Notice of Proposed Amendment 2018-12

Reduction of runway excursions

RMT.0570

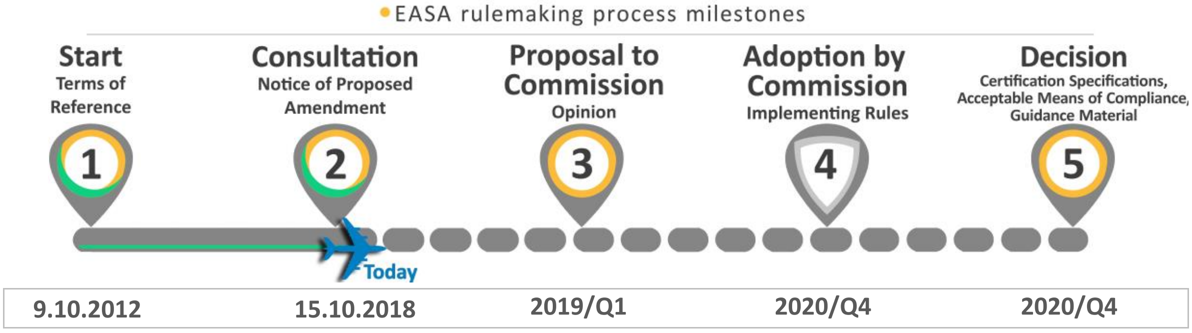
EXECUTIVE SUMMARY

The objective of this NPA is to address the safety issue of runway excursions that occur during landings.

This NPA proposes to require the installation of a runway overrun awareness and alerting system on new large aeroplane designs (CS-25), and on certain new large aeroplanes operated in commercial air transportation (CAT), and manufactured after a predetermined date (Part-26/CS-26).

The proposed regulatory changes are expected to increase safety by supporting the flight crew during the landing phase in identifying and managing the risk of a runway excursion. This should reduce the number of runway excursions that occur during landings.

Action area:	Runway safety		
Affected rules:	Part-26, CS-26, CS-25		
Affected stakeholders:	Large aeroplane operators, large aeroplane manufacturers and their suppliers, Supplemental Type Certificate applicants		
Driver:	Safety	**Rulemaking group:**	No
Impact assessment:	Full	**Rulemaking Procedure:**	Standard



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1. About this NPA

1.1. How this NPA was developed

The European Aviation Safety Agency (EASA) developed this NPA in line with Regulation (EU) 2018/1139[1] (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure[2]. This rulemaking activity is included in the EASA Rulemaking Programme as part of the European Plan for Aviation Safety (EPAS) 2018-2022[3] under rulemaking task (RMT).0570. The text of this NPA has been developed by EASA, taking into consideration the comments received further to the publication of NPA 2013-09, and the development of EUROCAE document ED-250, 'Minimum Operational Performance Standard for a Runway Overrun Awareness and Alerting System'. This NPA is hereby submitted to all interested parties[4] for consultation.

1.2. 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 **15 January 2019.**

1.3. The next steps

Following the closing of the public commenting period, EASA will review all the comments received. Based on the comments received, EASA will develop:

— an opinion that contains proposed amendments to Commission Regulation (EU) 2015/640[6]. The opinion will be submitted to the European Commission, which will use it as a technical basis in order to amend the regulation;

— a decision that amends CS-26[7]; and

— a decision that amends CS-25[8].

[1] Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91 (OJ L 212, 22.8.2018, p. 1) (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1535612134845&uri=CELEX:32018R1139).

[2] EASA is bound to follow a structured rulemaking process as required by Article 115(1) of Regulation (EU) 2018/1139. Such a process has been adopted by the EASA Management Board (MB) and is referred to as the 'Rulemaking Procedure'. See MB Decision No 18-2015 of 15 December 2015 replacing Decision 01/2012 concerning the procedure to be applied by EASA for the issuing of opinions, certification specifications and guidance material (http://www.easa.europa.eu/the-agency/management-board/decisions/easa-mb-decision-18-2015-rulemaking-procedure).

[3] https://www.easa.europa.eu/document-library/general-publications/european-plan-aviation-safety-2018-2022

[4] In accordance with Article 115 of Regulation (EU) 2018/1139 and Articles 6(3) and 7 of the Rulemaking Procedure.

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

[6] Commission Regulation (EU) 2015/640 of 23 April 2015 on additional airworthiness specifications for a given type of operations and amending Regulation (EU) No 965/2012 (OJ L 106, 24.4.2015, p. 18) (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1537864675699&uri=CELEX:32015R0640).

[7] Certification Specifications and Guidance Material for Additional airworthiness specifications for operations (CS-26).

[8] Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes (CS-25).

The comments received and the EASA responses to them will be reflected in a comment-response document (CRD). The CRD will be published together with the opinion and the respective decisions linked to this NPA.

2. In summary — why and what

2.1. Why we need to change the rules — issue/rationale

For the last few decades, runway excursions have been recognised as major contributors to accidents worldwide, and as significant risks to aviation safety. Recently, on-board systems have been developed that are able to significantly contribute to reducing the number of those events that occur, and in particular, those that occur longitudinally during landings (as statistically, around 80 % of the reported runway excursions occur during landings). These systems, can be installed on new designs of large aeroplanes, and also on existing already certified designs of large aeroplanes. In flight, such a system is typically able to provide a timely alert to the flight crew if the calculated stopping point is beyond the end of the runway.

After touch-down, the system is able to provide a timely alert to the flight crew if the measured deceleration is not sufficient to bring the aeroplane to a safe stop before the end of the runway. This NPA proposes certification standards for such systems, and their mandatory installation on new designs and all newly produced large aeroplanes to be operated in commercial air transport.

For more detailed analysis of the issues addressed by this proposal, please refer to Section 4.1. of the RIA, 'Issues to be addressed'.

Related safety issue

The US National Transportation Safety Board (NTSB) reported the following:

'On July 31, 2008, about 0945 central daylight time, East Coast Jets flight 81, a Hawker Beechcraft Corporation 125-800A airplane, N818MV, crashed while attempting to go around after landing on runway 30 at Owatonna Degner Regional Airport (OWA), Owatonna, Minnesota. The two pilots and six passengers were killed, and the airplane was destroyed by impact forces.'

The following safety recommendation (SR) has been addressed to the FAA by the National Transportation Safety Board (NTSB) further to the investigation of this accident:

The FAA was requested to 'actively pursue with aircraft and avionics manufacturers the development of technology to reduce or prevent runway excursions and, once it becomes available, require that the technology be installed.'

2.2. What we want to achieve — objectives

The overall objectives of the EASA system are defined in Article 1 of the Basic Regulation. This proposal will contribute to the achievement of the overall objectives by addressing the issues outlined above and in Section 4.1.

