competent Authorities to EASA originates in an Operator's SMS. Passengers do not report via an Operator's SMS and therefore the passenger's experience of emergency evacuations will be missing.

1.13.3 Emergency Commands in the Maritime Sector

In the maritime sector, passenger carrying ships are required to brief passengers on emergency procedures. Safety Of Life At Sea (SOLAS) Regulation 8 states that:

> *'Clear instructions to be followed in the event of an emergency shall be provided for every person on board'.*

In contrast to the aviation industry, it is common practice in the maritime industry to brief passengers on exactly what they will ***hear*** in the event of an emergency (seven short blasts on the ship's whistle followed by one long blast), and exactly what action they have to take if they hear this (proceed to muster stations).

1.14 Operator's Briefing of Passengers in Emergency Exit rows

The aircraft Operator provided the Investigation with their procedure relating to briefing passengers seated in emergency exit rows. The procedure requires cabin crew to advise passengers of the following;

- The overwing exits are designed to be operated by passengers in the event of an emergency.
- The briefing card describes the operation of the emergency exits
- To confirm that passengers are willing and able to open the emergency exits and to confirm that they have understood the briefing.

The Operator's procedures did not include briefing passengers on the emergency commands that may be used by the flight or cabin crew. The Operator informed the Investigation that the National Competent Authority had carried out an inspection of in-flight / cabin activities in September 2016 with no findings.

1.15 Previous Disembarkation / Evacuation Occurrences

Difficulties during rapid disembarkations and emergency evacuations have been identified in several investigation reports carried out by Safety Investigation Authorities (SIAs). In July 2013, a Boeing 777-300 was boarding at Paris Charles De Gaulle airport when a burning smell and smoke was observed in the cockpit and cabin. As the aircraft was parked on stand, the Commander decided to evacuate passengers using the air bridge. He initiated this using the command, *''Cabin crew this is the cockpit, evacuate the passengers via the doors, only via the doors''.* Some members of the cabin crew misunderstood the direction and opened the overwing emergency exits. The susbsequent investigation carried out by the French SIA, the BEA (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile) recommended (amongst other things) that the operator implement a *''precautionary deplaning''* procedure.

In August 2013, a Boeing 757-2Y0 landed in Gatwick airport to facilitate a crew changeover. During the changeover the on-coming commander noticed smoke near the left main landing gear, caused by a hydraulic fluid leak on to warm brakes. The commander reported that he initiated a disembarkation using the words, *"Ladies and gentlemen, we need to clear the aircraft immediately; there is smoke on the left hand side".* When passengers did not react, he followed it with, *"Move, come this way!"* Some passengers opened the overwing emergency exits and disembarked using the escape slides. There were five minor injuries to passengers. In that case the operator had a rapid disembarkation procedure and the subsequent investigation carried out by the UK Air Accident Investigation Branch (AAIB) found that it was followed correctly. The AAIB investigation noted the importance of flight crew communicating their intentions to cabin crew prior to initiating a rapid disembarkation, and that the language used in passenger commands should be unambiguous.

2. ANALYSIS

2.1 Failure of Avionics Bay Vent Fan

During subsequent inspection by maintenance personnel, the source of the fumes in the cockpit was found to have originated from rear bearing wear in the avionics bay blower fan.

Both the aircraft Manufacturer and the fan manufacturer were aware of operational issues caused by bearing wear to the avionics bay blower fan as there had been a number of occurrences per year. They sought to reduce the frequency of this problem by recommending scheduled maintenance (an overhaul) on the fan unit. At the time of the occurrence, the Operator had elected to implement this recommendation and was in the process of replacing all of the affected fans in its fleet. The fan in this occurrence was one of the fans that had not yet been replaced. It had accumulated 15,745 FH, which is significantly above the new threshold of 10,000 FH advised by the fan manufacturer in a SIL. However, a SIL is generally a means of communicating advisory information to operators and does not oblige them to act on the advice. Therefore, the Operator's implementation of the recommendations in the SIL was appropriate

Since the occurrence, the fan manufacturer has introduced two further initiatives to improve avionics bay fan reliability. In May 2018, a Ball-Bearing Health Monitoring system which can be retrofitted to the current fan design was made available, and a new fan design is expected in 2019. Due to these actions, no safety recommendation is made to the manufacturers of the aircraft or fan.

