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Terrain Awareness and Warning System; Final Rule

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 91, 121, 135

[Docket No. 29312; Amendment No. 91–263; 121–273; 135–75]

RIN 2120–AG46

Terrain Awareness and Warning System

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: The Federal Aviation Administration (FAA) is amending the operating rules to require that certain airplanes be equipped with an FAA-approved terrain awareness and warning system (also referred to as an enhanced ground proximity warning system). This final rule is a general aviation regulation that affects all U.S. registered turbine-powered airplanes with six or more passenger seats (exclusive of pilot and copilot seating). This change is in response to several accident investigations and studies that have shown a need to expand the safety benefits of ground proximity warning systems to certain additional operations. These investigations and studies have also shown that there is a need to increase the warning times and situational awareness of flight crews to decrease the risk of controlled flight into terrain accidents.

EFFECTIVE DATE: March 29, 2001.

FOR FURTHER INFORMATION CONTACT: Manuel Macedo, Aircraft Engineering Division, AIR–100, Aircraft Certification Service, Federal Aviation Administration, 800 Independence Avenue, SW., Washington, DC 20591; Telephone: (202) 267–9566.

SUPPLEMENTARY INFORMATION:

Availability of Final Rules

An electronic copy of this document may be downloaded using a modem and suitable communications software from the FAA regulations section of the FedWorld electronic bulletin board service (telephone: (703) 321–3339) or the Government Printing Office's (GPO) electronic bulletin board service (telephone: (202) 512–1661).

Internet users may reach the FAA's web page at *http://www.faa.gov/avr/arm/nprm/nprm.htm* or the GPO's web page at *http://www.access.gpo.gov/nara* for access to recently published rulemaking documents.

Any person may obtain a copy of this document by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM–1, 800 Independence Avenue, SW., Washington, DC 20591, or by calling (202) 267–9680. Communications must identify the amendment number or docket number of this final rule.

Persons interested in being placed on the mailing list for future rulemaking documents should request from the above office a copy of Advisory Circular No. 11–2A, Notice of Proposed Rulemaking Distribution System, which describes the application procedure.

Small Business Regulatory Enforcement Fairness Act

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Background

Beginning in the early 1970's, a number of studies looked at the occurrence of ''controlled flight into terrain'' (CFIT) accidents, where a properly functioning airplane under the control of a fully qualified and certificated crew is flown into terrain (or water or obstacles) with no apparent awareness on the part of the crew.

Findings from these studies indicated that many such accidents could have been avoided if a warning device called a ground proximity warning system (GPWS) had been used. As a result of these studies and recommendations from the National Transportation Safety Board (NTSB), in 1974 the FAA required all part 121 certificate holders (*i.e.*, those operating large turbine-powered airplanes) and some part 135 certificate holders (*i.e.*, those operating large turbojet airplanes) to install Technical Standard Order (TSO) approved GPWS equipment (§§ 121.360 and 135.153). (39 FR 44439, December 18, 1974).

In 1978 the FAA extended the GPWS requirement to part 135 certificate holders operating smaller airplanes: turbojet-powered airplanes with 10 or more passenger seats. These operators were required to install TSO-approved GPWS equipment or alternative ground proximity advisory systems that provide routine altitude callouts whether or not there is any imminent danger (§ 135.153). (43 FR 28176, June 29, 1978). This requirement was considered necessary because of the complexity, size, speed, and flight performance characteristics of these airplanes. The GPWS equipment was considered essential in helping the pilots of these airplanes to regain altitude quickly and avoid what could have been a CFIT accident.

Installation of GPWS's or alternative FAA-approved advisory systems was not required on turbo-propeller powered (turboprop) airplanes operated under part 135 because, at that time, the general consensus was that the performance characteristics of turboprop airplanes made them less susceptible to CFIT accidents. For example, it was thought that turboprop airplanes had a greater ability to respond quickly in situations where altitude control was inadvertently neglected, as compared to turbojet airplanes. However later studies, including investigations by the NTSB, analyzed CFIT accidents involving turboprop airplanes and found that many of these accidents could have been avoided if GPWS equipment had been used.

Some of these studies also compared the effectiveness of the alternative ground proximity advisory system to the GPWS. GPWS was found to be superior in that it would warn only when necessary, provide maximum warning time with minimal unwanted alarms, and use command-type warnings.

Based on these reports and NTSB recommendations, in 1992 the FAA amended § 135.153 to require GPWS equipment on all turbine-powered airplanes with 10 or more passenger seats. (57 FR 9944, March 20, 1992).

After the current rules were issued, advances in terrain mapping technology permitted the development of a new type of ground proximity warning system that provides greater situational awareness for flight crews. The FAA has approved certain installations of this type of equipment, known as the enhanced ground proximity warning system (EGPWS). However, in this final rule, the FAA is using the broader term ''terrain awareness and warning system'' (TAWS) because the FAA expects that a variety of systems may be developed in the near future that would meet the improved standards contained in this final rule.

The TAWS improves on existing GPWS systems by providing the flight crew much earlier aural and visual warning of impending terrain, forward looking capability, and continued operation in the landing configuration. These improvements provide more time

for the flight crew to make smoother and gradual corrective action.

In 1998, the FAA issued Notice No. 98–11, Terrain Awareness and Warning System (63 FR 45628, August 26, 1998), proposing that all turbine-powered U.S.-registered airplanes type certificated to have six or more passenger seats (exclusive of pilot and copilot seating), be equipped with an FAA-approved terrain awareness and warning system. This final rule is based on Notice No. 98–11.

NTSB Recommendations

Following the investigation of a CFIT accident south of Dulles International Airport on June 18, 1994, involving a Learjet 25D in which there were 12 fatalities, the NTSB recommended (Recommendation A–95–35) that the FAA mandate that all turbojet-powered airplanes equipped with six or more passenger seats have an operating ground proximity warning system installed. That recommendation also made reference to an earlier, similar NTSB recommendation (Recommendation A–92–55) resulting from a 1991 CFIT accident involving a Beechjet 400. Both planes were corporate jets flying under part 91 and were not required to have GPWS equipment installed.

More recently, the NTSB issued Recommendation A–96–101, based on its investigation of a CFIT accident northeast of Cali, Columbia, on December 20, 1995, involving an American Airlines Boeing 757 airplane operating under part 121, which resulted in 159 fatalities. Although the airplane involved in the accident was equipped with the mandatory GPWS, the GPWS did not provide the warning in time for the crew to avoid the mountainous terrain. The NTSB recommended that the FAA examine the effectiveness of the enhanced ground proximity warning system, and if found effective, require all transport-category airplane to be equipped with this system.

Volpe National Transportation Systems Center Studies

In recent years, the FAA commissioned two studies by the Department of Transportation's (DOT) Volpe National Transportation Systems Center (VNTSC) to examine the effectiveness of GPWS and EGPWS in preventing CFIT accidents in various airplane categories and operations. The two studies, hereafter called the Volpe part 91 study and the Volpe part 121/135 study, analyzed CFIT accidents during the period 1985–1995 and found that EGPWS could have prevented 95–100 percent of these accidents. (For more detail on these studies, see: DOT-TSC-FA6D1–96–01, and DOT-TSC-FA6D1–96–03, both entitled, ''Investigation of Controlled Flight Into Terrain'', which are included in the public docket.)

In the Volpe part 91 study VNTSC concluded that ''equipping aircraft with GPWS, or EGPWS when it becomes available, could be a particularly effective means of preventing CFIT accidents in the subject FAR Part 91 aircraft fleet.'' Likewise, in the Volpe part 121/135 study, VNTSC concluded that there was compelling evidence of the potential effectiveness of EGPWS in preventing CFIT accidents because the equipment would have provided the same or increased warning durations over GPWS. In addition, flight crews, given a continuous terrain display, could have responded to terrain threats well before an EGPWS alert.

Discussion of Comments

The FAA received over 200 comments in response to the Terrain Awareness and Warning System NPRM (63 FR 45628, August 26, 1998). After careful analysis of these comments, the FAA has made the following changes between the NPRM and the final rule:

1. The final rule is not applicable to parachute operations, aerial application operations, and firefighting operations.

2. The final rule is applicable to airplanes ''configured'' with 6 or more passenger seats, not to airplanes ''type certificated'' for 6 or more passenger seats.

3. The final rule addresses two classes of TAWS equipment, Class A and Class B. A new TSO, TSO–C151, includes the airworthiness requirements for both Class A and Class B equipment. Class A equipment will be required for airplanes operated under part 121 and part 135 of 10 or more passenger seats; this class of equipment will be the same as originally proposed. Class A equipment includes current GPWS required functions. Installers of Class A equipment required by this rule must install a terrain situational awareness display. Class B equipment will be required for airplanes operated under part 91 with 6 or more passenger seats and for airplanes operated under part 135 with 6–9 passenger seats. Class B equipment includes the basic TAWS safety features. These changes, in response to the comments, for airplanes operated under part 91 with 6 or more passenger seats and airplanes operated under part 135 with 6–9 passenger seats, will reduce the initial cost of purchasing and installing TAWS, while continuing to provide the desired level of safety.

