Notice of Proposed Amendment 2013-20

Seat crashworthiness improvement on large aeroplanes — Dynamic testing 16g

RMT.0069 (26.002) — 10/10/2013

EXECUTIVE SUMMARY

This Notice of Proposed Amendment (NPA) addresses a safety issue related to the crashworthiness of passenger and crew seats in order to mitigate the risk of subsequent injuries or deaths.

CS-25 provides specifications to protect large aeroplane occupants from serious injury in case of emergency landing. These specifications are CS 25.785, CS 25.561 and CS 25.562, and are only applicable to new large aeroplane types under certification and to some significant changes to existing types.

This NPA proposes, within the new framework introduced by Part-26 and CS-26 (proposed by NPA 2012-13 dated 13 September 2012 and Opinion 08/2013, dated 25 September 2013), to add additional airworthiness requirements and specifications for operations in order to make the above CS 25.562 specifications applicable also to newly produced aircraft of already approved type.

The proposed changes are expected to increase safety and improve harmonisation with the corresponding Federal Aviation Administration (FAA) requirements.

Applicability		**Process map**	
Affected regulations and decisions:	Part-26, CS-26	Concept Paper:	No
		Terms of Reference:	17/09/2010
		Rulemaking group:	No
Affected stakeholders:	EU Member States manufacturers of Large Aeroplanes used for CAT	RIA type:	Full
		Technical consultation during NPA drafting:	Yes
Driver/origin:	FAA Part-121, **Amendment No 121–315** of 27 September 2005	Duration of NPA consultation:	3 months
		Review group:	No
Reference:	Federal Register Vol. 70 No 186 dated 27 September 2005	Focussed consultation:	No
		Publication date of the Opinion:	2015/Q1
		Publication date of the Decision:	2016/Q1

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1. Procedural information

1.1. The rule development procedure

The European Aviation Safety Agency (hereinafter referred to as the 'Agency') developed this Notice of Proposed Amendment (NPA) in line with Regulation (EC) No 216/2008[1] (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure[2].

This rulemaking activity is included in the Agency's Rulemaking Programmefor 2014–2017 under RMT.0069 (26.002)[3]

The text of this NPA has been developed by the Agency. It is hereby submitted for consultation of all interested parties[4].

The *process map* on the title page contains the major milestones of this rulemaking activity to date and provides an outlook of the timescale of the next steps.

1.2. The structure of this NPA and related documents

Chapter 1 of this NPA contains the procedural information related to this task. Chapter 2 (Explanatory Note) explains the core technical content and summarises the Regulatory Impact Assessment (RIA). Chapter 3 contains the proposed text for the new requirements. Appendix 1 contains the RIA showing which options were considered and what impacts were identified, thereby providing the detailed justification for this NPA.

1.3. How to comment on this NPA

Please submit your comments using the automated **Comment-Response Tool (CRT)** available at **http://hub.easa.europa.eu/crt/**[5].

The deadline for submission of comments is **10 January 2013.**

1.4. The next steps in the procedure

Following the closing of the NPA public consultation period, the Agency will review all comments.

The outcome of the NPA public consultation will be reflected in the respective Comment-Response Document (CRD).

The Agency will publish the CRD with the Opinion and Decision.

The Opinion contains proposed changes to EU regulations and it is addressed to the European Commission, which uses it as a technical basis to prepare a legislative proposal.

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1 Regulation (EC) No 216/2008 of the European Parliament and the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (OJ L 79, 19.3.2008, p. 1), as last amended by Commission Regulation (EU) No 6/2013 of 8 January 2013 (OJ L 4, 9.1.2013, p. 34).

2 The Agency is bound to follow a structured rulemaking process as required by Article 52(1) of the Basic Regulation. Such process has been adopted by the Agency's Management Board and is referred to as the 'Rulemaking Procedure'. See Management Board Decision concerning the procedure to be applied by the Agency for the issuing of Opinions, Certification Specifications and Guidance Material (Rulemaking Procedure), EASA MB Decision No 01-2012 of 13 March 2012.

3 See: http://easa.europa.eu/agency-measures/docs/agency-decisions/2012/2012-013-R/4-Year%20RMP%202013-2016.pdf.

4 In accordance with Article 52 of the Basic Regulation and Articles 5(3) and 6 of the Rulemaking Procedure.

5 In case of technical problems, please contact the CRT webmaster (crt@easa.europa.eu).

The Decision containing Certification Specification (CS) and Guidance Material (GM) will be published by the Agency when the related Implementing Rule(s) is (are) adopted by the European Commission.

2. Explanatory Note

This NPA addresses a safety issue related to the crashworthiness of passenger and crew seats in order to prevent subsequent injuries or deaths.

The proposed changes are expected to increase safety and improve harmonisation with existing FAA requirements.

2.1. Overview of the issues to be addressed

Definition of the issue

In case of emergency landing and survivable accident impact, the level of protection of passenger and cabin crew seats was found not to be optimal on some large aeroplanes.

To compensate for this, seating system certification standards improvements were introduced in JAR-25 Change 13 (dated 5 October 1989), now transposed in EASA CS-25. Aeroplanes which were type certified before the introduction of these standards improvements have not necessarily upgraded their seating system, thus offering a lower level of occupant protection compared to more recent types.

JAR-25 Change 13 upgraded the seating system certification standards from a 9g static standard to an upgraded 9g static standard and a new 16 g dynamic standard.

In case of an accident, the number of serious injuries and fatalities would thus be potentially greater on older types than on recent types of large aeroplanes.

Types of aircraft, systems, constitutents or equipment affected

This issue affects large aeroplanes, still being produced and used for commercial air transportation of passengers, having a type certification basis which does not include the latest seating system standards introduced in JAR-25 Change 13, transposed into EASA CS-25.

Passenger and flight attendant seats of these aeroplanes are in the scope of CS 25.562(b), whereas flight crew seats are excluded from it. It shall be noted that in FAR 25, 25.562(b) is also applicable to *flight crew* seats, which constitutes a difference in applicability that is maintained in the proposed rules for consistency with CS 25.562.

Regulation history and status — EASA and FAA

In the EU, EASA CS-25 provides specifications to protect large aeroplane occupants from serious injuries in case of emergency landing. These specifications are CS 25.785, CS 25.561 and CS 25.562, and are applicable to the certification of new large aeroplane types and to some significant changes to existing types.

In the USA, FAR Part 25 provides similar specifications as CS-25 for new types. The introduction of seat standards improvements was done with Amendment 25-64, effective 16 June 1988. FAA AC 25.562-1A (dated 19 January 1996) provides guidance to industry on the dynamic testing of seats.

In addition, FAA published in 2005 a final rule amending Part 121 (Amendment 121-315) which requires that 'after October 27, 2009, no person may operate a transport category airplane type certificated after January 1, 1958 and manufactured on or after October 27, 2009 in passenger-carrying operations under this part unless all passenger and flight attendant seats on the airplane meet the requirements of § 25.562 in effect on or after June 16, 1988'.

Paragraph 25.561 of EASA CS-25 and FAR Part 25 provides seat static load testing instructions up to 9g in the forward direction. Seats meeting these testing requirements are commonly called '9g seats'. This paragraph already existed before but was upgraded at the time of FAR Part 25 Amendment 25-64 and JAR-25 Change 13.

Paragraph 25.562 of EASA CS-25 and FAR Part 25 provides for dynamic seat testing instructions with acceleration levels up to 16 g in the forward longitudinal direction, and also seat occupant protection criteria like the Head Injury Criterion (HIC). Seats meeting these testing requirements are commonly called '16 g seats'.

Aeroplanes that were not required to meet these certification requirements have not necessarily been upgraded to the improved seating standards and hence offer a lower level of occupant protection compared to more recent aircraft types. Thus, in an impact-related accident to these aircraft, there is a greater potential for serious and fatal injuries.

EASA retroactive airworthiness regulatory framework

In the JAA system, retroactive requirements were covered under JAR-26 (Additional Airworthiness Requirements for Operations); Subpart B was dedicated to Commercial Air Transport (Aeroplanes). If rendered mandatory by Member States' national legislation, they were/are applicable to operators of large aeroplanes.

The Agency is currently defining a new regulatory framework for the transposition of JAR 26 (rulemaking task 21.039(k)) into Part-26 and CS-26.

Once the regulatory framework is introduced through task 21.039(k), the result of this task RMT.0069 (26.002) will amend the newly defined applicable regulation and certification specification.

For a detailed analysis of the issues addressed by this proposal, please refer to the full RIA in *Chapter 6. Appendices*.

2.2. Objectives

The overall objectives of the EASA system are defined in Article 2 of the Basic Regulation. This proposal will contribute to the achievement of the overall objectives by addressing the issues outlined in Chapter 2 of this NPA.

The specific objective of this proposal is to improve the protection of occupants onboard large aeroplanes operated for commercial air transportation (CAT) of passengers, when they are involved in a survivable accident impact.

This improvement would be reached by introducing on large aeroplanes (used for CAT operations that were type certified without the JAR-25 Change 13 standards improvements) passenger and cabin crew seats meeting the improved standards for dynamic testing and occupant protection, already used for type certification of new large aeroplanes. The applicability to newly produced and/or in-service aircraft would be then refined depending on the results of the RIA, as summarised below.

2.3. Summary of the Regulatory Impact Assessment (RIA)

The RIA (Ref.: EASA.2011.OP.14/L2.03, dated March 2013) was prepared by *SGI Aviation* and *RGW Cherry and Associates* and is added as Appendix 1 to this NPA for further reference. For more details, please refer to the 'Final Report for the Task of Regulatory Impact Assessment for the Rulemaking Task RMT.0069(26.002) on Seat Crashworthiness Improvement on Large Aeroplanes – Dynamic Testing 16g' Issue 2, Ref.: EASA.2011.OP.14/L2.03, dated March 2013, SGI Aviation and RGW Cherry and Associates Aeronautical and Safety Engineers.

The purpose of the RIA is to compare the two options proposed in the related Pre-RIA:

— Option 1 requiring 16 g seats to be fitted to newly manufactured large aircraft used in commercial air transport;

— Option 2 requiring 16 g seats to be fitted to **in-service and** newly manufactured large aircraft used in commercial air transport.

In the RIA, it appears that the safety benefit of Option 2 is obviously better than Option 1, since more aircraft would be retrofitted in the EU fleet, which represents 4.8 lives saved as compared to 1.3 lives until 2030, i.e. 3.5 more lives saved in the whole EU fleet. However, the cost of retrofitting in-service fleet makes it prohibitive and makes Option 1 preferable.

The RIA also recommends to exclude large aeroplanes which, although operating in commercial air transport, do not typically offer scheduled flights, that is corporate jets or the so-called 'VIP' aircraft.

The primary reasons for this recommendation are that:

— the comparison of benefit and cost between Option 1 and Option 2 is largely insensitive to these aircraft which are rather few and/or configured with less than 20 passenger seats, simply because of the small total number of passenger seats concerned;

— this would also result in equivalency with FAA. In the USA, the rule is restricted to FAR 121 operators which, in their system, does not affect these types of aircraft and operations.

Because this distinction does not exist yet in the EASA system, it is adressed by specifying the applicability in the proposed amendment to Part-26.

2.4. Overview of the proposed amendments

New paragraphs are respectively added to EASA Part-26 and CS-26 to introduce the proposed change.

As for the conversion of JAR-26 into the respective EASA Part-26 and CS-26 (RMT 21.039(k)), this is done on the one hand by extracting the top level safety-relevant requirements and applicability from CS 25.562, and by listing them in Part-26, and on the other hand by listing the technical requirements by adding the corresponding paragraphs in CS-26 and AMC. Thus, this does not lead to any differences in substance between JAR 26 and Part-26 + CS-26. For the sake of simplicity, and since the subject relates to _Subpart B — Large Aeroplanes, 26.50 Seat, berths, safety belts and harnesses,_ the new requirements are added after 26.50 by creating a 26.60 new paragraph, as well as the corresponding AMCs as AMC1.26.60.

3. Proposed amendments

New paragraphs are respectively added to EASA Part-26 and CS-26 to introduce the proposed change. The text of the amendment is arranged to show deleted text, new or amended text as shown below:

(a) deleted text is marked with ~~strike through~~;

(b) new or amended text is highlighted in grey;

(c) an ellipsis (…) indicates that the remaining text is unchanged in front of or following the reflected amendment.

NOTE: Some parts of the current Part-26 and CS-26 have been voluntarily duplicated here in order to better understand the formulation of the introduced paragraph with respect to the overall rule and/or the paragraphs located before or after, even if they have not been changed.

3.1. Draft Regulation (Draft EASA Opinion)

DRAFT COMMISSION REGULATION (EU) No …/…

amending COMMISSION REGULATION (EU) No …/…

of […]

on additional airworthiness requirements for operations

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC ([6]) as amended by Regulation (EC) No 1108/2009 of the European Parliament and of the Council of 21 October 2009 in the field of aerodromes, air traffic management and air navigation services and repealing Directive 2006/23/EC ([7]), and in particular Article 5 thereof,

Whereas:

(1) Pursuant to Regulation (EC) No 216/2008 (hereinafter referred to as the 'Basic Regulation'), the Commission, assisted by the European Aviation Safety Agency (hereinafter referred to as 'the Agency'), is required to adopt the necessary implementing rules for common airworthiness requirements throughout the Union

(2) Such requirements, covering the entire life cycle of aeronautical products, may include additional requirements for a given type of operations to be implemented after the initial issuance of an airworthiness approval in the interest of safety.

[6] OJ L 79, 19.3.2008, p. 1.
[7] OJ L 309, 24.11.2009, p. 51.

(3) Seat standards improvements were introduced by FAA via FAR-25 Amendment 25-64, effective 16 June 1988, reflected in JAR-25 Change 13, and then in paragraphs CS-25.785, 25.561 and 25.562, but were only applicable to newly type certified large aeroplanes.

(4) The applicability of the latter FAR 25.562 requirements were extended by FAA to newly produced and in-service aircraft performing commercial air transport operations via an amendment to FAR 121.311 requiring that 'after October 27, 2009, no person may operate a transport category airplane type certificated after January 1, 1958 and manufactured on or after October 27, 2009 in passenger-carrying operations under this part unless all passenger and flight attendant seats on the airplane meet the requirements of § 25.562 in effect on or after June 16, 1988'.

(5) Considering the remaining risk to newly produced aircraft which are not yet compliant with CS-25.562 in the EU.

(6) The Agency prepared draft implementing rules and submitted them as an Opinion to the Commission in accordance with Article 19(1) of Regulation (EC) No 216/2008.

(7) The measures provided for in this Regulation are in accordance with the Opinion of the European Aviation Safety Agency Committee established by Article 65 of Regulation (EC) No 216/2008,

HAS INTRODUCED THE FOLLOWING CHANGES TO ITS REGULATION:

Article 1

Amendment to Commission Regulation (EU) No …/…

Annex I (Part-26) to Commission Regulation (EU) No …/… laying down additional airworthiness requirements for air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council are amended in accordance with Annex I to this Regulation.

Article 2

Entry into force

This Regulation shall enter into force on the 20th day following its publication in the *Official Journal of the European Union*.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels, …

For the Commission

The President

ANNEX I

DRAFT AMENDED PART-26

Additional airworthiness requirements for operations

Subpart B — Large aeroplanes

…

26.60 Emergency landing — dynamic conditions

Operators of large aeroplanes used in commercial air transport, type certified on or after 1 January 1958, and manufactured on or after [one year after the entry into force of this Regulation] shall ensure that:

(a) each seat and its restraint systems are designed to protect each occupant during an emergency landing condition when –

(1) proper use is made of seats, safety belts, and shoulder harnesses provided for in the design; and

(2) the occupant is exposed to loads resulting from dynamic emergency landing conditions.

(b) with the exception of flight deck crew seats, each seat type design approved for occupancy has successfully completed dynamic tests or is demonstrated by rational analysis based on dynamic tests of a similar type seat, in accordance with emergency landing conditions, with the seat configured in order to provide an optimum level of protection in an emergency landing whilst allowing the occupant's necessary functions and facilitating rapid egress.

…

3.2. Draft Certification Specifications (Draft EASA Decision)

DRAFT AMENDED CS-26

Additional airworthiness specifications for operations

Book 1
Subpart B — Large aeroplanes

…

CS 26.60 Emergency landing — dynamic conditions

Compliance with Part 26.60 is demonstrated by complying with CS 25.562, or equivalent, or with the following (see AMC 26.60):

(a) The tests are conducted with an occupant simulated by a 77 kg (170 lb anthropomorphic test dummy sitting in the normal upright position:

(1) A change in downward vertical velocity (∆v) of not less than 10.7 m/s (35 ft/s) with the aeroplane's longitudinal axis canted downward 30 degrees with respect to the horizontal plane and with the wings level. Peak floor deceleration occurs in not more than 0·08 seconds after impact and reaches a minimum of 14 g.

(2) A change in forward longitudinal velocity (∆v) of not less than 13.4 m/s (44 ft/s) with the aeroplane's longitudinal axis horizontal and yawed 10 degrees either right or left, whichever would cause the greatest likelihood of the upper torso restraint system (where installed) moving off the occupant's shoulder, and with the wings level. Peak floor deceleration must occur in not more than 0·09 seconds after impact and must reach a minimum of 16 g. Where floor rails or floor fittings are used to attach the seating devices to the test fixture, the rails or fittings must be misaligned with respect to the adjacent set of rails or fittings by at least 10 degrees vertically (i.e. out of parallel) with one rolled 10 degrees.

(b) The following performance measures must not be exceeded during the dynamic tests conducted in accordance with subparagraph (b) of this paragraph:

(1) Where upper torso straps are used tension loads in individual straps must not exceed 794 kg (1750 lb). If dual straps are used for restraining the upper torso, the total strap tension loads must not exceed 907 kg (2000 lb).

(2) The maximum compressive load measured between the pelvis and the lumbar column of the anthropomorphic dummy must not exceed 680 kg (1500 lb).

(3) The upper torso restraint straps (where installed) must remain on the occupant's shoulder during the impact.

(4) The lap safety belt must remain on the occupant's pelvis during the impact.

(5) Each occupant is protected from serious head injury under the conditions prescribed in subparagraph (a) of this paragraph. Where head contact with seats or other structure can occur, protection is provided so that the head impact does not exceed a Head Injury Criterion (HIC) of 1000 units. The level of HIC is defined by the equation –

$$HIC = \left\{ (t_2 - t_1) \left[\frac{1}{(t_2 - t_1)} \int_{t_1}^{t_2} a(t)dt \right]^{2.5} \right\}_{max}$$

Where –

t1 is the initial integration time,

t2 is the final integration time, and

a(t) is the total acceleration vs time curve for the head strike, and where

(t) is in seconds, and (a) is in units of gravity (g).

(6) Where leg injuries may result from contact with seats or other structures, protection is provided to prevent axially compressive loads exceeding 1021 kg (2250 lb) in each femur.

(7) The seat remains attached at all points of attachment, although the structure may have yielded.

(8) Seats do not yield under the tests specified in subparagraphs (a)(1) and (a)(2) of this paragraph to the extent they would impede rapid evacuation of the aeroplane occupants.

…

3.3. Draft Acceptable Means of Compliance and Guidance Material (Draft EASA Decision)

BOOK 2 — GUIDANCE MATERIAL (GM)

Subpart A — General

GM1 26.1 JAR-26 / JAR/CS-25 / FAR-25+121 / OPS / Part-26 / CS-26 / GM-26 Cross-reference table

This table is intended to be a quick cross-reference table between those requirements contained on the one hand in Part-26, CS-26 and GM-26, and on the other hand their 'parent' airworthiness code (when existing), i.e. JAR-26, FAA's requirements FAR-25 and/or FAR Part-121, as well as related EU-OPS and new EASA operational requirements. This table is only indicative and does not pre-empt compliance with applicable requirements, which shall be assessed by the competent authority.

JAR-26	JAR-25 / CS-25	FAR-25 / Part-121	OPS	Part-26	CS-26	GM-26
JAR 26.1	n/a	n/a	n/a	n/a	n/a	n/a
JAR 26.2	n/a	n/a	n/a	n/a	n/a	n/a
JAR 26.3	n/a	n/a	n/a	26.35	n/a	n/a
JAR 26.5	n/a	n/a	n/a	n/a	n/a	n/a
JAR 26.50	JAR 25.785(h), (j) & (k) at Change 8, 30/11/81 CS 25.785(g)	FAR 25.785(g), Amdt 25-51, 06/03/80 FAR 121.311 (d)(f) & (g) at Change 21, 17/02/98	OPS 1.730 CAT.IDE.A.205	Part 26.50	CS 26.50	GM1 26.50(c)
N/A	JAR 25.562 CS 25.562	FAR 25.562 FAR 121.311(j) Amdt 121-315	OPS 1.730 CAT.IDE.A.205	Part 26.60	CS 26.60	AMC1 26.60
JAR 26.100	JAR 25.807(d)(7) at Change 13 and Amdt 93/1 08/03/93 CS 25.807	121.310(m)	n/a	Part 26.100	CS 26.100	n/a
JAR 26.105	JAR 25.813(d) to (f) at Change 8, 30/11/81 CS 25.813	121.310(f)	OPS 1.735 CAT.IDE.A.215	Part 26.105	CS 26.105	n/a
JAR 26.110	JAR 25.811(a) to (d) and (f) to (g) at Change 8, 30/11/81 JAR 25.811(e) at Change 14, 27/05/94 CS 25.811	121.310(b)	OPS 1.815 CAT.IDE.A.275	Part 26.110	CS 26.110	GM1 26.110 (e)(4)

JAR-26	JAR-25 / CS-25	FAR-25 / Part-121	OPS	Part-26	CS-26	GM-26
JAR 26.120	JAR 25.812 (b),(c),(d) & (h) at Change 8, 30/11/81 JAR 25.812 (a) & (e) at Change12, 16/06/86 CS 25.812	FAR 121.310 (b),(c) & (d) at Change 21, 17/02/98	OPS 1.815(a)(1) CAT.IDE.A.275(b)	Part 26.120	CS 26.120	n/a
JAR 26.125	JAR 25.812 (f) & (g) at Change 8, 30/11/81 CS 25.812	FAR 121.310 (h)(1) at Change 21, 17/02/98	OPS 1.185(a)(1)(iv) and (v) CAT.IDE.A.275 (b)(4) and (5)	n/a	n/a	n/a
JAR 26.130	CS 25.810	FAR 25.2 (a) at Amdt 25-72, 20/08/90 FAR 121.310 (a) & (h)(2) at Change 21, 17/02/98	OPS 1.805 CAT.IDE.A.265	n/a	n/a	n/a
JAR 26.150	JAR 25.791 at Change. 8, 20/11/81 JAR 25.853(a) to (d) at Change 14, 27/05/94 JAR 25.853(e) at Change 13 plus Amdt 91/1, 12/04/91 JAR 25.853(f) and Appendix F at Change 14, 27/05/94 Appendix F, Part I, at Amdt 93/1, 08/03/93 Appendix F, Part II, III, IV, V at Change 13 05/10/89 CS 25.853	FAR 121.312	OPS 1.731 CAT.IDE.A.210	Part 26.150	CS 26.150 App. F	GM1 26.150 (a), GM1 26.150 (c), GM1 26.150 (d)
JAR 26.155	JAR 25.855 and Appendix F, Part III at Change.13 plus Amdt 93/1, 08/03/93 CS 25.855	121.314	n/a	Part 26.155	CS 26.155 App. F	n/a
JAR 26.160	JAR 25.854 at Change.13 at Amdt 93/1, 08/03/93 CS 25.854	121.308	n/a	Part 26.160	CS 26.160	n/a

JAR-26	JAR-25 / CS-25	FAR-25 / Part-121	OPS	Part-26	CS-26	GM-26
JAR 26.200	JAR 25.729 at Amdt 93/1, 08/03/93 CS 25.729	121.289, Amdt 121-227	n/a	Part 26.200	CS 26.200	n/a
JAR 26.250	n/a	121.313(j)(1)(ii)	n/a	Part 26.250	n/a	n/a
JAR 26.260	CS 25.795	121.313(j)(1)(ii)	OPS 1.1255 ORO.SEC.100.A	n/a	n/a	n/a

Subpart B — Large aeroplanes

...

AMC1 26.60 Emergency landing — dynamic conditions

AC 25.562-1A (dated 19 January 1996) is applicable when showing compliance with CS-26.60.

...

4. Regulatory Impact Assessment (RIA)

The RIA (Ref.: EASA.2011.OP.14/L2.03, dated March 2013) was prepared by *SGI Aviation* and *RGW Cherry and Associates*.

The RIA and the associated Final Report, both at Issue 2, are attached in *Chapter 6. Appendices* for reference.

