European Aviation Safety Agency

Notice of Proposed Amendment 2015-21

TAWS operation in IFR and VFR, and TAWS for turbine-powered aeroplanes under 5 700 kg MCTOM able to carry six to nine passengers

RMT.0371 & 0372 (OPS.078 (A) & (B)) — 18.12.2015

EXECUTIVE SUMMARY

This Notice of Proposed Amendment (NPA), developed in the context of rulemaking task RMT.0371 & 0372 (former task number OPS.078 (a) & (a)), addresses a safety issue related to terrain awareness warning systems (TAWS).

There are three safety recommendations (SRs) related to the task/NPA: ITAL-2009-001, SPAN-2012-010, and FRAN-2009-009. ITAL-2009-001 states that TAWS would have reduced the probability of occurrence of the aircraft accident, and FRAN-2009-009 proposes requiring operators to develop a policy and procedures for the use of TAWS dependent on the flying rules (instrument flight rules (IFR)/visual flight rules (VFR)).

The objective of this task is to mitigate the risks of accidents categorised as a controlled flight into terrain (CFIT) for turbine-powered airplanes having a maximum certified take-off mass (MCTOM) below 5 700 kg or a maximum operational passenger seating configuration (MOPSC) between six and nine.

Based on the regulatory impact assessment (RIA), rulemaking would be only recommended for newly manufactured aircraft performing commercial air transport operations. When building the safety case, one of the major aspects taken into account was that the absence of TAWS in the aircraft within the scope of the task was a factor in only two accidents in Europe in the last 10 years. Additionally, data showed that all new aircraft are equipped with TAWS B, and that a significant number of old aircraft have been retrofitted with either TAWS or an equivalent terrain awareness system. The specific objective of this rulemaking activity is to further reduce CFITs by equipping aircraft within the scope of this task with TAWS, which is already the case for the majority of said aircraft, regardless of the inexistence of a mandatory requirement for this in Europe.

This NPA proposes a regulatory change in accordance with the result of the RIA.

Applicability		Process map	
Affected regulations and decisions:	Regulation (EU) No 965/2012 (Annexes IV, V, VI, VII, and VIII)	Concept paper:	No
		Terms of reference:	31.1.2014
		Rulemaking group:	Yes
Affected stakeholders:	Aircraft/equipment manufacturers, air operators (CAT, NCC, NCO, SPO) of fixed wing, national aviation authorities (NAAs)	RIA type:	Full
		Technical consultation during NPA drafting:	No
Driver/origin:	Safety	Duration of NPA consultation:	3 months
Reference:	ICAO Annex 6 Part I and II		Yes
	Italian ANSV accident investigation report (OE-FAN 24/02/2004)	Review group:	Yes
		Focused consultation:	--
	German BFU accident report (Untersuchungsbericht BFU 3X004-09)	Publication date of the opinion:	
	Spanish CIAIAC accident investigation report A-07/1998	Publication date of the decision:	N/A
	French BEA accident investigation report No v2-I080628		
	Safety Recommendations: SR ITAL-2009-001, SPAN-2012-010, and FRAN-2009-009)		

Table of contents

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 4-year Rulemaking Programme under RMT.0371 & 0372 (former task number OPS.078 (a) & (a)).

The text of this NPA has been developed by the Agency based on the input of the Rulemaking Group for RMT.0371 & 0372 (OPS.078 (a) & (b)). It is hereby submitted for consultation of all interested parties[3].

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. Chapter 3 contains the proposed text for the new requirements. Chapter 4 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/[4].

The deadline for comments is **18 March 2016.**

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

The Agency will publish the CRD concurrently with the opinion.

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1 Regulation (EC) No 216/2008 of the European Parliament and the of 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).

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

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

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

2. Explanatory note

2.1. Overview of the issues to be addressed

The rate of accidents categorised as CFIT has been significantly reduced by TAWS.

Several SRs in this regard were addressed to the Agency, one of them stating that TAWS would have reduced the probability of occurrence.

The International Civil Aviation Organization (ICAO) recommends that aircraft within the scope of the task be equipped with a ground proximity system. Whereas these provisions were adopted by the Federal Aviation Administration (FAA), they have not been introduced in the European rules, which only require TAWS for aircraft with an MCTOM over 5 700 kg with an MOPSC of more than nine.

Furthermore, there was a SR addressed to the Agency, FRAN-2009-009, requiring operators to develop a policy and procedures for the use of TAWS dependent on the flying rules. This would only be considered together with the requirement of installing TAWS.

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

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 general NPA objective is to maintain a uniform and high safety level with cost-efficient rules.

The specific objective of this proposal is to further reduce CFITs. This could be achieved by equipping turbine-powered aircraft under 5 700 kg MCTOM able to carry six to nine passengers with TAWS. To complement this requirement, procedures for the use of TAWS should be introduced to avoid pilot confusion. This will contribute to the improvement of the TAWS efficiency in reducing CFITs.

2.3. Summary of the RIA

Although it is considered that CFITs are still one of the main causes for accidents in Europe, data only showed two fatal CFIT accidents with aircraft within the scope of the RMT in the last 10 years. Requiring turbine-powered aircraft under 5 700 kg MCTOM able to carry six to nine passengers to be equipped with TAWS could further reduce CFITs.

Following the recommendation given by Annex 6 of the Chicago Convention (see text of the recommendation in section 4.1), the FAA requires that aircraft within the scope of this task be equipped with, at least, TAWS B. This could justify that all aircraft in Europe, in accordance with the data collected by a survey (see Appendix), are delivered with this system. Accordingly, it would also justify the decrease of accidents compared to when aircraft were delivered without this feature.

While studying the different options, a matrix was created to assess all possibilities:

— Requirement for new aircraft performing commercial operations

— Requirement for new aircraft performing non-commercial operations

— Requirement for existing aircraft performing commercial operations

— Requirement for existing aircraft performing non-commercial operations

For each of these possibilities, three options were considered: do nothing, mandate TAWS B (or A), and mandate a terrain awareness capability as commonly available in new avionics, but which does not necessarily meet the TAWS specification. The result of the assessment was compiled in the final options, Options 0 to 3, analysed in Chapter 4. The favoured option of the Rulemaking Group was Option 0, which implies no regulatory action.

The Rulemaking Group saw no case for action as all new aircraft are fitted with TAWS B. The absence of TAWS was only a factor in two accidents in the last ten years, which the group thought did not justify enough safety risk for the mandate. Additionally, the capability is inherent in all typical avionics modernisation that operators may undertake (e.g. for performance-based navigation (PBN) capability) so, although TAWS is highly desirable, it was understood by the Rulemaking Group that regulating its installation would only reflect a common practice already performed by the industry and, therefore, rulemaking, in its opinion, was not necessary.

However, the arguments used to justify the lack of need for the mandate can also justify the necessity of having a requirement, as this would have no impact on newly manufactured aircraft. Based on this and the result of the assessment of the impacts, Option 1 was the preferred option.

