# *EASA REGULATORY IMPACT ASSESSMENT*

## *POWER SUPPLIES FOR PUBLIC ADDRESS, INTERPHONE AND EVACUATION ALERT SYSTEMS*

***SEPTEMBER 2009***

Issue 1

# AMENDMENT RECORD

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| | | |

# CONTENTS

# ABBREVIATIONS

| | |
|---|---|
| AAIB | Air Accidents Investigation Branch (UK) |
| EASA | European Aviation Safety Agency |
| EWIS | Electrical Wiring Interconnection System |
| NPA | Notice of Proposed Amendment |
| NTSB | National Transportation Safety Board (USA) |
| PA | Public Address |
| TSB | Transportation Safety Board of Canada |

# 1 PURPOSE AND INTENDED EFFECT

## 1.1 ISSUE WHICH THE NPA IS INTENDED TO ADDRESS

Public address (PA) and interphone systems, when installed to meet operational requirements, provide capability for crew to passenger and crew to crew communications that are vital in some emergencies. The integrity of the power supplies to these systems is therefore very important.

Aeroplanes are not required by operational rules to be equipped with evacuation alert systems. However, since some aeroplane types are equipped with these systems and the emergency evacuation procedures used by operators of these aeroplanes are dependant on the evacuation alert system being functional, the integrity of power supplies to these systems is very important.

Accident and incident data demonstrate that during some emergencies, PA, interphone and evacuation alert systems have become inoperable or severely degraded as a result of power supply failure or disconnection. There is consequently a need to improve the integrity of power supplies for PA systems, interphone systems and evacuation alert systems. This conclusion is verified by recommendations issued by accident investigation bodies and research studies commissioned by the NTSB, TSB and EASA.

CS-25 partially addresses requirements for PA system power supply but does not address requirements for interphone and evacuation alert system power supplies.

## 1.2 SCALE OF THE ISSUE

### 1.2.1 Accident and incident data

There is evidence of many survivable accidents and incidents in which power failure or intentional disconnection of the power to PA, interphone or evacuation alert systems occurred during an emergency. A sample of relevant accidents extracted from a study carried out for EASA (Reference 1), involving aeroplanes manufactured in compliance with FAR 25.1423, is shown in Table 1. The accident reports identified in the study for EASA did not include data on the number of injuries or fatalities that resulted from failure of the power supply to the communication systems. It is considered unlikely that such information could be determined during accident investigations.

**Table 1 Sample of recent accidents**

| Accident | Resume |
|---|---|
| B737-300 ( ZK-NGJ)<br>Auckland, New Zealand<br>12 September 2006 | **In-flight power failure to PA system, interphone and call button following Battery Bus failure.** Evacuation after landing due to smoke in cabin. No aircraft impact. Due to the unavailability of communication systems, the communications between flight crew and cabin crew, amongst cabin crew, and between crew and passengers had to be carried out face-to-face. |
| B737-700 (N471WN)<br>Chicago, U.S.A.<br>8 December 2005 | **Post crash power failure to PA system.** Moderate impact after a landing overrun. The PA system was unavailable for cabin crew direction of the evacuation. One cabin crew member expected the PA not to work due to aircraft power failure and therefore did not try. Another tried to use the PA and did not know it was not working until advised by a passenger that no sound was coming through. |

| Accident | Resume |
|---|---|
| A340 (F-GLZQ)<br>Toronto, Canada<br>2 August 2005 | **Post crash power failure to PA system, EVAC COMMAND and EVAC ON alert.** Landing overrun followed by moderate impact, fire and evacuation. The PA operated for a short time allowing three announcements including one evacuation announcement, but then failed. The EVAC COMMAND function failed to work when operated by the chief purser to notify the flight crew. The EVAC ON function failed to work when operated by the flight crew in order to activate the evacuation alert to the cabin crew. The accident report cites the vulnerable location of the PA system emergency power in the avionics bay as the reason. |
| MD88 (TC-ONP)<br>Groningen, Netherlands<br>17 June 2003 | **Post crash failure of PA system.** Rejected takeoff, overrun, moderate impact and evacuation. One passenger heard a PA announcement soon after the aircraft stopped but it was unintelligible. The Purser stated the PA system did not work after the crash. |

## 1.2.2 Discussion

### 1.2.2.1 Public address (PA) system

Aircraft configured with greater than 19 passenger seats are required by OPS.CAT.517 to be equipped with a public address system.