5. References

5.1 Affected regulations

EASA Part-26

5.2 Affected CS, AMC and GM

EASA CS-26 and related GM

5.3 Reference documents

1. RGW Cherry & Associates Limited and SGI Aviation Services B.V. *(2013). Final Report for the task of 'Regulatory Impact Assessment for the Rulemaking Task RMT.0069 (26.002) on Seat Crashworthiness Improvement on Large Aeroplanes – Dynamic Testing 16 g'* EASA.2011.OP.14/L2.03, European Aviation Safety Agency. Germany
2. European Aviation Safety Agency (2010). *Preliminary Regulatory Impact Assessment, Seat crashworthiness improvement on Large Aeroplanes - Dynamic testing 16g, 26.002,* European Aviation Safety Agency, Germany
3. RGW Cherry & Associates Limited, (2005). *A Benefit Analysis for Aircraft 16G Dynamic Seats Configured without Enhancements to Head Injury Criteria- CAA Paper 2005/03, DOT/FAA/AR-04/27*, U.K. Civil Aviation Authority, United Kingdom. http://www.caa.co.uk/docs/33/2005_03.pdf (last visited July, 2012).
4. RGW Cherry & Associates Limited, (2010). *Trends in Accidents and Fatalities in Large Transport Aircraft - DOT/FAA/AR-10/16* U.S. Federal Aviation Administration, United States of America http://www.fire.tc.faa.gov/pdf/10-16.pdf (last visited February, 2013).
5. RGW Cherry & Associates Limited, (January 2011). *The Cabin Safety Research Technical Group Accident Database,* Prepared for Transport Canada, the Federal Aviation Administration and the UK Civil Aviation Authority. United Kingdom: http://www.rgwcherry-adb.co.uk/ (last visited January, 2013).
6. The U.S. Department of Transportation, Office of Policy, Transportation Policy (2011). *Treatment of the Economic Value of a Statistical Life in Departmental Analyses – 2011 Interim Adjustment* http://www.dot.gov/policy/transportation-policy/treatment-economic-value-statistical-life (last visited December 2012)
7. 'Benefit analysis for aircraft 16-g dynamic seats' Report DOT/FAA/AR-00/13, dated April 2000 and Addendum Report DOT/FAA/AR-04/27 dated October 2005.

6. Appendices

6.1. Appendix 1 — Regulatory Impact Assessment (RIA)

EASA REGULATORY IMPACT ASSESSMENT

Seat Crashworthiness Improvement on Large Aeroplanes — Dynamic Testing 16 g

MARCH 2013

Issue 2

AMENDMENT RECORD

ISSUE NUMBER	DATE	REMARKS
1	February 2013	Initial Issue
2	March 2013	Issue 2 – Incorporating EASA comments

EASA REGULATORY IMPACT ASSESSMENT — SEAT CRASHWORTHINESS IMPROVEMENT ON LARGE AEROPLANES – DYNAMIC TESTING 16 g — Issue 2, March 2013

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EASA REGULATORY IMPACT ASSESSMENT — SEAT CRASHWORTHINESS IMPROVEMENT ON LARGE AEROPLANES – DYNAMIC TESTING 16 g — Issue 2, March 2013

1. Abbreviations

AIS	Abbreviated Injury Scale
AOC	Air Operator Certificate
CFR	Code of Federal Regulations (FAA)
CS	Certification Specification (EASA)
CSRTG	Cabin Safety Research Technical Group
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
HIC	Head Injury Criteria
NPA	Notice of Proposed Amendment (EASA)
NTSB	National Transportation Safety Board (USA)
RIA	Regulatory Impact Assessment
UK CAA	United Kingdom Civil Aviation Authority

EASA REGULATORY IMPACT ASSESSMENT — SEAT CRASHWORTHINESS IMPROVEMENT ON LARGE AEROPLANES – DYNAMIC TESTING 16 g — Issue 2, March 2013

2. Definition of Terms

25.562 compliant seats
Throughout this Regulatory Impact Assessment, the term "25.562 compliant seats" refers to seats that are manufactured and installed such that they are fully compliant with the requirements of CS 25.562.

Accident Scenario
That volume of the aircraft in which the occupants are subjected to a similar level of threat.

EASA Operator
An enterprise with a principal place of business in an EASA Member State that offers to the general public commercial air transportation of passengers in large aeroplanes.

Fatal Injury
"Fatal Injury" means any injury that results in death within thirty (30) days of the accident. (NTSB)

Serious Injury
"Serious Injury" means any injury that:

(1) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received;
(2) results in a fracture of any bone (except simple fracture of fingers, toes, or nose);
(3) causes severe haemorrhages, nerve, muscle, or tendon damage;
(4) involves injury to any internal organ; or
(5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface. (NTSB)

3. Process and consultation

The conclusions reached in this RIA are based primarily on a study commissioned by EASA (Reference 1). The study was aimed at analysing the impacts of implementing the two options identified in Section 6 of this Regulatory Impact Assessment (RIA). These options were defined by EASA in a Preliminary Regulatory Impact Assessment (Reference 2). The study involved consultation with aircraft manufacturers, seat manufacturers and European airlines via a series of questionnaires. These questionnaires were aimed at obtaining data regarding:

- The current and future prediction of the number of aircraft in-service, and in production, that are configured without "25.562 compliant seats".
- The costs associated with the installation of "25.562 compliant seats" for both passenger and cabin crew seats.
- Weight changes associated with the installation of "25.562 compliant seats" for both passenger and cabin crew seats.

Benefit and costs associated with the proposed regulatory options were assessed by means of mathematical models that were developed specifically for this Regulatory Impact Assessment.

Further details of the process employed and data requirements for assessing the impacts of the proposed regulatory options are described in Section 7 of this RIA.

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4. Issue analysis and risk assessment

4.1. Issue which the NPA is intended to address and sectors concerned

4.1.1. Issue addressed by the NPA

In survivable impact accidents, the level of protection afforded by passenger and cabin crew seats is not optimal on some Large Aeroplanes in "EASA Operator" fleets, with a consequential risk of Fatal or Serious Injury to occupants.

Improvements to seating system certification standards were introduced in JAR-25 change 13 (dated 5 October 1989). This amendment to the requirements upgraded the seating system certification standards from a 9 g static standard to an upgraded 9 g static standard and a new 16 g dynamic standard. These improved seat standards are now incorporated in EASA CS-25 (see Appendix 1).

Aeroplanes that were not required to meet these certification requirements have not necessarily been upgraded to the improved seating standard and hence have a lower level of occupant protection compared to more recent aircraft types. Thus in an impact related accident to these aircraft there is a greater potential for Serious and Fatal Injuries.

To address this issue EASA carried out a Preliminary Regulatory Impact Assessment (Reference 2) which identified two options for regulatory change as defined in Section 6 of this RIA.

The proposed regulatory change addresses passenger aeroplanes used for public transport, by airlines operating in EASA member states. However, it is recommended that it exclude Large Aeroplanes that although operating in Commercial Air Transport, do not typically offer scheduled flights, e.g. so called Corporate Jets or "VIP" aircraft.

The primary reasons for this recommendation are that:

- Comparisons of Benefit and Cost between Option 1 and Option 2 will be largely insensitive to these aircraft which are low in numbers and/or are configured with fewer than 20 passenger seats, simply because of the small total number of passenger seats concerned.

- This will also result in equivalency with the FAA. In the USA, the rule is restricted to FAR 121 operators which, in their system, results in these types of aircraft and operations being unaffected.

4.1.2. Sectors Concerned

The primary sectors concerned with the proposed regulatory change, intended to enhance occupant safety, are passengers and cabin crew, airlines, manufacturers of Large Aeroplanes, manufacturers of passenger or cabin crew seats and airline employees The potential economic impact on airlines and aircraft manufacturers is addressed in Section 8.3 of this RIA.

<u>Passengers and Cabin Crew</u>
The primary beneficiaries of the proposed regulatory standards are the passengers and cabin crew on-board "EASA Operators" aeroplanes who will be afforded a higher level of protection in impact related accidents.

<u>Airlines</u>
Incorporation of "25.562 compliant seats" on "EASA Operators'" aircraft is likely to result in costs being incurred by the airline. The primary cost burden to airlines is associated with the replacement of existing seats with passenger and cabin crew seats that are compliant with the 25.562 standard. Furthermore, if the replacement seats should result in weight increases there will also be an increase in aircraft operating costs due to the additional fuel burn. The potential for weight and costs being incurred may result directly from the seats or from other changes to the aircraft needed to comply with the CS 25.562 standard.

<u>Large Aeroplane Manufacturers</u>
Large Aeroplane manufacturers will already fit "25.562 compliant seats" for both passenger and cabin crew seats to aircraft intended to operate on the US register, or when specified by the customer. However, the proposed regulatory change will require all Large Aeroplanes manufactured for "EASA Operators" to be fitted with the "25.562 compliant seats".

<u>Seat Manufacturers</u>
Any increase in seat costs is likely to be borne by airlines or aircraft manufacturers rather than by seat manufacturers. Seat manufacturers will no longer supply 25.562 non-compliant passenger or cabin crew seats to manufacturers of aircraft destined for "EASA Operators'" aircraft.

<u>Airline employees</u>
If the proposed regulatory action imposed a disproportionate burden on "EASA Operators" then the threat to their economic viability might also impact on the jobs of the airline employees.

4.2. Risk Assessment

The proposed regulatory action is intended to improve occupant survivability in the event of an impact-related accident.

Based on the study carried out for EASA (Reference 1) [8], it is assessed that there are more than 3,400 "EASA Operators'" aircraft that are either non-compliant with the CS 25.562 seat standard or are only partially compliant. The magnitude of the issue, if no regulatory action is taken by EASA, is illustrated by the data contained in Table 1 and Table 2. These tables show the assessed number of in-service and new build aircraft with 25.562 non-compliant seats over the period 2012 to 2031. These data suggest that there will continue to be "EASA Operators'" aircraft operating with partially compliant, or non-compliant, CS 25.562 seats for the foreseeable future if no regulatory action is taken by EASA..

To support FAA proposed regulatory action in relation to the introduction of "16 g seats" a study was commissioned by the FAA and CAA UK (Reference 3). This study concluded:

> *"……the predicted number of lives and injuries to be saved for the accidents applicable to the US fleet of 14 CFR Part 121 aircraft over the period 1984 to 1998 inclusive:*
>
> *a) The revised benefit for 'fully compliant dynamic seats' becomes:*
>
> *Lives Saved = 56 x 5,37 x 0,152= 45*
> *Serious Injuries Saved = 49 x 5,37 x 0,152= 40*
>
> *b) The revised benefit for '16 g dynamic seats configured without enhancements to head injury criteria' becomes:*
>
> *Lives Saved = 34 x 5,37 x 0,152= 28*
> *Serious Injuries Saved = 27 x 5,37 x 0,152= 22"*

If 45 lives were saved over this period the lifesaving per flight would amount to approximately 3 (45÷15) lives per year. However, this assessment of life saving potential will have changed markedly since the time of the "FAA study". The major factors that would influence changes in this value, for any current prediction are:

1. The accident rate has reduced markedly since the time of the "FAA study".
2. Many aircraft now in service are already configured with "25.562 compliant seats".

Based on these factors it might be expected that the lifesaving potential would reduce dramatically since studies of accident rates such as that described in Reference 4 suggest significant improvements have been made over recent years.

Other factors will influence the lifesaving potential attributable to "25.562 compliant seats" and have been considered in the "EASA study" (Reference 1). The results of this study in terms of the potential safety impact of Options 1 and 2 are addressed in Section 8.1 of this Regulatory Impact Assessment.

[8] Henceforth referred to as the "EASA study"

Table 1 – Assessed Number of In-Service Aircraft for each year from 2012 to 2031

AIRCRAFT MODEL	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Airbus A300-600	4	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airbus A310	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airbus A318	19	21	22	23	24	25	26	27	28	29	30	31	33	34	35	36	37	34	31	28
Airbus A319	379	403	428	450	472	494	515	537	559	580	602	543	485	426	426	426	426	426	426	426
Airbus A320	583	604	624	643	661	680	698	716	667	617	567	517	468	418	368	368	368	368	368	368
Airbus A321	216	224	232	239	246	253	260	267	248	229	210	191	172	153	134	134	134	134	134	134
Airbus A330	85	85	85	85	85	85	85	85	85	85	85	75	66	56	46	36	27	17	7	0
Airbus A340	89	89	88	88	87	86	86	85	85	84	84	83	82	82	81	81	80	79	79	78
ATR 42	57	51	45	39	33	27	21	15	9	3	0	0	0	0	0	0	0	0	0	0
ATR 72	116	112	107	103	99	95	90	86	82	78	73	69	65	60	56	52	48	43	39	35
AVRO RJ	80	73	66	60	53	46	39	32	26	19	12	5	0	0	0	0	0	0	0	0
BAE ATP	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAE 146	18	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MD-11	9	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MD-80	64	55	47	38	30	21	12	4	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 717	9	9	9	9	9	8	8	8	8	8	8	8	8	8	8	7	7	7	7	7
Boeing 737 – 300/400/500	273	255	237	220	202	184	166	148	130	113	95	77	59	41	23	6	0	0	0	0
Boeing 737NG	753	805	858	910	963	1015	1057	1090	1114	1129	1135	1084	1033	981	930	879	828	777	726	674
Boeing 747 Classic	3	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 747-400	138	134	130	126	122	118	115	111	107	103	99	95	91	87	83	79	75	71	68	64
Boeing 757	106	98	90	81	73	65	57	48	40	32	24	15	7	0	0	0	0	0	0	0
Boeing 767	84	81	77	74	71	67	64	61	57	54	51	47	44	41	37	34	31	28	24	21
Bombardier CRJ Regional Jet (100/200)	30	27	25	22	20	17	14	12	9	7	4	1	0	0	0	0	0	0	0	0
Bombardier (DHC) Dash 8-100/200	22	19	15	12	9	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0

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AIRCRAFT MODEL	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Bombardier (DHC) Dash 8-300	32	25	17	10	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Embraer EMB-120 Brasilia	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fairchild/Dornier 328	22	20	18	16	15	13	11	9	7	5	4	2	0	0	0	0	0	0	0	0
Fokker 100	47	44	40	37	34	31	27	24	21	17	14	11	8	4	1	0	0	0	0	0
Fokker 50	47	41	35	29	23	17	11	5	0	0	0	0	0	0	0	0	0	0	0	0
Fokker 70	35	33	32	30	29	27	26	24	23	21	20	18	17	15	14	12	11	9	8	6
Saab 2000	39	35	32	28	24	20	17	13	9	5	2	0	0	0	0	0	0	0	0	0
Saab 340	50	45	41	36	31	27	22	17	13	8	4	0	0	0	0	0	0	0	0	0
BAE Jetstream 41	20	20	20	20	18	16	14	12	8	4	0	0	0	0	0	0	0	0	0	0
TOTAL	3,445	3,429	3,429	3,431	3,438	3,442	3,443	3,436	3,334	3,231	3,123	2,873	2,637	2,406	2,184	1,965	1,759	1,554	1,350	1,148

P/4220/Data/Aircraft Numbers/Hours Flights Number of Aircraft based on CAA Data v2

Table 2 – Assessed Number of New Build Aircraft for each year from 2012 to 2031

AIRCRAFT MODEL	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Airbus A300-600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airbus A310	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airbus A318	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Airbus A319	26	25	24	23	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Airbus A320	22	21	20	19	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Airbus A321	8	8	8	7	7	7	6	7	7	7	7	7	7	7	7	7	7	7	7	7
Airbus A330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airbus A340	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ATR 42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ATR 72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AVRO RJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAE ATP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAE 146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MD-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MD-80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 717	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 737 – 300/400/500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 737NG	52	52	53	52	53	52	42	33	24	15	6	0	0	0	0	0	0	0	0	0
Boeing 747 Classic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 747-400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 757	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 767	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bombardier CRJ Regional Jet (100/200)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AIRCRAFT MODEL	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Bombardier (DHC) Dash 8-100/200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bombardier (DHC) Dash 8-300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Embraer EMB-120 Brasilia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fairchild/Dornier 328	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fokker 100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fokker 50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fokker 70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saab 2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saab 340	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAE Jetstream 41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	109	107	106	102	101	100	89	81	72	63	54	48	48	48	48	48	48	48	48	48

P/4220/Data/Aircraft Numbers/Hours Flights Number of Aircraft based on CAA Data v2

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5. Objectives

The objective of the proposed rulemaking is to improve the protection of occupants on-board Large Aeroplanes operated for commercial air transportation of passengers, in a survivable impact accident.

This improvement would be achieved by introducing, on Large Aeroplanes used for commercial air transportation, passenger and cabin crew seats meeting the improved standard for dynamic testing and occupant protection, already used for type certification of new Large Aeroplanes. This improved standard is defined in CS 25.562, shown in Appendix 1 at Amendment 12, and was previously introduced in JAR-25 Change 13 in 1989.

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6. Options identified

In order to achieve the objectives defined in Section 5, the following options were identified in the EASA pre RIA (Reference 2):

1. Require the installation of passengers and cabin crews' seats meeting the improved standard for dynamic testing and occupant protection as defined in CS. 25.562, on Large Aeroplanes used for commercial air transportation of passengers that are newly manufactured after a given date.

2. Require the installation of passengers and cabin crews' seats meeting the improved standard for dynamic testing and occupant protection as defined in CS. 25.562, on Large Aeroplanes used for commercial air transportation of passengers that are already in service or newly manufactured, after a given date.

7. Methodology and data requirements

This Section of the Regulatory Impact Assessment gives a broad overview of the methodology, analytical methods and data requirements that have been employed in assessing the impacts of the proposed regulatory changes.

7.1. Number of Aircraft Non-compliant with the CS 25.562 Seat Standard

Only aircraft configured with seats that are not fully compliant with the CS 25.562 standard have the potential to incur costs, yield benefit or result in a social or environmental impact, from the proposed regulatory action. Hence, an assessment has been carried out of the numbers of aircraft that are non-compliant by aircraft type, in 2012, with an extrapolation of the likely numbers through to 2031. This assessment has been based on the following data sources:

a) Flightglobal for 2012 fleet data
b) UK CAA Hours and Landings Database
c) EASA for Type Certification data
d) Airbus and Boeing for market forecast data
e) Aircraft Manufacturers and Operators for information regarding aircraft that have "25.562 compliant seats" - these data were obtained by means of a series of questionnaires.

This has resulted in the predicted number of in-service aircraft and aircraft in manufacture, that are likely to be non-compliant with the CS 25.562 standard, from 2012 to 2031 as shown in Table 1 and Table 2 respectively.

7.2. Benefit and Cost Models

A primary issue in the Regulatory Impact Assessment is the determination of the Safety and Economic Impacts. The Safety Impact is the reduction in the number of Serious Injuries and Fatalities likely to be experienced and the Economic Impact is the cost resulting from implementation of Options 1 or 2. The Safety Impact may also be expressed as a monetary value by assigning a cost to the avoidance of Fatalities and Serious Injuries.

Assessments of the likely magnitude, of both the benefit and the cost, of installing "25.562 compliant seats" are made using mathematical models developed specifically for the project. These models are described in greater detail in Reference 1.

7.3. Rate of Occurrence of Impact Related Accidents

An important aspect of the determination of the potential injury reduction capability of "25.562 compliant seats" is an assessment of the likely rate of occurrence of impact related accidents that have the potential for survivability improvement from the proposed regulatory action.

As part of the "EASA study" impact related accidents were selected using the CSRTG Accident Database (Reference 5). The accidents selected were restricted to western built aircraft to ensure consistent data. The period over which accidents were selected was chosen based on a consideration of deriving a data set of a reasonable size and the derivation of an accident rate that is appropriate to current in-service aircraft.

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Accidents were identified satisfying the following criteria:

- The accident occurred to a western built passenger carrying aircraft model certificated for 30 passenger seats or more
- The accident was impact related involving Fatal and/or Serious Injuries but having some potential for survival
- Impact injuries were sustained by occupants other than as a result of crushing or mechanical asphyxiation
- The aircraft was operated by an "EASA Operator" or a FAR 121 Operator
- The accident occurred during the period 1997 to 2010.

The "EASA study" addressed aeroplanes configured with 20 seats or more, however, to derive a rate of occurrence of impact related accidents, aircraft certificated for 30 seats or more were analysed. Accident data availability tends to be greater on larger aircraft and since the number of flights used was related to these aircraft the derived accident rate is considered appropriate to all aircraft type certificated to 20 seats or more.

The number of flights, appropriate to the aircraft analysed was assessed from the UK CAA Database of Hours and Landings and found to be approximately 270,000,000 flights over the period 1997 to 2010. If it is assumed that over this period there were three accidents meeting the criteria specified above it might be expected that the predicted average accident rate would be:

$3 \div 270{,}000{,}000$ approximately equal to 1.1×10^{-8} per flight

However, the formula shown above gives an average accident rate. With such small datasets it is more realistic to develop distributions that indicate a confidence level in a range of accident rates.

The Δ^2 distribution may be used to derive the confidence level in any given accident rate based on the number of accidents experienced over a given time period as illustrated in Figure 1. Whilst the Δ^2 distribution has a sound mathematical basis it tends to give answers that are more pessimistic than might be expected. This may be seen by comparing the average accident rate with the data range illustrated in Figure 1.

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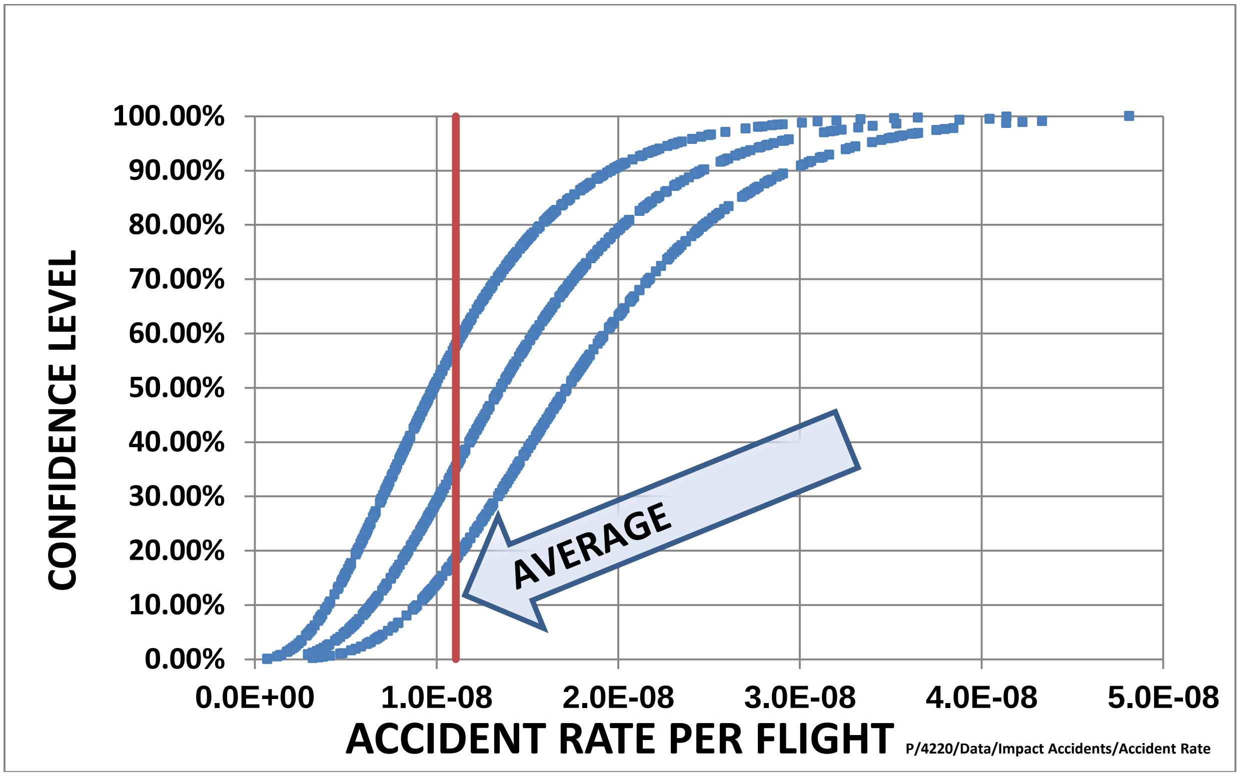

Figure 1 – Confidence Range in the Impact Accident Rate per Flight

Random selections are made by the Model of accident rate from the three derived distributions. The range of the accident rates reflects the degree of uncertainty in the data.

The derived accident rate is assumed to be appropriate to the entire period considered in this Regulatory Impact Assessment. This assumption is likely to be pessimistic since accident rates have been improving significantly over the past few decades.

7.4. Benefit per Occupant

An important aspect in the determination of the Safety Impact and Benefit is the degree to which "25.562 compliant seats" improve injury reduction for passenger and cabin crew members. This is expressed as a Benefit per Occupant (Passenger and Cabin Crew) and is made from a detailed evaluation of the injuries incurred by occupants in past accidents and an evaluation of the likely extent to which they might be mitigated by the improved seat standards.

To determine the Benefit per Occupant afforded by "25.562 compliant seats", use was made of the earlier assessments carried out in the "FAA study". In these studies, impact related accidents that occurred world-wide between 1984 and 1998 were analysed. The analysis was carried out for each accident scenario (see Section 0-) to assess the range of reduction in impact related fatalities and injuries had "25.562 compliant seats" been fitted. Also considered were the effects on passenger survivability of other cabin safety measures that have been the result of regulatory action, such as heat release flammability requirements. The manner in which the effects of both a reduction in the impact threat, from the installation of "25.562 compliant seats", and a reduction in the fire threat resulting from other regulatory improvements introduced after the accident date are explained in detail in the "EASA study" report.