A summary of the comments and an explanation of the changes made in the final rule in response to those comments appear below.

Approximately one-half of the comments were from individuals associated with parachute operations (skydivers and parachutists; skydiving and parachute operators; and associations). In addition, a total of 254 form letters from parachute participants and operators were submitted opposing the installation of TAWS or EGPWS in turbine-powered airplanes used in parachute activities. These commenters state that the proposed rule would be financially burdensome and would add no foreseeable safety benefit to parachute operations.

The remaining comments were from various part 91 and part 135 operators (*e.g.*, cargo, charter, and corporate operations) and their representative organizations; some part 121 operators and/or their representatives; and a comment from an EGPWS manufacturer, Allied Signal.

The following discussion summarizes these comments by the following issue areas: Applicability; Comments to NTSB recommendations; NPRM accident analysis; Comments on Cost of TAWS; GPWS/TAWS technology; TSO comments; supplemental type certificates; training; other government/industry efforts; compliance schedule; and miscellaneous comments.

Applicability

The FAA proposed adding §§ 91.223, 121.354, and 135.154 to require the installation of FAA-approved terrain awareness and warning systems (TAWS) on certain airplanes. For operations under part 121, the rule would apply to all turbine-powered airplanes. For all other operations (parts 91, 125, 129, and 135) the FAA proposed that the rule apply to all turbine-powered airplanes type certificated to have six or more passenger seats, excluding any pilot seat.

Applicability to the Parachute Industry

Parachute operators and parachutists say that they should be exempt from the proposed rule. They state that the nature of parachute operations makes GPWS and TAWS unnecessary. The U.S. Parachute Association (USPA) and the Parachute Industry Association strongly object to the mandatory installation of TAWS for airplanes used in parachute operations. The following arguments are presented by the parachute industry:

• Parachuting is primarily a visual flight rules (VFR) activity, conducted during the day, during which terrain is always visible and weather conditions

are good. Occasionally, parachute operators fly in instrument flight rules (IFR) conditions, *e.g.,* to ferry an airplane, but these operations are performed with no passengers.

• Parachuting is primarily done in the proximity of the departure airport (usually within a 10-mile radius) and the pilots are familiar with the obstacles and terrain features around their home fields.

• Parachutists are the passengers in these airplanes (not the traveling public, which the proposed rule is seeking to protect). These airplanes are used only as a means for the parachutists to get to altitude for jumping.

• Parachute operations have not been associated with CFIT accidents. Some commenters state that the NPRM cites no such accidents in parachute operations. Therefore, the commenters do not believe GPWS or TAWS would have made a difference in the outcomes of any accidents involving parachute operations.

USPA and other commenters from the parachute industry go on to say that since TAWS would provide no safety benefit to parachute operations, they should not have to bear the cost of installing TAWS on these airplanes. Some commenters add that these costs would be especially burdensome to small operators who already have a very small profit margin, which could result in their going out of business. Several commenters believe that the cost of installing TAWS on turbine-powered airplanes used in parachute operations could result in some operators switching back to using older and smaller non-turbine airplanes, which would have a negative effect on the growth and safety of the parachute industry.

The FAA agrees with the commenters. Parachute and skydiving operations are unique in that operations are conducted under VFR conditions, in close proximity to the home field, with constant reference to the ground. Furthermore, there are only a small number of airplanes involved in these types of operations. The FAA has changed § 91.223 in the final rule to exclude airplanes when used for parachute operations and operated within 50 miles of the home airport.

Applicability to Other Part 91 Operations

The National Business Aviation Association (NBAA) recommends that the FAA exempt turbine-powered airplanes operated under part 91 from the rule because part 91 allows operators the flexibility ''to equip their aircraft as necessary to accomplish the missions set forth by the company.'' The NBAA cites the safety record of corporate operations under part 91. The Aircraft Owners and Pilots Association (AOPA) recommends applying the proposed rule only to large turbojet airplanes used in commercial passenger-carrying operations. Several other part 91 operators also state that they should be exempt from the proposed rule.

The FAA disagrees with these commenters for the following reasons: (1) Two of the three NTSB recommendations discussed earlier were based on CFIT accidents involving airplanes operating under part 91. (2) The number of CFIT accidents occurring in part 91 operations is excessively high. (3) The Volpe part 91 study provides evidence that TAWS would have prevented 95 percent of the CFIT accidents studied.

Raytheon Aircraft Company (Raytheon) recommends applying the proposed rule to airplanes operated under part 135 and part 121 and exempting part 91 operations. Raytheon requests that the FAA make available the data it compiled from the Volpe part 91 study of the forty-four accidents which was stated in the NPRM, before issuing any final rule for part 91 operations.

Raytheon proposes excluding turbo-propeller airplanes operated under part 91 from the requirement of installing TAWS. As a second alternative, Raytheon proposes applying this requirement to turbine airplanes categorized at a minimum gross weight of 19,000 pounds (maximum certificated weight for a commuter category airplane), or a minimum gross weight of 12,500 pounds (FAA's defined certificated weight of a large airplane). Some commenters state that CFIT accidents have not been a problem for part 91 operations and that GPWS/TAWS is therefore unnecessary.

The FAA disagrees with Raytheon and other commenters who oppose TAWS on turboprop airplanes and has determined that turboprop airplanes should continue to be covered. A study done for the FAA as part of the 1992 rulemaking amending part 135, requiring GPWS equipment, revealed that turboprop airplanes have just as many, if not more CFIT accidents than turbojet airplanes. In fact, the Volpe part 91 study shows that 33 of 44 CFIT accidents involved turboprop airplanes.

A part 91 turboprop airplane operator states that he operates his airplanes in familiar terrain and that GPWS is unnecessary for his operations. The operator is involved in aerial applications and states that his operations are within 50 feet of the ground which would result in continuous nuisance alerting from TAWS; therefore this equipment is unnecessary. This commenter adds that the rule should make exceptions for operations such as his which operate airplanes with a payload capacity in excess of 6,000 pounds.

The FAA agrees with the commenter that operations involving aerial applications should be excluded. Therefore the final rule has been changed in § 91.223 so that it does not apply to airplanes used in aerial applications or agricultural operations.

Raytheon and others recommend rewording ''type certificated with * * * .'' to read ''configured with * * *.'' These commenters say that rewording the text will permit the type of TAWS equipment installed to be determined by the number of seats installed in the airplane, rather than the maximum number of seats permitted by the certification basis. Similarly, the Regional Airline Association (RAA) and a part 135 cargo operator, request that proposed §§ 91.223 and 135.154 be revised to replace ''certificated to have'' with ''having.''

Federal Express believes that airplanes type-certificated as cargo airplanes that do not carry passengers should not be required to install TAWS as proposed by the NPRM. Federal Express also believes that the Fokker airplanes, which were converted from a passenger to a cargo-only configuration, should not have been covered by the NPRM. Federal Express requests the FAA to amend the NPRM to expressly exclude cargo-only airplanes.

The FAA agrees with the commenters' recommendations that the equipment requirements be determined by the number of seats. The FAA has changed the final rule in §§ 91.223 and 135.154 so that the words ''type-certificated to have six or more passenger seats'' are changed to ''configured with six or more passenger seats.''

In response to Federal Express and others who state that passenger-carrying planes converted to cargo planes should not have to comply with the rule, the FAA partially agrees in that if the airplane (cargo carrying or not) is configured with fewer than 6 passenger seats and is operating under part 91, then TAWS is not required. However, for operations conducted under part 121 (cargo carrying or not), TAWS is required regardless of the number of passenger seats. Under existing rules, the FAA requires GPWS for part 121 regardless of the number of seats and is continuing to maintain the same safety standard.

In addition many airplanes operating under part 121 have older model GPWS equipment. Some of the NTSB recommendations discussed earlier include sub-recommendations that the FAA mandate replacement of the older equipment with more modern equipment. This final rule also responds to such recommendations.

The FAA disagrees with the commenter that cargo airplanes should be exempt from the rule. Specifically in § 121.360, the use of GPWS is required on turbine-powered airplanes operated under part 121. In this rule the FAA is maintaining the existing GPWS requirements (which also meets the ICAO requirements) by requiring TAWS that includes GPWS functions.

Applicability to Part 135 Operations

The National Air Transportation Association (NATA) and several part 135 operators ask why the FAA has put part 135 operators into the same category as part 91 operators. These commenters object to the FAA's use of part 91 accident statistics to justify requiring TAWS for them. The NATA states that the premise for this rulemaking is unfounded due to the FAA's failure to specifically review the part 135 on-demand community. The NATA contends that the lack of consideration of these specific types of airplanes and operations fails to provide complete data that is necessary to justify the application of a rule of this magnitude to this industry segment.

The NATA recommends that the FAA conduct a study of accidents involving airplanes operated on-demand under part 135. These commenters suggest that a new cost/benefit analysis, and a new Initial Regulatory Flexibility Determination and Analysis based on the study suggested would provide an accurate representation of the true cost to part 135 operators. The NATA's position is supported by a number of part 135 on-demand charter operators.