The specific objective of this proposal is to reduce the number of runway excursions during landings by providing design-related means to support the flight crew in identifying and managing the risk of a longitudinal runway excursion.

2.3. How we want to achieve it — overview of the proposals

The following changes are proposed in this NPA:

— an amendment to Commission Regulation (EU) 2015/640 to require all large aeroplanes operated in CAT, and manufactured after a certain date, to be equipped with a runway overrun awareness and alerting system; and

— an amendment of the large aeroplane certification specifications (CS-25), as well as the certification specifications for additional airworthiness specifications for operations (CS-26), to include provisions for the certification of such systems.

2.4. What are the expected benefits and drawbacks of the proposals

This proposal is expected to create a significant safety benefit[9], with an estimated 13 accidents avoided, 9 fatalities and 81 injuries prevented and avoided accident costs with a present value[10] in the order of EUR 94 million. The present value of the costs for implementing this option are estimated to range between EUR 65 and 196 million, depending on the unit cost assumptions.

No drawbacks are expected.

[9] Over the period 2022-2037.

[10] Present values were calculated using a 4 % discount rate.

3. Proposed amendments and rationale in detail

The text of the amendment is arranged to show deleted text, new or amended text as shown below:

- deleted text is struck through;
- new or amended text is highlighted in blue; and
- an ellipsis '(…)' indicates that the rest of the text is unchanged.

3.1. Draft regulation (Draft EASA opinion)

Amend Annex I (Part-26) to Commission Regulation (EU) 2015/640 as follows.

PART-26

ADDITIONAL AIRWORTHINESS SPECIFICATIONS FOR OPERATIONS CONTENTS

CONTENTS

(…)

SUBPART B – LARGE AEROPLANES

(…)

26.205 Runway overrun awareness and alerting systems

(…)

SUBPART B
LARGE AEROPLANES

(…)

26.205 Runway overrun awareness and alerting systems

Operators of large aeroplanes used in commercial air transport shall ensure that each of these aeroplanes, when first issued with an individual Certificate of Airworthiness on or after [*three years after the entry into force of this regulation*], is equipped with a real-time flight crew alerting system that makes (in-flight and on-ground) energy-based calculations of the predicted landing stopping point in comparison with the end of the runway.

3.2. Draft decision (amending CS-26)

Amend CS-26 as follows:

CONTENTS

(…)

BOOK 1 – CERTIFICATION SPECIFICATIONS

(…)

SUBPART B – LARGE AEROPLANES

(…)

CS 26.205 Runway overrun awareness and alerting systems

(…)

Book 1
SUBPART B — LARGE AEROPLANES

(…)

CS 26.205 Runway overrun awareness and alerting systems

Compliance with Part 26.205 is demonstrated by complying with CS 25.705.

(…)

3.3. Draft decision (amending CS-25)

Amend CS-25 as follows:

Book 1
SUBPART D — Design and Construction

(…)

CS 25.705 Runway overrun awareness and alerting systems
(See AMC 25.705)

A runway overrun awareness and alerting system (ROAAS) must be installed on each aircraft.

The system shall make energy-based calculations of the predicted landing stopping point in comparison with the end of the runway, and provide the flight crew with:

(a) a timely in-flight predictive alert of a longitudinal runway overrun risk, and

(b) an on-ground predictive alert, or an automated means of deceleration control, for longitudinal runway overrun protection during landing.

(…)

Book 2

AMC — SUBPART D

AMC 25.705 Runway overrun awareness and alerting systems

In showing compliance with CS 25.705, the applicant may take account of EUROCAE document ED-250, ‘Minimum Operational Performance Standard for a Runway Overrun Awareness and Alerting System’.

4. Impact assessment (IA)

4.1. What is the issue

Runway excursions have led to one fatal accident in CAT aeroplane operations involving airlines/cargo operations over the past decade, and a runway excursion is ranked as N°1 in the European Risk Classification Scheme (ERCS), according to the EASA Annual Safety Review for 2018. Furthermore, runway excursions accounted for 30 % of the non-fatal accidents over the same period and for the same population.

The average value of the aircraft damage caused by a runway excursion is estimated to amount to EUR 11 million per accident. The costs for the airport delays, cancellations and diversions that follow a runway excursion are estimated to be EUR 2.6 million per accident (see Table 5 below).

The number of occurrences of runway excursions during landings has increased in line with the growth in traffic. As aviation traffic is expected to continue to grow worldwide as well as in Europe, the number of runway excursions can also be expected to increase further.

This situation has driven aviation stakeholders worldwide to cooperate towards solutions that address this risk. In addition to their involvement in the development of operational and training solutions, some aeroplane and equipment manufacturers have developed, or are developing, systems that provide an alert when there is a risk of a runway overrun during a landing, and provide support to the flight crew for their decision-making.

Up to now, EASA has issued certification review items (CRIs) that provide acceptable means of compliance and interpretative material for the certification of such systems to be installed in new or in-service large aeroplane types on a voluntary basis.

To continue to tackle this runway safety and cost issue and to ensure a level playing field, EASA published NPA 2013-09 in 2013, which proposed certification standards for the mandatory installation of runway overrun prevention systems on all new large aeroplane designs, as well as new large aeroplanes produced after a certain date.

Many comments criticised the proposal, although all the comments recognised the relevance of the issue. Further to the feedback received, EASA decided to issue a new NPA on the reduction of runway excursions. As indicated in the Comment-Response Document (CRD) to NPA 2013-09 (published in April 2015), 'the proposal of this new NPA would put more emphasis on the safety objectives against the risk of runway excursions, while providing more flexibility in terms of design solutions. The means to achieve the objectives would be provided in a technical standard developed jointly by industry and national aviation authorities with the support of an international standardisation body'.

In May 2015, EUROCAE published its terms of reference for Working Group 101, which was tasked with developing Minimum Operational Performance Standards (MOPS) for a Runway Overrun Awareness and Alerting System (ROAAS).

The resulting EUROCAE document ED-250 was published in December 2017.

ED-250 defines the system characteristics and requirements for a ROAAS that should be useful to designers, manufacturers, installers, certification authorities and users of the equipment.

The proposal in this NPA considers the standards in ED-250.

4.1.1. Safety risk assessment

For operators certified in an EASA Member State, a runway excursion is one of the most frequent types of accident for CAT airlines and NCC business operations (as 81 high-risk occurrences were recorded in the period 2013-2017).

As Figure 1 shows, although there were some signs of improvement in earlier years (until 2012), there has been a trend since 2013 for the number of accidents and serious incidents to increase.