The primary reasons for using the PA system during emergency situations are to initiate an emergency evacuation and for the flight crew to call 'Brace for Impact'. The potential threats resulting from the PA system being un-powered at such times would therefore include:-

i) delayed commencement of evacuation
ii) evacuation attempted through unavailable exits (blocked by fire)
iii) evacuation commenced when not required
iv) evacuation commenced whilst engines running
v) occupants not bracing for impact

All of the above threats have the potential to cause fatal or serious injuries. It is therefore logical that CS 25.1423 requires the PA system to be powerable in the event of engines and APU not running, or the loss of generated power. CS 25.1423 originates from FAR 25.1423, which was introduced in 1989 and is effective for aircraft manufactured after 27 November 1990. This requirement caters for an in-flight loss of engines and APU and the possible need to shut down engines after an emergency landing or impact.

However, in the study carried out for EASA (Reference 1), several accidents were identified for the period 1998 to 2007 inclusive, where there was no power available to the PA system immediately after emergency landing or impact when the crew were faced with an evacuation situation. In one accident, (Toronto A340), the PA system received power for only enough time for three messages to be broadcast.

In some accidents, the power supplies to the PA systems failed despite there being relatively low levels of impact damage to the fuselages.

Additionally, it is possible for the power to the communications systems to be switched off by the flight crew and this occurred in at least one accident. The precise reason for loss of power is not available for some accidents and for others where the aircraft was

manufactured prior to FAR 25.1423 becoming effective, the PA system was not required to be powered following engine and APU shutdown.

Several examples of in-flight failure of the battery bus, which removed power supply to the PA system, are evident.

The study carried out for EASA (Reference 1) also states:-

> *"In 1995, the TSB published a document entitled A Safety Study of Evacuations of Large, Passenger-Carrying Aircraft. Twenty-one occurrences involving emergency evacuations were reviewed. In 8 of the 21 occurrences, the aircraft's PA system was inoperable or inaudible following the accident. As a result, cabin crew and/or passengers did not hear the initial command to evacuate and/or did not hear other emergency instructions. The onset of these evacuations was delayed, placing the safety of passengers and crew at risk. One of the recommendations resulting from this safety study is as follows:*
>
> *The Department of Transport review the adequacy of power supplies and standard operating procedures for PA systems in an emergency for all Canadian operators of large passenger aircraft. (A95-04)"*

#### 1.2.2.2 Interphone system

Aircraft configured with greater than 19 passenger seats or greater than 15,000 kg Maximum Take-off Weight are required by OPS.CAT.516 to be equipped with an interphone system allowing communications between flight deck crew and cabin crew.

OPS.CAT.516 clearly intends the interphone to be operable during emergency situations since AMC OPS.CAT.516 states *"The crew member interphone system should have a means for the recipient of a call to determine whether it is a normal call or an emergency call…"*

However, CS-25 does not require the interphone system to be powerable when the engines or APU are not running, as it does for the PA system. This means that aircraft compliant with CS-25 could potentially have non-functioning interphone systems as a result of engine shutdown or failure following emergency landing or impact, at a time when two way communications between the flight deck and cabin are most vital to establish the need for an evacuation. It is normal for the aircraft commander to initiate evacuation, but it is often the cabin crew who first recognise the need for evacuation, because either they have sight of an external fire or fire has entered the passenger compartment. Without an interphone system the ability of the cabin crew to notify the captain is severely degraded.

Similarly, following total engine failure in flight, two way communications between the flight deck and passenger compartment could be lost, degrading preparations for ditching or emergency landing. This threat is exacerbated by the requirement for locked cockpit doors.

Unlike the interphone system, CS-25 requires PA systems to be powerable when the engines and APU are off. There appears to be no obvious reason why CS-25 should not require an interphone system to be powerable by a supply that meets a similar standard.

