

The Gerhard Sedlmayr Lecture RAeS Hamburg  
Hamburg Aerospace Lecture Series - 4 June 2019

# Safety in the Cabin – Past, Present and Future

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Compiled in conjunction with Nick Butcher (FOG)

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RAeS Hamburg in cooperation with the DGLR, VDI, ZAL & HAW invites you to a lecture



## Annual Gerhard Sedlmayr Lecture

### Safety in the Cabin – Past, Present and Future

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Air Commodore **Dai Whittingham**: Chief Executive, UK Flight Safety Committee

**Date:** Tuesday 04 June 2019, 18:30

*(light refreshments available from 18.00 and there will be a get-together with refreshments after the lecture)*

**Location:** ZAL TechCenter, Hein-Sass-Weg 22, 21129 Hamburg

*(If you wish to attend, please [register online](#) or send a mail to [Susanne Altstaedt](mailto:susanne.altstaedt@airbus.com), [susanne.altstaedt@airbus.com](mailto:susanne.altstaedt@airbus.com))*

This presentation is partly based on two Royal Aeronautical Society Specialist Papers produced by its Flight Operations Group:

- Evacuation of commercial passenger aeroplanes (published in 2018); and
- Smoke, Fire and fumes in transport aeroplanes: Reference (published in 2018).

Most aeroplane accidents are survivable and this presentation will identify the many issues that are required to be addressed by regulators and manufacturers in respect of the airworthiness requirements for certification of the passenger cabin including the criteria for emergency evacuation.

From a design perspective we need to consider the safety of the passenger environment to enhance the safety of all the occupants. Compliance with the numerous airworthiness requirements should be reflected in compatible operational procedures as well as crew training. Are their sufficient links between the two disciplines to effectively achieve this?

So what determines the design of the passenger cabin? The obvious and main influences are the requirements in EASA CS25 and FAA FAR 25. However, another increasingly significant influence are the commercial pressures which can affect the design of the passenger cabin and in some cases might impact adversely on matters of flight safety.

This presentation will address the many positives regarding the design of the passenger cabin from a safety perspective. It will also address some of the negatives.

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**Hamburg Aerospace Lecture Series** von DGLR, RAeS, ZAL, VDI und HAW Hamburg (PSL)  
<http://hav-connect.aero/Group/Lectures>

**This presentation is based upon 2 papers  
published (2018) by the Flight Operations Group:**

## **Emergency Evacuation of Commercial Passenger Aeroplanes (2018)**

<https://www.aerosociety.com/media/8534/emergency-evacuation-of-commercial-passenger-aeroplanes-paper.pdf>

## **Smoke, Fire and Fumes in Transport Aircraft Part 1: Reference (2018)**

[https://www.aerosociety.com/media/9215/safita\\_part-1\\_v5.pdf](https://www.aerosociety.com/media/9215/safita_part-1_v5.pdf)

(The views expressed here are those of the FOG)



# Most fatalities in survivable accidents are avoidable

Regulators and manufacturers have made significant steps to improve occupant survivability but there is still much to do...

# Agenda

- Passenger and cabin crew seating
  - Pitch, width, density
- Emergency exits, slides, evacuations
- Lavatory compartments
- Flammability standards and heat release
- Floor proximity lighting systems
- Overhead bins and cabin baggage
- Operational considerations

# Designing the Passenger Cabin for maximum occupant protection

What drives passenger cabin design? (CS 25.803 *et seq*)

- Airworthiness
- Commercial Considerations
- Seat Pitch?
- Zonal Density?

**Cabin design and operational procedures must be in harmony to maximise passenger safety.**

Design improvements tend to focus on Premium not  
Economy cabins

Hence lavish design concepts (long haul) including first class suites, lounges  
and bars