The results of the "FAA study" are relevant to the present assessment of benefit per passenger, since the enhancement to safety afforded by "25.562 compliant seats" is no different on the current fleet of aircraft. However, the "FAA study" did not consider the effects on survivability due to the introduction of "25.562 compliant seats" for cabin crew. Hence, the impact related accidents were re-analysed in the "EASA study" to address this issue.

7.5. Costs Associated with the Installation of "25.562 compliant seats"

As described in Section 3 the cost, weight and data regarding aircraft non-compliant with the CS 25.562 standard were collected from aircraft manufacturers, seat manufacturers and European airlines via a series of questionnaires.

The methodology for assessing the economic impact is based on the costs incurred by the aircraft manufacturer and operator. It is evident that there will be differences in the costs for newly manufactured aircraft and in-service aircraft since replacement of seats on in-service aeroplanes is likely to result in the replaced seats being scrapped. All costs have been assessed at 2012 levels.

In a similar fashion to the estimation of Benefit, Costs are assessed by means of a mathematical model.

As well as the direct costs associated with the installation of "25.562 compliant seats" for passengers and cabin crew, in some instances other cabin configuration changes may be needed to accommodate the seat change. The costs of these other changes are assumed to be a function of either the number of passenger or cabin crew seats installed.

It is not envisaged that there will be any significant increase in maintenance costs due to the introduction of "25.562 compliant seats". In some instances airbags might be needed at some seat rows to ensure compliance with the HIC requirement of CS 25.562. In this case a maintenance penalty will be incurred. However, it is considered that these costs will be small in comparison to the direct costs involved in fitting "25.562 compliant seats". Aircraft downtime that may be associated with the fitment of "25.562 compliant seats" will also incur costs but once again these costs are likely to be relatively small.

As discussed in Section 7.6, it is not expected that the introduction of "25.562 compliant seats" will result in any significant weight increase. On this basis there will no costs incurred associated with additional fuel burn.

Hence, the primary cost drivers are those associated with the fitment of "25.562 compliant seats". These costs, based on the questionnaires sent to aircraft manufacturers, airlines and seat manufacturers, for both in-service and new build aircraft, are as shown in Table 3 to Table 8.

Table 3 - Passenger Seat Costs – In-Service Aircraft

FIRST CLASS SEAT COST – PER SEAT	BUSINESS CLASS SEAT COST– PER SEAT	ECONOMY CLASS SEAT COST– PER SEAT	FIRST CLASS SEAT LABOUR COST– PER SEAT	BUSINESS CLASS SEAT LABOUR COST– PER SEAT	ECONOMY CLASS SEAT LABOUR COST– PER SEAT
€ 10,200	€ 7,650	€ 1,700	€ 2,000	€ 2,000	€ 200
€ 9,372	€ 7,029	€ 1,562	€ 550	€ 550	€ 55
€ 10,944	€ 8,208	€ 1,824	€ 160	€ 160	€ 16
€ 13,518	€ 7,634	€ 2,253	€ 280	€ 280	€ 28

Table 4 - Other Costs – In-Service Aircraft

Other MATERIAL COSTS – PER SEAT associated with Passenger Seats (Seat Rail, Cabin layout changes, etc.)	Other LABOUR COSTS – PER SEAT associated with Passenger Seats (Seat Rail, Cabin layout changes, etc.)
€ 170	€ 20
€ 156	€ 6
€ 182	€ 2
€ 225	€ 3

Table 5 - Cabin Crew Seat Costs – In-Service Aircraft

CABIN CREW SEAT COST– PER SEAT	CABIN CREW SEAT LABOUR COSTS– PER SEAT	OTHER MATERIAL COSTS – PER SEAT associated with Cabin Crew Seats (Cabin layout changes, Bulkhead Strengthening etc.)	OTHER LABOUR COSTS – PER SEAT associated with Cabin Crew Seats (Cabin layout changes, Bulkhead Strengthening etc.)
€ 1,260	€ 250	€ 126	€ 25
€ 1,562	€ 550	€ 156	€ 55
€ 1,824	€ 160	€ 182	€ 16
€ 2,253	€ 280	€ 225	€ 28

Table 6 - Passenger Seat Costs – New Build Aircraft

FIRST CLASS INCREMENTAL SEAT COST – PER SEAT	BUSINESS CLASS INCREMENTAL SEAT COST– PER SEAT	ECONOMY CLASS INCREMENTAL SEAT COST– PER SEAT	FIRST CLASS SEAT LABOUR COST– PER SEAT	BUSINESS CLASS SEAT LABOUR COST– PER SEAT	ECONOMY CLASS SEAT LABOUR COST– PER SEAT
€ 1,020	€ 765	€ 170	€ 0	€ 0	€ 0
€ 937	€ 703	€ 156	€ 0	€ 0	€ 0
€ 1,094	€ 821	€ 182	€ 0	€ 0	€ 0
€ 1,352	€ 763	€ 225	€ 0	€ 0	€ 0

Table 7 - Other Costs – New Build Aircraft

Other MATERIAL COSTS – PER SEAT associated with Passenger Seats (Seat Rail, Cabin layout changes, etc.)	Other LABOUR COSTS – PER SEAT associated with Passenger Seats (Seat Rail, Cabin layout changes, etc.)
€ 170	€ 20
€ 156	€ 6
€ 182	€ 2
€ 225	€ 3

Table 8- Cabin Crew Seat Costs – New Build Aircraft

CABIN CREW INCREMENTAL SEAT COST – PER SEAT	CABIN CREW SEAT LABOUR COSTS – PER SEAT	OTHER MATERIAL COSTS – PER SEAT associated with Cabin Crew Seats (Cabin layout changes, Bulkhead Strengthening etc.)	OTHER LABOUR COSTS – PER SEAT associated with Cabin Crew Seats (Cabin layout changes, Bulkhead Strengthening etc.)
€ 126	€ 0	€ 126	€ 25
€ 156	€ 0	€ 156	€ 55
€ 182	€ 0	€ 182	€ 16
€ 225	€ 0	€ 225	€ 28

7.6. Weights Associated with the Installation of "25.562 compliant seats"

An increase, or decrease, in operating cost might be expected should the introduction of "25.562 compliant seats" result in weight changes. Any weight change will result in an associated change in fuel burn, which is aircraft model dependent. However, the "EASA study" concluded that:

> "On this basis, it has been assumed that there would be no weight increase for any passenger seats resulting from the proposed regulatory action.

A wide variation in weight changes due to the introduction of "25.562 compliant seats" were found from responses to the questionnaires sent to aircraft manufacturers, seat manufacturers and operators as illustrated by the data shown in Table 9. Five sources suggested there would be no weight change for economy class seats, three that there would be a weight decrease and one suggested a weight increase. Taking the average of the 8 numerical values proposed by the questionnaire respondents, gives a weight decrease of approximately one pound (-1 lb.) for an economy class seat..

Table 9 – Passenger Seat Weight Increases

	Economy Class	
Source	**Weight Change – Kg**	**Weight Change – lb.**
Aircraft Manufacturer 1	**0**	**0**
Aircraft Manufacturer 2	**lighter**	
Aircraft Manufacturer 3	**0**	**0**
Seat Manufacturer	**0.75**	**2**
Operator 1	**-2.3**	**-5**
Operator 2	**-1.9**	**-4**
Operator 3	**0**	**0**
Operator 4	**0**	**0**
Operator 5	**0**	**0**

P/4220/Data/Weights/Seat Weights

Only one data source responded to the questionnaire regarding business and first class seats. This was an aircraft manufacturer that suggested there would be no weight increase for any passenger seats resulting from the proposed regulatory action.

It is anticipated that there could be weight increases associated with installing "25.562 compliant seats" due to changes that might be required to other areas within the cabin (e.g. seat rails, bulkheads, etc.). However, as stated above, the average prediction for seat weight changes are a reduction of 1 lb. It is therefore assumed that this would accommodate any weight increases that might require change due to the introduction of "25.562 compliant seats". On this basis, it has been assumed that there would be no weight increase for any passenger seats resulting from the proposed regulatory action.

Since no data were obtained, in the "EASA study", from the questionnaires relating to cabin crew seat weights, it has been assumed that as for passenger seats there will be no net increase in weight due to the installation of "25.562 compliant seats".

EASA REGULATORY IMPACT ASSESSMENT — SEAT CRASHWORTHINESS IMPROVEMENT ON LARGE AEROPLANES – DYNAMIC TESTING 16 g — Issue 2, March 2013

7.7. Other Data Requirements and Analysis

Other data requirements required for the assessment of Safety and Economic Impacts, in the "EASA study", using the mathematical models, include the following;

7.7.1. Aircraft Cabin Configurations

For the Cost Model to make a determination of the likely annual costs that may be associated with the proposed regulatory change, the number of economy class, business class, first class and cabin crew seats needs to be determined for each of the aircraft models that are currently assessed to be not configured with "25.562 compliant seats". The total number of passenger seats and cabin crew seats are also required by the Benefit Model to assess improvements in occupant survivability due to the proposed regulatory change.

Data were obtained for all aircraft models addressed by this Regulatory Impact Assessment. This amounted to data pertinent to 1,937 "EASA Operators'" aircraft in 2012.

7.7.2. Monetary Value of Injuries

The output from the Benefit Model is expressed in Euros, or in terms of the reduction in the number of fatalities and serious injuries, per year. By default the Model derives Benefit as a monetary value. Evaluation of Benefit as a monetary value necessitates the assignment of a value, in Euros, to the avoidance of Fatal and Serious injuries.

This evaluation of Benefit is based on US$ 6,200,000 per life saved as proposed by the FAA in Reference 6. Serious Injuries are assigned a monetary value of US$ 2,660,000. This is the average value for injuries classified as Severe (AIS 4) and Critical (AIS 5) based on Reference 6. These values are also expressed in Euros based on an exchange rate of one US$ = € 0.763 as shown in Table 10.

Table 10 - Monetary Value of Injuries

INJURY SEVERITY	MONETARY VALUE MILLIONS OF US$	MONETARY VALUE MILLIONS OF EUROS
FATAL	**$6,200,000**	**€ 4,733,000**
SERIOUS	**$2,660,000**	**€ 2,031,000**

EASA have used lower monetary values for injuries as contained in Reference 7 Consideration is given in Section 8.4 of the implications on the conclusions of this Regulatory Impact Assessment of using values different to those contained in Table 10

7.7.3. Passenger and Cabin Crew Load Factor

The Benefit Model requires an assessment of the proportion of passenger seats that are likely to be occupied by passengers and the proportion of cabin crew seats that are likely to be occupied by cabin crew.

The number of passengers per seat is a discrete value which may be varied to determine the sensitivity of the Model outputs to its variation. Data has been collected, via the questionnaires sent to operators, to establish a typical value appropriate to "EASA Operators'" aircraft. The data suggests a value of approximately 78%. A discrete value is considered adequate rather than a distribution of load factors.

The number of cabin crew members per seat is also a discrete value which may be varied to determine the sensitivity of the model outputs to its variation. Using sample data from the accident aircraft on the CSRTG Accident Database suggests a value of approximately 80%.

8. Analysis of impacts

The following impacts are considered to be those most pertinent to the proposed regulatory change:

Safety impact
Social impacts
Economic impacts
Environmental impacts
Proportionality issues
Impact on regulatory coordination and harmonisation

Each of these impacts is considered separately in Section 8.1 through to Section 8.7.

EASA REGULATORY IMPACT ASSESSMENT — SEAT CRASHWORTHINESS IMPROVEMENT ON LARGE AEROPLANES – DYNAMIC TESTING 16 g — Issue 2, March 2013

8.1. Safety impact

From the "EASA study", the following Safety Impacts were derived based on an arbitrary compliance date for new build aircraft of 2016 and an in-service aircraft compliance date commencing in 2016 and completed by 2020:

8.1.1. Option 1 Benefit

Option 1 is likely to result in the saving of approximately 1.3 lives and the prevention of 1.3 Serious Injuries over the period ending 2030. Based on the data used it is expected that the likely range of these predicted values will be within ± 20%. Injury reduction for cabin crew is expected to be minimal.

Using the values given in Table 10 of Section 7.7.2 for the monetary value[9] of a life saved and a Serious Injury avoided results in a benefit of approximately 7 to 10 million euros through to 2030 - taken as a nominal value of 8.5 million euros.

8.1.2. Option 2 Benefit

Option 2 is likely to result in the saving of approximately 4.8 lives and the prevention of 4.6 Serious Injuries over the period ending 2030. Based on the data used it is expected that the likely range of these predicted values will be within ± 20%. Injury reduction for cabin crew is once again expected to be minimal. Using the values given in Table 10 of Section 7.7.2 for the monetary value of a life saved and a Serious Injury avoided results in a benefit of approximately 26 to 40 million euros through to 2030 - taken as a nominal value of 34 million euros).

[9] The effects on the conclusions of this Regulatory Impact Assessment of alternative values that might be considered for monetary values of injuries are addressed in Section 8.4..

EASA REGULATORY IMPACT ASSESSMENT — SEAT CRASHWORTHINESS IMPROVEMENT ON LARGE AEROPLANES – DYNAMIC TESTING 16 g — Issue 2, March 2013

8.2. Social impacts

8.2.1. Option 1 – New Build Aircraft Only

No significant Social Impacts relevant to Option 1 have been identified. Whilst this option is likely to result in the aircraft manufacturers incurring increased costs it is not expected that this will have any significant impact, either positive or negative on employment.

8.2.2. Option 2 – New Build and In-service Aircraft

Perhaps the greatest Social Impact for this option arises from the economic impact that might be imposed on smaller airlines if they were required to fit "25.562 compliant seats" and the potential threat that might result to the jobs of employees of "EASA Operators". There are several small European airlines that operate aircraft with 25.562 non-compliant seats. Those that have a small number of old aircraft are likely to incur a relatively high economic burden with a consequential threat to employment. This issue is addressed in Section 8.6 Proportionality issues.

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8.3. Economic impacts

Based on the "EASA study", it is expected that the Economic Impact of installing "25.562 compliant seats" will be much higher for Option 2 than Option 1. The study suggests that based on a five year in-service implementation date starting in 2016, the costs through to 2030 associated with Option 2 will be approximately €1,300,000,000. Almost all of these costs will be borne by the airlines. The equivalent costs for Option 1 are assessed to be approximately €60,000,000.

From the Model developed for the "EASA study", considering an implementation date for Option 1 of 2016 and an implementation period for Option 2 over a period of 5 years starting 2016 the costs incurred are shown in Figure 2 and Figure 3. The different scales for the two graphs should be noted. It may be seen from Figure 3 that the cost of implementing Option 2 will result in a large burden, primarily to the operators, being incurred over the a relatively short time – the five year implementation period. It may be seen that the range of these costs (90 percentile) is relatively small.

EASA REGULATORY IMPACT ASSESSMENT — SEAT CRASHWORTHINESS IMPROVEMENT ON LARGE AEROPLANES – DYNAMIC TESTING 16 g — Issue 2, March 2013

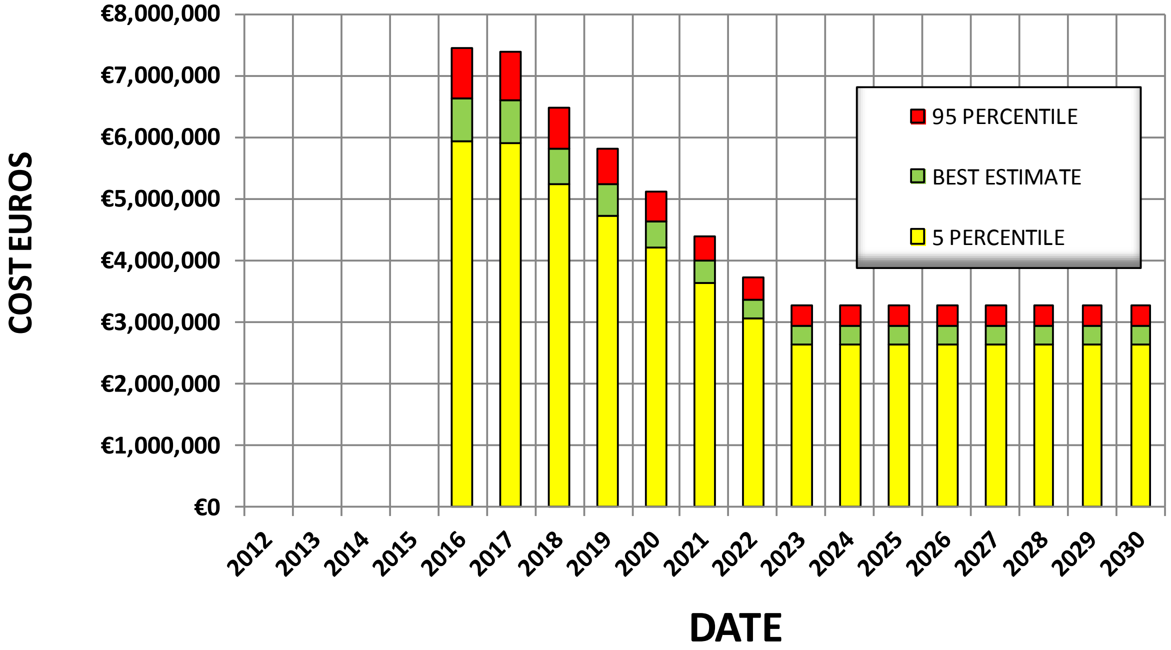

Figure 2 – Option 1 Costs

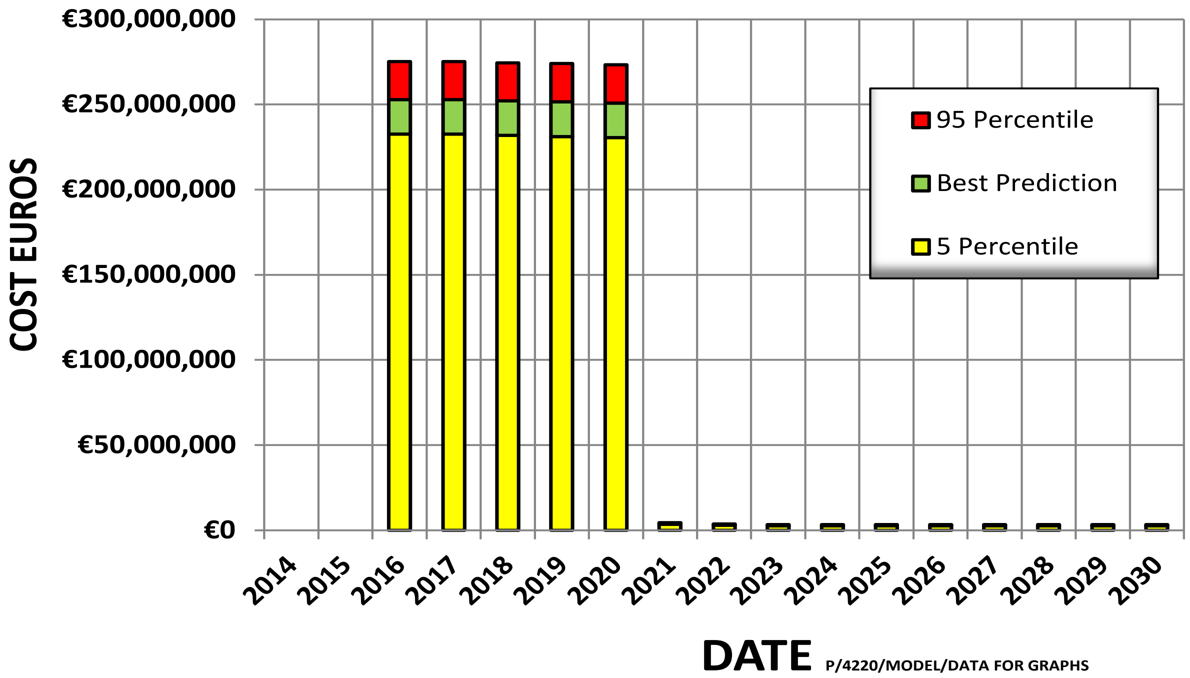

Figure 3 – Option 2 Costs

8.4. Comparison of Cost and Safety Impacts

A comparison of Cost and Safety Impacts is best made by considering the benefit as a monetary value as discussed in Section 7.7.2 and comparing this with the cost of implementing each of the two options. The ratio of the benefit to the cost of implementation, the cost benefit ratio, is an indicator of the relative effectiveness of the two options.

Based on the "EASA study", considering an implementation date for Option 1 of 2016 and an implementation period for Option 2 over a period of 5 years starting 2016 the benefit cost ratio through to 2030 was assessed to be:

Option 1 approximately 0.142
Option 2 approximately 0.026

These benefit cost ratios are based on the FAA monetary values of injury shown in Table 10. The values suggested in Reference 7, by EASA, would result in the monetary value of benefit reducing by approximately 40%. However, use of the EASA values would not affect the comparison between the benefit/cost ratios of the two options since both would be affected equally.

The benefit cost ratio comparison between the two options is also insensitive to variations in other data used in their derivation. For example, whilst the benefit and the costs will increase with the number of seats currently assessed to be non-compliant with the requirements of CS 25.562, the benefit cost ratio is largely insensitive to these assessments. Hence it is considered a good measure of the relative merits of the two options.

The costs and benefit incurred will vary markedly year on year dependent on the implementation period and the number of aircraft non-compliant with the CS 25.562 standard. Hence, it is more meaningful to compare the benefit accrued to a given period with the cost incurred over the same period. This comparison is shown, for the two options, in Figure 4 and Figure 5. The best prediction**s** of benefit cost ratio through to 2030 are 0.142 and 0.026 for Option 1 and Option 2 respectively.

Whilst there is a large range in the values shown in Figure 4 and Figure 5, there is a high degree of confidence that Option 1 results in the higher benefit cost ratio.

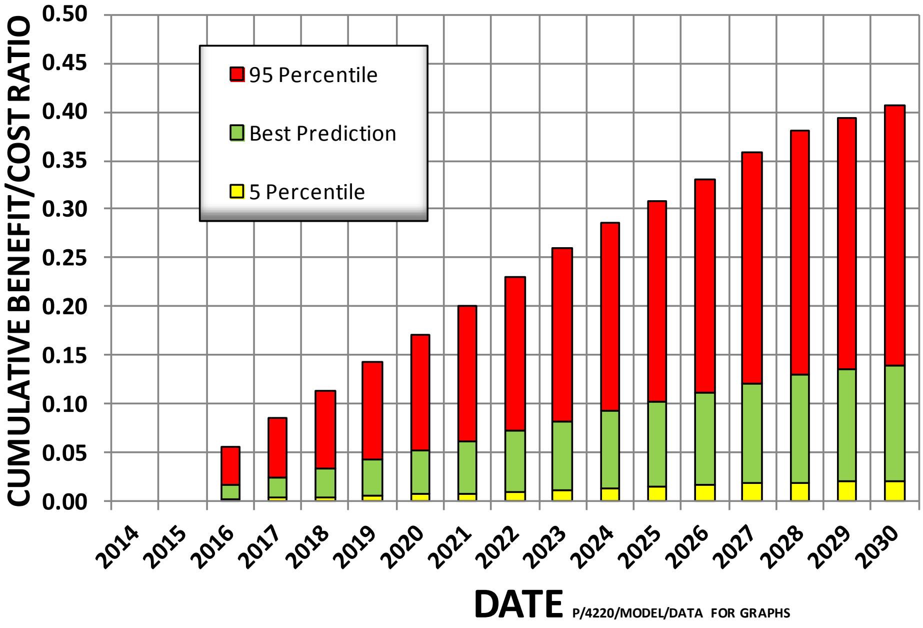

Figure 4 – Option 1 Cumulative Benefit Cost Ratio

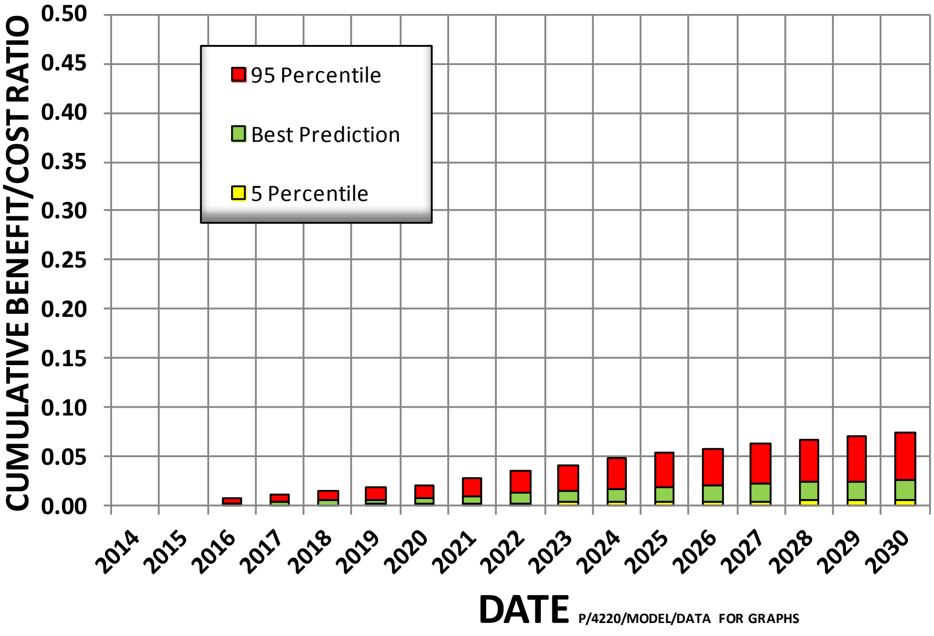

Figure 5 – Option 2 Cumulative Benefit Cost Ratio

8.5. Environmental impacts

The EASA pre-RIA (Reference 2) suggests that there are no significant negative environmental impacts resulting from either of the two options. No major environmental impacts have been identified as a result of this study. The only environmental impact identified is the potential for increased levels of emissions, due to increased fuel burn that might be associated with weight increases resulting from the installation of "25.562 compliant seats".