A charter operation states that turbine-powered airplanes with fewer than 10 seats should not be required to install GPWS/TAWS because most CFIT accidents have involved large commercial jets.

The Helicopter Association International (HAI) supports the position of the Alaska Air Carriers Association (AACA) and others who want part 135 operators exempt from the TAWS requirement. The HAI says that ''industry and government resources are finite, and that TAWS does not promise to advance the cause of aviation safety enough to justify the costs involved at this time.''

In the preliminary regulatory analysis the FAA did not specifically evaluate part 135 accidents. However, the FAA determined that the airplanes that are frequently found in part 135 on-demand operations are the same type that are typically operated in part 91. Therefore, the FAA extended the part 91 analysis to part 135 operations.

The operating rules of part 91 apply to all airplanes, including those operated under parts 121 and 135. The Volpe part 91 study supports the use of this equipment on the types of airplanes used by both parts 91 and 135.

In addition, the Volpe studies confirmed that compared to the GPWS, the TAWS equipment provides earlier audio and visual alerts. In fact, in the Volpe part 91 study the GPWS system used for comparison purposes was the most advanced GPWS system. In reality many of the GPWS systems in service are the older versions that have been plagued with nuisance and false alarms.

The HAI opposes any attempt to extend the TAWS requirement to rotorcraft and says that the decision whether to use TAWS should be left up to each rotorcraft operator ''who is best able to weigh the substantial costs involved against the safety benefit that may be obtained.''

In response to HAI's comment on requiring TAWS for rotorcraft, the FAA did not receive any comments that would justify extending this rule to rotorcraft at this time.

A commenter that operates a Pilatus/Fairchild PC–6 with a maximum of 11 seats, is against requiring TAWS for ''charter in the bush'' type operations. The commenter says that ''the PC–6 was designed to land on most of the terrain a Ground Proximity Warning System would request a pilot to avoid.''

The FAA disagrees. This type of operation is ideal for use of TAWS equipment because bush flying frequently involves operating over rugged terrain where TAWS is most valuable. However, for the landing phase of these types of operations, it is possible to customize the terrain data base during the installation approval process.

One commenter says that there are many part 135 small airplane freight operators who use airplanes that are not required to have radar equipment installed; and these airplanes often have entirely mechanical instrument panels. The commenter concludes that, these airplanes would not be equipped to provide a display.

The FAA has determined that airplanes configured for fewer than 6 seats and operated under part 91 or part 135 should continue to operate without a terrain awareness and warning system. These airplanes are not affected by this rulemaking action. In addition, the FAA has modified the requirement for airplanes configured with 10 or more seats under part 135. These airplanes must be operated with a terrain situational display to meet the requirements of this rule.

Applicability to Turbo-Propeller Airplanes

Piedmont Airlines, in conjunction with US Airways, proposes exempting turbo-propeller airplanes from the proposed rule because many of these airplanes have only recently been equipped with GPWS. This commenter questions the benefit of replacing later generation GPWS with TAWS when the effectiveness of the newly installed GPWS has yet to be tested.

Piedmont Airlines also points out that most CFIT accidents with GPWS equipped airplanes occurred in foreign territory and that due to their limited flying range, U.S. part 121 turboprop airplanes do not operate abroad. Piedmont Airlines asks the FAA to issue a supplemental notice of proposed rulemaking (SNPRM) to address turboprop airplanes separately.

The FAA agrees that the accident history data does not conclusively prove that the currently mandated GPWS is not effective in resolving the problem of CFIT accidents. However, the FAA has determined through the Volpe part 121 study that TAWS would have prevented CFIT accidents that current generation GPWS did not prevent. Due to the continued CFIT risk exposure with GPWS, the FAA is requiring TAWS.

The FAA acknowledges that the majority of CFIT accidents have occurred in foreign territory. However, a significant number of CFIT accidents still occur in the U.S. with turboprop airplanes equipped with GPWS. In regards to the commenter's assertion that U.S.-registered part 121 airplanes have a limited flying range, the FAA notes that many operators are located near and fly into foreign territory where CFIT accidents have occurred; *e.g.*, Canada, Mexico, and the Caribbean. The commenters have not provided any information to substantiate the need to further delay this action and there is no reason to believe new information would be obtained through publication of a supplemental notice.

Applicability to Reciprocating-Powered Airplanes

The FAA proposed that the rule apply only to turbine-powered airplanes. Additionally, the FAA specifically requested comments on whether it

should require the installation of TAWS on reciprocating engine-powered airplanes.

The General Aviation Manufacturers Association (GAMA) is against requiring TAWS on reciprocating-powered airplanes because the costs would be high (*e.g.*, ''TAWS equipment would cost more than the hull value of the aircraft''), and the panel space for installing TAWS with a situational display is not available in these airplanes.

The FAA did not receive any comments that would justify undertaking a new rulemaking project to mandate TAWS for reciprocating-powered airplanes.

However, regarding the issue of panel space, the FAA knows of at least one manufacturer who has developed a complete TAWS unit that was designed to replace an existing panel instrument.

Applicability to Foreign-Registered Airplanes

The Aerospace Industries Association (AIA) says that the language under proposed § 91.223 makes reference only to U.S.-registered airplanes and provides an unstated exemption for airplanes of foreign registry. The AIA says that the proposed rule does not address those cases where ''the production process requires that manufacturers operate production airplanes that have been issued a Standard Certificate of Airworthiness.'' The AIA adds that, ''while at this time the equipment is not of U.S. nor foreign registry the manufacturer would appear to be in violation of FAR Part 91 requirements during the production process if terrain awareness and warning systems have not been installed.'' The AIA says that the rule language should be changed to address this issue.

The Independent Pilots Association (IPA) recommends that TAWS be a uniform requirement for all airplanes over which the FAA has jurisdiction and not exclude foreign-registered airplanes operating in the United States.

The FAA's response to these comments is that the FAA is addressing requirements for foreign-registered airplanes through the ICAO process, which may result in all nations adopting the TAWS standard. Regarding AIA's comment about airplanes that have been operating under a standard airworthiness certificate prior to foreign registry, the FAA does not agree that there is a problem here. The majority of the manufacturers are including TAWS as standard equipment in new production models. Also, there are rules that the FAA has in place for ferrying airplanes to foreign countries that would allow for airplanes being exported that do not meet U.S. requirements.

Comments to NTSB Recommendations

The NTSB states that the NPRM is responsive to recommendations A–95–35 and A–96–101 by proposing that TAWS be installed on all turbine-powered airplanes with 6 or more passenger seats. If implemented, the NTSB contends that the rule will ''have a positive affect on aviation safety by reducing the opportunities for CFIT accidents.''

The NBAA comments on NTSB recommendations A–92–55 and A–95–35, which recommended that all turbojet powered airplanes with six or more passenger seats have an operating GPWS system installed. The NBAA states that these recommendations are flawed, because the accidents prompting these recommendations were due to many contributing factors (a high-speed unstable approach, minimally experienced crew, fuel shortage, marginal weather conditions, low visibility). The NBAA does not believe TAWS equipment could have prevented these accidents.

The FAA is confident in both the validity of the Volpe part 91 study and its conclusion that the accidents could have been avoided if the airplanes had been equipped with TAWS. As described in the NPRM, a CFIT accident occurs when a properly functioning airplane under the control of a fully qualified and certificated crew is flown into terrain (or water or obstacles) with no apparent awareness on the part of the crew. By the nature of this definition, it is obvious that there had to be other contributing factors causing the crew to lose situational awareness, otherwise there would not have been a crash. However, the other contributing factors do not include airplane malfunctions or incapacitated crew; they generally include situations such as low visibility, inclement weather conditions, and being lost. The TAWS caution alert would have given the crew sufficient time to analyze the situation, then take corrective action. Finally, the warning alert to ''pull up'' would have allowed the crew to gain altitude and avoid hitting the terrain.

The GAMA says that NTSB recommendations A–92–55 and A–95–35 only recommended GPWS (not TAWS) on turbojet airplanes (not turboprop airplanes). The USPA points out that NTSB has never issued a recommendation to require GPWS or TAWS on part 91 turboprops. The USPA further asserts that the FAA proposal appears to use the NTSB recommendation A–95–35 as the basis for including part 91 turboprops in the NPRM. The commenter further asserts that NTSB recommendation A–96–101 would require EGPWS on transport category airplanes (not on general aviation part 91 airplanes). Similar comments were made by AOPA.