Figure 1: Runway excursion accidents and serious incidents during landings (EASA MS)

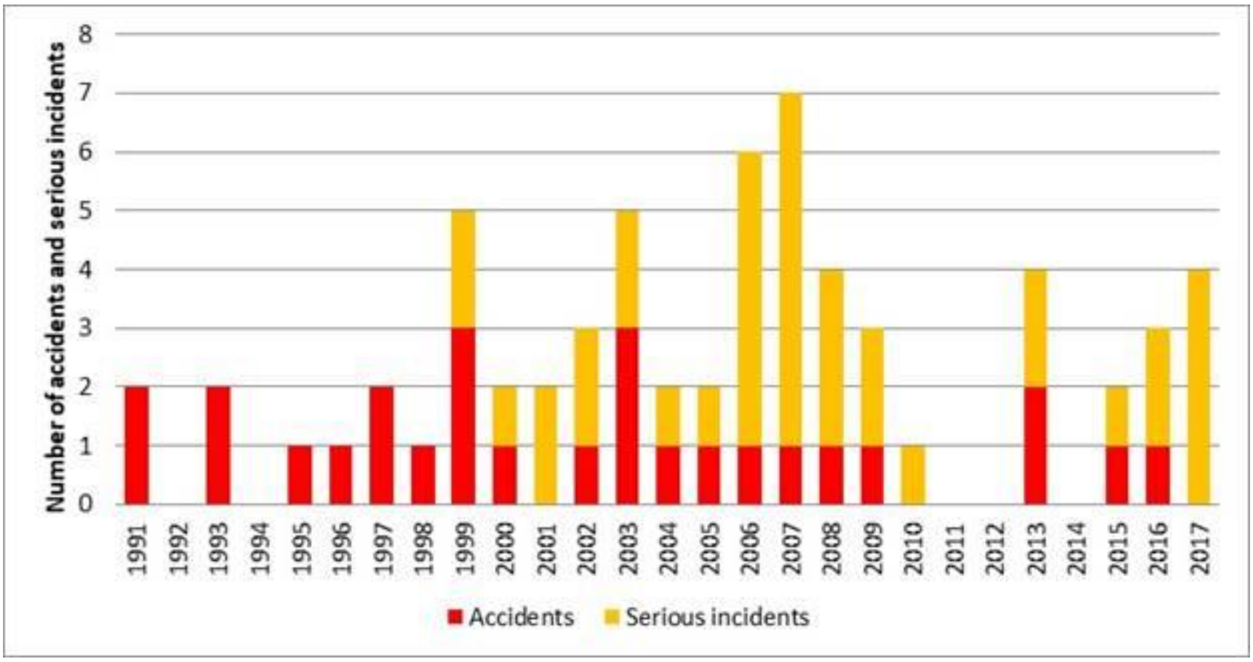
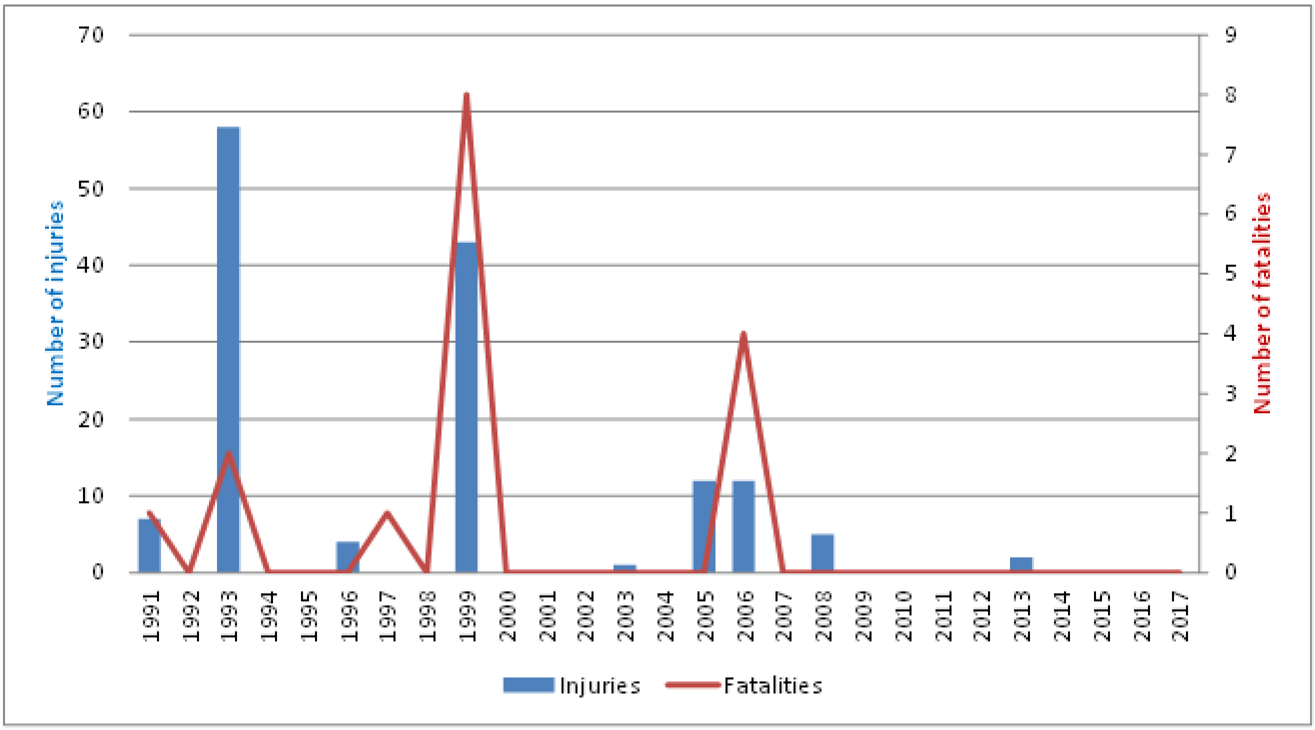


Figure 2 shows, however, that there has been no obvious upward trend in the number of casualties caused by runway excursions over the past fifteen years. Since the early 90s, the number and the frequency of fatalities and injuries appear to have remained fairly constant. Overall, EASA Member State operators had 64 longitudinal runway excursions, 27 accidents and 37 serious incidents between 1991 and 2017.

Figure 2: Fatalities and injuries due to runway excursions during landings, 1991–2017



4.1.2. Who is affected

Primarily affected stakeholders:

— manufacturers of large aeroplanes, some equipment manufacturers, and possibly other organisations who wish to install systems to provide alerts on the risk of runway excursions, since they design, produce, and install those systems (by means of STCs);

— European operators of large aeroplanes used for commercial air transport (of which there are close to 800), since they would have to ensure that their fleets are equipped in due time.

Secondarily affected stakeholders:

— approved training organisations (ATOs) and holders of flight simulator training device (FSTD) qualifications (more than 600).

4.1.3. How could the issue/problem evolve

If one were to predict future fatalities and injuries based on the data available, one would need to take into consideration that the number of runway excursions that occur is proportionate to the number of aircraft movements. Based on a 3.9 % average annual increase in traffic, Table 1 provides estimates of the numbers of fatalities and injuries to be expected in the years 2017 to 2037.