2.4. Overview of the proposed amendments

Amendments to existing rules are proposed by this NPA, in accordance with the result of the RIA. Chapter 3 includes the amendment that is proposed as a result of favouring Option 1.

3. Proposed amendments

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.

3.1. Draft Regulation (Draft EASA Opinion)

3.1.1. Changes to Regulation (EU) No 965/2012

(…)

CAT.IDE.A.150 Terrain awareness warning system (TAWS)

(a) Turbine-powered aeroplanes having an MCTOM of more than 5 700 kg or an MOPSC of more than nine shall be equipped with a TAWS that meets the requirements for Class A equipment as specified in an acceptable standard.

(b) Reciprocating-engine-powered aeroplanes with an MCTOM of more than 5 700 kg or an MOPSC of more than nine shall be equipped with a TAWS that meets the requirement for Class B equipment as specified in an acceptable standard.

(c) Turbine-powered aeroplanes for which the individual CofA was first issued after 1 January 2019, having an MCTOM of 5 700 kg or less and an MOPSC of six to nine, shall be equipped with a TAWS that meets the requirements for Class B equipment, as specified in an acceptable standard.

(…)

SPO.IDE.A.130 Terrain awareness warning system (TAWS)

(a) Turbine-powered aeroplanes with a maximum certified take-off mass (MCTOM) of more than 5 700 kg or an MOPSC of more than nine shall be equipped with a TAWS that meets the requirements for:

~~(a)~~ (i) class A equipment, as specified in an acceptable standard, in the case of aeroplanes for which the individual certificate of airworthiness (CofA) was first issued after 1 January 2011; or

~~(b)~~ (ii) class B equipment, as specified in an acceptable standard, in the case of aeroplanes for which the individual CofA was first issued on or before 1 January 2011.

(b) When used in commercial operations, turbine-powered aeroplanes for which the individual CofA was first issued after 1 January 2019, with an MCTOM of 5 700 kg or less and an MOPSC of six to nine, shall be equipped with a TAWS that meets the requirements for class B equipment, as specified in an acceptable standard.

(…)

4. Regulatory impact assessment (RIA)

4.1. Issues to be addressed

TAWS aim to prevent CFIT accidents, where a properly functioning airplane under the control of a full qualified and certified crew is flown into terrain (or water or obstacles) with no apparent awareness by the crew. TAWS have contributed to a reduction in the rate of these types of accidents.

Issue 1

Enabled TAWS significantly reduce the rate of accidents categorised as a CFIT. However, the current regulation (Regulation (EU) No 965/2012[5] — hereinafter referred to as the 'Air OPS Regulation') only requires this equipment for turbine-powered aeroplanes having an MCTOM in excess of 5 700 kg or an MOPSC of more than nine. This provision is inherited from EU-OPS (cf. EU-OPS 1.665).

Following a fatal accident involving a Cessna C 550 on 24 February 2004, operated in Commercial Air Transport (CAT), the Agenzia Nazionale per la Sicurezza del Volo (ANSV) recommended requiring such systems also for turbine-powered aircraft of less than 5 700 kg MTOW that are able to carry six to nine passengers. The accident report states in particular that the accident would have had a minor probability of occurrence if the aeroplane had been equipped with such a system.

In 2009, another accident, also in CAT, occurred in Germany involving a Piper Aircraft that collided with the terrain, resulting in the death of the pilot. This accident is now considered, together with the one above, relevant for this task even though no safety recommendation was addressed to the Agency.

As for the Italian accident mentioned above, the report also stated that TAWS would have reduced the probability of occurrence. Additionally, the Flight Safety Foundation (FSF) mentions in the report the lack of ground proximity warning system (GPWS) or TAWS as a factor affecting 'situational awareness and, therefore, terrain awareness'.

Whereas EASA's Annual Safety Review shows CFITs as one of the categories that led to several accidents in 2013 (including fatal and non-fatal), the taxonomy of the Agency's database does not allow to read the narratives when performing a search. It is, therefore, difficult to estimate the real number of accidents and incidents that could have been prevented using TAWS. Indeed, only the two above-mentioned accidents, in Italy and Germany, appear when performing a search for the last ten years. Another factor that contributes to this difficulty is the lack of in-flight recording systems in general aviation (GA), resulting in inability to determine the cause of the accident in some cases.

ICAO recommends (Annex 6, Part I, para. 6.15.5) that 'All turbine-engined aeroplanes of a maximum certificated take-off mass of 5 700 kg or less and authorized to carry more than five but not more than nine passengers should be equipped with a ground proximity warning system which provides the warnings of 6.15.8 a) and c), warning of unsafe terrain clearance and a forward looking terrain avoidance function'. A similar provision exists in Annex 6 Part II (cf. para. 2.4.11.2 'All turbine-engined aeroplanes of a maximum certificated take-off mass of 5 700 kg or less and authorized to carry more than five but not more than nine passengers should be equipped with a ground proximity warning system which has

[5] Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council (OJ L 296, 25.10.2012, p. 1).

a forward-looking terrain avoidance function'). Whereas these provisions were adopted by the FAA in the form of a requirement, they have not been introduced so far into the European rules. Indeed, Annexes IV and VI to the Air OPS Regulation only require this equipment for turbine-powered aeroplanes having an MCTOM of more than 5 700 kg or an MOPSC of more than nine and reciprocating engine-powered aeroplanes with an MCTOM of more than 5 700 kg or an MOPSC of more than nine.

In addition, it should be noted that this issue is included in the European Aviation Safety Programme, under action item AER3.6.

Issue 2

Although TAWS warnings have proven to be an effective mitigation to CFIT accidents, such warnings rely on correct flight crew response, up-to-date terrain databases and software, and on a source of information feeding into them. Outdated databases and deactivation of the software system, ignoring TAWS warnings, or an inappropriate response to the warnings can still place the aircraft at risk of an accident.

In the past, although pilots received TAWS warnings while flying in VFR, they may have considered that they could still clear the obstacle. Pilots assumed TAWS generated false alarms and, therefore, this second issue is related to the lack of confidence of some flight crews towards the TAWS due to its use in VFR and IFR.

After research by the FSF that showed pilots often delay reacting to TAWS warnings, the UK CAA conducted a study (UK FODCOM 06/2007) that revealed that TAWS produce seven times more false and nuisance warnings than genuine hard warnings.

The Air OPS Regulation contains in AMC3 ORO.MLR.100 the development of procedures for the use of TAWS in the operations manual, but it does not make a distinction between VFR and IFR. In June 2008, a DHC6 aircraft descended under the minimum sector altitude (MSA) to avoid flying in an active cloud while performing an instrument landing system (ILS) approach to Pointe-a-Pitre airport. As a result of this incident, the French BEA recommended to the Agency through SR FRAN-2009-009 to require operators to develop a policy and procedures for the use of TAWS dependent on the flying rules.