2.2 Flight Crew Response

As soon as the fumes were detected, the Flight Crew immediately informed ATC that they had a problem and were in the process of troubleshooting it. They then initiated the appropriate aircraft checklist which was the '*SMOKE/FUMES/AVNCS SMOKE'*. As they were working through the checklist, the Flight Crew paused intermittently to deal with communications from ATC, brief the Cabin Crew and inform the Passengers of their intention to return to EICK. During this period both Pilots had a high workload, but were task-focussed and composed throughout.

2.3 Inadvertent Emergency Evacuation

During this occurrence, the passengers seated in the overwing emergency exit rows initiated a disembarkation of the aircraft through the overwing emergency exits. This was not the exit procedure that the Commander had called for. However, the passengers heard the Commander give an unfamiliar instruction: *"Attention, Attention, this is the Captain, disembark the aircraft immediately",* which appears to have been interpreted as a direction to evacuate the aircraft. An aircraft evacuation is a rare occurrence and not something that most passengers would have experienced before. A misinterpretation of the Commander's instruction is understandable when one considers the entire sequence of events:

- The passengers had been informed by the Commander that there was a technical problem with the aircraft and that they were returning to Cork;
- Some passengers knew from the sound of the Commander's voice that he was wearing an oxygen mask;

- The passengers could likely see emergency services waiting on the runway for the aircraft;
- The emergency services followed the aircraft to stand and positioned themselves around the aircraft, pointing fire hoses at the aircraft;
- The Commander made an unfamiliar announcement directing the passengers to disembark;
- The Commander's instruction was followed by a subsequent direction from the SCCM to *"…make your way to the nearest exit."*

The passengers in this occurrence had effectively been primed to a higher level of alertness and therefore interpreted the Commander's instruction as a full evacuation.

An emergency responder boarded the aircraft through the forward aircraft doors two seconds before the first overwing exit was opened. Due to the close timing of these two events, the Investigation does not believe that the visibility of an emergency responder in the cabin was a factor in the passenger's decision to deploy the emergency overwing exits.

This sequence of events led to an unintended outcome. However, it does serve to highlight the importance of procedures and training that are in regular use in commercial aviation. In this instance, the passengers seated at the overwing emergency exits had been well-briefed in the use of the emergency exits, and therefore were able to take action, successfully deploying the emergency exits as soon as they perceived an emergency evacuation was required. The professionals involved; flight crew, cabin crew, ATC and emergency responders immediately initiated their standard operating procedures and managed the situation to its conclusion.

A rapid disembarkation procedure is not required by Regulation (EU) 965/2012, but an Operator may implement such a procedure at their discretion. The rapid disembarkation procedure must then be included in the Operator's Operations Manual and it must be included in their risk assessment. In this occurrence such a procedure was developed by the Operator who had identified the fact that there may be occasions where there is no immediate danger, but where they need to expedite the disembarkation of passengers. Other operators have similar procedures. The difficulty with both rapid disembarkation and emergency evacuation procedures is that passengers are not briefed on the procedure beforehand, or on the differences between types of disembarkation. Since occurrences of this nature are rare, most passengers will never experience either a rapid disembarkation or an emergency evacuation. They will not know exactly how an emergency evacuation is initiated by the crew, and therefore will not know how to distinguish it from other types of disembarkation. By comparison, on passenger carrying ships, it is common practice for passengers to be briefed on exactly what they will hear in the event of an emergency, and the action they should take.