Table 1: Future expected landing overrun fatalities and injuries of European operators in a regulatory no change scenario (Option 0)

Year	Accidents	Fatalities	Injuries
2017	1.0	0.7	6.4
2018	1.1	0.8	6.7
2019	1.1	0.8	6.9
2020	1.2	0.8	7.2
2021	1.2	0.8	7.5
2022	1.3	0.9	7.8
2023	1.3	0.9	8.1
2024	1.4	0.9	8.4
2025	1.4	1.0	8.7
2026	1.5	1.0	9.1
2027	1.5	1.1	9.4
2028	1.6	1.1	9.8
2029	1.6	1.1	10.2
2030	1.7	1.2	10.6
2031	1.8	1.2	11.0
2032	1.8	1.3	11.4
2033	1.9	1.3	11.9
2034	2.0	1.4	12.3
2035	2.1	1.4	12.8
2036	2.2	1.5	13.3
2037	2.2	1.6	13.8
Total	32.9	22.9	203.2

Based on the above analysis, the likelihood of runway excursions is considered to be improbable. But the severity of an occurrence can ultimately be catastrophic. Therefore, the combined runway overrun risk is considered to be of high significance. The following section will define the objectives based on this safety issue, and Section 4.3 will identify design options to address the issue.

4.2. What we want to achieve — objectives

The objective of this proposal is to improve safety by mitigating the risk of runway excursions.

4.3. How it could be achieved — options

Table 2: Selected policy options

Option No	*Short title*	**Description**
0		No policy change (i.e. no change to the rules; risks remain as outlined in the issue analysis). EASA would, nevertheless, continue to use the CRI process for approving the installation of ROAAS equipment offered as an option to airline operators.
1		Amend CS-25 to provide high-level requirements for the installation of a ROAAS on every aircraft of all new designs, making reference to ED-250 as an acceptable means of compliance.
2		Implement Option 1 and, in addition, introduce a requirement into Part-26 for the mandatory installation of a ROAAS on every large aeroplane operated in commercial air transport that is manufactured after a certain date, and amend CS-26 accordingly (with a production cut-in).
3		Implement Option 1 and, in addition, introduce a requirement into Part-26 for the mandatory installation of a ROAAS on every in-service large aeroplane that is operated in commercial air transport, and amend CS-26 accordingly (with a production cut-in and a full retrofit).

4.4. Methodology and data

4.4.1. Methodology applied

The benefits and costs of the options identified in the previous sections mainly depend on the unit costs for the various types of ROAAS, as well as the speed at which these systems will be introduced into the fleet.

4.4.2. Data collection

The unit costs estimated in this RIA are based on information provided by aeroplane and equipment manufacturers.

The fleet evolution for the different options is generated based on:

— the ASCEND/AIRCLAIMS fleet data base;

— fleet forecasts from manufacturers;

— the long-term traffic forecast by EUROCONTROL;

— the large aeroplane retirement curves generated from the ASCEND data; and

— assumptions on the number of new Type Certificates based on historical data.

As far as the safety impact is concerned, it is assumed that the rate at which ROAASs are introduced into the fleet determines the safety impact of a particular option.

In the comparison of options, we used cost-effectiveness analysis to calculate the cost needed to avoid one fatality. Cost-effectiveness analysis ranks regulatory options based on the 'cost per unit of effectiveness', i.e. the cost per fatality avoided.

In order to avoid a result that concentrates only on a single type of benefit (i.e. the number of fatalities avoided), the net cost of each option was calculated, which takes into account the benefit of avoiding aeroplane damage, airport delays and diversions.

For reasons of comparability, all monetary values are expressed in 2017 Euros. For future costs and benefits, we applied a standard discount rate of 4 %, and we also inflated past costs with the same value.

4.5. What are the impacts

Fleet evolution and ROAAS introduction

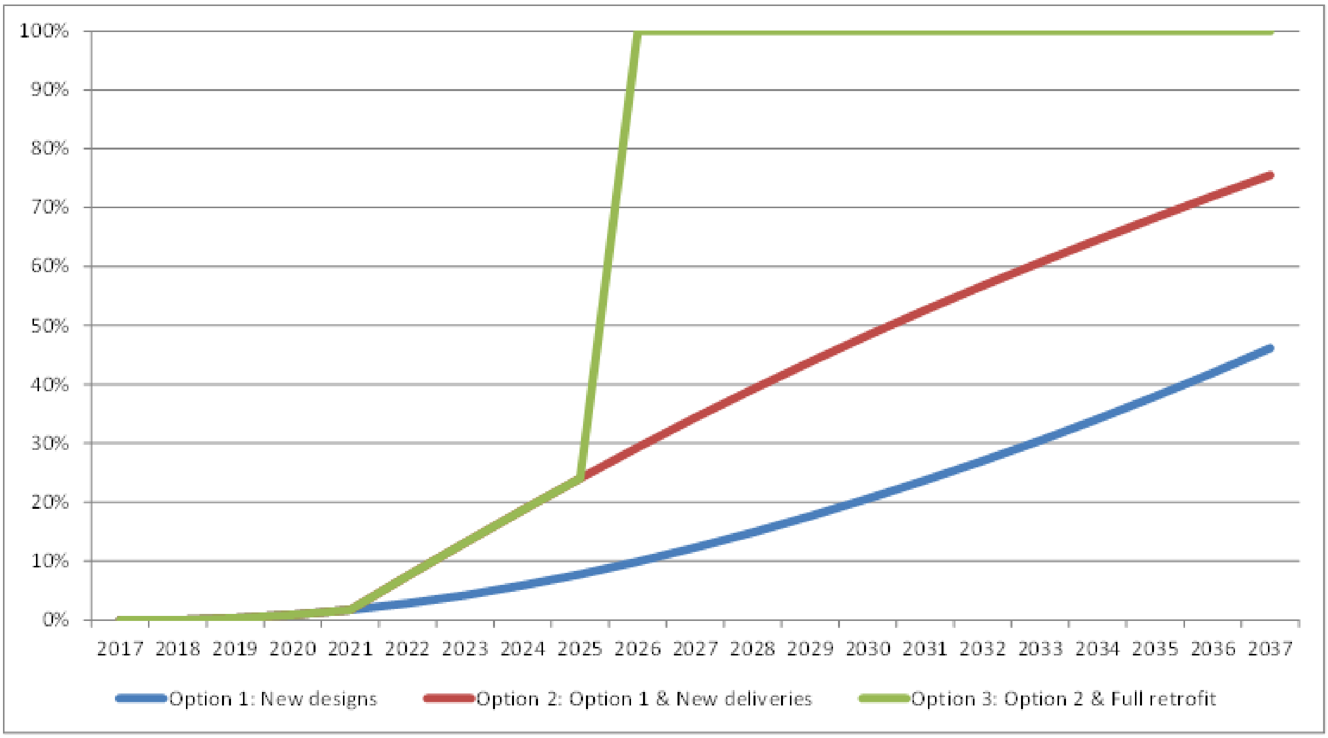
The three options identified result in different speeds at which the ROAAS technology is introduced in the fleet. In order to analyse these different speeds, the evolution of the fleet is analysed. Industry forecasts on average expect a 3.2 % annual increase in the fleet in Europe until 2037. The following analysis estimates the percentage of this fleet that would be equipped with ROAASs for the different options.