However, updated information received from the industry shows that TAWS are more reliable nowadays and pilots tend to trust these systems more. It was only in the past that TAWS generated a large amount of false alarms, which led pilots to often delay reactions to TAWS warnings and in some cases ignore them. Additionally, the frequency of such a situation without any visual reference of the ground is assumed to be extremely improbable.

4.1.1. Safety risk assessment

While performing the safety risk assessment, the Rulemaking Group only considered the data on accidents that took place in the last ten years. Information regarding accidents before that date was not considered relevant because it would not reflect the current situation, as the fleet has changed significantly in the last few years.

This is the case for recommendation SPAN-2012-010, which was issued in 2002, and then forwarded to the Agency in 2012. This recommendation was issued following a fatal accident which occurred in Barcelona on 18 February 1998, in CAT operation. A-07/1998, the report produced by the Spanish investigation authority (Comisión de Investigación de Accidentes e Incidentes de Aviación Civil (CIAIAC)),

stated that the accident was likely caused by establishing an improper descent angle in reduced visibility operations combined with possible crew fatigue.

In evaluating the safety impact, only the Cessna Citation accident and the one in Germany in 2009 were taken into account as relevant.

The low number of CFIT events for turbine-powered aircraft under 5 700 kg MCTOM able to carry six to nine passengers could be explained by the fact that all new aircraft within the scope of the RMT are fitted with TAWS B (or A), and that a significant number of the existing fleet have been retrofitted with TAWS B (or A), or a non-certified terrain awareness capability (data collected by the Agency in 2015 from manufacturers and operators).

Following the recommendation put forward by Annex 6 of the Chicago Convention, the FAA requires that aircraft within the scope of this task be equipped with, at least, TAWS B. This could potentially justify why all new aircraft are delivered with this system in Europe, even if this is not mandatory. Moreover, this could explain the decrease in accidents in the most recent years compared to the past, when aircraft were delivered without this feature fitted. This also proves that requiring turbine-powered aircraft under 5 700 kg MCTOM able to carry six to nine passengers to be equipped with TAWS could significantly reduce CFITs.

As a result of the mandate by the FAA to install TAWS in all turbine-powered air carrier operations in the U.S. and other countries, there was a worldwide reduction of CFIT accidents[6].

4.1.2. Who is affected?

This NPA affects all turbine-engined aeroplanes of an MCTOM of 5 700 kg or less and authorised to carry more than five but not more than nine passengers. This translates into 946 operators performing operations with, approximately, 846 aircraft, 80 % of them being commercial.

4.1.3. How could the issue/problem evolve?

Technology has evolved and most terrain awareness functions are nowadays an integral part of the avionics. Manufacturers selling in Europe and the US follow the recommendation from ICAO and offer this system with their new aircraft. Furthermore, a significant proportion of operators have voluntarily installed TAWS to existing aircraft in Europe, even if they are not required to do so (20 % of those responding to EASA survey).

These are the reasons why rulemaking was considered not necessary by the Rulemaking Group during the risk assessment. However, having TAWS installed proves to have significantly reduced the risk of CFIT. If the regulatory framework is not changed to include a requirement in Europe, the Agency would be relying on the effectiveness of FAA's rules and ICAO Recommendation to convince operators to voluntarily adopt these provisions.

Another problem of not having a requirement is that there would be, in aircraft that perform non-commercial operations, no obligation for the system to be maintained and, therefore, to function properly. Not having a functional system is equivalent to not having the system, and thus represents a potential risk.

[6] http://lessonslearned.faa.gov/ll_main.cfm?TabID=3&LLID=43&LLTypeID=2

For commercial operations, however, there is an obligation for the system to be repaired when not functioning properly. The problem for these operations, on the contrary, is that the operator may choose to deactivate the system rather than repair it when it does not function properly, which would represent a potential risk. A mandate to have this system installed would prevent such situations.

4.2. Objectives

The objectives of the European Union in the field of civil aviation are defined in Article 2 of the Basic Regulation. This proposal will contribute to the achievement of these objectives by addressing the issues outlined in section 4.1.

The general NPA objective is to maintain a uniform and high safety level with cost-efficient rules.

The specific objectives of this proposal are the following:

— to validate the need for a regulatory requirement for TAWS to be installed in turbine-powered aircraft under 5 700 kg MCTOM able to carry six to nine passengers with TAWS;

— to improve TAWS efficiency in reducing CFITs.

4.3. Policy options

In order to achieve the above objective, the options below were identified. Table 1 indicates the selected options assessed in the following chapters. This table is followed by a description of the options which were discarded.

Table 1: Selected policy options

Option No	*Short title*	*Description*
0	Do nothing	Baseline option (no change in rules; risks remain as outlined in the issue analysis).
1	ForwardFit TAWS Commercial	Mandate TAWS A, B, or a terrain awareness capability for new turbine-powered aeroplanes of less than 5 700 kg MCTOM able to carry six to nine passengers.
2	RetroFit TAWS Commercial	Mandate TAWS A, B, or a terrain awareness capability for new turbine-powered aeroplanes of less than 5 700 kg MCTOM able to carry six to nine passengers performing all operations and retrofit only commercial.
3	RetroFit TAWS all	Mandate TAWS A, B, or a terrain awareness capability for all turbine-powered aeroplanes of less than 5 700 kg MCTOM able to carry six to nine passengers.

Discarded options

In studying Option 1, both commercial and non-commercial operations were considered at an early state of the analysis because, in accordance with Figure 1 and Figure 2 of Appendix, all recently manufactured aircraft (since the year 2000) are delivered with either TAWS A or TAWS B. This applies also to future manufactured aircraft. However, after performing the analysis, it was decided that non-commercial

operations should not be included in the requirement to install TAWS, hence these operations are not considered within Option 1. As there have been no accidents with aircraft performing non-commercial operations in the last ten years, and because it is perceived by the industry as overregulating, it was decided to only recommend these systems to aircraft within the scope of the task performing this type of operations.

For Options 2 and 3, the possibility of retrofitting with TAWS-like functionalities rather than with TAWS A or B has been considered. Industry believes, and data supports it, that TAWS-like functions are effective in mitigating a CFIT risk. However, as there is no definition of TAWS-like, there is no guarantee that this system may offer the same level of protection as TAWS A or B. Additionally, old fleet aircraft not equipped with TAWS will retire in the forthcoming years, minimising the safety concern.

This possibility was also assessed for Option 1. However, all new aircraft are fitted with TAWS A or B, so there would be no economic benefit from requiring TAWS-like functionality rather than TAWS B in these kinds of aircraft.

For the reasons mentioned above, non-commercial operations will not be included in the requirement, although there will be a recommendation issued to the operators.

4.4. Methodology and data

4.4.1. Applied methodology

The methodology applied for this RIA is the multi-criteria analysis (MCA), which allows comparing all options by scoring them against a set of criteria.