Regulation (EU) 965/2012 CAT.OP.MPA.170 requires operators to brief passengers on various aspects of cabin safety. This regulation does not explicitly require passengers to be briefed on the emergency commands which may be used by the flight or cabin crew. Further guidance on appropriate content for such safety briefings is given in relevant AMC & GM documents. EASA informed the Investigation that guidance material is not intended to be prescriptive, and that the Competent Authorities of member states have the knowledge and resources to assess the appropriateness of an individual Operator's approach to emergency procedures.

The Investigation notes EASA's opinion that emergency evacuation is an extremely complex topic and that being overly prescriptive in guidance material will not always be helpful to the operator, or result in the best safety outcome.

The GM to this regulation suggests that passengers occupying seats with direct access to emergency exits and which are not staffed by crew members should be briefed to recognise the exact emergency commands which may be given by the crew. This intent being that in cases such as this, passengers understand the difference between a '*disembark*' command i.e. through the normal exits and steps and a full emergency evacuation i.e. using all exits and escape slides. The Operator's procedure for briefing passengers seated in emergency exit rows does not require passengers to be briefed on the emergency commands which may be used by the crew. However, this is acceptable within the requirements of the regulations, because the GM documents are '*…non-binding material issued by EASA which helps to illustrate the meaning of a requirement or specification*…' and as a holder of an Irish AOC, the Operator's procedures were reviewed by the National Competent Authority in September 2016 and there were no findings which related to passenger briefings.

EASA informed the Investigation that the '*EASA Collaborative Analysis Group – Fixed Wing'*, is currently considering the topic of emergency evacuations as a *'Candidate Safety Issue.'* This means that the topic of emergency evacuations would be analysed in significant detail using data provided by member states. Potential Safety Actions would then be identified and recommended for inclusion in EPAS. The Investigation noted the difficulties associated with collecting data related to emergency evacuations due to the fact that the data that is normally supplied by the Competent Authorities to EASA originates in an Operator's SMS and will not include reports supplied by passengers. Therefore, in order to analyse the safety issues associated with emergency evacuation fully, EASA or the Competent Authorities would need to engage directly with passengers.

Notwithstanding this potential difficulty, the Investigation believes that a research project of this type would be a positive step and could provide a valuable repository of shared knowledge and Best Practice for operators across member states. For this reason, the Investigation strongly encourages the '*EASA Collaborative Analysis Group – Fixed Wing'* to nominate the topic of emergency evacuations as a *'Candidate Safety Issue'* and accordingly does not make any Safety Recommendation to EASA on this occasion.

Escape slides are designed to quickly disembark large numbers of passengers in an emergency scenario. However, their use does carry some risk and research shows that injuries to passengers who evacuate on slides are possible. In addition, when passengers exit the aircraft on to the wing, there is a risk that they could fall from the wing, potentially causing serious injuries. Furthermore, the use of the slides renders the aircraft unserviceable until maintenance work is carried out to inspect key structures and re-instate the emergency exits. For these reasons it is important that unintended use of the escape slides is avoided where possible.

Two of the passengers on this aircraft were of the opinion that the escape slides appeared to be deflated. However, the Investigation reviewed CCTV footage of the complete disembarkation process and was satisfied that the slides had deployed and were operating as intended.

In this occurrence, both the Commander and the SCCM correctly actioned the Operator's Rapid Disembarkation SOP. This did not require the Commander to brief the SCCM on his intentions, nor did it require the SCCM to use any standard phraseology in subsequent announcements to the passengers. However, if the Commander had informed the Cabin crew of his intention to use the Rapid Disembarkation Procedure, it may have raised the alert level of the SCCM, who may then have used different wording when directing the passengers. In addition, the Operator's Rapid Disembarkation procedure uses wording that is very similar to a full evacuation procedure and this, combined with the fact that passengers are not required to be briefed on emergency commands prior to flight, may have contributed to the passengers' response in this case.