These conclusions are very clearly supported by a UK AAIB investigation into a cabin and flight deck smoke incident near Leeds, UK on 4 August 2005 involving a DHC-8-400. The AAIB incident report (Reference 2) stated:-

*"Flight deck and cabin crews work together to ensure the safety of the operation. Interphone systems, historically, have been provided and used as backups to face-to-face communications. With the advent of the locked flight deck door policy, full reliance for operationally necessary communications is placed on the electronic communications systems, and failure of the interphone system is itself considered to be an in-flight emergency. However, these systems were designed before the advent of present-day security policies and do not provide the necessary reliability for use in this role, particularly in emergencies as the busbars which supply them are not the aircraft's essential busbars. As a result, such essential communications will be lost if there is a loss of the associated electrical busbar supplies as, for example, if the aircraft were to be configured into a typical emergency electrical configuration such as might be expected if the flight crew were dealing with an electrical fire. In a recent AAIB investigation, due to such a power shutdown, a large public transport aircraft was evacuated on the stand without the knowledge or authority of the Commander (AAIB Bulletin 1/2007, Avro RJ 146-100 G-CFAE on 11 Jan 2006). In those situations where the training and resources of the flight and cabin crews are required to minimise injuries or loss of life, the necessary communications may be impeded, and may not be available at all. Therefore the AAIB makes the following Safety Recommendation:*

*Safety Recommendation 2007-004: It is recommended that for all large aeroplanes operating for the purposes of commercial air transport, the UK CAA and the EASA should take such steps, procedural or technical, as are necessary to improve the reliability and availability of communications between flight and cabin crews, including the reliability of communications equipment and associated power supplies in both normal and emergency configurations."*

#### 1.2.2.3 Evacuation alert system

Evacuation alert systems are not currently required by operational requirements or CS-25. However, it is evident from accident data, that on some aircraft types these systems have been introduced and airline operating procedures specify their use for initiating evacuations. In the Toronto A340 accident, the evacuation alert system failed to function when required.

If an aeroplane is equipped with an evacuation alert system and the system is to be used in an emergency procedure it is essential that the power supply to the system is available when required. It is therefore considered that the status and availability of the power supply to an evacuation alert system should be same as that for a PA system.

The study carried out for EASA (Reference 1) cites an NTSB recommendation to the FAA:-

*Require all newly manufactured transport-category airplanes operating under Title 14 Code of Federal Regulations Part 121 to be equipped with independently powered evacuation alarm systems operable from each crewmember station, and establish procedures and provide training to flight crews and flight attendants regarding the use of such systems. (A-00-90)*

In response to this recommendation, the FAA considered that crew interphone and public address systems perform the function of an evacuation alarm and it is therefore not necessary to mandate the requirement for an evacuation alarm system. The NTSB disagreed, and argued that it continues to investigate accidents and incidents in which the PA and interphone systems did not work at critical periods in an evacuation and in which an evacuation alarm was needed. The status of this recommendation is "Closed – Unacceptable action".

The regulatory action considered in this RIA is intended to improve the integrity of the power supplies to the PA and interphone systems on newly designed aeroplanes and may lessen the justification for evacuation alert systems on these aeroplanes. However, regulatory action resulting from the NPA would have no effect on the justification for mandating evacuation alert systems on newly built aeroplanes with existing type certificates.

### 1.2.3 Analysis of the requirements

In relation to the PA system power supply, CS-25 states:-

> ***CS 25.1423 Public address system***
>
> *A public address system required by operational rules must –*
>
> *(a) Be powerable when the aircraft is in flight or stopped on the ground, after the shutdown or failure of all engines and auxiliary power units, or the disconnection or failure of all power sources dependent on their continued operation, for –*
>
> *(1) A time duration of at least 10 minutes, including an aggregate time duration of at least 5 minutes of announcements made by flight and cabin crew members, considering all other loads which may remain powered by the same source when all other power sources are inoperative; and*
>
> *(2) An additional time duration in its standby state appropriate or required for any other loads that are powered by the same source and that are essential to safety of flight or required during emergency conditions*

In practice, 25.1423 part (a), shown above, may be interpreted as follows –

> *The PA system must be powerable after loss or disconnection of aeroplane generated electrical power. It must therefore be powered or have the capability to be powerable from a battery. To achieve this, it may be permanently connected to a battery bus, or may be connected to a bus that is selectable from generator to battery power, or may have its own independent battery. If the power source is selectable it may be manual or automatic.*

CS-25 has no equivalent electrical power requirements applicable to interphone or evacuation alert systems.