MCA covers a wide range of techniques that aim at combining a range of positive and negative impacts into a single framework to allow easier comparison of scenarios. Essentially, it applies cost-benefit thinking to cases where there is a need to present impacts that are a mixture of qualitative, quantitative, and monetary data, and where there are varying degrees of certainty. The MCA key steps generally include:

— establishing the criteria to be used to compare the options (these criteria should be measurable, at least in qualitative terms);

— attributing weight to each criterion to reflect its relative importance to the decision;

— scoring how well each option meets the criteria; the scoring needs to be relative to the baseline scenario;

— ranking the options by combining their respective weights and scores; and

— performing sensitivity analysis on the scoring to test the robustness of the ranking.

The criteria used to compare the options were derived from the Basic Regulation and the guidelines for RIA developed by the European Commission. The principal objective of the Agency is to ‘establish and maintain a high uniform level of safety’ (Article 2(1) of the Basic Regulation). As additional objectives, the Basic Regulation identifies environmental, economic, proportionality, and harmonisation aspects, which are reflected below.

The scoring of the impacts uses a simple scale with '+' and '–' to indicate the positive and negative impacts. This was found to be a proportionate way to assess the impacts, instead of analysing impacts with a scale from, e.g., -5 to +5 (very negative to very positive).

4.4.2. Data collection

The Agency's accident database has been used to collect from it information on the last 10 years' accidents of turbine aircraft within the scope of the RMT. The data showed that there were only two fatal CFIT accidents, one in Italy and one in Germany, where having TAWS fitted might have affected the outcome.

The Agency additionally launched a survey addressed to RAG, SSCC and OPS&FCL TAG Members on 3 March 2015. The deadline for answers was extended from 7 April 2015 to 23 April 2015. 4 manufacturers (Embraer, Piaggio, Pilatus and Vulcanair) and 103 operators from 13 countries answered. Please refer to Appendix for a summary of the survey.

This survey aimed to gather data on the fleet size and the level of TAWS equipment in the fleet from manufacturers and European operators. Hereinafter said survey is referred to as 'TAWS Survey 2015'.

A review of avionics equipment available for the aircraft within the scope of the RMT was conducted within the Rulemaking Group members to check whether TAWS was inherent in avionics and, therefore, integrated rather than offered as an additional feature.

Additionally, data was collected within the Rulemaking Group members regarding the costs of the equipment for existing aircraft and new aircraft. The group also collected information on the activation costs related.

4.5. Analysis of impacts

4.5.1. Safety impact

The accidents taken into account for the safety impact, following an analysis of the Agency's database of the last 10 years, were only those in scope of the task where TAWS was not fitted and might have affected the outcome. These are the Cessna Citation accident and the one in Germany in 2009. For the reasons explained in section 4.1, there are no accident records in GA and, therefore, GA was considered to not have accidents.

All new aircraft are equipped with TAWS B, and 20 % of the existing aircraft have been retrofitted with TAWS A, B, or a similar terrain awareness capability according to TAWS Survey 2015. As the existing aircraft retire, the number of aircraft fitted with this system will increase, potentially having a positive impact on safety.

However, the lack of a requirement does not guarantee that all new aircraft are operated with TAWS, as operators may decide to deactivate the function. Moreover, aircraft in Europe would not be obliged to have the system repaired in case of a breakdown. Nevertheless, these possibilities are assumed to be very rare.

The safety impact of all options was considered to not differ much from one option to another due to the limited exposure, being only negative for Option 0.

Option 0

No regulative action (Option 0) would have a slight negative impact, due to the fact that it is expected that all new aircraft have this functionality fitted, regardless of the existence of a requirement. It would be extremely unlikely that this functionality would be deactivated by the operator, and therefore, the risk is extremely low.

Option 1

All new aircraft have this functionality fitted, and accidents have significantly decreased as a result of this. The safety impact resulting from a regulatory action to require TAWS in new aircraft would be therefore very small, as new aircraft are expected to be equipped with TAWS B, regardless of the mandate.

Option 2

Installing TAWS B in existing aircraft would be of small benefit to safety. TAWS have already been voluntarily installed in some aircraft, regardless of the mandate. For the rest of the fleet that does not have TAWS installed, there would be a positive impact. However, a reasonable transition period should be contemplated. This would probably allow most of the existing aircraft that do not have TAWS to retire, explaining why the benefit would not be very noticeable.

Option 3

The same analysis conducted for Option 2 can be applied to Option 3, with the added factor that there have been no accidents in GA in the last ten years. Therefore, the safety benefit is also minor.

4.5.2. Social impact

It was estimated that, for pilots, having these systems installed improves the working conditions in comparison to operations without these systems.

Option 0

All new aircraft within the scope of this task are estimated to be equipped with TAWS B or A (TAWS Survey 2015). Social impacts are neutral for such pilots in terms of working conditions.

Over the past years, existing aircraft were retrofitted only on a voluntary basis. This occurred at an estimated rate of 1 % per year (according to the TAWS Survey 2015 for the period 2001–2015). If this trend is prolonged in the future, the positive social impact on the pilots operating these aircraft is very minor due to this low rate of retrofitted aircraft.

Option 1

All new aircraft within the scope of this task are estimated to be equipped with TAWS B or A (TAWS Survey 2015). In terms of working conditions the social impact on pilots is neutral.

Option 2 and 3

Over the past years, existing aircraft were retrofitted only on a voluntary basis. This occurred at an estimated rate of 1.2 % per year (according to the TAWS Survey 2015 for the period 2001–2015).

Options 2 and 3 require either commercial aircraft or all the existing aircraft be retrofitted with TAWS A or B. The compliance deadline for this retrofit will directly influence the size of the impacts: a short deadline for mandating retrofit (e.g. 2020) will impact much more than a rather remote deadline (e.g.

2030). Knowing that the current retrofit rate is low, a mandatory deadline (even remote by 2030) would increase by a factor 5 the annual retrofit rate.

Table 2 — Estimated retrofit rates

Item	*Value*	*Comment*
Current retrofit rate		
Total share of retrofitted aircraft with TAWS for the period 2001–2014	16 %	10 retrofitted aircraft out of 64 delivered without TAWS
Annual retrofit rate=	1.2 %	
Future retrofit rate		
Remaining part of the fleet to be retrofitted for the period 2017–2030	84 %	Assuming that 2030 would be the deadline to have all existing aircraft retrofitted with TAWS
Annual retrofit rate to have existing a/c retrofitted by 2030 =	6.5 %	

Source: EASA TAWS Survey 2015, see Appendix 1

Options 2 and 3 would have a positive social impact by facilitating pilots operations regarding the issue of CFIT.

4.5.3. Economic impact

For the economic impact, it is necessary to assess the cost difference between the different options (e.g. in terms of equipment) and the operational benefits provided by these options (e.g. avoided aircraft damages).