The Investigation reviewed IATA's recommended best practice in this area and investigation reports from other SIAs. The themes that emerge from these documents, with regards to rapid disembarkation procedures, are the need for clear communications between crew members, and the importance of using language that is unambiguous.

During the drafting process of this Final report, the Operator undertook a review of the Rapid Disembarkation procedure and concluded that the communications specified within the procedure were appropriate for their mixed fleet and operation. The Operator also re-examined the scenario where a Rapid Disembarkation escalates to a full evacuation. In order to address this potential escalation, the Operator informed the Investigation that they plan to update the rapid disembarkation procedure with the following additional instructions:

> *'If at anytime the situation deteriorates, an evacuation may be initiated and the **ON GROUND EMERGENCY PROCEDURE/ EVACUATION CHECKLIST** and associated procedures shall be completed.*
> *In this case when required the following PA shall be made:*
>
> *"Attention, Attention, this is the Captain, Cabin Crew Re-Arm Doors and Evacuate the Aircraft, use all available exits"'.*

Due to the Safety Actions taken by the Operator, the Investigation does not make any Safety Recommendations with regards to the Rapid Disembarkation procedure.

2.4 Loss of Data from Flight Data Recorder

By design, the FDR in this occurrence was de-energised when the aircraft was in the emergency electrical configuration. In an emergency situation, power is prioritised to systems that are required for continued safety of flight. However, loss of flight data during an emergency situation is a concern for safety investigators as this data is often crucial in understanding the probable cause of accidents and serious incidents. Installation of RIPS systems has provided a solution for CVRs in some applications, but the power requirements of FDRs are too great for currently available RIPS Systems. In addition, the dispersed nature of an FDR system, which incorporates the recorder itself, a data acquisition unit and dedicated sensors, makes providing an alternate power supply a more complex design challenge. Furthermore, in this occurrence, the initial event occurred more than 30 minutes prior to landing, so even with back-up power to the CVR, the primary recordings were overwritten. In this occurrence, the cockpit area microphone, which records for two hours, was available.

However, the Investigation considers that an uninterruptable power supply for the FDR and associated sensor systems is something that the aviation industry should aspire to for future aircraft. There are currently two industry working groups; the FLIRECSWG and EFRPG, preparing position papers and recommendations for ICAO and EASA on this subject. For this reason, the Investigation does not make any safety recommendations on this topic, but notes that continued diligence, and support of industry working groups will be required to drive regulations and technology forwards in this area. In that regard, the Investigation will supply a copy of this Report to both working groups.

2.5 Electrical Issues

During the occurrence flight and landing the Cabin Crew noted several issues related to the electrical system of the aircraft. Some items of cabin equipment did not operate as expected and the Cabin Crew were aware of unusual noises and vibrations in the floor beneath the cabin. The electrical issues were related to the emergency electrical configuration of the aircraft and the noises could be attributed to the deployment of the RAT.

In this occurrence, the Cabin Crew were able to manage the difficulties that arose in the cabin, and do not appear to have been unduly disturbed by them. However, such configuration and noises have the potential to unsettle a cabin crew. Since the occurrence, the Operator has reviewed the training that cabin crew receive to prepare for such incidents. The Operator determined that cabin crew training in this area could be strengthened by improving the capability of their in-house cabin simulator. The Operator plans to upgrade the simulator in 2019 to include the Cabin Intercommunication Data System. This will allow the Operator to simulate a variety of cabin electrical equipment failures.

3. CONCLUSIONS

3.1 Findings

1. The occurrence flight was the third flight of the aircraft that day.

2. The Flight Crew had experienced cockpit fumes on the first flight of the day. The Commander switched off the cockpit foot warmers and the fumes appeared to dissipate.

3. Maintenance checks carried out in EGLL following the first flight of the day did not identify any faults, which could have caused the initial cockpit fumes

4. In accordance with Regulation (EU) 965/2012, passengers seated in the emergency exit rows were briefed on the use of the overwing emergency exits, prior to the occurrence flight.