GAMA is correct in saying that the NTSB recommendations A–92–55 and A–95–35 did not refer specifically to TAWS nor to turboprop airplanes. The NTSB has recommended since then that all turbine-powered airplanes with six or more seats be equipped with an EGPWS or an TAWS (A–99–36). The FAA's decision to require TAWS instead of GPWS and to include turboprops are for the reasons already discussed in the preamble. The reasons are briefly restated here. At the time the NTSB prepared and issued its earlier recommendations, TAWS did not exist. In response to the earlier NTSB recommendations, the FAA commissioned Volpe to do a study to evaluate the effectiveness of GPWS on smaller airplanes operated strictly under part 91. After the FAA certificated TAWS, the FAA expanded the Volpe study to also evaluate TAWS and compare the effectiveness of TAWS and GPWS. This study convinced the FAA that TAWS is superior to GPWS in eliminating CFIT. In addition, a cost benefit analysis showed that TAWS did indeed provide a significant benefit to aviation safety. Furthermore, 33 of the 44 CFIT accidents analyzed in the Volpe part 91 study involved turboprop airplanes. This high rate of CFIT accidents involving turboprop airplanes confirm the results of earlier studies conducted by the FAA.

NPRM Accident Analysis

A number of part 91 and some part 135 operators say that GPWS/TAWS would do little to improve safety for their operations, and therefore is not worth the cost. Some of these commenters say that there is little factual data supporting the need for this equipment in their operations.

The RAA and USPA question the legitimacy and validity of the Volpe part 121/135 study and find the Volpe part 91 study inconclusive. These commenters say that, of the 44 accidents analyzed in the Volpe part 91 study, only 9 accidents may have been preventable using only EGPWS. The RAA believes the common causal link is the failure of the flight crews to follow procedures. The RAA believes that the accidents examined in the Volpe part 121/135 study should be more correctly categorized as ''approach and landing,''

many of them affected by weather conditions.

The USPA believes there are major flaws in the Volpe part 91 study. Among the probable causes listed for the accidents studied by NTSB are improper planning/decisionmaking, improper IFR/VFR procedures, failure to execute missed approach procedures, continuation of VFR flight into instrument meteorological conditions (IMC), poor crew coordination, and failure to establish proper climb rate. Similarly, another commenter says that the Dulles, Virginia, and Rome, Georgia, accidents cited in the Volpe part 91 study were not the result of a CFIT, rather they were due to such factors as inexperienced crew, low visibility, and an unstable approach.

The NBAA also analyzed the same accidents studied by Volpe (1985–1994) and found only six accidents involving part 91 turbine-powered airplanes (not 44 accidents, as cited in the NPRM) that could have been related to CFIT. The NBAA found that most of these accidents were due to other factors, including improper or missed approach procedures, intentional descent below minimums, continued operations in below minimum weather, and VFR flight into IMC. The AOPA adds that ''little is known about crew procedures, their mental state, and if the crew's actions would have been timely and accurate enough to avoid the accident once they responded to warnings estimated to be provided by the proposed TAWS equipment in that scenario.''

In addition, NBAA studied turbine-powered airplane CFIT accidents from 1966–1997 and found a total of 34 accidents involving part 91 airplanes. These NBAA findings are also cited by GAMA.

In response to comments made by NBAA, USPA, RAA, AOPA, and others that the accidents cited in the Volpe part 91 study were not the result of a CFIT, but were due to other factors such as poor crew coordination, the FAA disagrees. No accidents are caused by one single element. Under the FAA's definition of CFIT, these were CFIT accidents, have been designated as CFIT by the NTSB, and thus formed the basis for the NTSB's recommendations.

The RAA also comments on the Volpe part 91 study's statement regarding 6 of the 9 CFIT accidents under part 91: ''since airplane's gears and flaps were in landing condition, the Mode 4 warning of GPWS would have been desensitized.'' RAA states that ''the procedure used in regional/commuter operations is to not commit to landing flaps until the field is in sight, so we believe that the Volpe study should have completed their geometric analysis on these six accidents as well, in order to determine whether there would have been a significant difference in pilot response time'' between GPWS and TAWS.

The RAA believes that the FAA needs to determine whether the use of TAWS will lead to more approach and landing accidents that are characterized by the pilot's failure to adequately evaluate inflight weather conditions, failure to maintain sufficient altitude during the approach to land, etc.

In response to RAA's comments about the Volpe part 91 study, the FAA's position is that the Volpe part 91 study was done specifically to determine the effectiveness of TAWS, because that was the system the FAA was considering. The intent of the Volpe part 91 study was for the FAA to determine if TAWS was technically feasible. GPWS is a system using 1970's technology that has reached the limit of its usefulness. The FAA believes more modern technology is needed to gain more accident prevention potential to eliminate CFIT's. In the past the FAA has chosen not to require GPWS on airplanes operated under part 91 because of its technical limitations and costs. TAWS solves those limitations and has potential for future enhancements with lower cost for airplanes already equipped with GPWS.

In addition, the purpose of the Volpe part 91 study was to confirm that the TAWS system was superior to GPWS in eliminating CFIT. In fact, in the part 91 study the GPWS system used for comparison purposes was the most advanced GPWS system. In reality many of the GPWS systems in service are the older versions that have been plagued with nuisance and false alarms.

Similarly, GAMA references another study done outside of this rulemaking and refers to it as a second Volpe part 91 study. That study is dated July 1997, and examined all CFIT general aviation accidents (1983–1994) and concluded that CFIT is a small percentage of general aviation accidents. The GAMA says that the study showed 121 CFIT accidents in 1991, but that by 1994, such CFIT accidents had decreased to 68, which represented only 3.7% of all general aviation accidents.

In response to GAMA's comment that the second Volpe part 91 study concluded that CFIT is a small percentage of general aviation accidents, the same report also shows that the small percentage (3.7%) of accidents represents 17% of all fatalities and that accidents caused by CFIT and spins are the leading causes of general aviation fatalities. Furthermore, the FAA's cost-benefit analysis of TAWS equipment used for general aviation operations showed that TAWS did indeed provide a significant benefit to general aviation safety.

Some commenters state that the accident statistics provided in the NPRM do not justify requiring TAWS on turboprop airplanes. One-commenter points out that the NPRM says that TAWS will only avert 2.3 accidents per million flight hours in a 6–9 seat turboprop airplane. This commenter believes that this small number is justification for exempting this category of airplane from the TAWS rule. This commenter also comments that the Volpe part 91 study (table 10) said that 6 of the 33 turboprop accidents could have been prevented with TAWS. This commenter says that ''5 of the 6 accidents involved aircraft on approach to landing. These accidents resulted from pilot error in being too low on glideslope, or descending below MDA.''

As an example of the effectiveness of the current rule, Allied Signal cites differences in accident statistics between turboprops fitted with GPWS and turboprops without GPWS. After GPWS was required for part 135 turboprop operations, there was an estimated 20-to 30-times reduction in CFIT risk. Allied Signal further states that the results of the Volpe studies on the predicted effectiveness of TAWS correlate well with its own independent analysis.

In response to the comment that says that TAWS is not justified because it would avert only 2.3 accidents per million flight hours, the FAA emphasizes that its mission is to save lives. Studies show that TAWS does indeed save lives, is cost effective, and contributes significantly to general aviation safety.

The NATA and other operators comment that the nine CFIT accidents analyzed in the Volpe part 121/135 study did not include any airplanes with fewer than ten passenger seats conducted by part 135 on-demand air charter operators. The NATA says that these operations differ from scheduled operations, for example, airplanes with fewer than nine seats conduct few international operations where CFIT accidents are likely to occur. Therefore, TAWS should not be required for on-demand part 135 operations ''until such time as a convincing and thorough data-based review is conducted with associated cost/benefit analysis.''

The NATA and others are correct in their assertions that the Volpe part 121/135 study did not include airplanes with fewer than ten passenger seats in

part 135 operations. The study was conducted to determine the feasibility of retrofitting GPWS with TAWS. Currently, GPWS is not required for airplanes operated under part 135 with fewer than ten seats. The Volpe part 91 study shows compelling evidence supporting the use of TAWS, and the FAA has determined that the same types of airplanes are often operated under both parts 91 and 135. Therefore, the FAA is unable to justify setting a different standard based solely on the type of operation. The part 91 rule applies to all airplanes, including those operated under parts 121 and 135. The FAA is amending parts 121 and 135 to make it clear that airplanes operated under these parts will be required to replace current GPWS equipment with TAWS equipment. The Volpe part 91 study was conducted to consider installation of current GPWS or EGPWS on all part 91 turbine-powered airplanes of 6 or more passenger seats. The study concluded that GPWS could have avoided 33 of the 44 (75%) accidents and 96 fatalities, and EGPWS could have avoided 42 of the 44 (95%) accidents and 126 fatalities. These conclusions justify use of TAWS on all airplanes of 6 or more passenger seats.

In response to NATA's comment concerning the use of TAWS on airplanes used in part 135 on-demand operations, the FAA points out that the Volpe part 121/135 study was never intended to look at part 135 scheduled versus part 135 on-demand operations. The study was conducted to determine the effectiveness of TAWS on any airplane type, not the effectiveness in regard to the type of operation.

Comments on Costs of TAWS

Many commenters, including the Air Transport Association (ATA), RAA, USPA, Raytheon, Continental Airlines, and Aloha Airlines say that the NPRM's analysis vastly underestimates the installation, retrofit, and maintenance costs associated with GPWS and TAWS. They say that these costs would be prohibitive for part 91 and part 135 operators. Raytheon and USPA suggest that retrofit cost estimates would exceed the value of the small turbine-powered airplanes and would force unnecessary retirement of the airplanes. Some operators specifically address retrofit costs and state that their airplanes are not configured to be easily equipped with GPWS/TAWS equipment without major expense.