From accident and incident experience, it is evident that there are several power interruption scenarios that are not addressed by CS 25.1423 part (a):

(1) The system may be connected to a battery bus that fails due to an electrical fault.[1]
(2) The system may be connected to a battery bus that fails due to inertia forces in an emergency landing.[2]
(3) The system may be connected to a battery bus that fails due to deformation or rupture of the fuselage in a minor crash landing.[2]
(4) Failure of the pilot, due to injury, or by not following procedures, to manually select battery power to replace generator power when the engines have failed or been shut down in an emergency evacuation. (This is a hypothetical scenario that could occur on some aeroplane designs requiring manual selection).[3]
(5) Intentional in-flight disconnection of the bus supplying the system when carrying out an 'Electrical System Fire or Smoke' procedure.[4]

CS-25 should therefore be amended. It should retain the existing power supply requirements for the PA system with the addition of:-

(1) Similar power supply requirements for the interphone system and evacuation alert system (if fitted)
(2) A requirement for the power supplies to be maintained automatically
(3) A requirement that addresses inertia forces encountered during emergency landing
(4) A requirement that addresses a reasonable level of tolerance to fuselage damage resulting from emergency landing impact

## 1.3 BRIEF STATEMENT OF THE OBJECTIVES OF THE NPA

The NPA is intended to improve the integrity of power supplies to the PA, interphone and evacuation alert systems to enable these systems to remain functional for sufficient time for the crew to carry out emergency procedures that are dependant on crew to crew and crew to passenger communications.

The intention is to provide the aircraft manufacturer with a performance based and non-prescriptive requirement, providing flexibility as to the manner in which this goal is achieved.

[1] In flight failure of the battery bus occurred in the Auckland B737-300. See Table 1.
[2] Crash landing inertia forces or fuselage damage were the causes of the battery buses to fail in the Chicago B737-700, Toronto A340 and Groningen MD88 accidents. See Table 1.
[3] A comparable emergency scenario exists on the Boeing 737, whereby when conducting an emergency evacuation procedure, the pilot is required to manually select the standby bus to 'BAT' in order to maintain power to the VHF 1 radio to preserve communication capability with the tower.
[4] Intentional disconnection of the electrical bus occurred in an EMB-190 in-flight smoke incident overhead Edinburgh in January 2009. Subsequently, during the remainder of the flight when the aircraft was operating on battery and ram-air turbine emergency power, the functioning of the interphone system was severely degraded. (Reference 3)

# 2 OPTIONS

## 2.1 THE OPTIONS IDENTIFIED

Two regulatory options are considered in this Regulatory Impact Assessment:

**Option 1 – Do Nothing**

The "Do nothing" option means to make no improvements to CS-25 in relation to the power supply requirements for PA, interphone and evacuation alert systems.

**Option 2 – Amend CS-25** to provide power supplies for PA, interphone and evacuation alert systems, required by operational rules or otherwise, with the capability to maintain the functioning of these systems for sufficient time to allow completion of emergency procedures dependant on crew to crew and crew to passenger communications.

(Note: For the PA system only, CS 25.1423 already includes requirements that partially satisfy this intention).

Three potential solutions have been identified, but alternative means may be used. The PA, interphone and evacuation alert systems may –

(1) Be powerable from the emergency bus, or could be automatically selectable to the emergency bus upon power supply interruption, or –

(2) Be powerable from a dedicated power source, rechargeable from the aircraft normal electrical supply, or –

(3) Be powerable from an aeroplane generator or battery bus, but have an automatically activated dedicated standby power supply.

and –

for all solutions, the power source and any required controller and EWIS, including their supports and fixing to the aeroplane, must be capable of normal operation after having been subjected to the inertia forces listed in CS25.561(b), and all practicable measures must be taken to minimise the probability of failure caused by lower fuselage deformation or rupture following an emergency landing.

## 2.2 THE PREFERRED OPTION SELECTED

After due consideration the Agency believes that **Option 2 - Amend CS-25 to provide power supplies for PA, interphone and evacuation alert systems, required by operational rules or otherwise, with the capability to maintain the functioning of these systems for sufficient time to allow completion of emergency procedures dependant on crew to crew and crew to passenger communications** is to be preferred.

This rule would apply to aircraft equipped with these systems whether or not required by operational rules.