Option 0

The TAWS Survey 2015 launched by the Agency was aimed to gather data on the fleet size and the level of TAWS equipment in the fleet from operators and manufacturers. The result was that all new aircraft within the scope of the RMT are fitted with TAWS B (or A), and that 16 % of the existing fleet have been retrofitted with TAWS A and B over a period of 15 years (see Table 2 — Estimated retrofit rates).

Although new aircraft would already have this equipment installed, there was a concern that, without a requirement, TAWS would not be properly maintained and that, once it malfunctioned, the operator might decide to deactivate it rather than repair it. However, most aircraft are likely to have this function installed as part of other equipment in new aircraft and, therefore, will likely maintain it properly as malfunctioning would result in the malfunctioning of other necessary equipment as well.

In the relatively recent past, terrain awareness was not available except for an 'additional safety system' (e.g. A TAWS B systems with a dedicated display). However, a review of avionics equipment available for the aircraft within the scope of the RMT concluded that, in the present avionics market, terrain awareness is inherent in all of the following:

— TSO C146 Navigation units used for RNAV in aircraft below 5 700 kg

— electronic primary flight displays

— electronic multi-function displays

— integrated 'glass cockpit' systems

Option 0 would have no economic impact, as there is no requirement to acquire new equipment or to retrofit existing aircraft, and, therefore, no expense is incurred.

Option 1

The cost of the equipment for new aircraft is estimated EUR 10 000-25 000. All new aircraft are already delivered with this function.

Option 1 was assessed taking into account the different technologies offered. All new aircraft are offered with TAWS B, therefore, it is assumed that the economic impact would be, in any case, very small.

The requirement of having TAWS installed and functioning properly may result in a very small economic negative impact in those cases where the system malfunctioned and had to be repaired or the operator decided to deactivate the function. Both are, nevertheless, considered to be rare.

Additionally, there would be costs related to the publication of the rules, certification process, or oversight activities. These could include updates of checklists in cases where this equipment was not approved by the authority yet, update of the certification form, cost of the personnel involved in the rulemaking activity, etc. These one-off costs may translate into approximately one man-day per competent authority, summing up to approximately 40 one-man days. This economic impact is considered to be insignificant.

Options 2 and 3

A review of the TAWS solutions available for the aircraft within the scope of the RMT concluded that TAWS B equipment for already existing aircraft without any terrain awareness capability was available to the operator at a total cost of EUR 25 000-50 000.

A TAWS B capability upgrade for aircraft with non-certified terrain awareness was typically available from the avionics manufacturer at a total cost of EUR 20 000-30 000.

Options 2 and 3 require either commercial or all the existing aircraft be retrofitted with TAWS A or B. The compliance deadline for this retrofit will directly influence the size of the impacts: a short deadline for mandating retrofit (e.g. 2020) will impact much more than a rather remote deadline (e.g. 2030). Knowing that the current retrofit rate is low, a mandatory deadline (even remote by 2030) would increase by a factor 5 the annual retrofit rate (see Table 2 — Estimated retrofit rates).

Additionally, all the costs related to publication of the rules, certification process and oversight activities would be increased for the operator by the cost of having to add this functionality to the operations manual and, potentially, to put in place procedures regarding its use to be followed by the crew.

Therefore, for Options 2 and 3 the economic impact of retrofitting an aircraft with TAWS A or B was considered to be significantly negative.

4.5.4. GA and proportionality issues

Options 1 and 2 are not relevant for these criteria as they impact only on commercial operators.

There are no proportionality issues for Options 0 and 1. Option 1 requires all new aircraft within the scope of the task equipped with TAWS. Given that data shows that new aircraft are delivered already with this function, it would not represent an additional burden for GA. Nevertheless, this is considered

overregulating for the non-commercial operators, therefore aircraft performing these operations do not need a requirement.

Option 3

When assessing Option 3 against these criteria, TAWS B or A are considered disproportionate in terms of cost for GA (non-commercial operations).

4.5.5. Impact on 'better regulation' and harmonisation

It is a common current practice of manufacturers to deliver aircraft with TAWS B installed. Additionally, it is usual that operators maintain this function, as it might be part of another system. Therefore, industry perceives that there is no need to add a requirement in the regulations to install or maintain this system.

Option 0

Although European regulations would neither be in line with the ICAO recommendation nor harmonised with the FAA, the impact of Option 0 is considered to be of a minor negative level. In this case, the negative impact that would be caused by the lack of harmonisation is almost fully compensated by the concept of a 'better regulation', as mandating this equipment is considered unnecessary by the industry.

Option 1

The impact of Option 1 is neutral. Requiring TAWS B would partially achieve harmonisation with the FAA rules and the ICAO recommendation. In studying this option, it was considered that new systems should be taken into account. However, requiring other TAWS, different from TAWS A or B, is a proportionate alternative that recognises industry solutions, but does not achieve harmonisation. This is why the impact is considered to be null.

Option 2

Option 2 would be closer to harmonisation with the FAA and ICAO. However, requiring existing aircraft be retrofitted with TAWS B was considered a disproportionate action, regardless of harmonisation. The impact of Option 2 would be therefore slightly negative.

Option 3

Option 3 is considered to have a negative impact regardless of harmonisation. Industry thinks that requiring TAWS B or any other similar system in GA is overregulating and unnecessary.

4.6. Comparison and conclusion

4.6.1. Comparison of options

Type of impacts	***Option 0***	***Option 1***	***Option 2***	***Option 3***
Safety impact	0 to slightly –	0 to slightly +	Slightly +	Slightly +
Social impact	0	0 to slightly +	+	+
Economic impact	0	Slightly – (one-off cost = 40 man-days at EU level)	---	---
GA and proportionality issues	0	Not applicable	Not applicable	-
Impact on 'better regulation' and harmonisation	-	0	Slightly –	-
Overall	**0**	**0**	**-**	**-**

The absence of TAWS in the aircraft within the scope of this task was a factor in only two accidents in Europe in the last ten years. This is why it is considered that, for all the options, the safety impact would be very low.

Option 1 will bring a small safety benefit, because all new aircraft are assumed to be fitted with TAWS B regardless of the requirement. This and the decrease in the number of accidents in the last few years are the reasons why the Rulemaking Group considered there was no case for action in Option 1 and preferred not to regulate, thus, Option 0.

Nevertheless, it has to be considered that the fact that all new aircraft are fitted with TAWS B results in a requirement having almost no impact and, therefore, the same argument could also be used in favour of Option 1. This Option would back up a practice that is already implemented by the industry, possibly due to the FAA mandate, with a very small economic impact related.

Option 1 would additionally ensure that, by having a requirement, the operator maintains this functionality operative. Although minor, there is a risk that operators decide not to repair the system and/or deactivate it. Therefore, it could be questioned why the Agency decided not to adopt a mitigation measure that has almost a non-existent cost-related impact, and decided not to establish a requirement that only mirrors an industry practice.