## **An ethical question:**

**Does the price of your ticket influence your chances of survival?**



# Minimum Space for Seated Passengers: Seat Pitch and Width



**FORWARD PASSENGER  
CABINS TYPICALLY  
DEDICATED TO FIRST AND  
BUSINESS CLASS SEATS**

**AFT ECONOMY SECTIONS  
HAVE MORE DENSE  
SEATING CONFIGURATIONS**

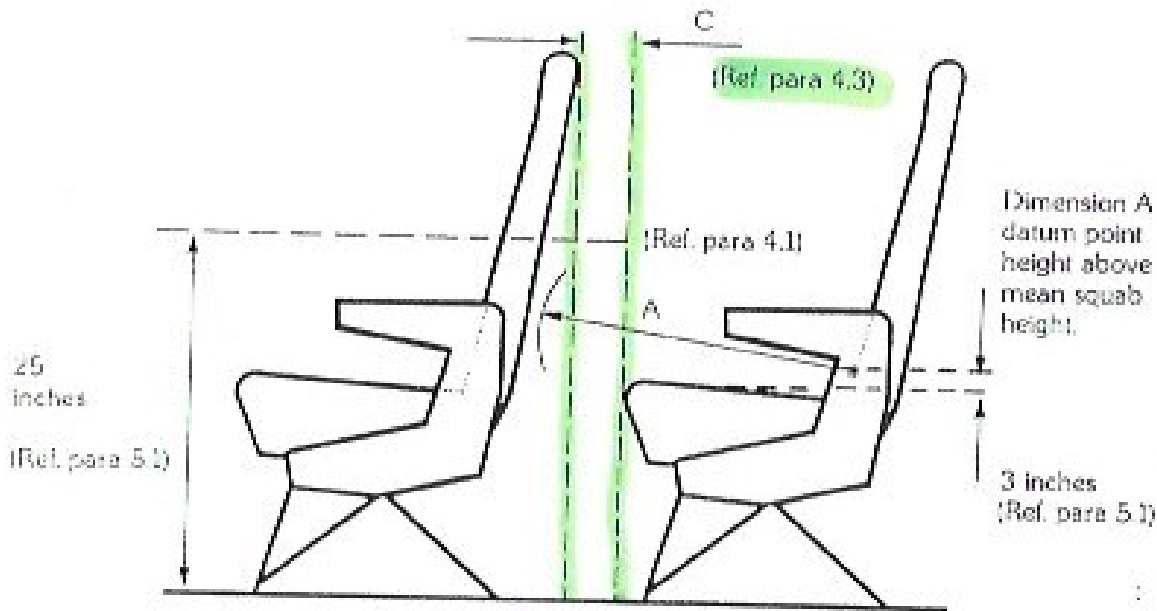


**ZONAL DENSITY?**

## UK CAA Airworthiness Notice (AN) 64 ‘Minimum Space for Seated Passengers’ (Mar 1989)

“The minimum distance between the back support cushion of a seat and the back of the seat or other fixed support structure in front, **shall be 26 inches.**” (66cm)

“The minimum distance between a seat and the seat or other fixed structure in front **shall be 7 inches.**” (17.8cm)



**“The minimum vertically projected distance between seat rows or between a seat and any fixed structure forward of the seat shall be 3 inches. This vertically projected distance shall be measured between the forward edge of the seat cushion or the most forward point of the armrests and the most aft part of the seat in front.” (CAA AN-64)**

# Protection of infants and young children?

- Regulators, manufacturers and operators need to co-operate on resolving the protection of infants and young children.
- Automotive child seats have been long accepted as a consumer option, protection needs to be defined not left to the discretion of the accompanying adult.

- **AN 64 criteria transferred to Civil Aviation Publication (CAP) 747 as a generic requirement but cancelled November 2014.**

- **EASA 2009 CS 25 Study:**

Further research into seat space might be required to:

“...investigate the **effects of various seat spacing dimensions on evacuation**, not just on the passengers’ **ease of egress** but also on the **overall dynamics** of the emergency evacuation.”

“The investigation should also take into account the **projected increasing proportion of elderly people** in the flying population and people from the **higher dimension percentile group**.”

- **No further EASA action since 2009 Study**

- However, in 2015 EASA stated:

*“....that the data presently at (its) disposal is **not sufficient to justify legislative measures on seat pitch at the EU level.**”*

and:

*“...(this is a) **commercial decision taken by the airlines in a competitive market, who are free to offer different levels of service and to charge different fees for them.**”*

FOG translation:

“...commercial considerations are more important than passenger safety.”



# FAA Position on Seated Space

- July 2018, USA Court of Appeals Circuit judge files opinion requiring the FAA to consider developing requirements for a minimum seat space.
- The FAA responded that it **would not regulate airline seat space** and legroom, and that **current seat size was not a safety issue**

# FAA Position on Seated Space

*“The time it takes passengers to get out of their seats, even if those seats are relatively narrow and close together, is less than the time it takes for the emergency exits to begin functioning and for the line that forms in the aisle to clear.”...*

*“The FAA has no evidence that a typical passenger, even a larger one, will take more than a couple of seconds to get out of his or her seat.”*