The RAA and USPA believe the FAA's cost estimates for complete TAWS installation are extremely low. Using GAMA avionics figures, these commenters estimate the installation of a TAWS on in-service turboprop airplanes used in parachute operations will range between $66,020 and $96,828, mostly because they lack the necessary prerequisite equipment.

The GAMA's comment included a cost analysis for part 91 newly manufactured and in-service turboprops and turbojets. The GAMA estimates the costs to install TAWS would be much higher than those estimated by the FAA. The following estimates were provided: (1) For newly manufactured turboprops, the range would be $24,600 to $108,163, depending on the additional equipage needed to meet TAWS; for existing turboprops, the range would be $34,600 to $141,163, depending on existing equipage; (2) For newly manufactured turbojets, the range would be $24,600 to $69,985, depending on equipage; for existing turbojets, the range would be $34,600 to $141,163, depending on equipage.

The NBAA and AOPA support GAMA's findings that TAWS costs would have a wide range, depending on the type of airplane operated. The NBAA also says that it was quoted, from an avionics repair station, an average cost of $105,000 for equipment, labor, installation, testing, and certification. The NBAA recommends that the FAA perform a new cost/benefit analysis which would include not only TAWS equipment, but the costs of system modifications necessary to accommodate TAWS, installation, labor, testing, and certification.

The HAI and other operators support the AACA's assertions that the FAA's cost projections for TAWS (purchase, installation, maintenance, and training) are significantly understated. The HAI says that the FAA's underestimation of costs, as well as its overestimation of safety benefits, echoes other recent rulemaking actions that affected the rotorcraft industry, including recent NPRM's on Digital Flight Data Recorders (DFDR) (61 FR 37144, July 16, 1996) and Type Certification Procedures for Changed Products (62 FR 24287, May 2, 1997).

The FAA acknowledges the cost to install TAWS and retrofit airplanes with TAWS is higher than originally estimated. The cost would be more burdensome for part 91 and some part 135 operators. The final rule provides relief to these operators. The FAA has changed TSO–C151 to include two acceptable classes of equipment. Class A equipment will be required for airplanes operated under part 121 and part 135 of 10 or more passenger seats; this class of equipment will be the same as originally proposed. Class B equipment will be required for airplanes operated under part 91 with 6 or more passenger seats and airplanes operated under part 135 with 6–9 passenger seats. Class B equipment includes basic TAWS safety features. The purchase and installation of Class B equipment reduces the costs to operators of airplanes operated under part 91 with 6 or more passenger seats and airplanes operated under part 135 with 6–9 passenger seats. In addition, the process of obtaining supplemental type certificates (STC's) will be greatly expedited. Unlike Class A equipment, Class B does not entail extensive installation procedures because it is not integrated with numerous airplane systems.

This final rule requires the use of Class A equipment on airplanes operated under part 121 and airplanes with ten or more passenger seats operated under part 135. The FAA made this decision for the following reasons. First, Class A equipment includes the functions of GPWS. The existing FAA and ICAO requirements are that these airplanes must install GPWS. The TAWS functions are in an addition to and separate from GPWS. Both TAWS and GPWS requirements are included in TSO–C151. Therefore, this rule does not eliminate the GPWS requirement. The ICAO, while also requiring TAWS, is also maintaining its GPWS requirements. The use of GPWS is a proven concept with over 20 years of preventing many CFIT accidents; however, the FAA is requiring TAWS to further reduce the number of CFIT accidents. Second, these airplanes also are required to carry windshear protection devices. Manufacturers have built the windshear protection into the GPWS equipment and are doing the same with the TAWS Class A equipment. Third, Class A equipment is packaged in a standard avionics box to fit into the avionics bay of these larger airplanes. Fourth, Class A equipment box is designed to meet the more rigorous requirements for electrical and electronic equipment such as 14 CFR sections 25.1301, 25.1309, 25.1321, 25.1351, 25.1353 and 25.1431. Fifth, Class A equipment is designed to be compatible with and to be integrated into other airplane systems typically found on large, commercial airplanes such as autopliot, flight management system, data bus, weather radar, flaps indicator, landing gear indicator, and instrument landing system glideslope.

This final rule requires, as a minimum, Class B equipment for airplanes operated under part 91 and airplanes with six to nine passenger seats operated under part 135. Class B equipment contains only TAWS functions, i.e. the comparison of the

airplane's current position information to an onboard database. It is a very basic piece of equipment, packaged in a small box that can be placed almost anywhere in a small airplane where there is available space. It is designed to provide protection from CFIT accidents for airplanes that currently do not have such protection. These airplanes never had a requirement for GPWS and in the NPRM the FAA proposed requiring GPWS and TAWS but decided in the final rule to require only TAWS. The Class B equipment is designed as a less costly, small device for airplanes that do not have much space and for airplanes that may not be compatible with Class A equipment. The operators of these airplanes may install Class A equipment if they desire. In fact, one manufacturer of TAWS equipment has informed the FAA that operators of large airplanes operating under part 91 voluntarily are installing Class A equipment because of the features and benefits of GPWS. Operators of airplanes required to install Class A equipment do not have the option of installing Class B equipment because the Class B equipment does not contain the required GPWS functions.

GAMA also comments that the FAA underestimated the production of new general aviation turbine-powered airplanes. GAMA says that ''in domestic production alone, American manufacturers of general aviation airplanes have already reported to GAMA deliveries of 282 new jets and 162 new turboprops through the third quarter of 1998.''

One commenter, a part 91 turboprop operator, says that GPWS costs would constitute about 10% of the value of his airplanes. This commenter recommends that, if mandated, the rule should be on a 5 to 10 year time line so that more GPWS systems will be produced and they will become cheaper.

A part 91 operator points out that the costs associated with installing TAWS could result in more accidents because some operators would sell their turboprops and fly piston airplanes. This commenter says that these airplanes ''are not as reliable, but can carry more passengers, are cheaper to operate, and will not be required to have TAWS.''

In response to the comment that some operators of existing turboprop airplanes would switch to piston-engine airplanes because piston-engine airplanes will not be required to have TAWS, it is not the intention of the FAA to put an undue financial burden on owners/operators of small turboprop airplanes nor to cause them to take such drastic action. Therefore, as described above, the FAA is amending proposed §§ 91.233(b) and 135.154(b) '' both having to do with existing planes '' by allowing part 91 operators of airplanes with 6 or more passenger seats and part 135 operators of airplanes with 6–9 passenger seats to meet different TAWS requirements.

The NATA contends that the FAA has failed to provide an accurate picture of the equipment and installation costs for part 135 on-demand air charter operations. The NATA points out that the discounted prices used in the NPRM (for 10 or more units) would not apply to most part 135 on-demand air charter operations since they typically operate a small number of airplanes. The NATA adds that the FAA fails to adequately cover other costs including wiring/installation kits, radar altimeters, other instruments needed to communicate with TAWS, airplane downtime during installation, and installation labor costs. The NATA says that the above factors would result in an average TAWS cost of $100,000 per airplane for part 135 on-demand charter operations.

The United States Air Tour Association (USATA) comments that, in order to comply with the existing rule, its members purchased and installed GPWS equipment in their airplane fleets at a cost of more than $41,000 per airplane. This substantial capital investment by USATA members was made in spite of the fact that most of the airplanes are used in day VFR sightseeing applications. A TAWS requirement would require USATA members to essentially scrap their recent investments. USATA does not believe the TAWS retrofit is justified, given the GPWS safety record.

In response to USATA, by the time operators have to comply with this final rule, the 10-year amortization of the cost of the GPWS system will be completed.

Some commenters state that GPWS will not have a large trade-in value once TAWS becomes a requirement for all airplane markets for which a GPWS might be used.

In response to the comment regarding trade-in values, the FAA stands by its use of trade-in value in the regulatory evaluation. The FAA was again advised by the manufacturer that it would give trade-in value against the purchase of TAWS. Other manufacturers may also offer trade-in credits.

An Alaska-based operator adds that the Unfunded Mandates Act of 1995, which requires that the FAA assess the impact of regulatory changes on state, local, and tribal governments, has not been adequately addressed. The commenter says that the requirements of the Act were not adhered to in the commuter rule when many carriers had voiced concern that they would not be able to bear the economic burden of that rule. The commenter believes that the ''requirements associated with this proposed rule will cause history to repeat itself in Alaska, thereby causing further disadvantage to the traveling public.''

The costs of the final rule does not equal $100 million in any one year due to changes that have taken place since the proposal. Some of those changes are (1) The final rule is not applicable to certain segments such as parachute, aerial and firefighting operations, (2) The allowance of lower cost TAWS equipment with equivalent safety and (3) The decision by a significant proportion of manufactures/operators to voluntarily equip airplanes with TAWS. Consequently, the Unfunded Mandates Reform Act does not apply to this rule.