On the other hand, the economic impact that would result from requiring both commercial and non-commercial aircraft within the scope of the task to be retrofitted with TAWS B, Options 2 and 3, is not justified by the safety case, especially for the GA, where this is considered overregulating and not proportionate. Therefore, for Options 2 and 3, it would be more appropriate to require, in any case, that an aircraft be equipped with a terrain awareness capability that does not have to be, specifically, TAWS B. This would differ from what is required by the FAA or recommended by ICAO, but it is justified by the fact that the evolution in avionics available and fitted in existing aircraft has significantly improved from the TAWS specification considered when developing the FAA's and ICAO's standards back some years ago. This possibility, however, was discarded (see section 4.3 for more information on discarded options). Additionally, whatever type of TAWS is required, the transition period that would be needed to appropriately implement the requirement for existing aircraft would probably allow for most of the aircraft not fitted with the system to retire, thus making this requirement unnecessary. Hence, Options 3 and 4 are not favoured.

4.6.2. Monitoring and ex post evaluation

The Agency may continue to monitor the accidents related to CFIT to consider whether it might be essential, due to an increase in them, to require TAWS for already existing aircraft and extending the requirement to GA, if necessary.

5. References

5.1. Affected regulations

— Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council (OJ L 296, 25.10.2012, p. 1) (Annexes IV, V, VI, VII, and VIII)

5.2. Reference documents

ICAO Annex 6, Part I and II

EASA CS-ACNS Subpart E, Section 1

Italian ANSV accident investigation report (OE-FAN 24/02/2004)

German BFU accident report (Untersuchungsbericht BFU 3X004-09)

Spanish CIAIAC accident investigation report (Informe Técnico A-07/1998)

Safety Recommendations: SR ITAL-2009-001, SPAN-2012-010, and FRAN-2009-009)

6. Appendix

6.1. Survey scope

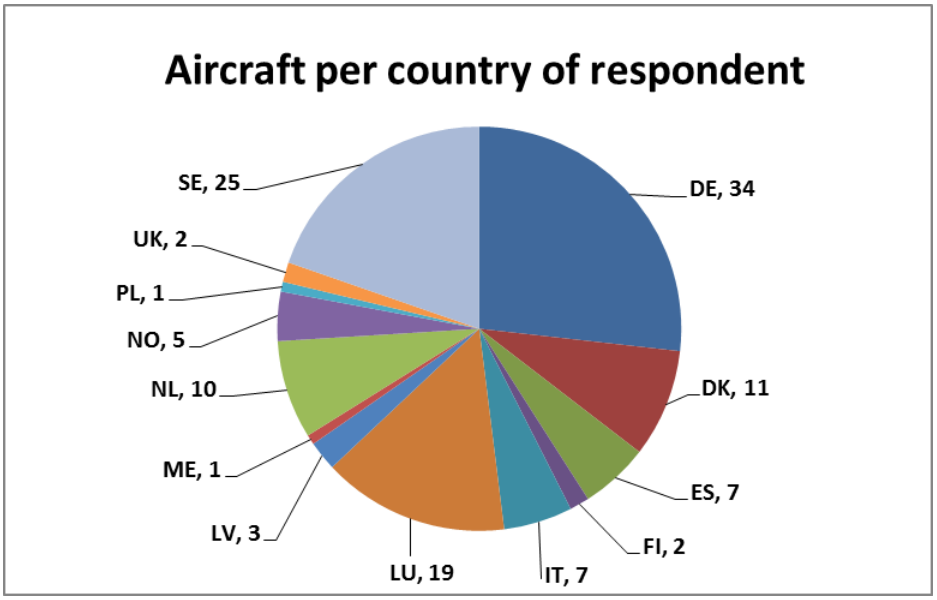
The survey was sent on 3 March 2015 to the following EASA Advisory Bodies: RAG, the plenary SSCC and the FCL&OPS TAG. They worked in relays to get answers from manufacturers and EASA Member States operators. The deadline was 23 April 2015.

The scope of the survey was:

1. the turbine-powered aeroplanes under 5 700 kg MCTOM able to carry six to nine passengers having an MOPSC of six to nine where applicable (commercial operations) or configured for six to nine seats, excluding any pilot seats.
2. aeroplanes mentioned in (1) equipped with TAWS. ETSO-C151b defines 3 classes of TAWS (A, B, C). The fourth case would be a TAWS-like function (in this case, the type of product is indicated).
3. aeroplanes mentioned in (1) already in service or subject to future deliveries.

6.2. Number of answers

4 manufacturers (Embraer, Piaggio, Pilatus and Vulcanair) and 103 operators from 13 countries answered.



The operators' fleet corresponds to 162 aircraft. After a validation of the data by the Rulemaking Group (regarding the seat category, the aircraft type, etc.), 127 aircraft from 85 operators were considered to be relevant to the scope of this task, approximately 80 % of the original dataset. The Rulemaking Group considered that this is sufficient sample to be used in the impact assessment.

6.3. Outcome of the survey

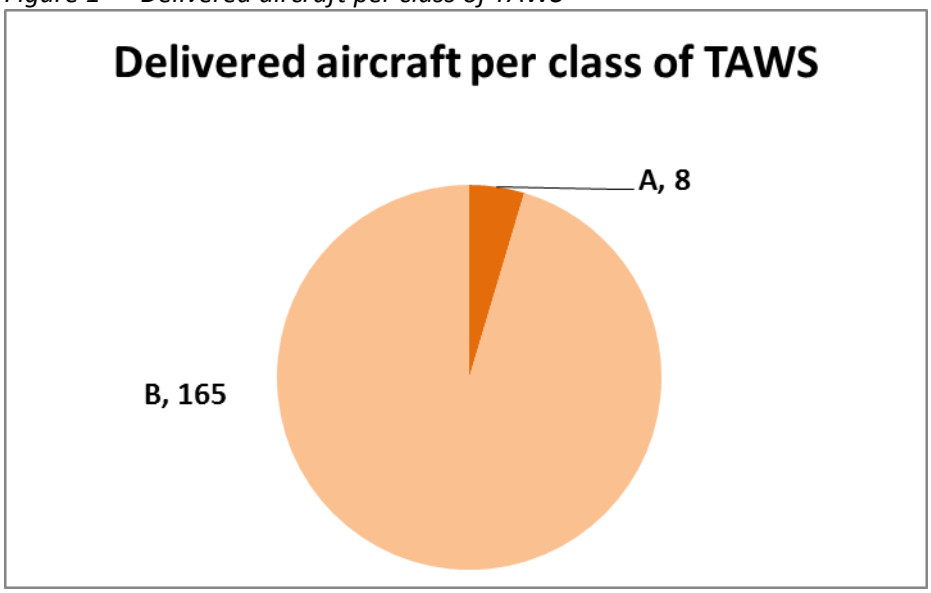
6.3.1. What is the number of aircraft per aircraft type and per type of TAWS sold to operators?