**VALID ARGUMENTS?**

# THE BRACE POSITION

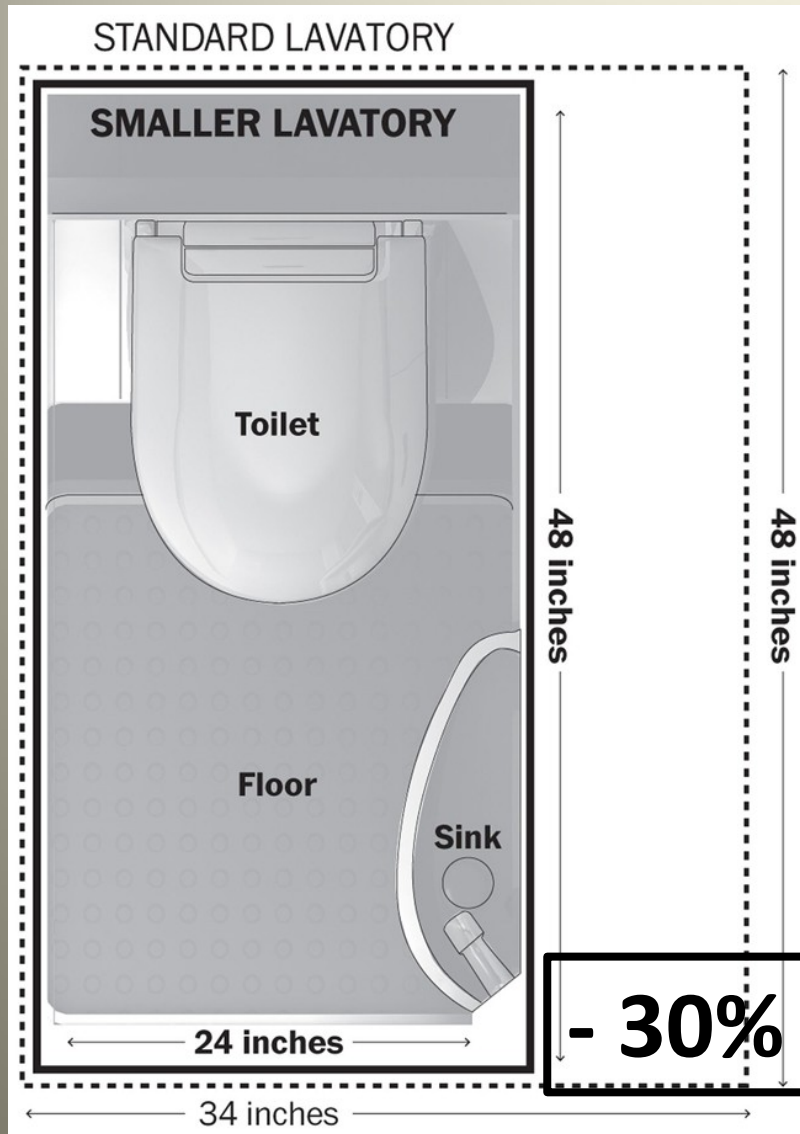
The International Branch for Research into Aircraft Crash Events [IBRACE] has concluded that with seat pitches of **less than 30 inches** an average passenger would be unable to adopt the recommended brace position.

Sled impact testing with a 28 inch seat pitch not possible: the **standard Hybrid III test dummy does not fit into the space!**

# The FOG view

- Reduction of passenger seated space could seriously compromise an emergency evacuation
- Regulators should urgently develop minimum dimensions for passenger seating, taking account of:
  - An ageing population with reduced mobility
  - An increase in average body mass
  - The potential for Deep Vein Thrombosis where movement is restricted by seat dimensions
  - The ability to easily locate, remove from stowage and don life-jackets
  - The ability to adopt an approved brace position

# Lavatory Compartments



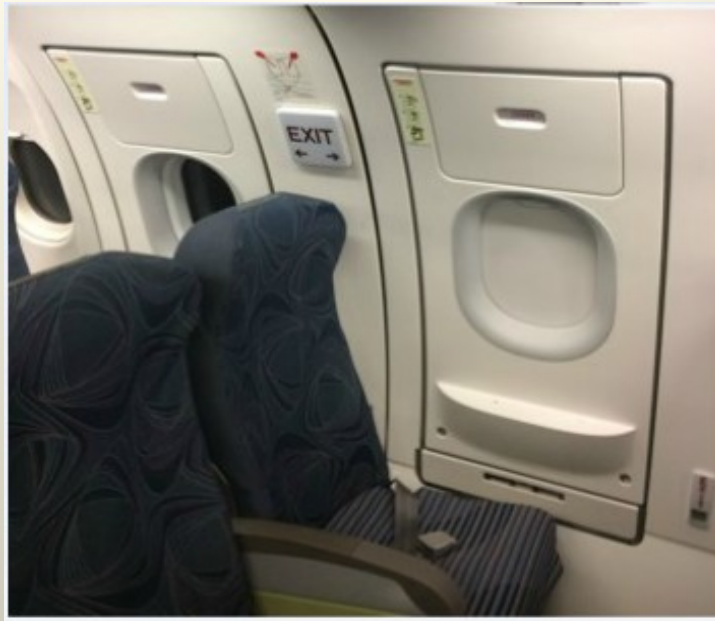
- Comfort/user issue?
  - Child? Nappy change!
- Security checks?
- Fire fighting?
- Incapacitation?
- Illness?
- Disabled passengers?