5. The briefing given to passengers seated in the overwing emergency exits did not include the commands that would be used by flight or cabin crew in the event of an emergency, nor was it required to.

6. In accordance with the aircraft QRH the Flight Crew initiated the '*SMOKE/FUMES/AVNCS SMOKE*' checklist.

7. The fumes did not readily dissipate and the Flight Crew commenced the second stage of the '*SMOKE/FUMES/AVNCS SMOKE'* checklist, which required them to put the aircraft temporarily into an emergency electrical configuration.

8. The Commander decided to return to EICK.

9. The emergency electrical configuration appeared to cause some of the cabin equipment such as the (Flight Attendant Panel, the interphone and the seatbelt signs) to operate intermittently.

10. The emergency electrical configuration resulted in the FDR being de-energised.

11. The aircraft generators were switched back on shortly before landing.

12. Some cockpit instruments, including flight director bars were not restored when the aircraft was returned to its original electrical configuration.

13. The emergency services on the ground responded promptly and were awaiting the aircraft when it landed in EICK.

14. Once on stand in EICK, the Commander called for a Rapid Disembarkation of the passengers in accordance with the Operator's SOP.

15. The wording used by the Commander in the event of a rapid disembarkation is very similar to the wording for an emergency evacuation.

16. The Cabin Crew then made an announcement on the aircraft PA system asking passengers to *"use the nearest available exit."*

17. Some passengers opened the overwing emergency exits, with some passengers remaining on the wing for some time before using the escape slide or returning to the cabin to disembark.

18. The overwing exits and associated slides operated correctly.

19. There were no reported injuries to passengers or crew during the disembarkation process.

20. Following disembarkation, one passenger became unwell and was taken to a local hospital.

21. Following the occurrence, the Operator reviewed the Rapid Disembarkation Procedure and intends to revise the guidance material, which addresses an escalation from a rapid disembarkation to a full evacuation.

22. The source of the cockpit fumes was the avionics bay vent fan.

23. The avionics bay vent fan had operated for 15,745 FH since new and was maintained on an *'on-condition'* basis.

24. In 2013, the avionics bay vent fan manufacturer issued a SIL recommending that the fan be overhauled at 10,000 FH.

25. Prior to the occurrence, the Operator had initiated a fleet-wide maintenance campaign to overhaul all avionics bay vent fans and implement scheduled maintenance at 10,000 FH in accordance with the avionics bay fan manufacturer's SIL.

26. Subsequent investigation of the removed avionics bay vent fan by an approved maintenance organisation determined that the cause of the fan failure was wear of the rear bearing.

27. The FDR was de-energised when the aircraft was in Emergency Electrical Configuration and therefore did not record any data during that period.

28. EASA AMC & GM to Annex IV Commercial air transport operations (Part CAT) of Commission Regulation (EU) No 965/2012 does not explicitly recommend that passengers should be briefed on the emergency commands that might be used by flight or cabin crew. However, the guidance material for this document suggests that passengers seated in emergency exit rows should be briefed on emergency commands.

3.2 Probable Cause

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1. Unintended use of the emergency overwing exits, following a return to the departure airport, due to fumes entering the cockpit.

3.3 Contributory Cause(s)

1. Rear bearing failure of the avionics bay blower fan.

2. Heightened alertness among passengers due to diversion.

3. Visual cues to passengers who saw emergency responders outside the aircraft.

4. Similarity between rapid disembarkation instruction and emergency evacuation instruction.

5. Direction to the passengers following the rapid disembarkation direction to *"use the nearest available exit."*

4. SAFETY RECOMMENDATIONS

This Investigation does not sustain any safety recommendations.

- END -

In accordance with Annex 13 to the Convention on International Civil Aviation, 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 this investigation is to prevent aviation accidents and serious incidents. It is not the purpose of any such 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.

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