GPWS/TAWS Technology

The AIA comments on the section in the NPRM under ''VNTSC Conclusion'', which states that ''The study emphasized that the CFIT accident prevention in all cases would have resulted not so much from increased warning durations following system detection of terrain threats, as from the fact that flight crews, given a continuous terrain display, would have perceived these terrain threats and responded to them well before EGPWS was required to generate warnings.'' The AIA comments that Boeing would object to a change in the GPWS intended function, and adds that the NPRM assumes that a flight crew would want to have terrain data continuously displayed.

In response to AIA's comment about a continuous terrain display, the FAA previously pointed out that the Volpe part 121/135 study stated that the continuous terrain display feature of EGPWS may be even more important than the terrain threat detection/alert/warning features in breaking the chain of decisions leading to CFIT. Flight crews lacking an outside visual perspective are given an internal continuous display of nearby terrain, greatly heightening situational awareness. Rather than a last ditch warning of imminent danger, the continuous terrain display would allow crews to maneuver to avoid terrain long before it ever becomes an obstruction to their flight path. TAWS represents a pivotal advance in providing flight crew terrain awareness. Thus, the FAA has determined that the terrain situation awareness display is a valuable function, and is requiring its use for all part 121 operations and for those part 135 operations conducted with

airplanes configured with 10 or more passenger seats. However, the FAA recognizes that in accomplishing normal piloting duties, the flight crew should not continuously stare at the terrain display. In addition, the display may be used for other information such as weather. The FAA therefore is not requiring the continuous use of the display.

The AIA also recommends that the preamble language under ''Functions of TAWS,'' ''Terrain Clearance Floor,'' should be changed to read ''The terrain clearance floor creates an increasing terrain clearance envelope around the closest (not ''intended'') airport runway related to the distance from the runway * * *'' The AIA says that the NPRM language assumes that the closest runway is the intended runway, and that ''EGPWS has no way of knowing what the ''intended'' (*i.e.* destination) airport would be unless significant design changes were made.

In response to AIA's comment about the terrain clearance floor feature, the FAA agrees that, concerning one manufacturer's TAWS, the commenter is correct; the closest runway is not always the intended runway and on a landing approach when flying by a nearby unintended runway, the TAWS may temporarily build a terrain clearance envelope around the unintended runway. However, the FAA does not see this as a problem for four reasons. First, the TAWS will, in sufficient time, switch the terrain clearance floor to the intended runway as soon as it becomes the closest. Second, if the envelope around the unintended runway gives off an alert, this is an indication that the plane is obviously too close to terrain related to the unintended runway. Three, the clearance floor is not displayed so there would be no confusing information presented to the flight crew. Finally, not all TAWS systems have this method of operation.

The NBAA and GAMA say that there could be difficulty in integrating TAWS, (which is a digitally based piece of hardware) into the many airplanes that use analog-based systems. The GAMA and AOPA say that other systems required by TAWS include the air data computer, radar altimeter, global positioning system, as well as four annunciators (alarms) and a display for the information. The NBAA says that ''it is unclear whether all of the modifications necessary to adapt such an advanced piece of hardware into a legacy avionics suite will result in a fully functional TAWS system.'' The NBAA, GAMA, and AOPA say that these integration difficulties would greatly affect the cost estimates for purchase, installation, and approval of TAWS.

Regarding comments by NBAA and GAMA about integrating TAWS into airplanes with analog based systems, the FAA is aware that manufacturers are designing digital and analog TAWS models. Thus, there should be an appropriate model for each airplane's existing configuration.

Some commenters, including a part 91 charter operation, say that current GPWS technology still presents the problem of false warnings, causing pilots to disregard these warnings (*e.g.*, when descending to an airport). One commenter says that GPWS technology should be further developed to insure that these kinds of problems are eliminated, and that the FAA should postpone this rule until the technology is improved.

In response to the commenters who says that false warnings are still a problem and the commenter who requested that the FAA postpone this rule until GPWS technology is improved, the FAA's position is that the proposed rule recognized the false warning problem in existing GPWS. As stated in the NPRM, GPWS equipment has been improved since it was first required in the 1970's. These advances include improvements in terrain detection logic that provides increased terrain warning durations in the order of 10–15 seconds on average, resulting in additional time for the pilot to maneuver that can be crucial in preventing accidents. In addition, the NTSB also recognized and addressed this issue by recommending to the FAA that early generation GPWS equipment be upgraded (NTSB recommendations A–92–39 through A–92–42). The final rule implements these NTSB recommendations to retrofit all GPWS with TAWS.

Another commenter responds to the FAA's statement in the NPRM that it ''expects that manufacturers will provide (an alert) at least 20 seconds in advance of a potential impact.'' This commenter says that TAWS should provide a first alert of not less than 30 seconds prior to potential impact.

Regarding the comment about the TAWS alert time, the FAA addresses alert times in the TSO document. However, for clarity, the FAA restates the following concerning alert times from the NPRM:

''The function of the new proposed TAWS standard is to prevent CFIT by providing alerting times earlier than those provided by existing ground proximity warning systems manufactured in accordance with Technical Standard Order (TSO)–C92c. Typically GPWS aural and visual warnings occur about 20 seconds or less before potential impact with terrain. The visual warning is usually a blinking light and the aural warning is usually a message through the airplane's audio system.

''Studies indicate that average combined pilot and aircraft reaction time to avoid a CFIT after warning is within the 12 to 15 second range. The FAA has approved for installation a TAWS (the EGPWS) that provides an initial alert approximately 60 seconds before potential impact and another alert about 30 seconds before potential impact. These alerts are both aural and visual. These alerting times were based on data from actual CFIT accidents and were chosen by the manufacturer as the best compromise to provide timely alerts while still minimizing nuisance alarms. Human factors research and FAA experience show that, if an aural cockpit alarm sounds too often as a false alarm, the flight crew will either begin to ignore it or will be tempted to disable the system. Therefore, while the forward looking capability of TAWS could provide an alert far in advance of potential impact, the alerting time must be as short as possible, while still allowing an adequate time to avoid impact. The FAA will carefully evaluate the alerting times for each proposed TAWS, but expects that manufacturers will provide at least 20 seconds in advance of a potential impact.''

The NTSB comments that standards for TAWS design should be developed to minimize the potential for misuse of the equipment. The NTSB says that the FAA alluded to this issue in the NPRM when it pointed to the possibility that pilots would be tempted to use TAWS for navigational purposes and that pilot training should be developed to prevent this occurrence. The NTSB states that pilot training should not be used to ''compensate for potential deficiencies in the TAWS design.'' The NTSB adds that the design of TAWS should ''reflect the results of a thorough human factors evaluation to obviate the need for training and other procedural requirements that compensate for design deficiencies or misuse of design principles.''

In response to the NTSB's comment, the NPRM pointed out that the Volpe part 121/135 study recognized that the terrain display may present a new set of challenges to pilots. The TAWS's topographical map display could offer a temptation for pilots to use it for navigational purposes. Therefore, the FAA stated in the NPRM that pilot training should emphasize that other

airplane systems are intended for this purpose, and any TAWS terrain display features are intended only to provide terrain awareness, not for aerial navigation. (The NPRM also cited Notice N8110.64, Enhanced Ground Proximity Warning System, which provides guidance on EGPWS and specifies that Airplane Flight Manuals should state that EGPWS shouldn't be used for navigational purposes.)

The Air Line Pilots Association (ALPA) strongly supports the NPRM's inclusion of the visual display of terrain as part of the overall TAWS system. The ALPA emphatically agrees with the Volpe part 121/135 study finding that the visual display is the most important function of the TAWS system because it provides flight crews with a picture of the surrounding terrain threat that can be responded to well before the system is required to generate warnings.

The ALPA supports the need for the TAWS system to have a backup to the synthetic terrain data, such as radar altimeter inputs for generating warnings in the event of erroneous terrain database information or erroneous navigational inputs.

The ALPA encourages the FAA to preclude delay of the final rule due to potential objections by part 91 operators. The ALPA feels the final rule should be applied to commercial operators as soon as possible in an effort to prevent future controlled-flight-into-terrain accidents.

In response to ALPA's first comment that supports mandating a terrain situational awareness display, the FAA agrees that such a display is a very valuable tool and therefore will continue to mandate such a display for part 121 operators and part 135 operators of airplanes with 10 or more passenger seating. However, the FAA is revising the final rule to make such a display optional for part 91 operators and part 135 operators of 6 to 9 passenger seating for the following reasons:

While the display adds an additional level of safety to large commercial transports (and this is in line with the FAA policy of requiring a higher level of safety for such airplanes), the display itself does not save lives. Once in a potential CFIT situation, what saves lives is the TAWS caution alerts and warning commands. Requiring a display on a smaller, older airplane in some instances will present such an oppressive financial burden that the owner/operator may either go out of business or convert to a less safe piston-engine airplane. Furthermore, there is promising new technology such as moving maps that in the near future will provide inexpensive additional terrain situational awareness to these smaller, older airplanes.