The existing CS 25.1423 includes requirements specific to the PA system that are not related to power supply. Therefore, the power supply requirements for the PA system would need to be deleted from CS 25.1423 and be incorporated, suitably modified, into a new CS-

25 requirement that includes the power supply requirements for interphone and evacuation alert systems. The following would be deleted from CS 25.1423:-

*(a) Be powerable when the aircraft is in flight or stopped on the ground, after the shutdown or failure of all engines and auxiliary power units, or the disconnection or failure of all power sources dependent on their continued operation, for –*

*(1) A time duration of at least 10 minutes, including an aggregate time duration of at least 5 minutes of announcements made by flight and cabin crew members, considering all other loads which may remain powered by the same source when all other power sources are inoperative; and*

*(2) An additional time duration in its standby state appropriate or required for any other loads that are powered by the same source and that are essential to safety of flight or required during emergency conditions*

A new rule would be added to CS-25 to include the electrical power requirements for the PA, interphone and evacuation alert systems:-

***CS 25.xxx Power supplies for public address, interphone and evacuation alert systems***

*(a) When required by operational rules or installed for other purposes, a public address system, interphone system and evacuation alert system must be powerable when the aircraft is in flight or stopped on the ground.*

*(b) The power supplies must be automatically maintained following the shutdown, disconnection or failure of any generated powered source, or the disconnection or failure of any non-emergency battery powered bus except following normal termination of aeroplane operation by the flight crew, for-*

*(1) A time duration of at least 10 minutes, including –*

*(i) an aggregate time duration of at least 5 minutes of public address system announcements made by flight and cabin crew members considering all other loads which may remain powered by the same source when all other power sources are inoperative; and*

*(ii) an aggregate time duration of at least 10 minutes of interphone communications made by flight and cabin crew members considering all other loads which may remain powered by the same source when all other power sources are inoperative; and*

*(iii) a aggregate time duration of at least 5 minutes of evacuation alert system operation considering all other loads which may remain powered by the same source when all other power sources are inoperative; and*

*(2) An additional time duration in their standby states appropriate or required for any other loads that are essential to safety of flight or required during emergency conditions.*

*(c) The power source and any required controller and EWIS, must be capable of normal operation after being subjected to the inertia forces specified in CS 25.561(b)(3)*

*(d) All practicable measures must be taken to minimise the probability of failure of the power supplies to the public address, interphone and evacuation alert systems resulting from deformation or rupture of the lower fuselage lobe in a minor crash landing.*

# 3 SECTORS CONCERNED

The proposed regulatory change is to CS-25 and hence the aeroplanes affected will be those for which the application for a type certificate is made after the regulatory change considered in this Regulatory Impact Assessment. All such CS-25 aeroplanes equipped with interphone, PA or evacuation alert systems will need to comply.

The primary cost of the regulatory change will be borne by the operator due to increased fuel costs associated with increased weight. There will be marginal costs to manufacturers due to engineering and material costs, marginal cost to EASA in their oversight of the manufacturer in showing compliance with the regulatory change and marginal cost to operators due to increased maintenance.

# 4 IMPACTS

## 4.1 ALL IMPACTS IDENTIFIED

### 4.1.1 Safety

**Option 1 – Do Nothing**

This option would have no impact on safety.

It would not change the current level of safety required by CS-25 for the power supplies to PA, interphone and evacuation alert systems on some aeroplane types. This is considered unsatisfactory. There would be continued occurrences of crew to crew and crew to passenger communications capability becoming partially or totally degraded during the execution of emergency procedures that are dependant on communication.

**Option 2 – Amend CS-25**

This option would improve the current level of safety by ensuring the power supplies to the PA, interphone and evacuation alert systems, for which some emergency procedures are dependant, are maintained for sufficient time for the emergency procedures to be completed. This applies in particular to the execution of Electrical System Fire or Smoke, Ditching, Emergency Landing and Emergency Evacuation procedures.

### 4.1.2 Economic

**Option 1 – Do Nothing**

No economic impacts have been identified.

**Option 2 – Amend CS-25**

It is expected that to comply with Option 2, aeroplanes will need to be equipped with new and additional parts. Some existing parts may be redundant. This will add the following costs:-

(a) Engineering cost: Parts will be required to be designed and tested. This is likely to be carried out by specialist suppliers and airframe manufacturers. The engineering cost of some parts may be amortised across more than one aeroplane type (e.g. an integral amplifier, standby power source and controller). The costs will be borne by the aircraft manufacturers and are expected to be minimal once amortised across many aeroplanes. Operators will incur marginal additional engineering costs associated with increased maintenance due to additional parts.

(b) Material cost: It is expected that some existing parts may be redundant and will offset the cost of new and additional parts. Material cost per aeroplane is expected to be minimal.