However, as discussed in Section 7.6 it is considered that the replacement of existing seats with "25.562 compliant seats" is not likely to result in any weight increases. Therefore it is concluded that the environmental impacts are likely to be negligible for both options and regulatory action associated with the installation of "25.562 compliant seats" will be largely environmentally neutral.

8.6. Proportionality issues

The primary issue regarding the impact of the two options on Small and Medium-Sized Enterprises, is the effect that Option 2 might have on smaller airlines, with perhaps older aircraft, if they are required to install "25.562 compliant seats". Option 2 is considered to have the potential for significantly disadvantaging smaller airlines due to the economic burden of introducing "25.562 compliant seats". This issue is considered likely to be significant since if smaller airlines are required to install "25.562 compliant seats" this may incur a significant threat to their economic viability.

It may be inferred from Table 1 – Assessed Number of In-Service Aircraft for each year from 2012 to 2031, that there are several airlines, with a small number of aircraft, having seats that are non-compliant with the CS 25.562 standard. In particular small operators of the ATR 42, Avro RJ, Boeing 757, Fairchild Dornier 328, Fokker 100, Saab 2000 and the Jetstream 41 could find the installation of "25.562 compliant seats" a disproportionate burden.

8.7. Impact on regulatory coordination and harmonisation

ICAO does not expressly require "25.562 compliant seats" in its Standards and Recommended Practices.

The FAA requires that for FAR 121 operators "25.562 compliant seats" be fitted for passengers and flight attendants (cabin crew), on aircraft manufactured on or after 27 October 2009. However, the FAA does not require that in-service aeroplanes are retrofitted with "25.562 compliant seats".

FAR 121.311 (j) states:

> *(j) After October 27, 2009, no person may operate a transport category airplane type certificated after January 1, 1958 and manufactured on or after October 27, 2009 in passenger-carrying operations under this part unless all passenger and flight attendant seats on the airplane meet the requirements of §25.562 in effect on or after June 16, 1988.*

The Brazilian Aviation Authority - Agência Nacional de Aviação Civil (ANAC) adopts a similar position to the FAA, as does the Australian Civil Aviation Safety Authority (CASA); Australian Civil Aviation Safety Regulations 1998 - REG 90.280 states:

Seats

(1) This regulation applies to a transport category aeroplane that:

- *is an aeroplane to which this Subpart applies; and*
- *was originally certificated on or after 1 January 1958; and*
- *is manufactured on or after 27 October 2009; and*
- *is engaged in regular public transport operations.*

Note It is anticipated that the application of this regulation will be extended to cover operations mentioned in paragraph 206 (1) (b) of CAR when provisions of Parts 121 and 135 relating to air transport operations commence.

(2) The registered operator of the aeroplane commits an offence if:

(a) the registered operator:

(i) operates the aeroplane; or

(ii) permits a person to operate the aeroplane; and

(b) while the aeroplane is operating, a seat for a passenger or cabin crew member does not meet the standards of FARs section 25.562, as in force on 16 June 1988.

Hence, the current position is that the EASA requirements, in this respect, are not harmonised with the United States of America, Brazil and Australia. This results in the potential for "EASA Operators'" aircraft being to a lower safety standard than those operating in these countries.

Adoption, by EASA, of Option 1 would result in a harmonised position with the USA, Brazil and Australia. Option 2, requiring retrofitting of aircraft with "25.562 compliant seats", would not result in a harmonised position and will impose a burden on European airlines that is not experienced by operators in the United States, Brazil and Australia.

9. Conclusion and Preferred Option

9.1. Comparison of options

Based on the analysis of impacts contained in Section 8 of this Regulatory Impact Assessment the following conclusions may be reached regarding the comparison of Option 1 and Option 2:

(i) Based on the analysis of the **safety impacts** contained in Section 8.1 it is evident that **Option 2** has a greater safety impact than Option 1. It is assessed that Option 2 will save approximately 4.8 lives and prevent 4.6 Serious Injuries through to 2030. The equivalent safety impact for Option 1 is 1.3 lives saved and 1.3 Serious Injuries prevented through to 2030. The injury reduction, for both options, is largely restricted to passengers, since neither option is expected to result in a significant reduction to cabin crew injuries or fatalities. In monetary terms Option 2 is likely to result in a benefit over the period through to 2030 which is in the region of €25 million greater than Option 1 (based on the FAA monetary values for injuries).

However, these benefits must be considered in relation to the costs associated with the two options as discussed below.

(ii) **Option 1** will result in a much less severe **economic impact** than Option 2 since the costs incurred will result from the implementation of "25.562 compliant seats" on new build aircraft only. Aircraft in manufacture will incur only the cost difference between a compliant and a non-compliant seat. Aircraft in service will incur the full cost of a replacement seat. The cost incurred by the industry through to 2030 is likely to be in the region of 1.2 billion euros higher for Option 2 than Option 1.

(iii) The **Benefit Cost Ratio** will favour **Option 1**. Through to 2030, with reasonable implementation dates, for the proposed regulatory change, it is assessed that the Benefit Cost Ratio will be of the order of 5 to 6 times greater for Option 1 in comparison to Option 2. This conclusion may be made irrespective of many of the values used for the derivation of the Benefit and Cost values including the following:

- The monetary values assigned to injuries as discussed In Section 8.4.
- The number of seats in-service that are non- compliant with the CS 25.562 standard (It should be noted that whilst the benefit and the costs will increase with the number of passenger and cabin crew seats currently non-compliant with the requirements of CS 25.562, the benefit cost ratio is largely insensitive to these assessments.)
- The rate of occurrence of impact related accidents
- The benefit per occupant afforded by "25.562 compliant seats"

(iv) The **Social Impacts and Proportionality** will favour **Option 1** due to the potential economic burden on operators of replacing seats on in-service aircraft as required by Option 2, and the potential threat that this might pose to employment.

(v) If "25.562 compliant seats" are heavier than non-compliant seats then Option 2 will have a greater negative environmental impact since the European fleet will be modified with "25.562 compliant seats" earlier. However, based on the "EASA study" it is assessed that any weight increases, due to the proposed regulatory action, are likely to be small. Hence, environmental impacts are likely to be negligible for both options.

(vi) Only **Option 1** would result in a **harmonised** position with the FAA. Option 2 would impose a burden on European airlines that is not experienced by operators in the United States.

9.2. Preferred Option

After due consideration the Agency believes that the preferred option is:

"**Option 1**- Require the installation of passengers and cabin crews' seats meeting the improved standard for dynamic testing and occupant protection as defined in CS. 25.562, on Large Aeroplanes used for commercial air transportation of passengers that are newly manufactured after a given date"

10. References

1. RGW Cherry & Associates Limited and SGI Aviation Services B.V. *(2013). Report for the task of 'Regulatory Impact Assessment for the Rulemaking Task RMT.0069 (26.002) on Seat Crashworthiness Improvement on Large Aeroplanes – Dynamic Testing 16 g' EASA.2011.OP.14/L2.03.* European Aviation Safety Agency. Germany

2. European Aviation Safety Agency. (2010). *Preliminary Regulatory Impact Assessment, Seat crashworthiness improvement on Large Aeroplanes - Dynamic testing 16g, 26 .002, 1.* European Aviation Safety Agency. Germany

3. RGW Cherry & Associates Limited, (2005). *A Benefit Analysis for Aircraft 16G Dynamic Seats Configured without Enhancements to Head Injury Criteria- CAA Paper 2005/03, DOT/FAA/AR-04/27*, U.K. Civil Aviation Authority, United Kingdom. http://www.caa.co.uk/docs/33/2005_03.pdf (last visited July, 2012).

4. RGW Cherry & Associates Limited, (2010). *Trends in Accidents and Fatalities in Large Transport Aircraft - DOT/FAA/AR-10/16* U.S. Federal Aviation Administration, United States of America http://www.fire.tc.faa.gov/pdf/10-16.pdf (last visited February, 2013).

5. RGW Cherry & Associates Limited, (January 2011). *The Cabin Safety Research Technical Group Accident Database,* Prepared for Transport Canada, the Federal Aviation Administration and the UK Civil Aviation Authority. United Kingdom: http://www.rgwcherry-adb.co.uk/ (last visited January, 2013).

6. The U.S. Department of Transportation, Office of Policy, Transportation Policy (2011). *Treatment of the Economic Value of a Statistical Life in Departmental Analyses – 2011 Interim Adjustment* http://www.dot.gov/policy/transportation-policy/treatment-economic-value-statistical-life (last visited December 2012)

7. European Aviation Safety Agency. (2011). *Notice Of Proposed Amendment (NPA) No 2011-03*. European Aviation Safety Agency, Germany: Author.

Appendix 1 – CS 25.562 (Amendment 12)

CS 25.562 Emergency landing dynamic conditions

(a) The seat and restraint system in the aeroplane must be designed as prescribed in this paragraph to protect each occupant during an emergency landing condition when –

(1) Proper use is made of seats, safety belts, and shoulder harnesses provided for in the design; and

(2) The occupant is exposed to loads resulting from the conditions prescribed in this paragraph.

(b) With the exception of flight deck crew seats, each seat type design approved for occupancy must successfully complete dynamic tests or be demonstrated by rational analysis based on dynamic tests of a similar type seat, in accordance with each of the following emergency landing conditions. The tests must be conducted with an occupant simulated by a 77 kg (170 lb.) anthropomorphic, test dummy sitting in the normal upright position:

(1) A change in downward vertical velocity, (Δv) of not less than 10·7 m/s, (35 ft/s) with the aeroplane's longitudinal axis canted downward 30 degrees with respect to the horizontal plane and with the wings level. Peak floor deceleration must occur in not more than 0·08 seconds after impact and must reach a minimum of 14 g.

(2) A change in forward longitudinal velocity (Δv) of not less than 13·4 m/s, (44 ft/s) with the aeroplane's longitudinal axis horizontal and yawed 10 degrees either right or left, whichever would cause the greatest likelihood of the upper torso restraint system (where installed) moving off the occupant's shoulder, and with the wings level. Peak floor deceleration must occur in not more than 0·09 seconds after impact and must reach a minimum of 16 g. Where floor rails or floor fittings are used to attach the seating devices to the test fixture, the rails or fittings must be misaligned with respect to the adjacent set of rails or fittings by at least 10 degrees vertically (i.e. out of parallel) with one rolled 10 degrees.

(c) The following performance measures must not be exceeded during the dynamic tests conducted in accordance with sub-paragraph (b) of this paragraph:

(1) Where upper torso straps are used tension loads in individual straps must not exceed 794 kg. (1750 lb.) If dual straps are used for restraining the upper torso, the total strap tension loads must not exceed 907 kg (2000 lb.).

(2) The maximum compressive load measured between the pelvis and the lumbar column of the anthropomorphic dummy must not exceed 680 kg. (1500 lb.).

(3) The upper torso restraint straps (where installed) must remain on the occupant's shoulder during the impact.

(4) The lap safety belt must remain on the occupant's pelvis during the impact.

(5) Each occupant must be protected from serious head injury under the conditions prescribed in sub-paragraph (b) of this paragraph. Where head contact with seats or other structure can occur, protection must be provided so that the head impact does not exceed a Head Injury Criterion (HIC) of 1000 units. The level of HIC is defined by the equation -

$$HIC = \left\{ \left(t_2 - t_1\right) \left[\frac{1}{\left(t_2 - t_1\right)} \int_{t_1}^{t_2} a(t)dt \right]^{2.5} \right\}_{max}$$

Where –
t_1 is the initial integration time,
t_2 is the final integration time, and
a(t) is the total acceleration vs. time curve for the head strike, and where
(t) is in seconds, and (a) is in units of gravity (g).

(6) Where leg injuries may result from contact with seats or other structure, protection must be provided to prevent axially compressive loads exceeding 1021 kg (2250 lb.) in each femur.

(7) The seat must remain attached at all points of attachment, although the structure may have yielded.

(8) Seats must not yield under the tests specified in sub-paragraphs (b)(1) and (b)(2) of this paragraph to the extent they would impede rapid evacuation of theaeroplane occupants.

6.2. Appendix 2 — Final Report

Final Report for the Task of 'Regulatory Impact Assessment for the Rulemaking Task RMT.0069 (26.002) on Seat Crashworthiness Improvement on Large Aeroplanes – Dynamic Testing 16 g'

Final Report for the Task of 'Regulatory Impact Assessment for the Rulemaking Task RMT.0069 (26.002) on Seat Crashworthiness Improvement on Large Aeroplanes – Dynamic Testing 16 g'

EASA.2011.OP.14/L2.03

Issue 2

Prepared for:
The European Aviation Safety Agency

March 2013

SGI AVIATION

RGWCHERRY
AND ASSOCIATES
AERONAUTICAL AND SAFETY ENGINEERS

4220/R/000557/KK— Issue 2,March 2013

AMENDMENT RECORD

ISSUE NUMBER	DATE	REMARKS
1	February 2013	Initial Issue
2	March 2013	Issue 2 – Incorporating EASA comments

4220/R/000557/KK— Issue 2,March 2013

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Executive Summary

This Report describes the scope, methodology and results of a study that was aimed at the development of a Regulatory Impact Assessment intended to support the EASA Rulemaking Task on Seat Crashworthiness Improvement on Large Aeroplanes.

The primary objective of the study is to develop a Regulatory Impact Assessment that compares two possible regulatory options related to the incorporation of "25.562 compliant seats":

1. *Require the installation of passenger and cabin crew seats meeting the improved standard for dynamic testing and occupant protection as defined in CS 25.562, on Large Aeroplanes used for Commercial Air Transport of passengers that are newly manufactured after a given date.*

2. *Require the installation of passenger and cabin crew seats meeting the improved standard for dynamic testing and occupant protection as defined in CS 25.562, on Large Aeroplanes used for Commercial Air Transport of passengers that are already in service or newly manufactured, after a given date.*

This Final Report complements the Regulatory Impact Assessment, contained in Attachment 1, which has been developed in sufficient detail so that it may be read as a "stand-alone" document.

The primary impacts considered, safety and economic, have been assessed by a mathematical model developed specifically for this project. Cost data and assessments of the number of aircraft that might be affected by the proposed regulatory action have been acquired by means of questionnaires sent to aircraft manufacturers, seat manufacturers and operators. The other primary data requirements are based on other reputable data sources.

Based on a comparison of the impacts, of the two regulatory options, it is evident that Option 1 is the preferred option. Although Option 2 is likely to result in enhancements to occupant survivability which are greater than Option 1, this improvement is relatively small in comparison with the associated costs; the lifesaving potential of Option 2 being in the region of 4.6 lives through to 2030 in comparison with approximately 1.3 lives for Option 1.

The cost, benefit/cost ratio, social impacts, proportionality and harmonisation comparisons for the two options all favour Option 1. The environmental impacts are considered to be negligible for both options.

It is therefore concluded that Option 1 is the preferred option.

1 Introduction

This report has been produced to support the EASA Rulemaking Task *RMT.0069 (26.002) on Seat Crashworthiness Improvement on Large Aeroplanes – Dynamic Testing 16 g*. It contains the methodology and conclusions of a study carried out by SGI Aviation Services B.V. and RGW Cherry & Associates Limited, intended to support the Regulatory Impact Assessment contained in Attachment 1 to this report.

EASA have carried out a Pre-RIA (Reference 2) on the subject, which clearly defines the issue:

> *"In case of emergency landing and survivable impact accident, the level of protection available from passengers and cabin crews' seats is not optimal on some Large Aeroplanes.*
>
> *Indeed, seating system certifications standards improvements were introduced in JAR-25 change 13 (dated 5 October 1989), now in EASA CS-25. Aeroplanes type certificated before these standards improvements have not necessarily upgraded their seating system, thus leaving a lower level of occupants' protection compared to more recent types. JAR-25 change 13 upgraded the seating system certification standards from a 9g static standard to an upgraded 9g static standard and a new 16g dynamic standard.*
>
> *In case of an accident, the number of potential serious injuries and fatalities is thus more important on older types than on recent Large Aeroplanes types."*

Throughout this report, the term "25.562 compliant seats" refers to seats that are manufactured and installed such that they are fully compliant with the requirements of CS 25.562.

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2 Abbreviations

AEA	Association of European Airlines
AIS	Abbreviated Injury Scale
AOC	Air Operator Certificate
CS	Certification Specification (EASA)
CSRTG	Cabin Safety Research Technical Group
EASA	European Aviation Safety Agency
ERAA	European Regions Airlines Association
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
HIC	Head Injury Criteria
IACA	International Air Carrier Association
MTOW	Maximum Take-Off Weight
NTSB	National Transportation Safety Board (USA)
RIA	Regulatory Impact Assessment
UK CAA	United Kingdom Civil Aviation Authority
VPC	Value for Preventing a Casualty
VSL	Value of a Statistical Life

3 Objectives

The objectives of this study are to develop a Regulatory Impact Assessment (RIA) relating to the installation of "25.562 compliant seats" in accord with the options identified by EASA in their Pre-RIA (Reference 2):

- Option 1 Require the installation of passenger and cabin crew seats meeting the improved standard for dynamic testing and occupant protection as defined in CS 25.562, on Large Aeroplanes used for Commercial Air Transport of passengers that are newly manufactured after a given date.

- Option 2 Require the installation of passenger and cabin crew seats meeting the improved standard for dynamic testing and occupant protection as defined in CS 25.562, on Large Aeroplanes used for Commercial Air Transport of passengers that are already in service or newly manufactured, after a given date.

The Pre-RIA has tentatively selected Option 1. However, EASA require that a full RIA be developed that compares the impacts of Option 1 and Option 2. This report contains the methodology and results used to make this comparison.

The results of this study are summarised in the Regulatory Impact Assessment contained in Attachment 1 which has been carried out in accord with the EASA process defined in Reference 0.

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4 Scope

This study and the resultant Regulatory Impact Assessment has been carried out for Large Aeroplanes used for Commercial Air Transport of passengers. It addresses passenger aeroplanes used for Commercial Air Transport, by "EASA Operators[10]". However, it excludes large aeroplanes that, although operating in Commercial Air Transport, do not typically offer flights to the general public, e.g. so called "Corporate Jets" or "VIP Aircraft".

The primary reasons for this are that:

- Comparisons of Benefit and Cost between Option 1 and Option 2 will be largely insensitive to these aircraft which are low in numbers and/or are configured with fewer than 20 passenger seats, simply because of the small total number of passenger seats concerned.

- This will also result in equivalency with the FAA. In the USA, the rule is restricted to FAR 121 operators which, in their system, results in the same types of aircraft and operations being affected.

The study therefore addresses Large Aeroplanes used for scheduled Commercial Air Transport of passengers, type certificated for 20 passenger seats or more.

[10] See Section 15 - Definitions

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5 Number of Aircraft Non-compliant with the 25.562 seat standards

Only aircraft configured with seats that are not 25.562 compliant have the potential to incur costs, yield benefit or result in a social or environmental impact, from the proposed regulatory action. Hence, an assessment is required of the numbers of aircraft that are non-compliant by aircraft model, in 2012, with an extrapolation of the likely numbers through to 2030. This assessment has been based on the following data sources:

f) Flightglobal for 2012 fleet data
g) UK CAA Hours and Landings Database
h) EASA website for EASA Type Certificate Data Sheets
i) Airbus and Boeing for market forecast data
j) Aircraft Manufacturers and Operators for information regarding aircraft that have “25.562 compliant seats” - these data were obtained by means of a series of questionnaires.

5.1 Number of Aircraft Non-compliant in 2012

The number of aircraft in service with “EASA Operators” in 2012 was determined from data provided by Flightglobal, supported by the UK CAA Hours and Landings Database.

With regard to 25.562 compliance, aircraft may be divided into three categories

1. Category 1 - Aircraft for which “25.562 compliant seats” are required by EASA Type Certification[11];

2. Category 2 - Aircraft for which partial compliance with CS 25.562 is required by EASA Type Certification. (Partial compliance typically refers to passenger seats being CS 25.562 structurally compliant, but not complying with HIC and femur injury criteria as required by CS 25.562(c)(5) and (c)(6) respectively). However some aircraft in this category may be fitted with seats that comply with all aspects of CS 25.562.

3. Category 3 - Aircraft for which “25.562 compliant seats” are not required by EASA Type Certification. However some aircraft in this category may be fitted with seats that comply with all aspects of CS 25.562.

Based on 2012 “EASA Operators’” fleet figures for aircraft with a passenger seating capacity of 30 or more, the proportion in each of these three categories is as shown in Figure 6. This distribution is based on the type certification basis only and does not account for aircraft that may have been fitted with seats beyond what is required by their type certification standard.

[11] Where reference in this document is based on EASA Type Certification and type certification basis, the data source used is the relevant EASA Type Certification Data Sheet.as valid in November 2012

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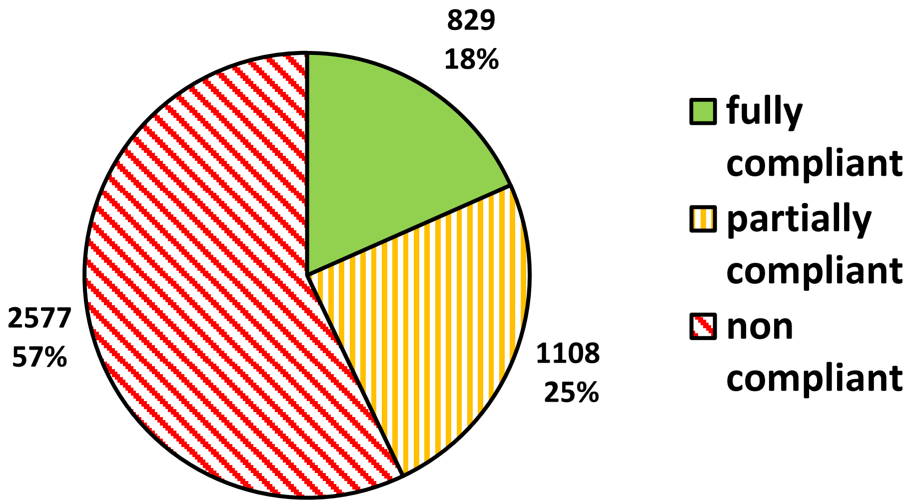

Figure 6 – Proportion of European Fleet 25.562 Compliant

5.1.1 Category 1 Aircraft

Category 1 aircraft include the aircraft models shown in Table 1.

Table 11 – Category 1 Aircraft

Manufacturer	Model	In production in 2012
Airbus	A330 (post July 2007)	Yes
Airbus	A340 (post July 2007)	No
Airbus	A350	Post 2012
Airbus	A380	Yes
Boeing	737 MAX	Post 2012[12]
Boeing	747-8	Yes
Boeing	777	Yes
Boeing	787	Yes
Bombardier	C Series	Post 2012
Bombardier	CRJ 700/900/1000	Yes
Bombardier	Dash 8 400	Yes
Dornier	328 JET	No
Embraer	ERJ 135/145	No
Embraer	170/175/190/195	Yes
Sukhoi	100	Yes

Category 1 aircraft are of no further relevance to this assessment, as neither Option 1 nor Option 2 will affect these aircraft.

[12] Boeing expects that the type certification basis of the 737 MAX will include "25.562 compliant seats".

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5.1.2 Category 2 Aircraft

Category 2 aircraft models involve those that are either expected to be in production for the foreseeable future, and would therefore qualify for Options 1 and 2, or involve aircraft models that are no longer in production and, hence, would only be affected by Option 2.

Category 2 aircraft include the aircraft models shown in Table 2.

Table 12 – Category 2 Aircraft

Make	Model	In production 2012
Airbus	A318	Yes
Airbus	A330 (prior to July 2007)	No
Airbus	A340 (prior to July 2007)	No
BAE	Jetstream 41	No
Boeing	737-600/700/800/900 (737 NG)	Yes
Bombardier	CRJ 200	No
Fairchild/Dornier	328	No
Fokker	70	No
Saab	2000	No

Of these 9 models, there are two that are expected to be in production by the time that the regulation may come into effect. These models are the Airbus A330 and the Boeing 737 NG[13]. They will thus be affected by both Option 1 and Option 2. The impacts are limited to the non-compliant areas. For the purposes of this study partially compliant aircraft are considered to have similar impacts to those that are non-compliant.