In response to ALPA's second comment to require a radar altimeter as a backup to the terrain database, the FAA is requiring TSO–C151 Class A equipment for part 121 operators and part 135 operators of 10 or more passenger seating and TSO–C151 Class B equipment for part 91 operators and part 135 operators of 6 to 9 passenger seating. Class A equipment requires a radar altimeter; Class B equipment does not. The reasons behind this decision are the same as mentioned above concerning the terrain situational awareness display.

In response to ALPA's third comment concerning not delaying the rule due to potential objections by part 91 operators by applying it to commercial operators as soon as possible, the FAA believes it is processing the rule as expeditiously as possible. The FAA further believes it can process the rule faster as currently defined and believes that redefining it at this time into two rules—one for commercial operators and one for part 91 operators—would actually delay its implementation.

The ATA recommends that the final rule clearly state that TAWS systems installed before adoption be considered compliant, including those installed under FAA-approved Supplemental or Amended Type Certificates, Service Bulletins or JAA approvals. ATA adds that the final rule should clearly state whether systems without a color terrain display, certificated and installed prior to the final rule, would be in compliance.

In response to ATA's first comment requesting that the FAA formally recognize as compliant TAWS systems installed before adoption of the final rule, the FAA recognizes and appreciates the significant voluntary action by ATA and its members as well as by other segments of the industry. It has been and still is the FAA's intention to recognize all FAA approved TAWS installations (*i.e.*, those that meet the requirements of TSO–C151) done voluntarily before issuance of the rule as being in compliance with the rule.

In response to ATA's second comment concerning a color display, the FAA believes that ATA misunderstands the display requirements. The FAA is not requiring only a color display; monochromatic displays have been allowed and will continue to be allowed. Therefore, the FAA sees no reason to reference this subject in the final rule.

TSO Comments

When the FAA published the TAWS NPRM, it also made available a draft of a proposed Technical Standard Order (TSO)–C151, entitled Terrain Awareness and Warning System. The proposed TSO was made available under a separate Notice of Availability in the **Federal Register** on November 4, 1998 (63 FR 59494), which requested public comments on the TSO. All comments related to the TSO, whether in response to the NPRM or the TSO Notice of Availability, were given to an FAA technical team to evaluate and use in developing the final TSO.

In response to the TSO notice of availability, commenters submitted a large number of suggested changes to the TSO. (The substance of these comments are discussed in the TSO disposition report.) In trying to be as flexible and as accommodating as technically feasible, the FAA accepted and included most of the suggested changes, and developed a revised version of the draft TSO. This proposed TSO was made available in a second notice of availability in the **Federal Register** on May 27, 1999 (64 FR 28770), which again requested public comments on the TSO.

Based on the above actions, the FAA issued a final version of TSO–C151 on August 16, 1999. This TSO will be the means to obtain approval of TAWS products and is described below.

TSO–C151 prescribes the minimum operational performance standards that TAWS equipment must meet to be identified with the TSO–C151 Class A or B marking. At present the TSO includes two classes of equipment: (1) Class A, intended for airplanes operated under part 121, and for airplanes of 10 or more passenger seating operated under part 135; and (2) Class B, intended for airplanes operated under part 91, and for airplanes of 6 to 9 passenger seating operated under part 135. TSO–C151 does not require the use of specific design criteria nor prescribe the use of specific components. The applicant is free to design its own system providing it meets the minimum operational performance requirements of the TSO.

Class B equipment includes basic TAWS safety features, such as: Forward looking terrain warnings; minimum ground clearance plane function; GPWS mode 1 (high descent rates), mode 3 (descents after takeoff), and mode 6 (the 500 foot voice callout). Optional TAWS features of Class B equipment include: radio altimeter; a landing gear position sensor input to TAWS; a flap position sensor input to TAWS; a glideslope

deviation input to TAWS; a flap override switch in the cockpit; a glideslope (mode 5) inhibit switch in the cockpit; a TAWS inhibit switch in the cockpit; a terrain display; and a weather/terrain switching function.

TAWS technology, as well as other avionics technology, is advancing at a very rapid pace. Because of this, the FAA expects to revise TSO–C151 periodically and amend the rule when necessary, to include other classes or subclasses as new technology is developed and proven. An example of a new class could be the addition of a Class C intended for piston-powered airplanes and turbine-powered airplanes of less than 6 passenger seating. An example of a new subclass could be a Class B, level 1 that could include geometric calculation of altitude using GPS/WAAS (Global Positioning System/ Wide Area Augmentation System) when that system is operational. The FAA also realizes that technology may advance and prove itself faster than the FAA can keep TSO–C151 up to date. In these situations, the FAA will make use of the deviation process allowed under § 21.609, Approval for Deviation. The FAA intends to provide maximum flexibility for industry to continuously develop more advanced and less expensive TAWS equipment.

Supplemental Type Certificates (STC's)

The NATA says that the NPRM's estimate of 82 STC's for retrofitting the part 135 fleet with TAWS is low because in some cases, ''a single aircraft model, particularly older aircraft models, may have evolved to a point where the cockpit/avionics panel and currently installed equipment vary greatly. As a result of this variance, ''follow-ons'' may not be available for many airplanes and many more ''first of type'' installations will be required for Part 135.'' This could result in STC approval delays and could significantly impede timely equipment installations. Other commenters questioned the number of estimated STC's.

FAA Response

The FAA disagrees with NATA's statement that there would be delays in STC approvals and equipment installations. When the FAA developed the compliance schedule, the FAA took into account the potential FAA STC approval workload. In addition manufacturers have obtained additional STC's since the NPRM was published and are making them available for their customers. Taking all this into consideration, the FAA has determined that the approval process will not hinder the implementation of this rule.

Training

The FAA did not propose changes to existing training requirements. However recent new training requirements on crew resource management (CRM) for flight crewmembers should provide additional safeguards in conjunction with the use of TAWS. This requirement applies to flight crewmembers operating under parts 121 and 135 and took effect on March 19, 1998. (60 FR 65940, December 20, 1995).

The Independent Pilots Association (IPA) criticizes the FAA for not changing current training requirements to specifically require training in the use of TAWS. IPA believes that without specific training in what TAWS is designed to do and what it is not designed to do, the full safety benefits and risk reduction will not be realized.

Alternatively, a number of commenters say that increased training for situational awareness and monitoring is needed, rather than ''another expensive electronic box.''

Raytheon points out that even in some of the part 121 CFIT accidents that involved airplanes that ''were new generation and well equipped with the latest in technology'', there was a loss of situational awareness by the flightcrew. Therefore, the best way for operators to reduce CFIT accident risk is through ''improved training, emphasis on standardization of procedures, and review of human factors.''

FAA Response

The FAA agrees that training is an important element to minimizing CFIT and recommends a three-pronged approach: (1) Proper pilot training; (2) Better decision-making tools; (3) Electronic hardware to assist the pilot. TAWS addresses the electronic hardware issue. The FAA's position is that training alone has not been successful in reducing CFIT accidents; therefore the FAA believes that it is necessary to require TAWS.

The fact that the final rule does not mention training does not mean that no TAWS training is required. Under existing §§ 121.415 and 135.293 certificate holders are required to insure that each crewmember is qualified in new equipment, procedures, and techniques, including modifications to airplanes. The effect of this requirement is that whenever an operator installs new equipment, part of the approval process for that equipment includes showing that crewmembers have been adequately trained to use the new equipment.

In addition, although not directly related to training, the final rule requires that operators include in their Airplane Flight Manuals the appropriate procedures for operating and responding to the audio and visual warnings of TAWS. Existing § 91.9 requires that the pilot operate the airplane in accordance with the approved flight manual.

Other Government/Industry Efforts

The NBAA recommends that the FAA delay action on this rule until it receives a report from the Joint Safety Analysis Team (JSAT). The NBAA is participating on the workgroup teams to study several root causes of general aviation accidents, including CFIT. The NBAA says that the JSAT's recommendations may include more cost effective alternatives to TAWS. A similar comment is also made by GAMA, which is the industry co-chair of the JSAT.

Raytheon strongly recommends that the FAA further investigate the effectiveness of TAWS in general aviation operations and consider alternatives to TAWS better suited to the general aviation environment. Raytheon states that further investigations are also supported by the Joint Industry/FAA Team, Proposed Action Plan, ''Controlled Flight into Terrain (CFIT) Avoidance for General Aviation.'' The Joint Industry/FAA Team submitted five recommendations to the FAA for reducing CFIT accidents, including equipment enhancements, pilot education and improvement in decision making aids for pilots.

Similarly, AOPA recommends that the FAA implement the recommendations made by the ''Controlled Flight Into Terrain (CFIT) Avoidance for General Aviation'' report (August 1998). This report was put forth by a joint industry/FAA team which was established to respond to the ''The White House Commission on Aviation Safety and Security'' recommendation regarding EGPWS in general aviation airplanes. The team had concluded that there are a number of causes of CFIT accidents and that these factors can be addressed ''in more affordable, practical, and effective solutions.'' AOPA states that these recommendations would lead to voluntary equipage and would be more effective in reducing CFIT accidents than would a mandate for TAWS.