Option 0 is the reference option as described in the issue analysis in Section 4.1. As the technology is available and can be certified based on CRIs, it can be assumed that the technology will be introduced into the fleet at a rate that is very limited to negligible. This introduction will depend on the will of applicants for TCs/STCs to include such systems in their designs.

Option 1 requires only new large aeroplane type designs as of 2019 (the date of publication of the new certification standards) to have ROAASs installed. Based on data analysis, it is assumed that every year, 1.2 new type designs are certified on average. An even distribution of deliveries per type is assumed, so, e.g., if 20 types are available on the market in a given year, then each type represents a 5 % share of the total deliveries. As the number of new deliveries and the percentage of new types in that number increases every year, so does the number of deliveries per new type.

As Figure 3 shows, by 2037, less than 50 % of the fleet would be equipped with the technology.

Figure 3: Percentage of European operators' fleets fitted with ROAASs for each option



Option 2 mandates the installation of ROAASs on new type designs and all newly delivered aeroplanes to be operated in commercial air transport by European operators from 2022.

Consequently, roughly 75 % of the fleet would be equipped with the technology by 2037.

Option 3 mandates the installation of ROAASs on all new deliveries and on all in-service aeroplanes (with a production cut-in and a full retrofit), i.e. all the fleet would need to be equipped with these systems by 2026. Thus, in that year (at the latest), the whole of the EASA fleet would be equipped with the ROAAS technology. Note that the graph in Figure 3 assumes that the equipment would all be installed during the implementation year. In reality, it is likely that the introduction will be carried out gradually after the new rule is announced. Thus the associated costs and benefits are likely to occur earlier with this option.

Table 3: Fleet evolution

Year	Option 1: New designs	Option 2: Option 1 & New deliveries	Option 3: Option 2 & Full retrofit
2017	0.0%	0.0%	0.0%
2018	0.0%	0.0%	0.0%
2019	0.3%	0.3%	0.3%
2020	0.9%	0.9%	0.9%
2021	1.7%	1.7%	1.7%
2022	2.8%	7.5%	7.5%
2023	4.2%	13.2%	13.2%
2024	5.9%	18.7%	18.7%
2025	7.8%	24.1%	24.1%
2026	9.9%	29.3%	100.0%
2027	12.3%	34.3%	100.0%
2028	14.9%	39.2%	100.0%
2029	17.6%	43.8%	100.0%
2030	20.6%	48.3%	100.0%
2031	23.7%	52.6%	100.0%
2032	27.0%	56.7%	100.0%
2033	30.5%	60.7%	100.0%
2034	34.1%	64.6%	100.0%
2035	37.9%	68.3%	100.0%
2036	42.0%	72.0%	100.0%
2037	46.1%	75.5%	100.0%

4.5.1. Safety impact

Firstly, as outlined above, the safety impacts of the different options depend on the speed at which the new technology is introduced into the fleet. The impacts are, thus, assumed to be directly proportionate to the rates shown in Figure 3 and Table 3 above.

Secondly, the safety impacts depend on how many of the observed accidents the system could prevent. A thorough analysis of the past events for European operators indicated that around half of the observed 64 serious incidents and accidents shown in Table 4 could have been prevented by ROAASs.

Table 4: Number of runway excursions of EASA operators during landings

Year	Total number of		Thereof			
			Preventable		Non-preventable	
	Accidents	Serious incidents	Accidents	Serious incidents	Accidents	Serious incidents
1991	2		2			
1992						
1993	2				2	
1994						
1995	1				1	
1996	1		1			
1997	2		2			
1998	1				1	
1999	3	2	1	1	2	1
2000	1	1	1	1		
2001		2		1		1
2002		2		1		1
2003	4	2	1	1	3	1
2004	1	1		1	1	
2005	1	1	1	1		
2006	1	5		2	1	3
2007	1	6		3	1	3
2008	1	3	1	3		
2009	1	2	1	1		1
2010		1		1		
2011						
2012						
2013	2	2	2	2		
2014						
2015	1	1	1	1		
2016	1	2	1	2		
2017		4		4		
Total	27	37	15	26	12	11

In this analysis, all the existing factors that contribute to a runway overrun (the weather, the condition of the runway, the configuration of the aeroplane, etc.) were taken into account.

It was considered that, if installed, a ROAAS could not have prevented events where:

— a mechanical failure was the major factor that contributed to the runway overrun,

— the landing was performed in weather conditions that were clearly outside the limitations of the aeroplane.

An installed ROAAS was given a lower, 50 % credit, for instance in the case where the system would have informed the flight crew of the risk of a long landing/a runway overrun (and a proposed go-around) but where, at the same time, a braking action that was less vigourous than expected (with the runway reported wet instead of contaminated), contributed to the overrun.

Finally, a credit of 100 % was given to the ROAAS, if installed, for events which occurred on a perfectly airworthy aeroplane and in normal weather and runway conditions (e.g. a long/fast landing on a dry runway).

Out of 15 preventable accidents, there are two with the lower, 50 % credit, while among the preventable serious incidents, there are 18 cases out of 26 in which the most probable efficacy of ROAAS was estimated to be less than 100 %.

The following table (Table 5) shows the estimated number of fatalities and injuries involving EU-registered aeroplanes that could be avoided in the future by the introduction of the ROAAS technology, based on the safety data provided in Section 4.1. and the expected extent to which the systems are installed in the fleet, for each option. The estimate is based on the forecasted number of future accidents and fatalities as provided in Table 2 and the percentage of the fleet that is equipped with the new technology as shown in Figure 3.

It is assumed that the use of ROAAS equipment can help to significantly reduce the number of accidents and fatalities/injuries if the equipment is installed and performing its intended function. Therefore an unjustified increase in the go-around rate is not expected. In order to estimate the safety benefits, we forecasted the number of future accidents based on historical data and the expected increase in the traffic of EASA Member State airlines. Based on data analysis, we assumed 0.7 fatalities and 6.2 injuries per accident.