5.1.3 Category 3 Aircraft

As for Category 2, Category 3 involves aircraft models that are either expected to be in production when the anticipated regulation comes into force, and would therefore qualify for Option 1, or involve aircraft models no longer in production and, hence, would only be affected by Option 2. Category 3 aircraft are shown in Table 3.

[13] For both models replacement models are under development (A350 and 737 MAX respectively)

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Table 13 – Category 3 Aircraft

Manufacturer	Model	In Production in 2012
Airbus	A300-600	No
Airbus	A310	No
Airbus	A319[14]	Yes
Airbus	A320	Yes
Airbus	A321	Yes
ATR	42	Yes ATR now only manufactures the-600 variants
ATR	72	Yes ATR now only manufactures the -600 variants
BAE	AVRO RJ	No
BAE	ATP	No
BAE	146	No
Boeing	717	No
Boeing	737 – 300/400/500	No
Boeing	747 Classic	No
Boeing	747 – 400	No
Boeing	757	No
Boeing	767 – 200	No
Boeing	767 – 300	Yes
Boeing	MD-11	No
Boeing	MD-80	No
Bombardier	Dash 8 100	No
Bombardier	Dash 8 200/300	No
Embraer	EMB – 120 Brasilia	No
Fokker	50	No
Fokker	100	No
Saab	340	No

[14] Airbus reports that they expect that the A319 neo, A320 neo, A321 neo will not be CS 25.562 compliant

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5.1.4 Aircraft Models for Evaluation

Table 14 shows those aircraft models and numbers, that are currently in-service with "EASA Operators", which are assessed to be potentially Category 2 and Category 3 aircraft. Table 14 also shows the assessed number of aircraft in production in 2012. These aircraft models are those that require to be evaluated with regard to the proposed regulatory action.

Table 14 – "EASA Operators" - Aircraft Models and Numbers potentially fitted with seats that may not be 25.562 compliant

AIRCRAFT MODEL	NUMBER OF AIRCRAFT IN SERVICE WITH "EASA OPERATORS" - 2012	NUMBER OF AIRCRAFT IN PRODUCTION FOR "EASA OPERATORS" - 2012
Airbus A300-600	4	0
Airbus A310	7	0
Airbus A318	19	1
Airbus A319	379	26
Airbus A320	583	22
Airbus A321	216	8
Airbus A330	85	0
Airbus A340	89	0
ATR 42	57	0
ATR 72	116	0
AVRO RJ	80	0
BAE ATP	4	0
BAE 146	18	0
MD-11	9	0
MD-80	64	0
Boeing 717	9	0
Boeing 737 – 300/400/500	273	0
Boeing 737 NG	753	52
Boeing 747 Classic	3	0
Boeing 747-400	138	0
Boeing 757	106	0
Boeing 767	84	0
Bombardier CRJ Regional Jet (100/200)	30	0
Bombardier (DHC) Dash 8-100/200	22	0
Bombardier (DHC) Dash 8-300	32	0
Embraer EMB-120 Brasilia	4	0
Fairchild/Dornier 328	22	0
Fokker 100	47	0
Fokker 50	47	0
Fokker 70	35	0
Saab 2000	39	0
Saab 340	50	0
BAe Jetstream 41	20	0

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5.2 Number of Aircraft Non-compliant - 2013 to 2031

A prediction was made, for each of the years 2013 to 2031[15] inclusive, of the number of aircraft having seats that are non-compliant or only partially compliant with the 25.562 seat standards.

The future extrapolation of the total number of aircraft for each aircraft model that is operated by "EASA Operators" was based on trends derived from annual hours and landings data provided by the UK CAA. For aircraft still in production, the future growth in aircraft numbers is compatible with aircraft manufacturer's anticipated European market forecasts. For aircraft out of production the assessment was based solely on the rate of decline in aircraft numbers based on the trend in aircraft hours and landings.

Having established the projected annual "EASA Operators" fleet size for each aircraft model, the number of aircraft *non-compliant,* or only partially compliant, *with the* 25.562 seat standard was assessed for each year by subtracting the following number of aircraft from the total:

a) The annual number of aircraft expected to remain in use by "EASA Operators" that had "25.562 compliant seats" fitted voluntarily prior to 2012. The number of aircraft voluntarily fitted with "25.562 compliant seats" was based on information provided by aircraft manufacturers.

b) The number of future new build aircraft (2013 to 2031) for "EASA Operators" having "25.562 compliant seats" that would continue to be fitted voluntarily even if no regulatory change is made. This assessment was based on information provided by aircraft manufacturers.

It was assumed that the number of used aircraft (with "25.562 compliant seats" and without "25.562 compliant seats") transferred to "EASA Operators" would be equal to the number taken from their fleets, thus having no impact on the analysis.

Based on this methodology the assessed number of in-service and new build aircraft with 25.562 non-compliant seats, if no regulatory action was taken, was derived as shown in Table 5 *and Table 6 respectively. The number of aircraft in 2012 is shown in these tables for reference.*

[15] Whilst the study limits the period for evaluation to 2030, the data input to the model is made through to 2031

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Table 15 – Assessed Number of In-Service Aircraftfor each year from 2012 to 2031

AIRCRAFT MODEL	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Airbus A300-600	4	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airbus A310	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airbus A318	19	21	22	23	24	25	26	27	28	29	30	31	33	34	35	36	37	34	31	28
Airbus A319	379	403	428	450	472	494	515	537	559	580	602	543	485	426	426	426	426	426	426	426
Airbus A320	583	604	624	643	661	680	698	716	667	617	567	517	468	418	368	368	368	368	368	368
Airbus A321	216	224	232	239	246	253	260	267	248	229	210	191	172	153	134	134	134	134	134	134
Airbus A330	85	85	85	85	85	85	85	85	85	85	85	75	66	56	46	36	27	17	7	0
Airbus A340	89	89	88	88	87	86	86	85	85	84	84	83	82	82	81	81	80	79	79	78
ATR 42	57	51	45	39	33	27	21	15	9	3	0	0	0	0	0	0	0	0	0	0
ATR 72	116	112	107	103	99	95	90	86	82	78	73	69	65	60	56	52	48	43	39	35
AVRO RJ	80	73	66	60	53	46	39	32	26	19	12	5	0	0	0	0	0	0	0	0
BAE ATP	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAE 146	18	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MD-11	9	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MD-80	64	55	47	38	30	21	12	4	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 717	9	9	9	9	9	8	8	8	8	8	8	8	8	8	8	7	7	7	7	7
Boeing 737 – 300/400/500	273	255	237	220	202	184	166	148	130	113	95	77	59	41	23	6	0	0	0	0
Boeing 737 NG	753	805	858	910	963	1015	1057	1090	1114	1129	1135	1084	1033	981	930	879	828	777	726	674
Boeing 747 Classic	3	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 747-400	138	134	130	126	122	118	115	111	107	103	99	95	91	87	83	79	75	71	68	64
Boeing 757	106	98	90	81	73	65	57	48	40	32	24	15	7	0	0	0	0	0	0	0
Boeing 767	84	81	77	74	71	67	64	61	57	54	51	47	44	41	37	34	31	28	24	21
Bombardier CRJ Regional Jet (100/200)	30	27	25	22	20	17	14	12	9	7	4	1	0	0	0	0	0	0	0	0
Bombardier (DHC) Dash 8-100/200	22	19	15	12	9	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Bombardier (DHC) Dash 8-300	32	25	17	10	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Embraer EMB-120 Brasilia	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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AIRCRAFT MODEL	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Fairchild/Dornier 328	22	20	18	16	15	13	11	9	7	5	4	2	0	0	0	0	0	0	0	0
Fokker 100	47	44	40	37	34	31	27	24	21	17	14	11	8	4	1	0	0	0	0	0
Fokker 50	47	41	35	29	23	17	11	5	0	0	0	0	0	0	0	0	0	0	0	0
Fokker 70	35	33	32	30	29	27	26	24	23	21	20	18	17	15	14	12	11	9	8	6
Saab 2000	39	35	32	28	24	20	17	13	9	5	2	0	0	0	0	0	0	0	0	0
Saab 340	50	45	41	36	31	27	22	17	13	8	4	0	0	0	0	0	0	0	0	0
BAE Jetstream 41	20	20	20	20	18	16	14	12	8	4	0	0	0	0	0	0	0	0	0	0
TOTAL	3,445	3,429	3,429	3,431	3,438	3,442	3,443	3,436	3,334	3,231	3,123	2,873	2,637	2,406	2,184	1,965	1,759	1,554	1,350	1,148

P/4220/Data/Aircraft Numbers/Hours Flights Number of Aircraft based on CAA Data v2

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Table 16 – Assessed Number of New Build Aircraft for each year from 2012 to 2031

AIRCRAFT MODEL	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Airbus A300-600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airbus A310	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airbus A318	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Airbus A319	26	25	24	23	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Airbus A320	22	21	20	19	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Airbus A321	8	8	8	7	7	7	6	7	7	7	7	7	7	7	7	7	7	7	7	7
Airbus A330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airbus A340	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ATR 42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ATR 72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AVRO RJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAE ATP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAE 146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MD-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MD-80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 717	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 737 – 300/400/500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 737 NG	52	52	53	52	53	52	42	33	24	15	6	0	0	0	0	0	0	0	0	0
Boeing 747 Classic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 747-400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 757	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boeing 767	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bombardier CRJ Regional Jet (100/200)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bombardier (DHC) Dash 8-100/200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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AIRCRAFT MODEL	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Bombardier (DHC) Dash 8-300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Embraer EMB-120 Brasilia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fairchild/Dornier 328	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fokker 100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fokker 50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fokker 70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saab 2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saab 340	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAE Jetstream 41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	109	107	106	102	101	100	89	81	72	63	54	48	48	48	48	48	48	48	48	48

P/4220/Data/Aircraft Numbers/Hours Flights Number of Aircraft based on CAA Data v2

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6 Overview of Safety and Economic Impact Assessment

A primary issue in the Regulatory Impact Assessment is the determination of the Safety and Economic Impacts. The Safety Impact is the benefit from the reduction in the number of Serious Injuries and Fatalities likely to be experienced and the Economic Impact is the cost resulting from implementation of Options 1 or 2. The Safety Impact may also be expressed as a monetary value by assigning a cost to Serious Injuries and Fatalities.

Assessments of the likely magnitude, of both the benefit and the cost, of installing "25.562 compliant seats" are made using mathematical models developed specifically for the project. These benefit and cost models are described in greater detail in Sections 7 and 8 respectively.

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7 Benefit Model

The impact on safety is addressed in terms of the reduction in the number of Serious Injuries and Fatalities likely to be experienced per year resulting from each of the two options. This assessment is based partially on an analysis of past accidents in a similar manner to that utilised in the studies carried out for the FAA and UK CAA (References 0 and 3 – subsequently referred to as the "FAA Studies"). The reduction in the number of Serious Injuries and Fatalities is assessed separately for passengers and cabin crew.

The primary factors influencing the predicted reduction in Serious Injuries and Fatalities are the rate of occurrence of impact related accidents and the injury reduction afforded by the introduction of "25.562 compliant seats".

To assess the likely reduction in the number of Serious Injuries and Fatalities a Survivability Chain model (see Appendix 1 – Survivability Chains) utilising Monte Carlo simulations has been developed.

Monte-Carlo simulation is a method where variables are randomly chosen based on their probability of occurrence. The variables are then combined to determine the required output – in this case the reduction in the number of Serious Injuries and Fatalities resulting from the implementation of Options 1 and 2. The Monte Carlo Benefit Model, developed specifically for this evaluation, is run many thousands of times, to obtain these predictions and the associated distributions.

The structure of the Monte Carlo Benefit Model is shown in Figure 7. The output from the Model is an assessment of the Benefit, expressed in either a monetary value per year or a reduction in the number of Serious Injuries and Fatalities resulting from the introduction of "25.562 compliant seats" for both passenger and cabin crew seats. This assessment is carried out for "EASA Operators'" aircraft. The output from the Benefit Model, as illustrated in Figure 7, is expressed in Euros, or in terms of the reduction in the number of Serious Injuries and Fatalities, per annum. By default the model derives benefit as a monetary value and the model is described on this basis. Evaluation of Benefit as a monetary value necessitates the assignment of a value, in Euros, to Serious Injuries and Fatalities. This aspect is addressed further in Section 7.1.3.

Benefit assessments have been carried out for both Option 1 and Option 2. They are derived on a year-by-year basis over the period 2013 to 2030.

The model has been developed so that various options may be considered:

- Selection of the proposed implementation date for new build aircraft – any year through to 2030
- Selection of the proposed implementation period for in-service aircraft – any range of years through to 2030 (e.g. issue of regulation in 2016 with compliance being complete by 2019)
- Regulation applicable to passenger seats only or passenger and cabin crew seats.

Equation 1 illustrates the basis on which the Benefit Model has been developed and each of the terms is explained in detail in Sections 7.1 through to 7.6.

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$$\frac{Benefit}{Year} = \frac{Benefit}{Occupant} \times \frac{Seats}{Aircraft} \times \frac{Occupants}{Seat} \times \frac{Flights}{Year} \times \frac{Accidents}{Flight}$$ . . Equation 1

The Model predictions of Benefit per year are contained in Section 7.6.

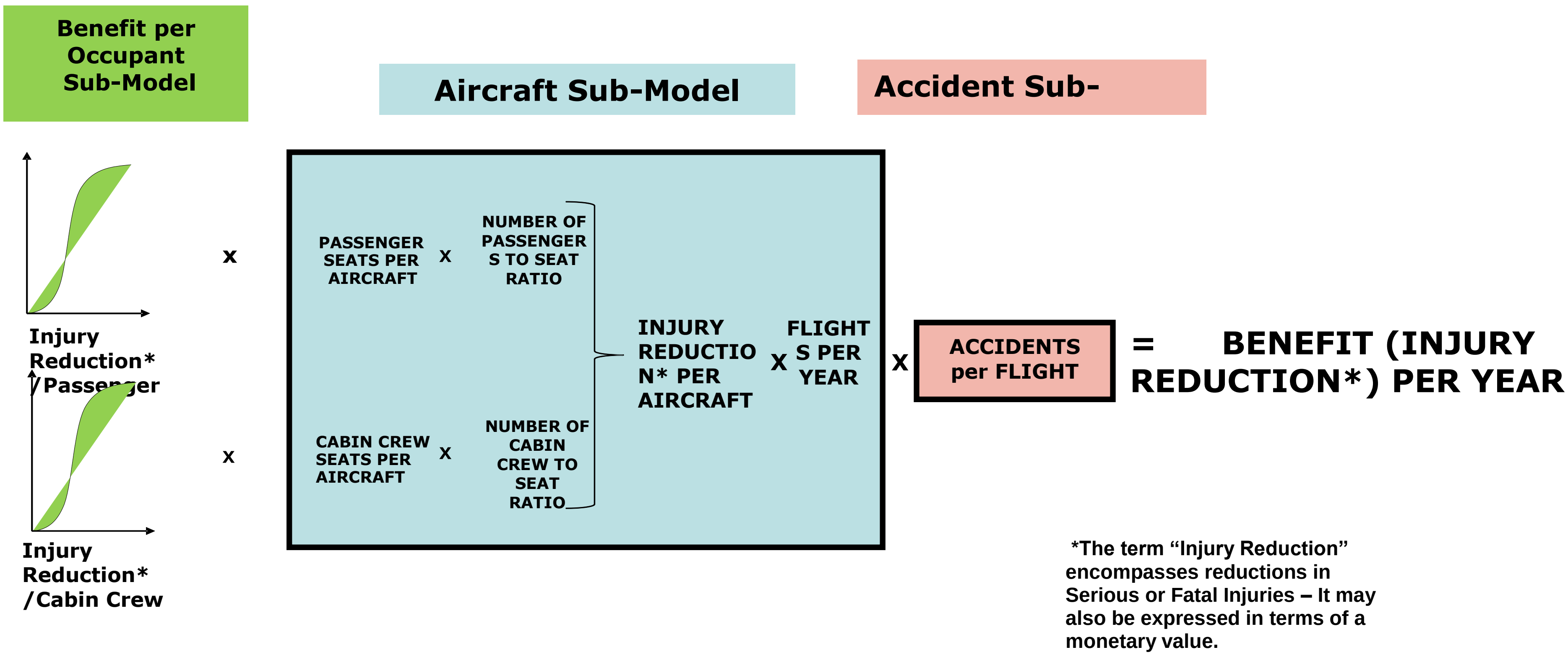

Figure 7 – Benefit Model Structure

7.1 Benefit per Occupant

7.1.1 Accidents Selected for Analysis

To determine the Benefit per Occupant afforded by “25.562 compliant seats”, use is made of earlier assessments made in the “FAA studies”. In Reference 3, the effect of fitting “25.562 compliant seats” was assessed, also considering the effects of other cabin safety measures that have been the result of regulatory action, such as heat release flammability requirements. The second study (Reference 4) focused on the effects of having “25.562 compliant seats” installed, but not meeting the HIC requirement of 25.562(c)(5). This study also re-evaluated the assessment of benefit for “25.562 compliant seats” based on the acquisition of further data, for the accidents analysed, and the development of an improved methodology.

In the FAA studies, twenty-five (25) impact related accidents that occurred world-wide between 1984 and 1998 were analysed. The results of these studies are relevant to the present assessment of benefit per occupant, since the enhancement to safety afforded by “25.562 compliant seats” is no different with the current fleet of aircraft than it was at the time of the FAA studies. However, these accidents have been reviewed to make an assessment of the benefit per cabin crew member, since cabin crew seats were not addressed in the FAA studies. This review also eliminated accidents that were assessed unlikely to yield benefit from “25.562 compliant seats” resulting in the sixteen (16) accidents shown in Table 17 .

It should be noted that the assessment of the accident rate per flight (see Section 7.5) has necessitated an analysis of more recent accidents, since the rate of occurrence of impact related accidents is known to have reduced dramatically since the time of the FAA studies.

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Table 17 - List of accidents assessed for benefit from "25.562 compliant seats"

Date	Location	Aircraft
02-Jul-94	Charlotte	DC9-31
21-Mar-94	Vigo	DC9-32
14-Sep-93	Warsaw	A320
06-Apr-93	Shemya	MD11
21-Dec-92	Faro	DC10
22-Mar-92	La Guardia	F28-4000
20-Jan-92	Strasbourg	A320
14-Feb-90	Bangalore	A320
25-Jan-90	Cove Neck	B707
19-Jul-89	Sioux City	DC10-10
10-Mar-89	Dryden	F28
08-Jan-89	Kegworth	B737
15-Apr-88	Seattle	DHC8
15-Nov-87	Denver	DC9-14
02-Aug-85	Dallas	L1011
21-Jan-85	Reno	L188C

P/4220/Model/Lives Saved per Occupant

7.1.2 Accident Analysis

The "FAA studies" analysed each of the selected accidents and an assessment was made for each accident scenario (see Section 15 - Definitions) using Survivability Chains[16]. Based on a review of the injuries sustained by each of the passengers and cabin crew members an assessment is made of the extent to which their injuries might be reduced by the introduction of "25.562 compliant seats". This assessment is made on the basis of there also being a reduction in the fire threat, from that at the time of the accident, to the impact survivors by the improved fireworthiness of cabin interiors afforded by the latest cabin interior flammability standards.

Table 18 shows an example of the manner in which the variation in the reduction in Fatal and Serious Injuries is assessed.

Table 18 – Example of Injury Reduction Assessment

SCENARIO 3 PASSENGERS	MINOR/NO INJURIES	SERIOUS INJURIES	FATAL
ACTUAL	4	13	3
HIGH	4	13	3

[16] For an explanation of Survivability Chains see Appendix 1 – Survivability Chains

MEDIAN	**12**	**6**	**2**
LOW	**19**	**0**	**1**

The row in Table 8 annotated "ACTUAL" indicates the impact injuries sustained in a particular scenario (see Section 15 - Definitions) in the actual accident. The row annotated "HIGH" is the worst outcome that might be expected if "25.562 compliant seats" were installed on the accident aircraft i.e. no reduction in the number of Serious Injuries and Fatalities. The row annotated "MEDIAN" represents the best assessment of the reduction in Serious Injuries and Fatalities likely to be achieved from the installation of "25.562 compliant seats". This assessment is based on a detailed study of the nature of the injuries sustained by each passenger in the accident. The row annotated "LOW" indicates the best assessment of the reduction of Serious Injuries and Fatalities, once again based on a detailed evaluation of the nature of the injuries sustained by each passenger or cabin crew member in the accident.

The Monte Carlo Benefit Model makes random selections over the range of injuries and at each iteration of the model derives the associated number of passenger or cabin crew members sustaining Minor/No Injuries, Serious Injuries and Fatal Injuries. The reduction in the number of Serious and Fatal Injuries from that experienced in the actual accident may then be calculated at each iteration.

Table 19 shows the benefit per occupant that might be expected from "25.562 compliant seats" from the accidents analysed. The values in the table are derived from the Model in the manner described in this section of the report. The benefit is expressed for each of the sixteen (16) accidents in terms of life saving and injury reduction for both passengers and cabin crew. This benefit is also expressed as a value per passenger or cabin crew member as appropriate. In some instances "25.562 compliant seats" may prevent Fatal Injuries but the occupant may still sustain Serious Injuries as a result of the impact or the fire. This would result in a decrease in the number of fatal injuries but an increase in the number of Serious Injuries. Any increases in injuries are indicated by a negative benefit in Table 19.

Table 19 – Benefit per Occupant

Date	Location	Aircraft	Total Number of Passengers	Total Number of Cabin Crew	Passengers Benefit		Cabin Crew Benefit		Passengers Benefit		Cabin Crew Benefit	
					Lives Saved	Injuries Saved	Lives Saved	Injuries Saved	Lives Saved per Passenger	Injuries Saved per Passenger	Lives Saved per Cabin Crew Member	Injuries Saved per Cabin Crew Member
02-Jul-94	Charlotte	DC9-31	52	3	0.000	0.000	0.000	0.635	0.000	0.000	0.000	0.212
21-Mar-94	Vigo	DC9-32	110	4	0.000	0.492	0.000	0.000	0.000	0.004	0.000	0.000
14-Sep-93	Warsaw	A320	64	4	0.070	3.409	0.000	0.250	0.001	0.053	0.000	0.063
06-Apr-93	Shemya	MD11	235	12	0.480	5.182	0.000	0.000	0.002	0.022	0.000	0.000
21-Dec-92	Faro	DC10	327	10	2.369	6.913	0.000	0.000	0.007	0.021	0.000	0.000
22-Mar-92	La Guardia	F28-4000	47	2	2.015	1.653	0.000	0.624	0.043	0.035	0.000	0.312
20-Jan-92	Strasbourg	A320	90	4	10.600	-0.996	0.250	0.000	0.118	-0.011	0.063	0.000
14-Feb-90	Bangalore	A320	139	5	2.375	-0.707	0.000	0.000	0.017	-0.005	0.000	0.000
25-Jan-90	Cove Neck	B707	149	6	19.073	17.636	0.000	0.000	0.128	0.118	0.000	0.000
19-Jul-89	Sioux City	DC10-10	285	8	4.668	-1.213	0.000	0.000	0.016	-0.004	0.000	0.000
10-Mar-89	Dryden	F28	65	2	0.000	3.140	0.000	0.000	0.000	0.048	0.000	0.000
08-Jan-89	Kegworth	B737	118	5	4.189	10.033	0.000	0.000	0.036	0.085	0.000	0.000
15-Apr-88	Seattle	DHC8	37	1	0.000	1.119	0.000	0.000	0.000	0.030	0.000	0.000
15-Nov-87	Denver.	DC9-14	77	3	2.701	3.926	0.000	0.000	0.035	0.051	0.000	0.000
02-Aug-85	Dallas	L1011	152	8	0.000	1.491	0.000	0.240	0.000	0.010	0.000	0.030
21-Jan-85	Reno	L188C	65	3	1.174	-0.196	0.000	0.000	0.018	-0.003	0.000	0.000
Average Values					3.1	3.2	0.016	0.109	0.026	0.028	0.004	0.039

P/4220/Model/Lives Saved per Occupant

7.1.3 Monetary Evaluation of Benefit

The benefit per occupant may be derived in terms of injury reduction (Fatal and Serious), as illustrated in Table 19 or on a monetary basis, derived by assigning a value to a life saved or a Serious Injury avoided.

The FAA suggests in Reference 6 that the value of a life saved is US$ 6,200,000. Using this same data source the average value for injuries classified as Severe (AIS 4) and Critical (AIS 5) is US$ 2,660,000 and this value is used to evaluate the avoidance of a Serious Injury. Table 10 summarises these values and shows the equivalent Euro value based on an exchange rate of one US$ = € 0.763.