— 173 aircraft (Embraer, Piaggio, Pilatus, Vulcanair)

— All these aircraft are equipped with TAWS A or B

— 5 % with TAWS A

Figure 1 — Delivered aircraft per class of TAWS



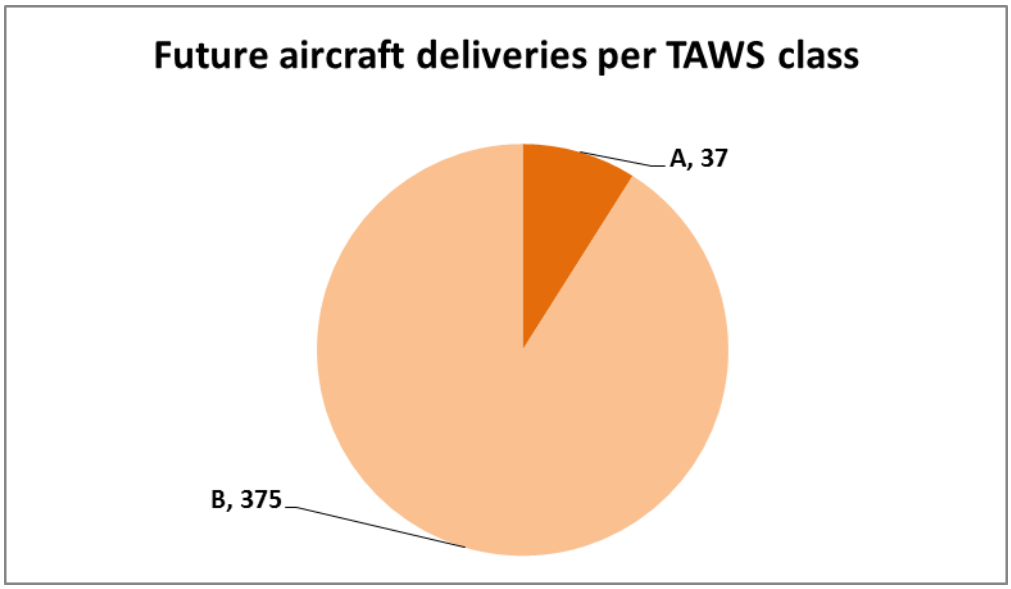
6.3.2. What is the number of aircraft per aircraft type and per type of TAWS sold to operators?

— 412 aircraft (Embraer, Piaggio, Pilatus, Vulcanair)

— All new aircraft to be delivered in the next 5 years are equipped with TAWS A or B

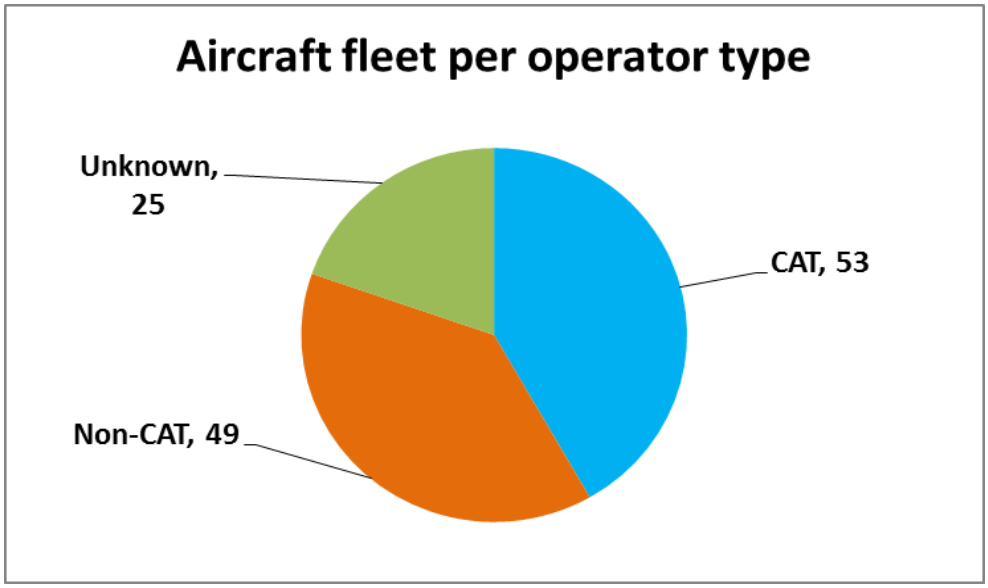
— 9 % with TAWS A

Figure 2 — Future aircraft deliveries according to TAWS class



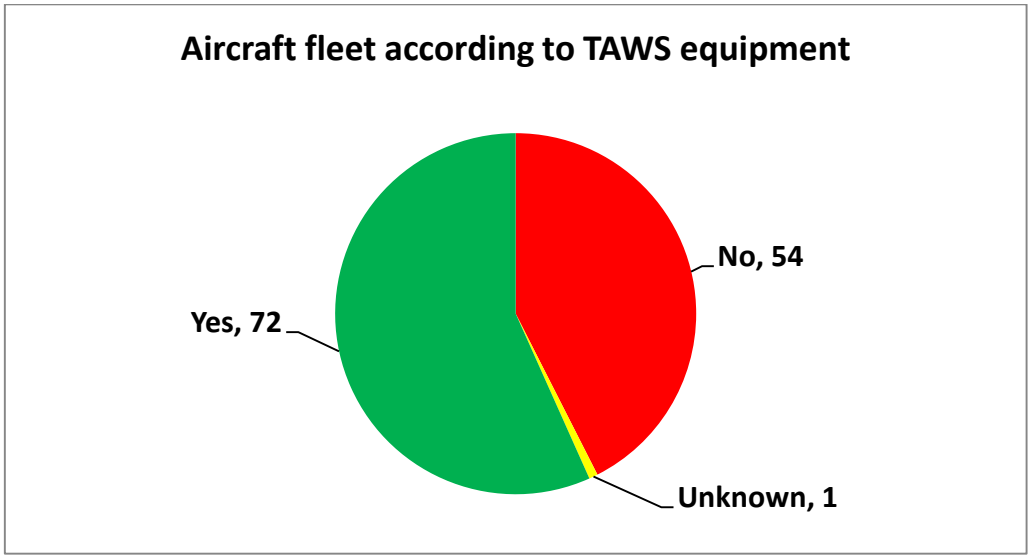
6.3.3. What is the aircraft fleet per type of operators from the EU operators' respondents?