Table 5: Statistical safety benefits of ROAAS over the 20-year analysis period (casualties avoided)

Year	Option 1: New TCs			Option 2: New Deliveries			Option 3: Full retrofit		
	Accidents	Fatalities	Injuries	Accidents	Fatalities	Injuries	Accidents	Fatalities	Injuries
2017	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2018	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2019	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1
2021	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1
2022	0.0	0.0	0.2	0.1	0.1	0.6	0.1	0.1	0.6
2023	0.1	0.0	0.3	0.2	0.1	1.1	0.2	0.1	1.1
2024	0.1	0.1	0.5	0.3	0.2	1.6	0.3	0.2	1.6
2025	0.1	0.1	0.7	0.3	0.2	2.1	0.3	0.2	2.1
2026	0.1	0.1	0.9	0.4	0.3	2.7	1.5	1.0	9.1
2027	0.2	0.1	1.2	0.5	0.4	3.2	1.5	1.1	9.4
2028	0.2	0.2	1.5	0.6	0.4	3.8	1.6	1.1	9.8
2029	0.3	0.2	1.8	0.7	0.5	4.5	1.6	1.1	10.2
2030	0.4	0.2	2.2	0.8	0.6	5.1	1.7	1.2	10.6
2031	0.4	0.3	2.6	0.9	0.7	5.8	1.8	1.2	11.0
2032	0.5	0.3	3.1	1.0	0.7	6.5	1.8	1.3	11.4
2033	0.6	0.4	3.6	1.2	0.8	7.2	1.9	1.3	11.9
2034	0.7	0.5	4.2	1.3	0.9	8.0	2.0	1.4	12.3
2035	0.8	0.5	4.9	1.4	1.0	8.7	2.1	1.4	12.8
2036	0.9	0.6	5.6	1.5	1.1	9.6	2.2	1.5	13.3
2037	1.0	0.7	6.4	1.7	1.2	10.4	2.2	1.6	13.8
Total	6.4	4.5	39.7	13.1	9.1	80.9	22.8	15.9	141.0

4.5.1.1 Aircraft damage costs avoided

As far as equipment damage is concerned, Table 6 gives an estimate of the future damage that could be avoided. The estimate is based on the historical values of the 1991-2010 period, where 11 out of the 27 runway excursion accidents could have been prevented by the ROAAS. The average annual number of accidents of 1.15 is expected to increase in the future in line with the predicted traffic increase of 3.9 % annually. Using the average cost per accident of EUR 11.1 million, the total figures are estimated for the 21-year analysis period (2017-2037). Option 3 forces a full retrofit by 2026, and thus creates the highest benefit in terms of the present value of avoided equipment damage or loss, amounting to an estimated EUR167 million. This level of hull loss and liability claims also significantly affects the amount of hull and liability insurance paid on a yearly basis by aeroplane operators.

4.5.1.2 Diversion, delay, and cancellation costs avoided

The costs of a runway excursion accident are not limited to equipment damage, but also include costs for operational disruptions. To account for this, it is assumed that after an excursion, the runway is closed for a duration of ten hours on average, and that the number of affected movements is 10 per hour. On a smaller airport with only one runway, this can mean a closure of the whole airport, causing diversions, cancellations and delays. Although on a larger airport, there might still be operational runway(s), the number of affected flights is expected to be similar because of the proportionally heavier traffic.

Delays, cancellations and diversions were monetised using values based on Eurocontrol recommendations. The average cost to an airline of a ground delay of a passenger air transport aeroplane is EUR 7 900 per hour, the average cost of a diversion to another airport for a scheduled commercial flight is EUR 13 900, and the average cost of a cancellation on the day of operation is EUR 33 100. During the 10-hour period while the runway is closed, we expect 15 arrivals to be diverted, 20 arrivals to be cancelled and 15 arrivals to be delayed. Among the 50 planned departures, 35 are assumed to be cancelled, and 15 are expected to be delayed.

Based on the above assumptions, a runway excursion accident is estimated to cost EUR 399 000 for diversions, EUR 355 500 for delays and EUR 1 820 500 in cancellation costs. The financial benefits of avoiding 7.7, 15.6 and 27.2 accidents (for Options 1, 2 and 3, respectively) are EUR 9.2, 19.2 and 34.3 million respectively in 2017 Euros (see Table 6 and Table 7).

Table 6: Estimation of diversion, cancellation and delay costs

Time after accident (hour)	Average delay (hours)	Arrivals				Departures				Total
		Diversions (aircraft)	Cancellations (aircraft)	Delays (aircraft)	Value	Diversions (aircraft)	Cancellations (aircraft)	Delays (aircraft)	Value	
0–1	9.5	5			€ 133,000		5		€ 165,500	€ 298,500
1–2	8.5	5			€ 133,000		5		€ 165,500	€ 298,500
2–3	7.5	5			€ 133,000		5		€ 165,500	€ 298,500
3–4	6.5		5		€ 165,500		5		€ 165,500	€ 331,000
4–5	5.5		5		€ 165,500		5		€ 165,500	€ 331,000
5–6	4.5		5		€ 165,500		5		€ 165,500	€ 331,000
6–7	3.5		5		€ 165,500		5		€ 165,500	€ 331,000
7–8	2.5			5	€ 98,750			5	€ 98,750	€ 197,500
8–9	1.5			5	€ 59,250			5	€ 59,250	€ 118,500
9–10	0.5			5	€ 19,750			5	€ 19,750	€ 39,500
0–10		15	20	15	€ 1,238,750	0	35	15	€ 1,336,250	€ 2,575,000

Table 7: Statistical safety benefits of the use of ROAASs over the 21-year analysis period, in 2017 Euros[11]

(avoided aeroplane damage and delay/diversion costs)