Table 20 – FAA Monetary Value of Injuries

INJURY SEVERITY	MONETARY VALUE MILLIONS OF US$	MONETARY VALUE MILLIONS OF EUROS
FATAL	**$6,200,000**	**€ 4,733,000**
SERIOUS	**$2,660,000**	**€ 2,031,000**

EASA have used different values for monetary value of injuries as contained in Reference 7 which states

> *For the purpose of this impact assessment we use the mean value of 2,000,000 euros for preventing a casualty, as recommended by the Impact Assessment Guidelines of the European Commission (15 January 2009, Annex p 42).8*
>
> *For the value of avoided injuries, we use relative value coefficients based on the Abbreviated Injury Scale (AIS), which calculates the benefit of preventing injuries as a fraction of VSL[17] (e.g. a minor injury is AIS level 1, which is 0.2% of the VPC[18], i.e. 4,000 euros).*

Consideration is given in Section 13 of the implications on the conclusions of this study of using values different from those contained in Table 10.

[17] VSL = Value of a Statistical Life
[18] VPC = Value for Preventing a Casualty

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7.2 Seats per Aircraft

Data has been collected regarding the number of first class, business class, economy class and cabin crew seats for each aircraft model shown in Table 14. It should be noted that "Economy Class" seats include Short Haul Business Class seats and Premium Economy seats. Seating configuration data has been entered into the model for a total of 1,937 aircraft operating with "EASA Operators" in 2012.

Table 21 shows an example of two airline cabin configurations for the Airbus A330 aircraft. The model accommodates the number of aircraft in-service with each airline.

It is considered unnecessary to collect data for all "EASA Operators'" aircraft, since sufficient data has been collected to ensure that seating configurations are typical for the aircraft model.

Table 21 – Example Data - Number of Seats per Aircraft

AIRLINE	FIRST CLASS SEATS	BUSINESS CLASS SEATS	ECONOMY SEATS	TOTAL NUMBER OF PASSENGER SEATS	CABIN CREW SEATS
Operator 1	8	48	165	221	9
Operator 2	0	28	261	289	11

At each iteration of the Model and for each aircraft model, a random selection on a configuration is made to determine the number of passenger and cabin crew seats.

7.3 Number of Occupants To Seat Ratio

7.3.1 Number of Passengers to Seat Ratio

The number of passengers per seat ratio[19] is a discrete value which may be varied to determine the sensitivity of the Model outputs to its variation. Data derived from the questionnaires received from European operators suggests a value of approximately 78%. This value seems to be compatible with information obtained from other data sources. However, there is quite a significant variation amongst airlines.

7.3.2 Number of Cabin Crew to Seat Ratio

The number of cabin crew to seat ratio is a discrete value which may be varied to determine the sensitivity of the Model outputs to its variation. Using sample data from the accident aircraft on the CSRTG Accident Database (Reference 5) suggests a value of approximately 80%.

[19] Often known as passenger load factor

7.4 Flights per Year

The Model requires the number of flights per year, of the aircraft that would be modified with "25.562 compliant seats" as a result of regulatory action, to make a determination of the benefit attributable to each aircraft model.

Inputs to the Model are the proposed date of introduction of "25.562 compliant seats" onto production aircraft, and for Option 2 the "start" and "finish" dates for the installation of "25.562 compliant seats" on in-service aircraft. Aircraft fitted with "25.562 compliant seats" will provide a benefit for each year that they are in-service that is proportionate to the number of flights. Based on the modification introduction dates, the Model assesses the number of modified aircraft in-service for each aircraft model, by "EASA Operators", using the data described in Section 5.

The number of aircraft flights per year is derived by simply multiplying the number of modified aircraft in-service, over the period 2013 to 2031[20] for each year, by the average number of flights per year appropriate to the Model.

The average number of flights per year for the aircraft models addressed in the model is shown in Table 22. Much of these data are approximations but are considered to be of sufficient accuracy to make reasonable determinations of benefit.

[20] N.B. The Model requires data through to 2031, however only outputs through to 2030 are displayed.

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Table 22 - Average Number of Flights per Year

AIRCRAFT MODEL	NUMBER OF FLIGHTS PER AIRCRAFT PER YEAR
Airbus A319	1560
Airbus A320	1560
Airbus A321	1560
Airbus A330	900
Airbus A340	900
Airbus A300-600	900
Airbus A310	900
Airbus A318	1587
ATR ATR 42	1654
ATR ATR 72	1908
AVRO RJ	1500
Boeing 717	1500
BAE ATP	600
Boeing 737 – 300/400/500	1353
Boeing 737NG	1862
Boeing 747 Classic	600
Boeing 747-400	600
Boeing 757	1500
Boeing 767	937
Bombardier (Canadair) CRJ Regional Jet (100/200)	1200
Bombardier (DHC) Dash 8-100/200	1200
Bombardier (DHC) Dash 8-300	1200
Embraer EMB-120 Brasilia	1200
Fairchild/Dornier 328	1200
Fokker 100	1998
Fokker 50	1500
Fokker 70	2040
BAE 146	1500
BAE Jetstream 41	1500
MD-11	900
MD-80	1500
Saab 2000	1200
Saab 340	1200

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7.5 Accidents per Flight

7.5.1 Accident Selection

Impact related accidents were selected using the CSRTG Accident Database (Reference 5). The accidents selected were restricted to western built aircraft to ensure consistent data. The period over which accidents were selected was chosen based on a consideration of deriving a data set of a reasonable size and the derivation of an accident rate that is appropriate to current in-service aircraft.

Accidents were identified satisfying the following criteria:

- The accident occurred to a western built passenger carrying aircraft model certificated for 30 passenger seats or more
- The accident was impact related involving Fatal and/or Serious Injuries but having some potential for survival
- Impact Injuries were sustained by occupants other than as a result of crushing or mechanical asphyxiation
- The aircraft was operated by an "EASA Operator" or a FAR 121 Operator
- The accident occurred during the period 1997 to 2010.

This study addresses aeroplanes configured with 20 seats or more, however, to derive a rate of occurrence of impact related accidents aircraft certificated for 30 seats or more were analysed. Accident data availability tends to be greater on larger aircraft and since the number of flights used related to these aircraft the derived accident rate is considered appropriate. The period 1997 to 2010 was chosen as a compromise between ensuring that the accidents were over a period that reflects the current accident rate and ensuring that the data set was sufficiently large.

The accident selection resulted in the identification of four accidents as shown in Table 23. Of these four accidents, two are considered likely to have met the selection criteria and a further two could possibly meet the selection criteria. The uncertainty in this respect is because insufficient data are available to confirm the precise details of the accidents.

The Benefit Model randomly selects between two and four accidents to obtain an accident rate with a confidence range as described in Section 7.5.2.

Table 23 – Impact Related Accidents over the period 1997 to 2010

DATE	LOCATION	AIRCRAFT	DESCRIPTION	MEETS SELECTION CRITERIA
01-Jun-99	NATIONAL AIRPORT, LITTLE ROCK, ARKANSAS, U.S.A.	MD82	The accident involved seat deformation and detachment. Many of the passengers and cabin crew sustained fatal or serious injuries as a result of the impact	likely
21-Dec-99	AURORA INTL A/P, GUATEMALA CITY, GUATEMALA	DC 10-30	*The aircraft landed on runway 19, which was wet, with a landing weight of approximately 176 tons, with 50 deg flaps and with the autopilot in mode CWS. At the end of the runway the aircraft deviated from its course towards the right and fell into the chasm just in front of the head of runway 01. No fire occurred during the accident or afterwards. [Of the 18 crewmembers and 296 passengers onboard, 8 crewmembers and 8 passengers were fatally injured and 1 crewmember and 9 passengers suffered serious injuries.]	possible
29-Aug-01	NEAR MALAGA AIRPORT, SPAIN	CASA 235	* Some seats which had remained anchored exhibited cracks in their front legs due to compression and shearing. The structural damage of the bottom of the fuselage caused two rows of front seats to break away on the right side and five on the left side, due to the cutting up of the longitudinal beams and connecting angle-irons which constitute the bearing structure of the rails to which the seats are anchored. The passenger cabin crew suffered serious injuries on impact and therefore were physically unable to assist in the evacuation	yes
02-Aug-05	LESTER B PEARSON INTL AIRPORT, TORONTO, CANADA	A340-313	Nine persons received serious injuries as a result of the impact. When the aircraft left the runway, it bounced violently and repeatedly until it came to an abrupt stop in the ravine. On each impact, occupants were propelled upward from their seats; a minimum of three distinct impacts were reported. Simultaneously, occupants were subjected to longitudinal decelerating forces. A number of passengers hit their heads on the seat-back in front of them and/or on the cabin sidewall panels. Passengers who incurred impact injuries were ambulatory during the evacuation. One of the cabin crew, seated in the same general area as the crew and passengers who incurred serious impact injuries, was not injured. This cabin crew's seat was aft-facing; the other seats were forward-facing.	likely

*This text has been translated into English. As accurate as the translation might be, the original text in Spanish should be considered as the work of reference.

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7.5.2 Assessment of Accidents per Flight

From the UK CAA Hours and Landings Database it is assessed that over the period 1997 to 2010 the European and United States fleet accumulated approximately 270,000,000 flights. Based on the assessment described in Section 7.5.1 it might be expected that the number of relevant impact related accidents, in which "25.562 compliant seats" could have been beneficial, during this time period, was between two and four. If the average of these numbers of accidents is taken, 3, then the predicted average accident rate would be:

$$3 \div 270{,}000{,}000 \text{ approximately equal to } 1.1 \times 10^{-8} \text{ per flight}$$

However, the formula shown above gives an average accident rate. With such small datasets it is more realistic to develop distributions that indicate a confidence level in a range of accident rates. The χ^2 distribution may be used to derive the confidence level in any given accident rate, based on the number of accidents experienced over a given time period. Distributions have been developed relevant to 2, 3 and 4 accidents as illustrated in Figure 1.

Whilst the χ^2 distribution has a sound mathematical basis it tends to give answers that are more pessimistic than might be expected. This may be seen by comparing the average accident rate with the data range illustrated in Figure 1.

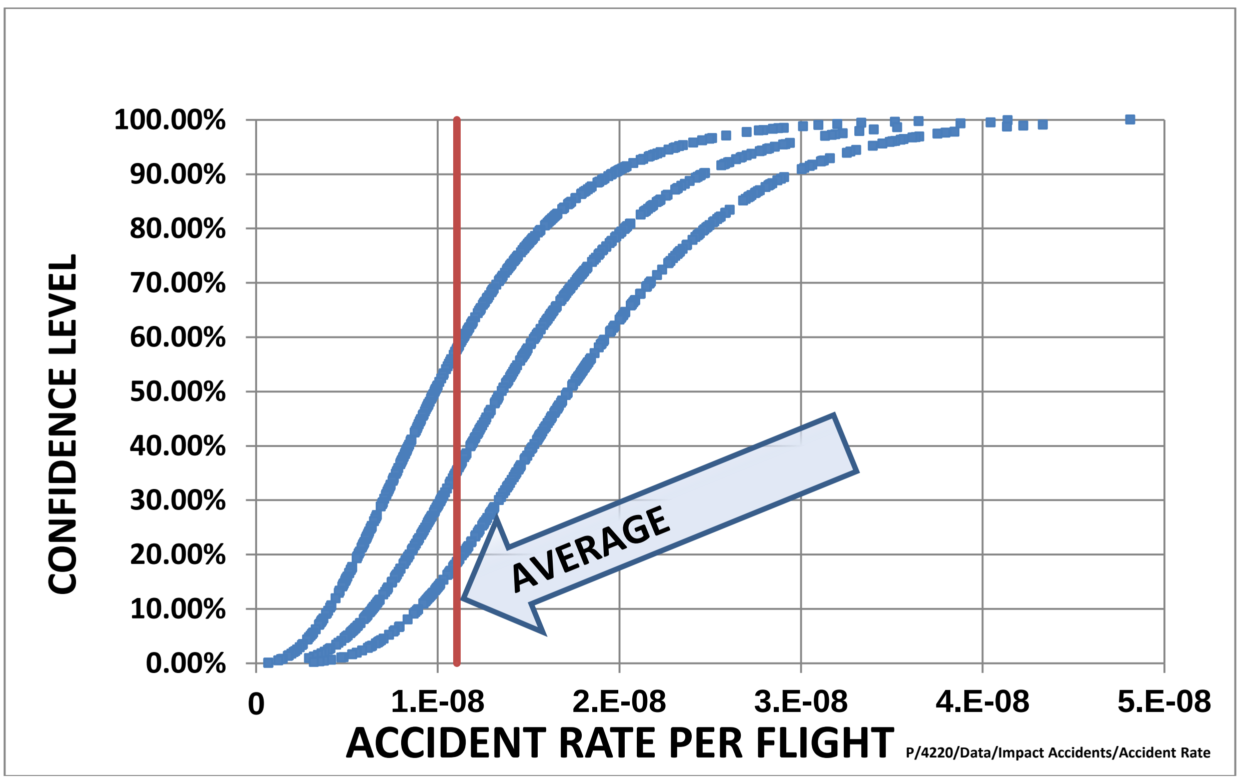

Figure 8 – Confidence Range in the Impact Accident Rate per Flight
Random selections are made, by the Model, of accident rate from the three derived distributions. The range of the accident rates reflects the degree of uncertainty in the data.

The derived accident rate is assumed to be appropriate to the entire period considered in the study. This assumption is likely to be pessimistic since accident rates have been improving significantly over the past few decades.

7.6 Benefit per Year

At each iteration of the Model, each of the values described in Sections 7.1 to 7.5 are multiplied together to arrive at a benefit per year for each aircraft model in accord with Equation 1.

These values are then added together to derive a benefit distribution for the total fleet, in either monetary terms or a reduction in the number of Serious Injuries and Fatalities, for each year through to 2030. The benefit is calculated separately for passengers and cabin crew members and added to derive the overall assessment of benefit.

As a means of validating the Benefit Model a comparison may be made between the assessments of benefit derived from the FAA study (Reference 3) and the Model outputs. The FAA study suggested a benefit in terms of life saving of 45 passenger lives over a fifteen year period, or an average of 3 lives per year. The model developed for this study suggests a lifesaving of 0.48[21] passenger lives per year if the entire fleet of aircraft in-service with “EASA Operators” were fitted with “25.562 compliant seats”, or a ratio of approximately 6.25. This difference may be explained by:

1) Differences in the number of flights accumulated by the current European fleet and the US fleet at the time of the FAA study and

2) Differences between the accident rate at the time of the FAA study and the current accident rate.

Comparing the number of flights: Over the period of the “FAA study” (1984 to 1998) the US fleet accumulated approximately 144,000,000 flights or approximately 9,600,000 per year. This compares with approximately 5,200,000 per year for aircraft non-compliant with the 25.562 standard in use by “EASA Operators”. The ratio of these numbers of flights is approximately 1.85. Therefore, for the results of the FAA study and this study to be comparable the accident rate must have reduced by a factor of 6.25 ÷ 1.85 or approximately 3.4. This degree of improvement in accident rate is considered reasonable when compared to the FAA study on accident trends contained in Reference 4.

The Benefit per year predictions, described in Sections 7.6.1 and 7.6.2, are based on an arbitrary compliance date for new build aircraft of 2016 and an in-service aircraft compliance date commencing in 2016 and completed by 2020.

The Model output also shows the benefit afforded from the installation of “25.562 seats” for cabin crew.

7.6.1 Option 1 Benefit

The Model suggests that Option 1 is likely to result in the saving of approximately **1.3** lives and the prevention of **1.3** Serious Injuries over the period ending 2030. Based on the data used it is expected that the likely range of these predicted values will be within ± 20%. Injury reduction for cabin crew is expected to be minimal. Using the values given in Table 10 of Section 7.1.3 for the monetary value of a life saved and a Serious

[21] This value reflects the lifesaving potential of “25.562 compliant seats” in the current European fleet and would be the value achieved if all seats were currently to this standard.

Injury avoided results in a benefit of approximately 7 to 10 million euros through to 2030 - taken as a nominal value of **8.5 million euros**.

7.6.2 Option 2 Benefit

The Model suggests that Option 2 is likely to result in the saving of approximately **4.6** lives and the prevention of **4.8** Serious Injuries over the period ending 2030. Based on the data used it is expected that the likely range of these predicted values will be within ± 20%. Injury reduction for cabin crew is once again expected to be minimal. Using the values given in Table 10 of Section 7.1.3 for the monetary value of a life saved and a Serious Injury avoided results in a benefit of approximately 26 to 40 million euros through to 2030 - taken as a nominal value of **34 million euros**.

8 Cost Model

The methodology for assessing the economic impact is based on the costs incurred by the aircraft manufacturer and operator. It is evident that there will be differences in the costs for newly manufactured aircraft and in-service aircraft since replacement of seats on in-service aeroplanes is likely to result in the replaced seats being scrapped. All costs are assessed at 2012 levels.

In a similar fashion to the estimation of benefit, costs are assessed by means of a Monte Carlo simulation model.

As well as the direct costs associated with the installation of "25.562 compliant seats" for passengers and cabin crew, in some instances other cabin configuration changes may be needed to accommodate the seat change. The costs of these other changes are assumed to be a function of either the number of passenger seats or cabin crew seats installed.

It is not envisaged that there will be any significant increase in maintenance costs due to the introduction of "25.562 compliant seats". In some instances airbags might be needed at some seat rows to ensure compliance with the HIC requirement of CS 25.562. In this case a maintenance penalty will be incurred. However, it is considered that these costs will be small in comparison to the direct costs involved in fitting "25.562 compliant seats". Aircraft downtime that may be associated with the fitment of "25.562 compliant seats" will also incur costs but once again these costs are likely to be relatively small. Changes in fuel burn associated with weight changes that might be incurred are also considered.

Hence, the primary cost drivers are those associated with the fitment of "25.562 compliant seats".

The overall Cost Model structure is shown in Figure 9. Each of the elements shown in Figure 9 is described in Section 8.1 to 8.5.

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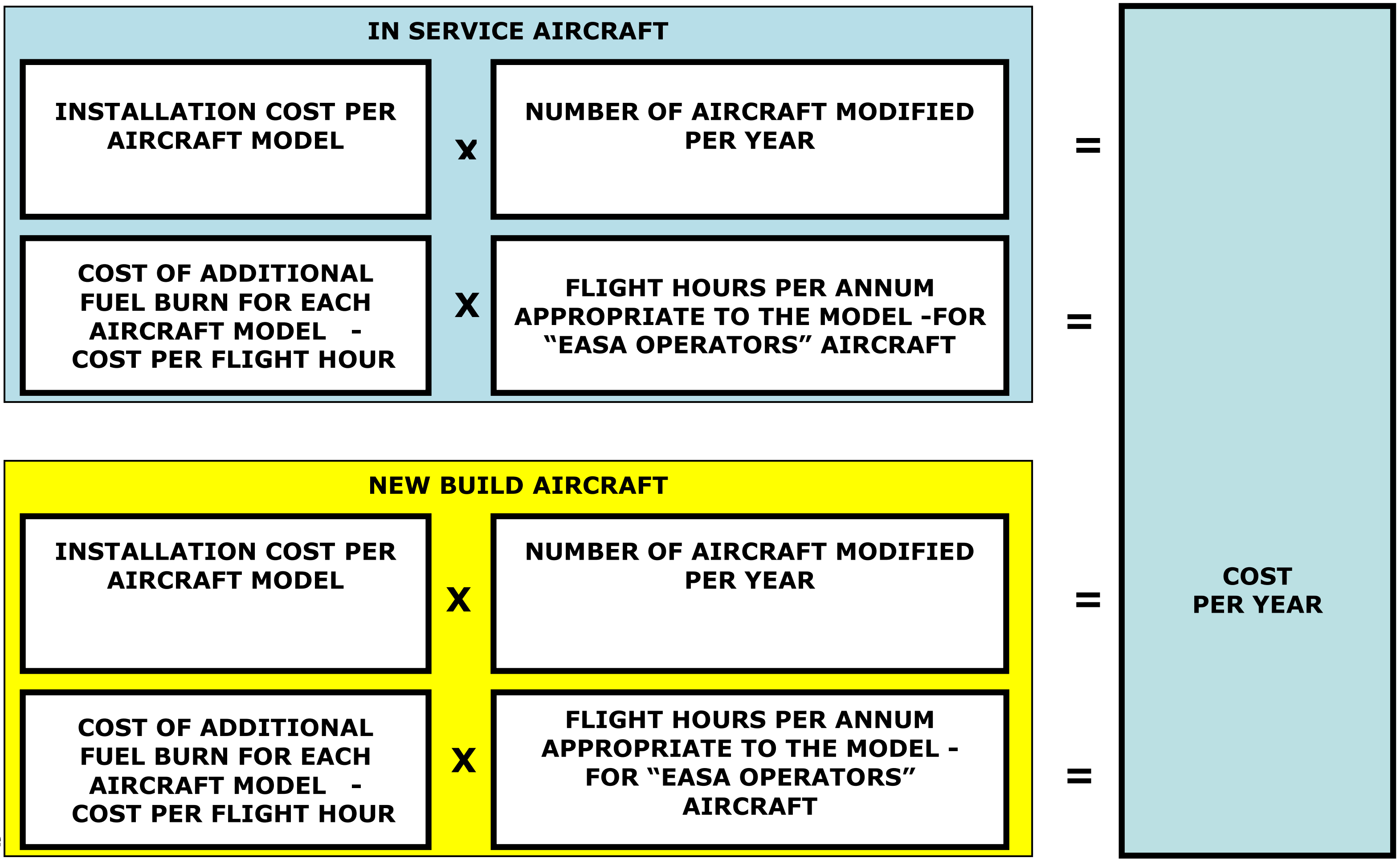

Figure

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8.1 Installation Cost per Aircraft Model

For each aircraft model the Cost Model assesses the number of first class, business class, economy class and cabin crew seats as described in Section 7.2. The Model also contains cost assessments for the installation of "25.562 compliant seats" for both in-service and new build aircraft as described in Sections 8.1.1 and 8.1.2.

At each iteration, the Model makes random selections on both the costs per seat and the number of seats for the Model to derive an installation cost for each aircraft model.

As may be seen from Figure 9 the costs incurred from installing "25.562 compliant seats" on in-service and new build aircraft are assessed separately since they will be different.

As well as the direct costs associated with the installation of "25.562 compliant seats" for passengers and cabin crew, in some instances other cabin configuration changes may be needed to accommodate the seat change. The costs of these other changes are assumed to be a function of either the number of passenger seats or cabin crew seats installed.

Questionnaires were sent to aircraft manufacturers, airlines and seat manufacturers in an attempt to obtain cost data. Whilst some of the industry members were extremely co-operative the response overall was limited.

8.1.1 In-service Seat Costs

8.1.1.1 Passenger Seats

All costs associated with passenger seats are shown in **Table 3** and **Table 4**.

Replacement Costs

Four airlines responded in the questionnaires providing seat costs for the replacement of economy class seats with "25.562 compliant seats". These costs, which were inclusive of design costs, were € 1,700, € 1,562, € 1,824 and € 2,253 per seat, as shown in Table 3.

Only one airline supplied costs for Business Class seats – US$ 10,000 (€ 7,634) per seat. However, three further data points have been entered into the model on the assumption that business class replacement costs are 4.5 times that of economy class seats.

Since no responses were received, from airlines, for First Class seats, it is assumed, that on average, it might be expected that the replacement cost for a first class seat is 6 times that of an economy class seat.

Labour Costs

Labour costs or man-hours for economy class seats were also provided by three airlines. These were € 200, € 55, €28[22] and €, 16 per seat.

[22] Converted from man-hours to euros at a labour rate of €42 per hour

No responses were received from airlines relating to Business Class or First Class seats. Hence, it was assumed that the labour costs would be 10 times that of an economy class seat.

Other Costs

All other replacement and labour costs associated with installing "25.562 compliant seats" (seat rail, cabin layout changes, etc.) were assumed to add an average of 10% to the economy class seats since no data was provided by airlines.

8.1.1.2 Cabin Crew Seats

Only one response to the questionnaires was received from airlines in relation to cabin crew seats. This suggested a replacement cost of € 1,260 and a labour cost of € 250.

It was assumed for the remaining three data entry points that cabin crew seat replacement costs would be the same as an economy class seat and that the labour cost would be the same as for a Business Class seat.

Other costs associated with the fitment of "25.562 compliant seats" for cabin crew (cabin layout changes, bulkhead strengthening etc.) were assumed to add an average of 10% to the cabin crew seat replacement and labour costs.

All costs associated with cabin crew seats are shown in.Table 5.