Figure 3 — Aircraft fleet per operator type



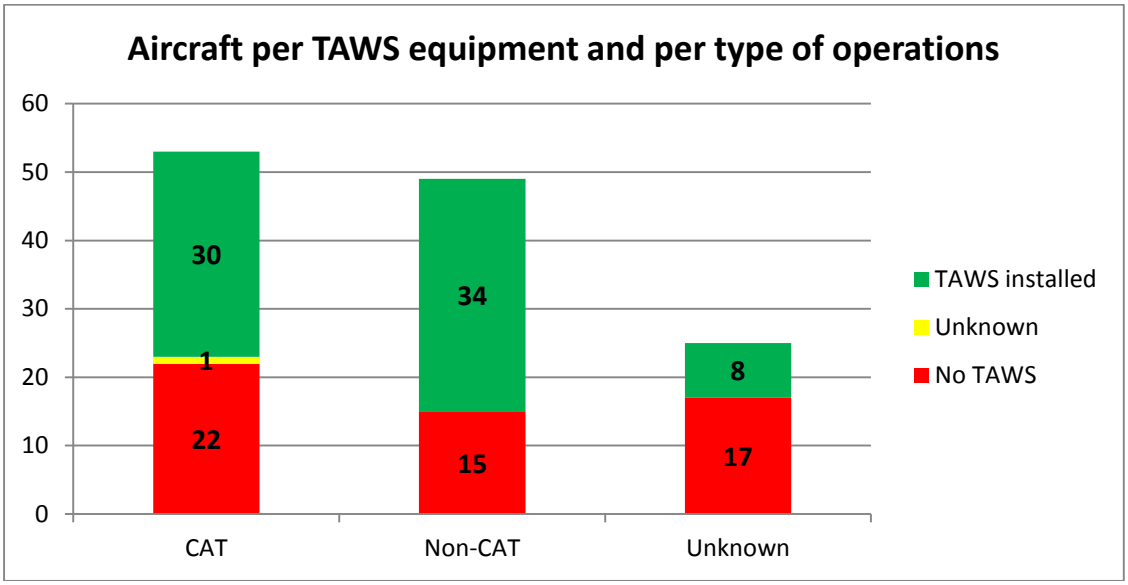
6.3.4. How many aircraft operated by the EU operators' respondents have TAWS installed?

Figure 4 — Aircraft fleet according to TAWS equipment



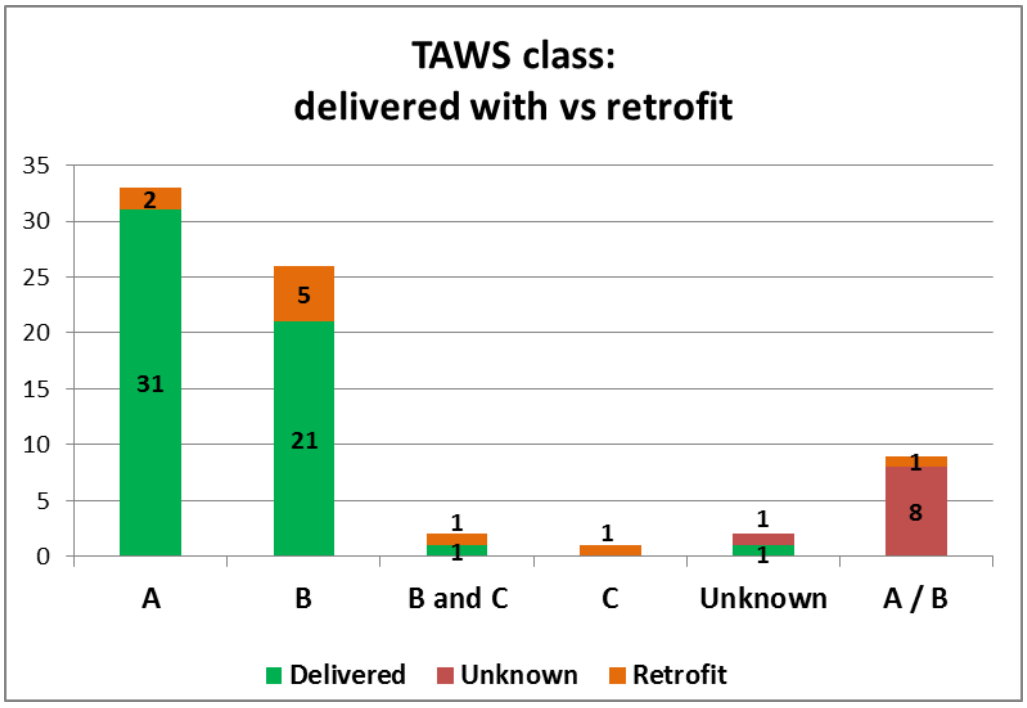
6.3.5. What is the status of TAWS equipment per type of operators?

Figure 5 — Aircraft per TAWS equipment and per type of operations



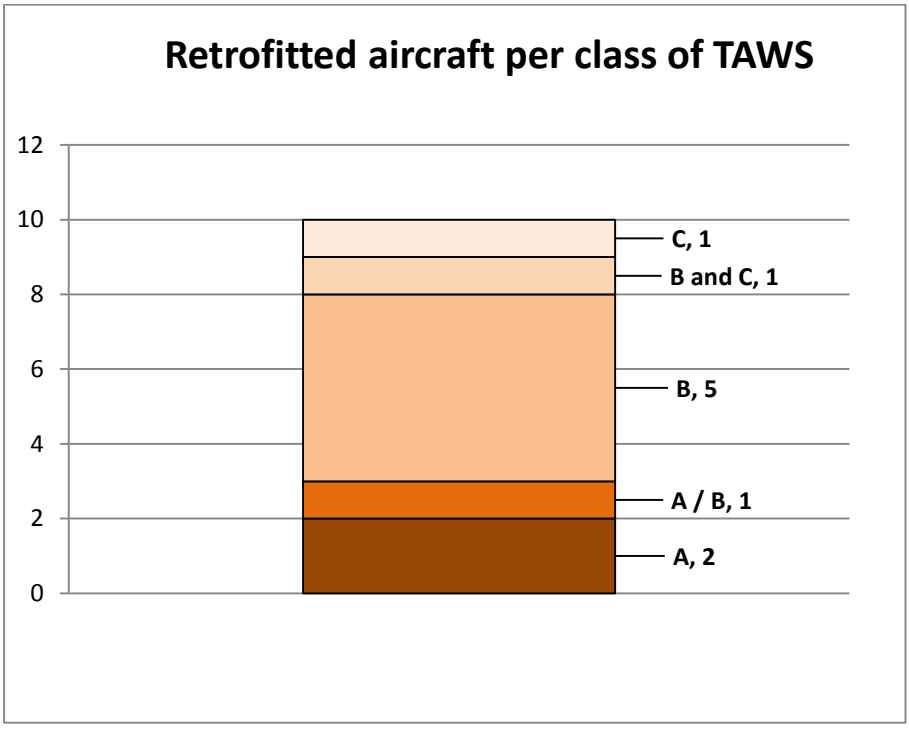
6.3.6. What is the type of TAWS equipment installed in new aircraft and retrofitted aircraft?

Figure 6 — TAWS class: delivered with vs retrofitted



6.3.7. How many aircraft were retrofitted with TAWS?

Figure 7 — Retrofitted aircraft per class of TAWS for the period 2002–2014



6.3.8. What is the number of retrofitted aircraft per type of operations?

Figure 8 – Retrofitted aircraft per type of operations