Year	Option 1: New TCs			Option 2: New Deliveries			Option 3: Full retrofit		
	Accidents	Aircraft damage	Delay and diversion	Accidents	Aircraft damage	Delay and diversion	Accidents	Aircraft damage	Delay and diversion
2017	0.0	€ 0	€ 0	0.0	€ 0	€ 0	0.0	€ 0	€ 0
2018	0.0	€ 0	€ 0	0.0	€ 0	€ 0	0.0	€ 0	€ 0
2019	0.0	€ 31,090	€ 7,803	0.0	€ 31,090	€ 7,803	0.0	€ 31,090	€ 7,803
2020	0.0	€ 92,913	€ 23,319	0.0	€ 92,913	€ 23,319	0.0	€ 92,913	€ 23,319
2021	0.0	€ 182,433	€ 45,786	0.0	€ 182,433	€ 45,786	0.0	€ 182,433	€ 45,786
2022	0.0	€ 301,694	€ 75,717	0.1	€ 799,611	€ 200,680	0.1	€ 799,611	€ 200,680
2023	0.1	€ 447,601	€ 112,335	0.2	€ 1,397,419	€ 350,713	0.2	€ 1,397,419	€ 350,713
2024	0.1	€ 621,813	€ 156,058	0.3	€ 1,981,526	€ 497,308	0.3	€ 1,981,526	€ 497,308
2025	0.1	€ 822,291	€ 206,372	0.3	€ 2,549,215	€ 639,782	0.3	€ 2,549,215	€ 639,782
2026	0.1	€ 1,049,141	€ 263,305	0.4	€ 3,100,029	€ 778,021	1.5	€ 10,588,356	€ 2,657,382
2027	0.2	€ 1,299,202	€ 326,063	0.5	€ 3,631,719	€ 911,460	1.5	€ 10,578,175	€ 2,654,826
2028	0.2	€ 1,570,715	€ 394,206	0.6	€ 4,140,792	€ 1,039,223	1.6	€ 10,568,004	€ 2,652,274
2029	0.3	€ 1,860,619	€ 466,963	0.7	€ 4,626,141	€ 1,161,032	1.6	€ 10,557,843	€ 2,649,724
2030	0.4	€ 2,171,222	€ 544,916	0.8	€ 5,095,512	€ 1,278,831	1.7	€ 10,547,691	€ 2,647,176
2031	0.4	€ 2,499,519	€ 627,310	0.9	€ 5,544,005	€ 1,391,390	1.8	€ 10,537,549	€ 2,644,630
2032	0.5	€ 2,842,012	€ 713,266	1.0	€ 5,970,443	€ 1,498,414	1.8	€ 10,527,416	€ 2,642,087
2033	0.6	€ 3,204,126	€ 804,146	1.2	€ 6,383,354	€ 1,602,043	1.9	€ 10,517,294	€ 2,639,547
2034	0.7	€ 3,584,959	€ 899,725	1.3	€ 6,783,412	€ 1,702,447	2.0	€ 10,507,181	€ 2,637,009
2035	0.8	€ 3,983,176	€ 999,666	1.4	€ 7,169,718	€ 1,799,399	2.1	€ 10,497,078	€ 2,634,473
2036	0.9	€ 4,399,828	€ 1,104,234	1.5	€ 7,545,456	€ 1,893,699	2.2	€ 10,486,985	€ 2,631,940
2037	1.0	€ 4,834,623	€ 1,213,355	1.7	€ 7,909,898	€ 1,985,163	2.2	€ 10,476,901	€ 2,629,409
Total	6.4	€ 35,798,980	€ 8,984,544	13.1	€ 74,934,685	€ 18,806,512	22.8	€ 133,424,680	€ 33,485,867

4.5.1.3 Other costs avoided

Runway excursion accidents have other direct and indirect costs that were not included in the calculation of economic benefits. These include:

— rescue costs of the accident;

— repair costs for the runway; and

— accident investigation costs.

The monetary values for the economic benefits are considered to be under-estimated, since they neither include the above 'other costs', nor the costs of incidents and serious incidents.

4.5.2. Environmental impact

None

4.5.3. Social impact

None

[11] All future costs and benefits are discounted to 2017 Euros with a 4 % discount rate.

4.5.4. Economic impact

4.5.4.1 Costs for the introduction of the ROAAS

The unit cost for the introduction of a ROAAS is estimated to range from EUR 10 000 to EUR 120 000 per airframe. The low estimate uses EUR 10 000 for a new aircraft, and EUR 40 000 for a retrofit, while the high estimate calculates EUR 30 000 for a new aircraft and EUR 120 000 for a retrofit. The analysis is based on the assumption that the technical requirements for this safety standard are sufficiently generic that they can be met by different airframe and equipment manufacturers. These figures are used as lower and upper estimates for further cost analysis. Stakeholders are invited to comment on these figures in particular.

4.5.4.2 Other costs

The introduction of a ROAAS has other direct and indirect costs that were not included in the calculations. These include:

— the adaptation of SOPs/checklists;

— the adaptation of crew training; and

— additional functional checks.

Table 8: Cost estimate for European operators for the ROAAS rules by option (in 2017 EUR)

Year	Low estimate			High estimate		
	Option 1 New TCs	Option 2 New Deliveries	Option 3 Full retrofit	Option 1 New TCs	Option 2 New Deliveries	Option 3 Full retrofit
2017	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
2018	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
2019	€ 212,648	€ 212,648	€ 212,648	€ 637,944	€ 637,944	€ 637,944
2020	€ 426,718	€ 426,718	€ 426,718	€ 1,280,155	€ 1,280,155	€ 1,280,155
2021	€ 624,007	€ 624,007	€ 624,007	€ 1,872,021	€ 1,872,021	€ 1,872,021
2022	€ 838,366	€ 5,358,965	€ 5,358,965	€ 2,515,097	€ 16,076,894	€ 16,076,894
2023	€ 1,035,312	€ 4,149,151	€ 4,149,151	€ 3,105,936	€ 12,447,454	€ 12,447,454
2024	€ 1,246,265	€ 4,156,750	€ 4,156,750	€ 3,738,796	€ 12,470,251	€ 12,470,251
2025	€ 1,446,767	€ 4,143,013	€ 4,143,013	€ 4,340,300	€ 12,429,040	€ 12,429,040
2026	€ 1,651,079	€ 4,124,184	€ 203,300,498	€ 4,953,236	€ 12,372,552	€ 609,901,493
2027	€ 1,837,535	€ 4,087,163	€ 4,087,163	€ 5,512,604	€ 12,261,490	€ 12,261,490
2028	€ 2,013,701	€ 4,020,906	€ 4,020,906	€ 6,041,103	€ 12,062,718	€ 12,062,718
2029	€ 2,173,598	€ 3,947,453	€ 3,947,453	€ 6,520,793	€ 11,842,360	€ 11,842,360
2030	€ 2,348,245	€ 3,915,743	€ 3,915,743	€ 7,044,734	€ 11,747,229	€ 11,747,229
2031	€ 2,506,242	€ 3,851,759	€ 3,851,759	€ 7,518,726	€ 11,555,276	€ 11,555,276
2032	€ 2,643,059	€ 3,775,799	€ 3,775,799	€ 7,929,177	€ 11,327,396	€ 11,327,396
2033	€ 2,813,696	€ 3,748,035	€ 3,748,035	€ 8,441,088	€ 11,244,106	€ 11,244,106
2034	€ 2,982,699	€ 3,727,090	€ 3,727,090	€ 8,948,096	€ 11,181,269	€ 11,181,269
2035	€ 3,144,411	€ 3,697,275	€ 3,697,275	€ 9,433,233	€ 11,091,824	€ 11,091,824
2036	€ 3,313,004	€ 3,683,225	€ 3,683,225	€ 9,939,012	€ 11,049,676	€ 11,049,676
2037	€ 3,482,232	€ 3,664,787	€ 3,664,787	€ 10,446,697	€ 10,994,362	€ 10,994,362
Total	€ 36,739,583	€ 65,314,672	€ 264,490,986	€ 110,218,748	€ 195,944,017	€ 793,472,958

The cost estimates in Table 8 illustrate the costs associated with the three options. Option 1 is the least costly (EUR 37 million to EUR 110 million for the low and high estimates respectively), as it applies only to newly certified types. This would leave manufacturers and operators the longest period to adjust, and in the early years of implementation, it would only apply to a small fraction of the fleet.