(c) Added fuel cost: The new and additional parts are expected to weigh more and thus there will be a fuel-weight penalty over existing designs. It is estimated that additional weight will be around 5kg per aeroplane. This induces additional fuel consumption which equates to approximately 1.7 million Euros of additional fuel costs per year to the industry worldwide, (once all aeroplanes in the world fleet are in compliance).

### 4.1.3 Environmental

**Option 1 – Do Nothing**

No significant environmental impacts have been identified.

**Option 2 – Amend CS-25**

It is expected that to comply with Option 2, aeroplanes will need to be equipped with additional parts. Carbon dioxide emissions to the atmosphere will consequently increase, resulting from parts manufacture and increased fuel burn associated with increased aeroplane weight. However, the increase in carbon dioxide emissions will be minimal.

No other environmental impacts have been identified.

### 4.1.4 Social

No social impacts have been identified.

### 4.1.5 Other aviation requirements outside EASA scope

There would be no impact on other aviation requirements outside EASA scope.

### 4.1.6 Foreign comparable regulatory requirements

ICAO Annex 6 and Annex 8 were reviewed and no text was found in conflict with the content or overall objectives of the NPA.

Since there are no current rulemaking activities within the FAA or Transport Canada regarding this subject, a rule change will introduce differences in the standards.

### 4.2 ISSUES OF EQUITY AND FAIRNESS

There are no issues of equity and fairness associated with any of the regulatory options considered in this Regulatory Impact Assessment.

## 5 SUMMARY AND FINAL ASSESSMENT

### 5.1 COMPARISON OF THE POSITIVE AND NEGATIVE IMPACTS FOR EACH OPTION EVALUATED

**Option 1:** This is the "Do Nothing" option. It would have no impacts and would make no changes to the current level of safety required by CS-25 for the power supplies to PA, interphone and evacuation alert systems. Events would continue, in which crew to crew and crew to passenger communication capability is partially or totally degraded during the execution of emergency procedures that are dependant on communication. The consequences are likely to result in serious or fatal injuries to occupants.

**Option 2:** This option would bring the highest safety benefits with related economic consequences that are considered acceptable.

### 5.2 A SUMMARY DESCRIBING WHO WOULD BE AFFECTED BY THESE IMPACTS AND ANALYSING ISSUES OF EQUITY AND FAIRNESS

**Option 1** would have no impact on the aeroplane manufacturers, operators, or EASA.

**Option 2** would require the aeroplane manufacturer to incur increased engineering and material costs related to the provision of new and additional parts. These costs would be minimal. For operators, this option would increase fuel costs due to the increased weight of the aeroplane and would marginally increase maintenance costs due to additional parts. There will be marginal costs incurred by EASA in their oversight of the manufacturer in showing compliance with the regulatory change.

### 5.3 FINAL ASSESSMENT AND RECOMMENDATION OF A PREFERRED OPTION

After due consideration Option 2 (Amend CS-25) is to be preferred. It provides an increased level of safety over Option 1 (Do Nothing).

Option 2 will ensure the PA, interphone and evacuation alert systems are:-

i) powerable for sufficient time for the crew to carry out emergency procedures that are dependant on crew to crew and crew to passenger communications

ii) automatically powerable when all other power supplies have failed or been disconnected

iii) powerable by a supply that will operate normally after being subjected to inertia forces and deformation or rupture of the lower fuselage lobe that may occur during an emergency landing impact.

The engineering and material costs of introducing Option 2 on new type designs are minimal. However, aeroplane operating costs will be increased due to additional fuel burn

associated with weight increase. These costs are considered to be outweighed by the potential safety benefits provided.

# 6 REFERENCES

1. RGW Cherry and Associates (2009). *Study on CS-25 Cabin Safety Requirements 4208/R/000454/KK*, prepared for the European Aviation Safety Agency.
2. AAIB (2007). *AAIB Bulletin: 4/2007 Incident near Leeds, West Yorkshire, UK on 4 August 2005 involving Bombardier DHC-8-400, G-JECE, Ref. EW/C2005/08/10.*
3. AAIB (2009). *AAIB Special Bulletin: 1/2009 Incident Overhead Edinburgh, Scotland, UK on 15 January 2009 involving EMB-190-200, G-FBEH, Ref. EW/C2009/01/03*