**Operational  
considerations?**

# Emergency Exits



Type III



## Airbus A321 Type III emergency exits



# The FOG View



- All new-build aeroplanes should, where relevant, be equipped with improved Type III exits
- Where practicable, older Type III exits should be replaced with the improved versions



# EMERGENCY EVACUATIONS

Once an evacuation order has been given, it is **essential that passengers evacuate** the aeroplane **as quickly as possible** using all usable exits.

**Airworthiness\*** requirements need to be **reflected in operational procedures** and training for both flight and cabin crew, and must be compatible with each cabin configuration.

\*Engineering aspects



July 2013 - Asiana Airlines - Boeing 777-200 - San Francisco, USA

- **Certification test requirement:** all passengers and crew to be on the ground within **90 seconds** and with only **50% of exits** available.
- Evacuation time influenced by number/location of exits, number of passengers, external conditions (fire, debris) and internal damage.



**11 August 2005 - Air France - Airbus A340-300 - Toronto, Canada**

- Commercial considerations: seat dimensions, baggage, seat allocations
- Commercial pressures: short turn-round times and impact on briefings. 'Able-bodied'?
- 'Corporate image' – safety cards, education

# Evacuation Slides



- 1.8m/6ft drop = slide required
  - Arbitrary! Testing, provenance?
  - Aged/infirm? Young?
- SOPs usually requires flaps extended for over-wing exits
- Potential for (pax) confusion
  - Markings needed

A380 upper deck evacuation slide



Airbus A320 wing markings



(Photo AAIB)

B737-800



Airbus A320 off-wing slide

- 2000 NTSB Safety Study ‘Emergency Evacuation of Commercial Airplanes’: NTSB recommended that the FAA review the 6 foot height criteria.
- EASA 2009 CS25 Study: “The evidence available from accidents and research studies suggests that the requirements to jump to the ground from a height of 1.8m (6 feet) during evacuation, without assist means, may potentially cause serious injury or may delay the progress of an evacuation due to hesitation or unwillingness to jump.”

**THE FOG AGREES...**



# Flammability Standards and Heat Release



DC-9, Cincinnati, June 1983

- ✓ Materials now
- Lithium battery fires?
- Better smoke/fumes removal needed!

**TOMBSTONE REGULATION...**

# Floor Proximity Lighting Systems

- The requirement for floor path lighting is well-established.
- **FOG endorses** EASA 2009 CS 25 study conclusion:
  - further research is needed to identify technologies that might be used by passengers to locate emergency exits in conditions of low visibility and without the assistance of cabin crew.

# (Cabin Crew) Seating and Emergency Equipment

- Seats must be crash-worthy, tested to  $>9g$
- Assessment of direct view of the cabin (CS 25) needs also to be addressed in EASA operational regulations
- Commercial pressure for rapid turn-rounds risks satisfactory completion of crew safety checks

# Flight Deck Security

- The post-9/11 flight deck security requirements must be compatible with flight and cabin crew operational procedures
- Secondary barrier installations (US - Saracini Act) must not be permitted to compromise escape routes for passengers and crew in the event of an emergency evacuation

# Cabin Baggage and Overhead Bins



- Bin weights can exceed physical abilities of pax and crew
- Reduced survivable space
- No requirement for dynamic load testing
- Injury mechanism
- Notional weights?
- Safety of displaced bags



# My bag is worth more to me than your life...



Lockable overhead bins?

Baggage considered in certification testing?









# FOG Wish List - Operational Issues

- Greater involvement of operational personnel in initial type certification
- Better standardisation of cabin crew emergency equipment locations/ease of access
- Feasibility study into lockable overhead bins
- Dynamic load testing of bins, better placarding and load management
- Sufficient turn-round time!
- Fire ports in lavatory doors

# Recommendations

- Multiple recommendations contained in FOG ‘Evacuation of Commercial Passenger Aeroplanes’ (2018)
  - Required cabin crew numbers
  - Exits, slides, numbering, operation and passenger briefing
  - Evacuation procedures, decisions, training
  - Seat allocations, child restraint systems
  - Cabin baggage...

# Conclusions

- Many improvements in the last 30 years
  - occupant safety has been enhanced
- Commercial pressures directly affect operational safety
- Toxic/flammable materials was the killer in the 70's/80's, cabin baggage is today's threat in otherwise survivable accidents
- **Tombstone regulation is unacceptable!**