For Option 2, all newly delivered aeroplanes as of 2022 would have to be equipped with a ROAAS. This would lead to higher overall costs (EUR 65 million to EUR 196 million), as a higher percentage of the fleet would need to be equipped.

Option 3 mandates, in addition to Options 1 and 2, a full retrofit, i.e. as of 2026, all the existing fleet and new deliveries would have to be equipped with the new system. This would generate the highest costs, which would be between EUR 264 million and EUR 793 million EUR. In the analysis, it is assumed that all of the retrofit costs are applicable during the 2026 implementation year. This is a simplification, as in reality, it can be expected that the fleet would be gradually fitted with the required equipment in order to meet the deadline in 2026. However, for the overall results and comparison of options, this simplification is negligible and can be ignored.

Question to stakeholders on economic impacts:

Stakeholders are invited to provide quantified justifications of the possible economic impacts for the options proposed, or alternatively to propose another justified solution to the issue.

4.6. Conclusion

4.6.1. Comparison of options

The comparison of options in Table 9 below provides an overview of the impacts expected from the options that have been considered as well as the cost-effectiveness assessment.

The results of this RIA suggest that Option 2 is the most cost-effective option. It creates a significant safety benefit, with an estimate of 13 accidents avoided, 9 fatalities and 81 injuries prevented over a 21-year period, and avoided accident costs in the order of EUR 94 million. The costs for implementing this option are estimated to range between EUR 65 and 196 million, depending on the unit cost assumptions.

To support the decision-making, a key cost-effectiveness indicator was calculated, which was the net cost per fatality prevented. According to this indicator, Option 2 is the most cost-effective: the avoided accident costs are higher than the low estimate for the equipment costs, while the high estimate for the equipment installation would result in a cost of EUR 11 million per fatality prevented.

As regards Option 1, the safety benefits are low compared with the costs, due to the slow introduction of the system into the fleet (on new types only). Regarding Option 3, the mandatory retrofit for aeroplanes in-service increases the costs per prevented fatality disproportionately.

Thus, EASA proposes Option 2, as it is the most cost-effective option.

Table 9: Summary of impacts, and cost-effectiveness assessment (2017–2037, in 2017 EUR)

	Option 1 New TCs	Option 2 New Deliveries	Option 3 Full retrofit
BENEFITS			
Number of accidents prevented	6.4	13.1	22.8
Casualties prevented			
Fatalities prevented	4.5	9.1	15.9
Injuries prevented	39.7	80.9	141.0
Avoided costs			
Aircraft damage avoided	€ 35,798,980	€ 74,934,685	€ 133,424,680
Diversions, delays and cancellations	€ 8,984,544	€ 18,806,512	€ 33,485,867
Total avoided costs	€ 44,783,524	€ 93,741,197	€ 166,910,547
COSTS			
Equipment (implementation costs)			
Low estimate	€ 36,739,583	€ 65,314,672	€ 264,490,986
High estimate	€ 110,218,748	€ 195,944,017	€ 793,472,958
COST EFFECTIVENESS			
Net costs (Gross costs - Avoided costs)			
Low estimate	-€ 8,043,941	-€ 28,426,525	€ 97,580,439
High estimate	€ 65,435,224	€ 102,202,820	€ 626,562,411
Net cost per fatality prevented			
Low estimate	-€ 1,797,008	-€ 3,116,757	€ 6,141,491
High estimate	€ 14,618,157	€ 11,205,781	€ 39,434,415

Question to stakeholders

Stakeholders are also invited to provide any other quantitative information that they may find necessary to bring to the attention of EASA.

As a result, the relevant parts of the RIA might be adjusted on a case-by-case basis.

4.7. Monitoring and evaluation

The monitoring of the effects created by the proposed amendments of CS-25 and Part-26/CS-26 will consist of:

(a) feedback from future large aeroplane certification projects, and

(b) in the long term, the direction of the trend of the numbers of accidents and incidents triggered by runway excursions during landings.

Item 1 depends on the applications received after the amendment of CS-25 and Part-26/CS-26. A review may be made at the earliest 5 years after the CS-25 amendment in order to include feedback from new type design certifications, in addition to certifications of existing designs and STCs.

Item 2 would be available once the aeroplanes equipped with ROAASs have entered into service and have experienced sufficient flight time, which would require several years (at least 5 years to obtain relevant statistical information).

In addition, the changes made to CS-25 and Part-26/CS-26 might be subject to interim/ongoing/ex post evaluation that will show what is the outcome obtained after the application of the new rules, taking into account the earlier predictions made in this impact assessment. The evaluation would provide an evidence-based judgement of the extent to which the proposal has been relevant (given the needs and its objectives), effective and efficient, coherent, and has achieved added value for the EU. The decision as to whether an evaluation will be necessary should also be taken based on the monitoring results.

5. Proposed actions to support implementation

— Focused communication for advisory body meeting(s) (TeB, TEC)

(Advisory body members)

N/A

— Providing supporting clarifications in electronic communication tools EASA - NAAs (CIRCABC, SINAPSE or equivalent)

(Primarily targeted audience: competent authority)

N/A

— EASA Circular

(Primarily targeted audience: competent authority, industry)

N/A

— Detailed explanation with clarification and indicated hints on the EASA web

(Industry, competent authority)

N/A

— Dedicated thematic workshop/session

(Industry, competent authority)

N/A

— Series of thematic events organised on the regional principle

(Industry, competent authority)

N/A

— Combination of the above selected means

(Industry, competent authority)

N/A

6. References

6.1. Affected regulations

— Commission Regulation (EU) 2015/640 of 23 April 2015 on additional airworthiness specifications for a given type of operations and amending Regulation (EU) No 965/2012 (OJ L 106, 24.4.2015, p. 18) (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1538170107669&uri=CELEX:32015R0640)

6.2. Affected decisions

— ED Decision 2015/013/R of 8 May 2015 adopting Certification Specifications for additional airworthiness specifications for operations 'CS-26 — Issue 1' https://www.easa.europa.eu/document-library/agency-decisions/ed-decision-2015013r

— ED Decision No. 2003/2/RM of 17 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes 'CS-25' (https://www.easa.europa.eu/document-library/agency-decisions/ed-decision-2003002rm)

6.3. Other reference documents

— NPA 2013-09 and CRD to NPA 2013-09
(https://www.easa.europa.eu/document-library/notices-of-proposed-amendments/npa-2013-09)
(https://www.easa.europa.eu/sites/default/files/dfu/CRD%202013-09.pdf)