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Table 24 - Passenger Seat Costs – In-Service Aircraft

FIRST CLASS SEAT COST – PER SEAT	BUSINESS CLASS SEAT COST– PER SEAT	ECONOMY CLASS SEAT COST– PER SEAT	FIRST CLASS SEAT LABOUR COST– PER SEAT	BUSINESS CLASS SEAT LABOUR COST– PER SEAT	ECONOMY CLASS SEAT LABOUR COST– PER SEAT
€ 10,200	€ 7,650	€ 1,700	€ 2,000	€ 2,000	€ 200
€ 9,372	€ 7,029	€ 1,562	€ 550	€ 550	€ 55
€ 10,944	€ 8,208	€ 1,824	€ 160	€ 160	€ 16
€ 13,518	€ 7,634	€ 2,253	€ 280	€ 280	€ 28

Table 25 - Other Costs – In-Service Aircraft

Other MATERIAL COSTS – PER SEAT associated with Passenger Seats (Seat Rail, Cabin layout changes, etc.)	Other LABOUR COSTS – PER SEAT associated with Passenger Seats (Seat Rail, Cabin layout changes, etc.)
€ 170	€ 20
€ 156	€ 6
€ 182	€ 2
€ 225	€ 3

Table 26- Cabin Crew Seat Costs– In-Service Aircraft

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CABIN CREW SEAT COST– PER SEAT	CABIN CREW SEAT LABOUR COSTS– PER SEAT	OTHER MATERIAL COSTS – PER SEAT associated with Cabin Crew Seats (Cabin layout changes, Bulkhead Strengthening etc.)	OTHER LABOUR COSTS – PER SEAT associated with Cabin Crew Seats (Cabin layout changes, Bulkhead Strengthening etc.)
€ 1,260	€ 250	€ 126	€ 25
€ 1,562	€ 550	€ 156	€ 55
€ 1,824	€ 160	€ 182	€ 16
€ 2,253	€ 280	€ 225	€ 28

8.1.2 New Build Aircraft

8.1.2.1 Passenger Seats

It is assumed that the substitution of “25.562 compliant seats” would increase costs of new seats by 10%. This assessment was based on a response from a seat manufacturer that considered that for first class, business class and economy class seats the cost increase would be less than 10%.

The labour costs for all passenger seats are assumed to be unchanged from those for the installation of 25.562 non-compliant seats. The other costs associated with the installation of “25.562 compliant seats” (seat rail, cabin layout changes, etc.) are assumed to be the same as for in-service aircraft.

All costs associated with passenger seats are shown in Table 3 **- Passenger Seat Costs – In-Service Aircraft**

FIRST CLASS SEAT COST – PER SEAT	BUSINESS CLASS SEAT COST– PER SEAT	ECONOMY CLASS SEAT COST– PER SEAT	FIRST CLASS SEAT LABOUR COST– PER SEAT	BUSINESS CLASS SEAT LABOUR COST– PER SEAT	ECONOMY CLASS SEAT LABOUR COST– PER SEAT
€ 10,200	€ 7,650	€ 1,700	€ 2,000	€ 2,000	€ 200
€ 9,372	€ 7,029	€ 1,562	€ 550	€ 550	€ 55
€ 10,944	€ 8,208	€ 1,824	€ 160	€ 160	€ 16
€ 13,518	€ 7,634	€ 2,253	€ 280	€ 280	€ 28

Table 4 - Other Costs – In-Service Aircraft

EASA REGULATORY IMPACT ASSESSMENT — SEAT CRASHWORTHINESS IMPROVEMENT ON LARGE AEROPLANES – DYNAMIC TESTING 16 g — Issue 2, March 2013

Other MATERIAL COSTS – PER SEAT associated with Passenger Seats (Seat Rail, Cabin layout changes, etc.)	Other LABOUR COSTS – PER SEAT associated with Passenger Seats (Seat Rail, Cabin layout changes, etc.)
€ 170	€ 20
€ 156	€ 6
€ 182	€ 2
€ 225	€ 3

Table 5 - Cabin Crew Seat Costs – In-Service Aircraft

CABIN CREW SEAT COST– PER SEAT	CABIN CREW SEAT LABOUR COSTS– PER SEAT	OTHER MATERIAL COSTS – PER SEAT associated with Cabin Crew Seats (Cabin layout changes, Bulkhead Strengthening etc.)	OTHER LABOUR COSTS – PER SEAT associated with Cabin Crew Seats (Cabin layout changes, Bulkhead Strengthening etc.)
€ 1,260	€ 250	€ 126	€ 25
€ 1,562	€ 550	€ 156	€ 55
€ 1,824	€ 160	€ 182	€ 16
€ 2,253	€ 280	€ 225	€ 28

and
Table 7.

8.1.2.2 Cabin Crew Seats

For cabin crew seats, similar assumptions were made regarding the costs incurred for the installation of passenger seats. That is a 10% increase in seat cost, no change in labour costs and similar costs for the other costs as assessed for in-service aircraft.

All costs associated with cabin crew seats are shown in
Table 8.

Table 27 - Passenger Seat and Labour Costs – New Build Aircraft

FIRST CLASS SEAT COST – PER SEAT	BUSINESS CLASS SEAT COST– PER SEAT	ECONOMY CLASS SEAT COST– PER SEAT	FIRST CLASS SEAT LABOUR COST– PER SEAT	BUSINESS CLASS SEAT LABOUR COST– PER SEAT	ECONOMY CLASS SEAT LABOUR COST– PER SEAT
€ 1,020	€ 765	€ 170	€ 0	€ 0	€ 0
€ 937	€ 703	€ 156	€ 0	€ 0	€ 0
€ 1,094	€ 821	€ 182	€ 0	€ 0	€ 0
€ 1,352	€ 763	€ 225	€ 0	€ 0	€ 0

Table 28 - Other Costs– New Build Aircraft

Other MATERIAL COSTS – PER SEAT associated with Passenger Seats (Seat Rail, Cabin layout changes, etc.)	Other LABOUR COSTS – PER SEAT associated with Passenger Seats (Seat Rail, Cabin layout changes, etc.)
€ 170	€ 20
€ 156	€ 6
€ 182	€ 2
€ 225	€ 3

Table 29- Cabin Crew Seat and Labour Costs – New Build Aircraft

CABIN CREW SEAT COST – PER SEAT	CABIN CREW SEAT LABOUR COSTS – PER SEAT	OTHER MATERIAL COSTS – PER SEAT associated with Cabin Crew Seats (Cabin layout changes, Bulkhead Strengthening etc.)	OTHER LABOUR COSTS – PER SEAT associated with Cabin Crew Seats (Cabin layout changes, Bulkhead Strengthening etc.)
€ 126	€ 0	€ 126	€ 25
€ 156	€ 0	€ 156	€ 55
€ 182	€ 0	€ 182	€ 16
€ 225	€ 0	€ 225	€ 28

8.2 Number of Aircraft Modified per Year

Using the data for each aircraft model, used by “EASA Operators”, that do not have “25.562 compliant seats” (see Section 5.2), the Model assesses the number of in-service and new build aircraft that will be modified for each year from 2013 to 2030. An input to the Model is the start and finish dates for the regulatory option of incorporating “25.562 compliant seats” on in-service aircraft and the compliance date for new build aircraft. Based on these inputs the Model determines the number of in-service and the number of new build aircraft modified each year over the period 2013 to 2031.

8.3 Changed Fuel Burn for each Aircraft Model (US$ per Flight Hour)

Whilst as discussed in Section 8.3.1 it is assessed that there will be no significant weight change associated with the introduction of “25.562 compliant seats” the Cost Model has been developed to assess the cost that would be incurred should this not be the case. Any aircraft weight change would affect fuel burn with an associated increase or decrease in operating costs.

The associated operating cost change, in US$ per aircraft flight hour, may be derived from the following equation:

$$w \times g \times c \quad \text{- Equation 2}$$

Where:

w is the incremental weight change (which might be positive or negative) associated with the introduction of “25.562 compliant seats” (lb.)

g is the incremental fuel burn per pound per aircraft flight hour (U.S. gallons/lb. flight hour)

c is the fuel cost in US $ per U.S. gallon

The Model uses Equation 2 to determine a distribution of the changed operating cost per year for both in-service and new build aircraft.

8.3.1 Incremental Weight Change, w

Any weight changes are expected to be similar for in-service and new build aircraft.

8.3.1.1 Incremental Weight Change - Passenger Seats

A wide variation in weight changes due to the introduction of “25.562 compliant seats” were found from responses to the questionnaires sent to aircraft manufacturers, seat manufacturers and operators as illustrated by the data shown in Table 9*. Five sources suggested there would be no weight change for economy class seats, three that there would be a weight decrease and one suggested a weight increase. Taking the average of the 8 numerical values proposed by the questionnaire respondents, gives a weight decrease of approximately one pound (-1 lb.) for an economy class seat.*

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Table 30 – Passenger Seat Weight Increases - Economy Class

Source	Economy Class	
	Weight Change – Kgs.	Weight Change – lbs.
Aircraft Manufacturer 1	0	0
Aircraft Manufacturer 2	lighter	
Aircraft Manufacturer 3	0	0
Seat Manufacturer	0.75	2
Operator 1	-2.3	-5
Operator 2	-1.9	-4
Operator 3	0	0
Operator 4	0	0
Operator 5	0	0

P/4220/Data/Weights/Seat Weights

Only one data source responded to the questionnaire regarding business and first class seats. This was an aircraft manufacturer that suggested there would be no weight increase for any passenger seats resulting from the proposed regulatory action.

It is anticipated that there could be weight increases associated with installing "25.562 compliant seats" due to changes that might be required to other areas within the cabin (e.g. seat rails, bulkheads, etc.). However, as stated above, the average prediction for seat weight changes are a reduction of 1 lb. It is therefore assumed that this would accommodate any weight increases that might require change due to the introduction of "25.562 compliant" seats.

8.3.1.2 Incremental Weight Change - Cabin Crew Seats

Since no data were obtained from the questionnaires relating to cabin crew seat weights, it has been assumed that as for passenger seats there will be no net increase in weight due to the installation of "25.562 compliant seats".

8.3.2 Incremental Fuel Burn Per Pound per Aircraft Flight Hour, g

Should it be required to determine the effect on operating costs due to weight changes then data needs to be entered into the Cost Model relating to the Incremental fuel burn per pound per aircraft flight hour, g. These data have been obtained from Reference 0 and are shown in Table 31, for each of the aircraft models considered in this study.

Table 31 – Incremental Fuel Burn by Aircraft Model

AIRCRAFT MODEL	INCREMENTAL FUEL BURN U.S. GALLONS PER POUND FLIGHT HOUR
Airbus A319	0.0095
Airbus A320	0.0095
Airbus A321	0.0095
Airbus A330	0.0040

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Airbus A340	0.0040
Airbus A300-600	0.0040
Airbus A310	0.0040
Airbus A318	0.0095
ATR 42	0.0010
ATR 72	0.0010
AVRO RJ	0.0050
BAE 146	0.0050
BAE ATP	0.0050
BAE Jetstream 41	0.0010
Boeing 717	0.0095
Boeing 737– 300/400/500	0.0045
Boeing 737 NG	0.0045
Boeing 747 Classic	0.0045
Boeing 747-400	0.0065
Boeing 757	0.0055
Boeing 767	0.0050
Bombardier (Canadair) CRJ Regional Jet (100/200)	0.0040
Bombardier (DHC) Dash 8-100/200	0.0010
Bombardier (DHC) Dash 8-300	0.0010
CASA 212	0.0010
Embraer EMB-120 Brasilia	0.0010
Fairchild/Dornier 328	0.0010
Fokker 100	0.0045
Fokker 50	0.0010
Fokker 70	0.0045
MD-11	0.0045
MD-80	0.0040
Saab 2000	0.0010
Saab 340	0.0010

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8.3.3 Fuel Cost $ per US Gallon, c

To determine the effect on operating costs due to any weight changes that might be incurred the Cost Model requires data relating to fuel cost. Figure 10 illustrates the variation in fuel cost per U.S. gallon over the period May 2000 to June 2012, which was obtained from Reference 0. The average value over the period January 2011 to June 2012 of approximately US $2.9 (2.22 Euros) per US gallon is used for the fuel cost in this study.

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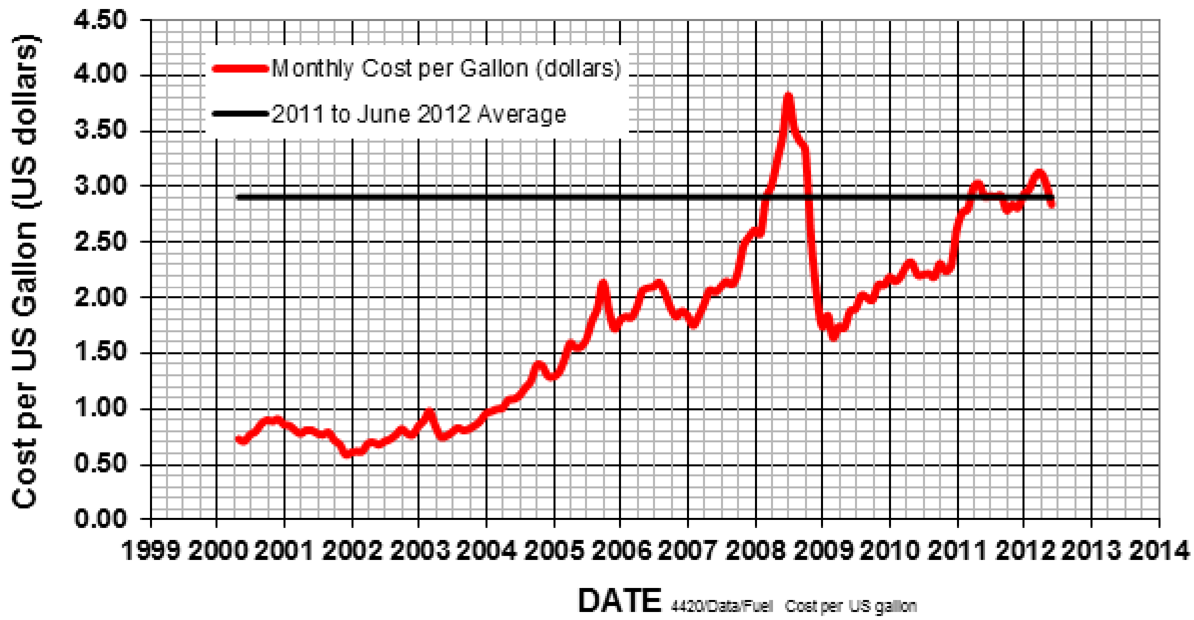

Figure 10 - Variation in Fuel Cost per U.S. Gallon over the Period May 2000 to June 2012

8.4 Aircraft flight hours per Year

The Cost Model requires the number of flight hours per year, for aircraft that have seats that are not to the 25.562 compliant standard, in order to make a determination of the annual change in fuel burn costs. Flight hours are derived by the Model using a similar methodology to that used for the determination of aircraft flights per year as described in Section 7.4.

The average number of flight hours per year for the aircraft models addressed in the model is shown in Table 32. Much of these data are approximations but are considered to be of sufficient accuracy to make reasonable determinations of costs.

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Table 32 - Average Number of Flight Hours per Year

AIRCRAFT MODEL	NUMBER OF FLIGHT HOURS PER AIRCRAFT PER YEAR
A319	2107
A320	2548
A321	2645
A330	4869
A340	7046
Airbus A300-600	1799
Airbus A310	3427
Airbus A318	2205
ATR ATR 42	1543
ATR ATR 72	1511
AVRO RJ	1704
B717	1614
BAE ATP	416
Boeing 737 – 300/400/500	1891
Boeing 737 NG	3664
Boeing 747 Classic	3468
Boeing 747-400	4943
Boeing 757	3972
Boeing 767	4988
Bombardier (Canadair) CRJ Regional Jet (100/200)	1339
Bombardier (DHC) Dash 8-100/200	950
Bombardier (DHC) Dash 8-300	1082
CASA 212	1423
Embraer EMB-120 Brasilia	1100
Fairchild/Dornier 328	1299
Fokker 100	2248
Fokker 50	1423
Fokker 70	2283
BAE 146	1636
Jetstream 41	1423
MD-11	5933
MD-80	1847
Saab 2000	1196
Saab 340	945

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8.5 Cost per year

8.5.1 Overview of Cost Model Output

The seat installation cost per year is determined by the Model, for both new build and in-service aircraft, for each year through to 2030 by simply multiplying the appropriate cost per aircraft by the appropriate number of aircraft modified per year.

The Model is capable of assessing changes in operating cost, attributable to weight changes, by simply multiplying the changed fuel burn for each aircraft model by the associated flight hours per year for each year through to 2030 as described in this section of the report. This would be done separately for new build aircraft and in-service aircraft that are fitted with “25.562 compliant seats” as a result of regulatory action.

The total cost per year may be derived for each year through to 2030 by simply adding the installation cost per year, and the change in operating cost per year, for all aircraft models utilised by “EASA Operators”. Since, as explained in Section 8.3.1, it is assessed that there will be no significant weight increase due to the introduction of “25.562 compliant seats” the Cost Model output is simply that attributable to the cost of fitting the revised standard of seats.

The Model output also shows the contribution of cabin crew seats and passenger seats to the overall cost.

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8.5.2 Option 1 Costs

Option 1 relates to new build aircraft only. Based on an implementation date of 2016 the model suggests an annual cost in 2016 in the region of €6,500,000 reducing to approximately €3,000,000 by 2023 as illustrated in Figure 2. The reason for the reduction in annual costs is that the number of aircraft being manufactured that have seats that are not "25.562 compliant" will reduce, as suggested by Table 6.

The costs through to 2030 are assessed to be approximately **€60,000,000**, based on a 2016 implementation date. Based on the data used it is expected that the likely range of these predicted values will be less than ± 1%. Of the €60,000,000, approximately €1,000,000 is attributable to **cabin crew seats**, i.e. **less than 2%**.

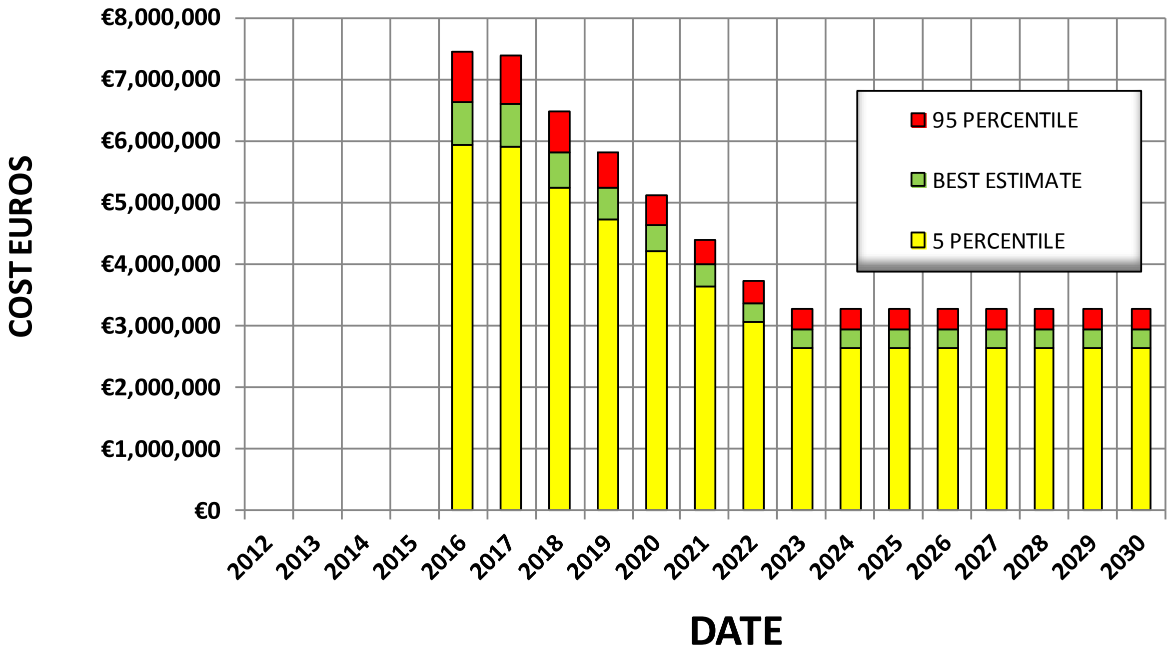

Figure 11 – Option 1 Costs

8.5.3 Option 2 Costs

Option 2 relates to new build and in-service aircraft. Based on an implementation date of 2016 for new build, and an in-service implementation period starting in 2016 and ending in 2020 (5 year implementation period) the model suggests an annual cost of approximately €250,000,000 during the in-service implementation period, as illustrated in Figure 3. The range on this prediction, based on the data entry used, is between approximately €230,000,000 and €275,000,000 per annum. Costs incurred after the in-service implementation period will be solely those related to the installation of "25.562 compliant seats" on new build aircraft. The relative magnitude of these costs can also be seen in Figure 3.

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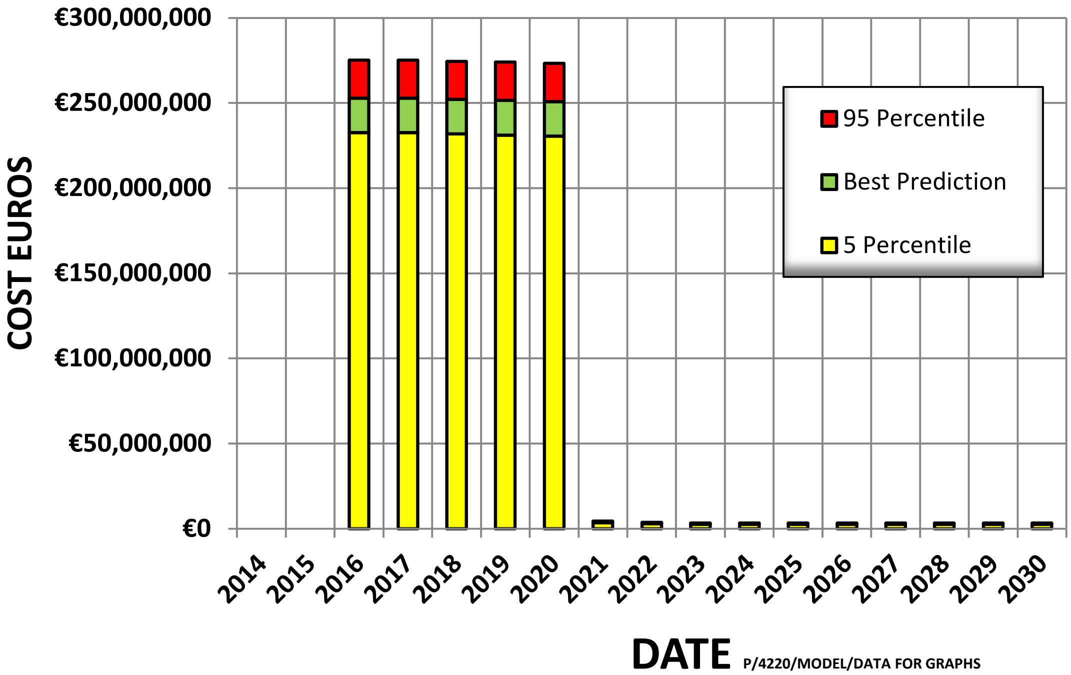

Figure 12 – Option 2 Costs

These costs will tend to reduce if the implementation start date is postponed, since there will be fewer aircraft in-service that are not configured with "25.562 compliant seats". By way of example, if the implementation start date for new build and in-service aircraft was 2020 with an end date for the in-service aircraft of 2024 the annual cost would reduce to approximately €187,000,000.

The assessed costs through to 2030 are approximately **€1,300,000,000**, based on a five year implementation date starting in 2016. Almost all of these costs will be borne by the airlines. Of this €1,300,000,000, approximately €40,000,000 is considered to be attributable to **cabin crew seats**, i.e. **less than 2%**.

9 Social Impacts

9.1 Option 1

No significant Social Impacts have been identified resulting from the requirement to install “25.562 compliant seats” on new build aircraft. Whilst this option is likely to result in the aircraft and seat manufacturers incurring increased costs it is not expected that this will have any significant impact, either positive or negative on employment.

9.2 Option 2

The effect on employment of Option 2, if any, will be positive as more seats need to be replaced. However, it is considered that this is unlikely to result in the creation of new jobs.

Perhaps the greatest Social Impact for this option arises from the economic impact that might be imposed on smaller airlines if they were required to fit “25.562 compliant seats” and the potential threat that might result to the jobs of employees of “EASA Operators”. There are several small European airlines that operate aircraft with 25.562 non-compliant seats. Those that have a small number of old aircraft are likely to incur a relatively high economic burden with a consequential threat to employment.

This issue is addressed further in Section 11.

10 Environmental Impacts

The EASA pre-RIA (Reference 2) suggests that there are no significant negative environmental impacts resulting from either of the two options. No major environmental impacts have been identified as a result of this study. The only potential environmental impact identified in this study was the potential for increased levels of emissions due to increased fuel burn that might be associated with weight increases resulting from the installation of "25.562 compliant seats". If "25.562 compliant seats" were heavier than non-compliant seats then Option 2 will have a greater negative environmental impact since the European fleet will be modified with "25.562 compliant seats" earlier. Hence, heavier seats would favour Option 1 and lighter seats will favour Option 2 from an environmental aspect.

However as discussed in Section 8.3.1 it is considered that the replacement of existing seats with "25.562 compliant seats" is not likely to result in any weight increases. Therefore it is concluded that the environmental impacts are likely to be negligible for both options and *"25.562 compliant seats" will be largely environmentally neutral.*

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11 Proportionality

The primary issue, regarding the impact of the two options on Small and Medium-Sized Enterprises, is the effect that Option 2 might have on the smaller airlines, with perhaps older aircraft, if they are required to introduce "25.562 compliant seats" on their aircraft. Option 2 is considered to have the potential for significantly disadvantaging smaller airlines due to the economic burden of introducing "25.562 compliant seats". This issue is considered likely to be significant.

It may be inferred from Table 1, that there are several airlines, with a small number of aircraft, having seats that are non-compliant with the 25.562 standard. In particular small operators of the ATR 42, Avro RJ, Boeing 757, Fairchild Dornier 328, Fokker 100, Saab 2000 and the Jetstream 41 could find the economic burden of installing "25.562 compliant seats" disproportionate to their revenue.

If they are required to install "25.562 compliant seats" this may incur a significant threat to their economic viability.

A further issue related to proportionality is the inclusion, in both options, of cabin crew "25.562 compliant seats" since it was not possible to justify their inclusion on the basis of a comparison between the safety and economic impacts. However, if "25.562 compliant seats" are installed for passengers then it would seem disproportionate to not install them for cabin crew, especially when it is considered that cabin crew survival in accidents is a critical element of passenger survivability.

12 Harmonisation

ICAO does not expressly require "25.562 compliant seats" in its Standards and Recommended Practices.

The FAA requires that for FAR 121 operators "25.562 compliant seats" be fitted for passengers and flight attendants (cabin crew), on aircraft manufactured on or after 27 October 2009. However, the FAA does not require that in-service aeroplanes are retrofitted with "25.562 compliant seats".

FAR 121.311 (j) states:

> *(j) After October 27, 2009, no person may operate a transport category airplane type certificated after January 1, 1958 and manufactured on or after October 27, 2009 in passenger-carrying operations under this part unless all passenger and flight attendant seats on the airplane meet the requirements of §25.562 in effect on or after June 16, 1988.*

The Brazilian Aviation Authority - Agência Nacional de Aviação Civil (ANAC) adopts a similar position to the FAA, as does the Australian Civil Aviation Safety Authority (CASA); Australian Civil Aviation Safety Regulations 1998 - REG 90.280 states:

Seats

(1) This regulation applies to a transport category aeroplane that:

- *is an aeroplane to which this Subpart applies; and*
- *was originally certificated on or after 1 January 1958; and*
- *is manufactured on or after 27 October 2009; and*
- *is engaged in regular public transport operations.*

Note It is anticipated that the application of this regulation will be extended to cover operations mentioned in paragraph 206 (1) (b) of CAR when provisions of Parts 121 and 135 relating to air transport operations commence.

(2) The registered operator of the aeroplane commits an offence if:

(c) the registered operator:

(j) operates the aeroplane; or

(ii) permits a person to operate the aeroplane; and

(b) while the aeroplane is operating, a seat for a passenger or cabin crew member does not meet the standards of FARs section 25.562, as in force on 16 June 1988.

Hence, the current position is that the EASA requirements, in this respect, are not harmonised with the United States of America, Brazil and Australia. This results in the potential for "EASA Operators'" aircraft being to a lower safety standard than those operating in these countries.

Adoption, by EASA, of Option 1 would result in a harmonised position with the USA, Brazil and Australia. Option 2, requiring retrofitting of aircraft with "25.562 compliant seats",

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would not result in a harmonised position and will impose a burden on European airlines that is not experienced by Operators in the United States, Brazil and Australia.

13 Comparison of Option 1 and Option 2

13.1 Benefit

Based on the Benefit Model outputs discussed in Section 7.6 it is evident that **Option 2** has a greater safety impact than Option 1. It is assessed that Option 2 will save approximately **3.5 lives** and prevent approximately **3.5 Serious Injuries** more than Option 1 through to 2030. This injury reduction is likely to be restricted to passengers since neither option is expected to result in significant reduction to cabin crew injuries. In monetary terms Option 2 is likely to result in a benefit over the period through to 2030 which is in the region of **€25 million** greater than Option 1 (based on the FAA monetary values for injuries).

However, these benefits must be considered in relation to the costs associated with the two options as discussed in Section 13.3.

13.2 Cost

Based on the Cost Model outputs discussed in Section 8.5 it is evident that **Option 1** has the better economic impact. The costs associated with Option 2 are assessed to be approximately **€1,200,000,000** (1.2 billion euros) greater than Option 1 through to 2030.

13.3 Benefit Cost Ratio

For implementation dates of 2016 for new build aircraft, and 2016 through to 2030 for in-service aircraft, the cost benefit ratios are:

Option 1 approximately 0.142

Option 2 approximately 0.026

These cost benefit ratios are based on the FAA monetary values of injury shown in Table 10. The values suggested in Reference 7, by EASA, would result in the monetary value of benefit reducing by approximately 40%. However, use of these values would not affect the comparison between the two options since both would be affected equally. Furthermore, whilst the benefit and the costs will increase with the number of seats currently non-compliant with the requirements of CS 25.562, the benefit cost ratio is largely insensitive to these assessments. Hence it is considered a good measure of the relative merits of the two options.

Since Option 2 results in a large cost being incurred over the in-service implementation period, the benefit cost ratios are best compared by considering the cumulative benefit with the cumulative cost to a given year. **Figure 4** and **Figure 5** show the cumulative benefit cost ratio for Options 1 and 2 respectively. The best prediction of benefit cost ratio for 2030 are the values 0.142 and 0.026.

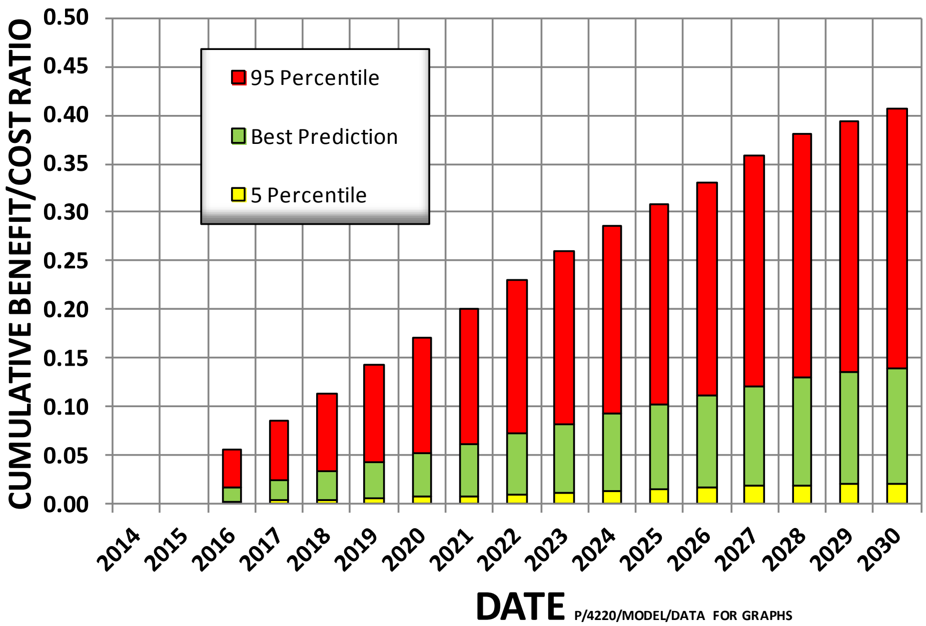

Figure 13 – Option 1 Cumulative Benefit Cost Ratio

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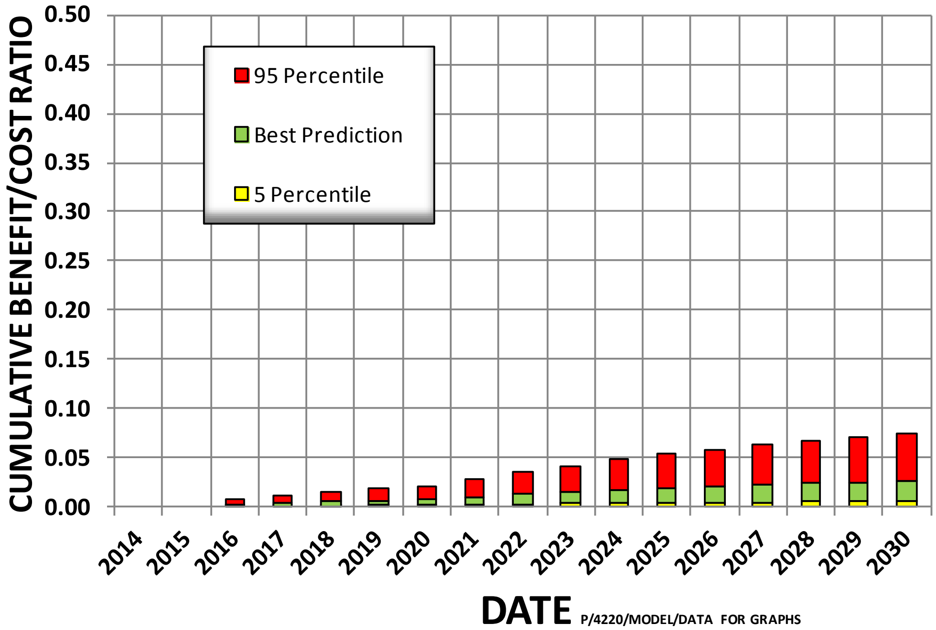

Figure 14 – Option 2 Cumulative Benefit Cost Ratio

Whilst there is a large range in the values shown in Figure 4 and Figure 5, there is a high degree of confidence that Option 1 results in the higher benefit cost ratio.

13.4 Social Impacts & Proportionality

The primary issue with social impacts and proportionality is the economic burden that would be imposed on operators by the need to fit “25.562 compliant seats” to in-service aircraft. This will be particularly severe for small operators that may have old aircraft where the cost of replacing seats, and possibly making other changes to the cabin, could be disproportionate to the value of the aircraft. In extreme cases the regulatory action could threaten the viability of the operator with the potential to result in the loss of employment for airline staff.

The proposed regulatory changes are considered unlikely to impact on employment with aircraft and seat manufacturers.

Hence, it is evident that **Option 1** will avoid the adverse Proportionality and Social Impacts associated with Option 2.

13.5 Environmental Impacts

The only potential environmental impact identified in this study was the potential for increased levels of air pollution due to increased fuel burn that might be associated with weight increases resulting from the installation of “25.562 compliant seats”. However as discussed in Section 8.3.1 it is considered that the replacement of existing seats with “25.562 compliant seats” is not likely to result in any weight increases. Therefore it is concluded that the environmental impacts are likely to be negligible for both options.

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13.6 Harmonisation

Only **Option 1** would result in a harmonised position with the FAA. Option 2 would impose a burden on European airlines that is not experienced by operators in the United States. Adoption of Option 1 will result in harmonisation with the FAA.

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14 Conclusions

Based on a comparison of the impacts of the two regulatory options addressed in Section 13, it is evident that Option 1 is the preferred option. Although Option 2 is likely to result in enhancements to occupant survivability which are greater than Option 1, this improvement is relatively small in comparison with the associated costs; the lifesaving potential of Option 2 being in the region of 4.6 lives through to 2030 in comparison with approximately 1.3 lives for Option 1.

The cost, benefit/cost ratio, social impacts, proportionality and harmonisation comparisons for the two options all favour Option 1. The environmental impacts are considered to be negligible for both options.

It is therefore concluded that Option 1 is the preferred option

15 Definitions

25.562 compliant seats

Throughout this Regulatory Impact Assessment, the term "25.562 compliant seats" refers to seats that are manufactured and installed such that they are fully compliant with the requirements of CS 25.562.

Accident Scenario

That volume of the aircraft in which the occupants are subjected to a similar level of threat.

EASA Operator

An enterprise with a principal place of business in an EASA Member State that offers to the general public commercial air transportation of passengers in large aeroplanes.

Fatal Injury

"Fatal Injury" means any injury that results in death within thirty (30) days of the accident. (NTSB)

Serious Injury

"Serious Injury" means any injury that:
(1) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received;
(2) results in a fracture of any bone (except simple fracture of fingers, toes, or nose);
(3) causes severe haemorrhages, nerve, muscle, or tendon damage;
(4) involves injury to any internal organ; or
(5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface. (NTSB)

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16 References

2. European Aviation Safety Agency. (2010). *Preliminary Regulatory Impact Assessment, Seat crashworthiness improvement on Large Aeroplanes - Dynamic testing 16g, 26 .002, 1.* European Aviation Safety Agency. Germany.

2.1 European Aviation Safety Agency.(2011). *Regulatory Impact Assessment (RIA) Methodology* WI.RPRO.00046-002. European Aviation Safety Agency, Germany (http://www.easa.europa.eu/rulemaking/procedures-and-work-instructions.php) (last visited September 2012).

3. RGW Cherry & Associates Limited, (2005). *A Benefit Analysis for Aircraft 16G Dynamic Seats Configured without Enhancements to Head Injury Criteria- CAA Paper 2005/03, DOT/FAA/AR-04/27*, U.K. Civil Aviation Authority, United Kingdom. http://www.caa.co.uk/docs/33/2005_03.pdf (last visited July, 2012).

3.1 RGW Cherry & Associates Limited, (2000). *Benefit Analysis for Aircraft 16-g Dynamic Seats, DOT/FAA/AR-00/13*, Federal Aviation Administration, Washington DC, United States of America. http://www.fire.tc.faa.gov/pdf/00-13.pdf, (last visited July, 2012).

4. RGW Cherry & Associates Limited, (2010). *Trends in Accidents and Fatalities in Large Transport Aircraft - DOT/FAA/AR-10/16* U.S. Federal Aviation Administration, United States of America http://www.fire.tc.faa.gov/pdf/10-16.pdf (last visited February, 2013).

5. RGW Cherry & Associates Limited, (January 2011). The Cabin Safety Research Technical Group Accident Database, Prepared for Transport Canada, the Federal Aviation Administration and the UK Civil Aviation Authority. United Kingdom: http://www.rgwcherry-adb.co.uk/ (last visited January, 2013).

6. The U.S. Department of Transportation, Office of Policy, Transportation Policy (2011). *Treatment of the Economic Value of a Statistical Life in Departmental Analyses – 2011 Interim Adjustment* http://www.dot.gov/policy/transportation-policy/treatment-economic-value-statistical-life (last visited December 2012)

7. European Aviation Safety Agency.(2011). *Notice Of Proposed Amendment (NPA) No 2011-03*. European Aviation Safety Agency, Germany.

8. Federal Aviation Administration, (2007). *Economic Values for FAA Investment and Regulatory Decisions, A Guide - Contract No. DTFA 01-02-C00200)*, FAA Office of Aviation Policy and Plans, U.S. Federal Aviation Administration, Washington DC, United States of America http://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/ECONOMICVALUESFORFAAINVESTMENTANDREGULATORYDECISIONS10032007.pdf (last visited December 2012)

9. Research and Innovative Technology Administration, Bureau of Transportation Statistics, (2012). *Airline Fuel Cost and Consumption (U.S. Carriers - Scheduled)*, United States of America: Author

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Appendix 1 – Survivability Chains

The accidents analysed involved aircraft with varying standards of fireworthiness. To determine the benefit likely to be accrued by aircraft compliant with today's standards, an allowance is made for a reduction in fire fatalities and injuries that might result from the improved fire characteristics of cabin materials compliant with the current standards of CS-25.

Where sufficient data are available, each accident is divided into scenarios and a Survivability Chain constructed. The following is an example of the model and the effects of improvement in Serious Injuries and Fatalities resulting from changes to survivability factors.

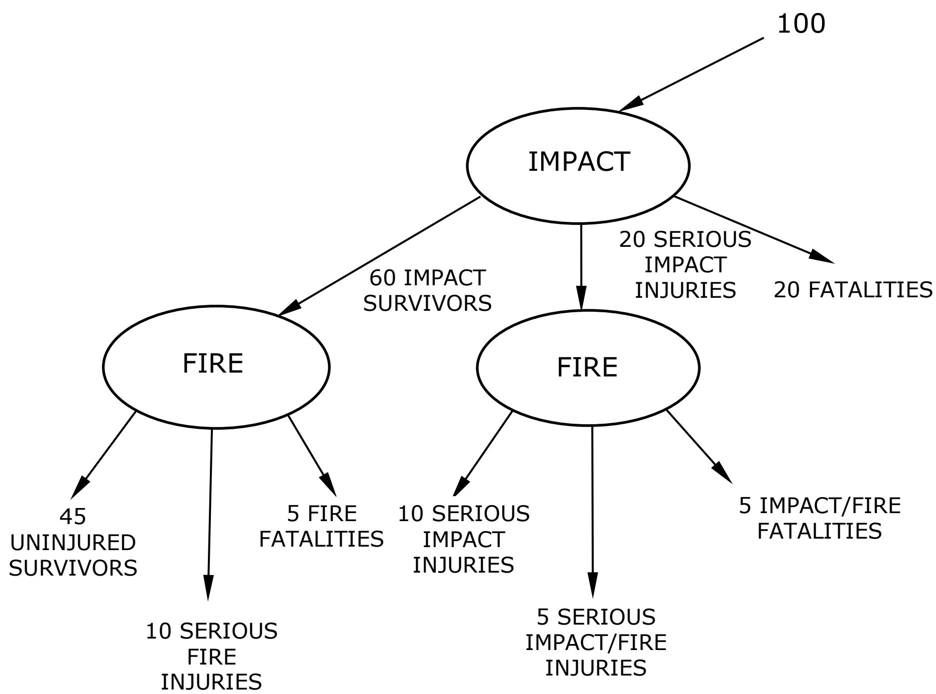

Figure A1- 1- Example of survivability chain for an accident Scenario

As illustrated in Figure A1-1, of the 100 occupants in the scenario there are:

- 45 uninjured survivors.
- 25 Serious Injuries, 10 as a result of the impact, 10 as a result of the fire, and 5 seriously injured as a result of the impact and fire.
- 30 fatalities, 20 as a result of the impact, and 10 as a result of the fire (5 of whom sustained non-fatal injuries from the impact).

If improvements are made to an impact-related survivability factor, such that there are only 12 fatalities and 16 seriously injured of the 100 occupants, the survivability chain then becomes as illustrated in Figure A1-2.

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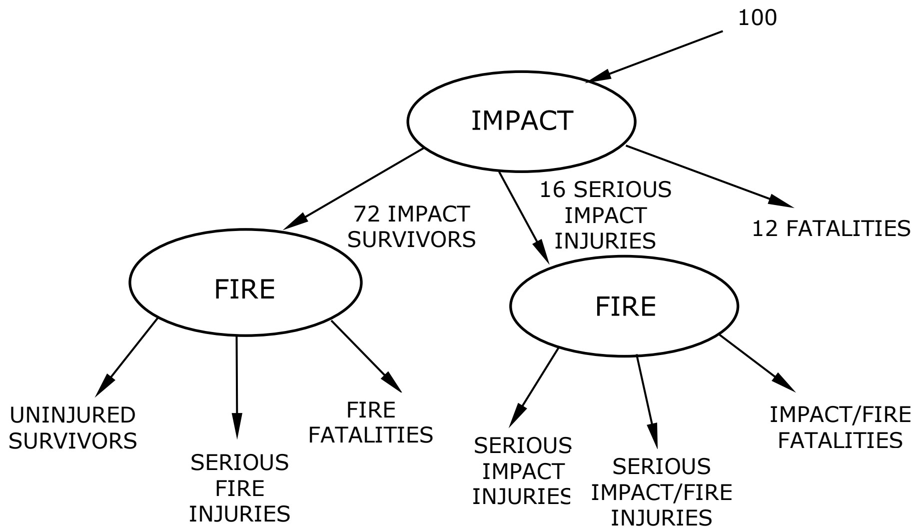

Figure A1- 2 Example of survivability chain showing possible improvements in impact-related survivability factor

It is known from the accident that 5/60ths of those that survive the impact uninjured and 5/20ths of those that sustain injuries from the impact subsequently succumb to death because of the fire. Furthermore, 10/60ths of those that survive the impact seriously injured are seriously injured from fire and 5/20ths of those that sustain injuries from the impact also sustain injuries because of the fire. It is assumed that these ratios are constant for this particular scenario.

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On this basis an assessment of the numbers of Serious Injuries and Fatalities may be made as follows: -

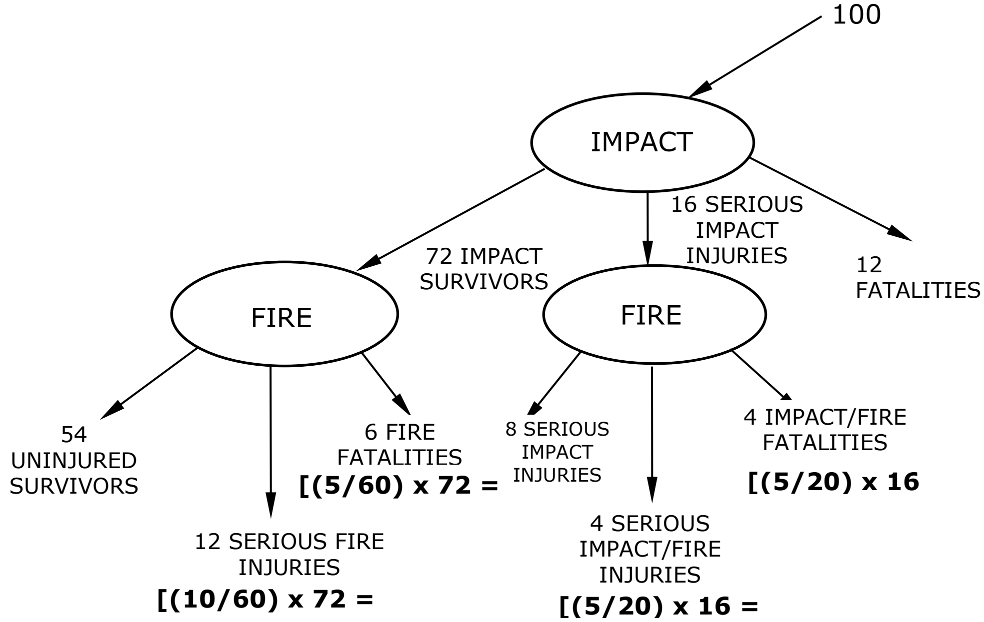

Figure A1- 3 Example of survivability chain showing the overall improvements in survivability

Hence, the improvement to the impact related survivability factor results in: -

- 54 survivors.
- 24 Serious Injuries, 8 as a result of the impact, 12 as a result of the fire, and 4 seriously injured as a result of the impact and fire.
- 22 fatalities, 12 because of the impact, and 10 because of the fire (4 of whom sustained Non-fatal Injuries from the impact).

It should be noted that the survivability factor improvement resulted in a reduction in impact fatalities of 8 and impact injuries of 4. However, the overall situation is as shown in Table A1-1, with the number of Serious Injuries being reduced by only one due to the fire threat.

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Table A1- 1 - Summary of Reduction of Serious Injuries and Fatalities

	Survivors	Serious Injuries	Fatalities
Actual Accident Injuries	45	25	30
Assessed number of Injuries following the introduction of “25.562 compliant seats”	54	24	22
Serious Injury/Fatality Reduction		1	8

A software package has been developed to use the Survivability Chain model in a mathematical representation of an accident using Monte Carlo simulations. This enables an assessment to be made of the change in numbers of survivors, injuries, and Fatalities resulting from predictions of the range of improvements likely to be made from the introduction of “25.562 compliant seats”.

The data for the Model is based on an analysis of past accidents to determine the reduction of Serious Injuries and Fatalities due to the introduction of “25.562 compliant seats”.

The severity of hazard in an accident can vary markedly throughout the aircraft. Experience has shown that considering occupant injuries on a “whole” aircraft basis can be misleading when assessing the effects of survivability factors. It is therefore desirable to divide the aircraft into “Scenarios”. A Scenario is defined as:

“That volume of the aircraft in which the occupants are subjected to a similar level of threat.”

A similar level of threat need not necessarily result in the same level of injury to occupants. The extent of injury sustained can vary with numerous factors including age, sex, adoption of the brace position etc. Furthermore, the threat to occupants can vary over relatively small distances. For example, a passenger may receive Fatal Injuries because of being impacted by flying debris, and a person in an adjacent seat may survive uninjured. Dividing accidents into scenarios provides a more meaningful basis on which to analyse accidents than considering the whole aircraft due to the marked variation in potential for survival with occupant location.

The flight deck and flight attendant areas are generally considered as separate scenarios. The cabin crew areas are normally considered as a separate scenario from the passenger cabin, due to the significant differences in seating, restraint systems and exit availability.

For these reasons, where sufficient data are available, the assessments of injury reduction are carried out for each accident scenario. For each scenario, a numerical assessment is made of the impact on number of Serious Injuries and Fatalities because of changes resulting from the introduction of “25.562 compliant seats”. The assessment results in a prediction of the highest, mean, and lowest number of Serious Injuries and Fatalities that could reasonably be expected from the change. This reduction is expressed on a per seat basis.

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Based on this methodology an assessment is made of the likely reduction in Serious Injuries and Fatalities per passenger seat. This is expressed as a distribution such that a best estimate (average value) and a range may be determined. A similar assessment is made, for each of the accidents analysed, of the likely reduction in cabin crew injuries.