GAMA encourages voluntary equipage of TAWS on general aviation turbine-powered airplanes.

FAA Response

In response to NBAA and GAMA comments that the FAA delay the rule until it receives a report from the Joint

Safety Analysis Team (JSAT), the FAA does not believe such a delay is necessary, warranted or wise; the report was completed in April 1999. The NBAA and GAMA are valuable participants on the team and GAMA is a co-chair of the general aviation section of JSAT (GA–JSAT). The FAA is the other co-chair and also is a major participant, and as such, the FAA is aware of all JSAT transactions and activities. The FAA is aware that the GA–JSAT is emphasizing training. The FAA agrees that training is important, but as discussed earlier, training by itself, unfortunately will not solve the CFIT problem. The pilot needs a technical aid. The limitation of training is profoundly illustrated in the transport area. Commercial pilots have access to the best training in the world, yet CFIT accidents are the leading cause of fatalities in commercial aviation worldwide. In fact, the Transport Section of JSAT, in recognizing the limitations of training, has made TAWS its primary intervention strategy. There currently is a successful, cost effective technical aid available—TAWS—and it is incumbent upon the FAA to require this technical aid as expeditiously as possible.

Raytheon and AOPA make reference to another FAA sponsored activity and report, the joint FAA/industry team report titled ''Controlled Flight into Terrain (CFIT) Avoidance for General Aviation.'' This team was organized by the FAA to supplement the TAWS rulemaking activity, not to replace it. The TAWS rule applies to U.S.-registered, turbine-powered airplanes of 6 or more passenger seating. The team was formed to investigate how to eliminate CFIT accidents in the remaining group of general aviation airplanes not covered by the proposed TAWS rule, specifically piston-powered airplanes regardless of number of passenger seats and other airplanes of less than 6 passenger seats. In preparing the report, the team became convinced that its recommendations could be applicable to all general aviation airplanes, not just the narrow group mentioned above, and stated this in its report. The FAA co-chaired the team and participated in its deliberations. The FAA supports the recommendations of the team and, in fact, is supporting and participating in all the recommendations. The FAA sees no conflict between this report and the TAWS rule. As mentioned in the discussion in the section addressing the TSO, the FAA is building in the flexibility to incorporate the new technologies identified in the report as those new technologies come on line. Therefore, in response to Raytheon's first comment that the FAA further investigate the effectiveness of TAWS, the FAA already is participating actively in ongoing CFIT research and investigations and will continue its participation. In the mean time, as mentioned in the FAA response concerning the JSAT report, there currently is a successful, cost effective technical aid available—TAWS—and it is incumbent upon the FAA to require this technical aid as expeditiously as possible.

In response to Raytheon's second comment that the FAA consider alternatives to TAWS, the FAA believes that Raytheon misunderstands the concept of TAWS. TAWS is a technical aid to eliminate CFIT accidents and is one of several integrated approaches; the others include improved training, better decision making information and better weather information. The new technologies, discussed in the report referenced by Raytheon, when integrated properly into an airplane, would be a TAWS and would provide TAWS functions.

In response to AOPA's first statement that the recommendations in the report would lead to voluntary equipage, the FAA recognizes the voluntary effort by industry. Unfortunately, many owners/operators do not take voluntary action, so the FAA must require them to take action.

In response to AOPA's second comment that the recommendations in the report will result in a more effective means of reducing CFIT accidents than would a mandate for TAWS, the FAA believes that, like Raytheon, AOPA misunderstands TAWS. The FAA believes that the technical recommendations in the report will lead to better and less expensive TAWS equipment. Much of this equipment will be available well before the compliance due dates. But the FAA and industry cannot keep waiting for better and less expensive equipment. CFIT accidents are tied with spins as the leading cause of fatalities in general aviation in the United States. There currently is a successful, cost effective technical aid available—TAWS—and it is incumbent upon the FAA to require this technical aid as expeditiously as possible. Waiting to do more research and investigations, or not using all available means at our disposal, including the use of cost effective technical aids, while additional people die in CFIT accidents, would be a dereliction of duty.

Compliance Schedule

The FAA proposed amending §§ 121.360 and 135.153 to add an expiration date of four years after the effective date of the final rule for the use of current GPWS systems. Thereafter, compliance with those sections would not be allowed in lieu of the provisions amended herein.

The FAA proposed that, beginning one year after the effective date of the final rule, U.S.-registered airplanes manufactured after that date be equipped with TAWS. The FAA also proposed that turbine-powered airplanes manufactured on or before that date be equipped with TAWS within four years after the effective date of the final rule.

The NATA states that, since there is only one TAWS product available that would meet FAA approval, there should be a longer compliance period for non-part 121 operations. This, coupled with the likelihood of changes to the TSO (based on incoming comments) will have a direct impact on the ability of current and future TAWS manufacturers to develop and offer their products in the marketplace. For these reasons, NATA says that the FAA should provide a ten-year timetable for part 135 on-demand air charter operations.

The NATA also states that, since the most significant safety benefits will occur with TAWS installation on part 121 airplanes, and since manufacturers will have limited production capabilities, the emphasis should be on supplying equipment to part 121 operations. Also, a longer timetable will allow ''natural market development to help alleviate product supply, installation, certification, and cost dilemmas through increased manufacturer competition and the ability to absorb the substantial costs over time.''

The RAA requests the compliance period be extended to a five year period for all 30+ seat turboprop airplanes; a seven year period for all 10 to 29 passenger seat turboprop airplanes; and eight year period for all 6 to 9 passenger seat turboprop airplanes; and extended to December 20, 2010, for all non-transport category airplanes that are classified as § 121.157(f) types that will be phased out of part 121 operations on the same date.

Likewise, Northwest Airlines requests that airplanes planned for retirement prior to 2008 be exempt from the final rule. This would allow Northwest to focus more on accelerated installation on airplanes in its long-term fleet plan.

The ATA comments that a one-year effective date after publication of the

final rule is necessary to accommodate realistic lead times for the productions ramp-up for piece parts and kits. The ATA also recommends that the final rule clearly state that TAW systems installed before the adoption of the final rule will be considered compliant. A related issue is whether systems certificated and installed before the adoption of the final rule without a color terrain display would be in compliance with the rule.

Trans World Airlines, in conjunction with ATA, believes that the NPRM public comment period should be connected to the TSO public comment period for complete project public comments.

Japan Airlines comments that the effective date of the final rule should be fixed on the basis of the progress made in manufacturing and installing TAWS, with special attention given to retrofit issues, such as changing from analog to digital.

FAA Response

In response to comments from NATA, RAA, ATA, and Japan Airlines, the FAA does not believe that the rule should be delayed. Since the proposed rule was published, several other manufacturers have developed TAWS. The initial manufacturer, in response to this competition, has already lowered the selling prices of its TAWS products and has developed several smaller, less expensive systems for older planes, both analog and digital.

When the FAA initially developed the compliance schedule, it took into account the production capability of only one manufacturer and the anticipated certification workload for the FAA. Since then, additional manufacturers have been developing and making available additional products beyond what was anticipated. Furthermore, TAWS manufacturers and airframe manufacturers are obtaining STC's and making them available to customers who install TAWS, thereby reducing the anticipated FAA certification workload. When taking these two factors into consideration, the FAA is convinced that the initially proposed compliance schedule can easily be met.

In response to Northwest Airline's comment about exempting airplanes planned for retirement, the FAA does not agree. The commenter has not provided adequate justification as to why these airplanes should be exempted. Although Northwest Airlines may intend to retire certain airplanes by 2008, there is no guarantee that this will happen. Further, even if Northwest does retire the airplanes, there is no guarantee that those airplanes will go out of service permanently. They may be sold and used by others and, therefore, will need TAWS protection.

Miscellaneous Comments

A commenter recommends that each airplane be given a rating system that indicates that it has a GPWS on board. It would then be up to the passenger to decide whether or not to fly on that airplane.

FAA Response

The FAA does not think such a rating system would be practical or workable. Given the complexity of all the equipment required on the airplane, it would be difficult to convey to a boarding passenger, how each piece of equipment contributes to the overall safety of the airplane.

Paperwork Reduction Act

As required by the Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)), the FAA has submitted a copy of these sections to the Office of Management and Budget for its review. The collection of information was approved and assigned OMB Control Number 2120–0631. This final rule requires a Terrain Awareness and Warning System for all U.S.-registered turbine-powered airplanes of 6 or more passenger seating. TAWS is a passive, electronic, safety device located in the avionics bay of the airplane. TAWS alerts pilots when there is terrain in the airplanes' flight path. Since there is not an actual collection of information, we cannot estimate a burden hour total and no comments were received on this information collection submission. However, for the purpose of controlling this submission, we will assign an one-hour burden to the package. There is a total cost estimate of 340 million dollars, for purchase and installation of the passive, electronic, safety device.

An agency may not conduct or sponsor and a person is not required to respond to a collection of information unless it displays a currently valid Office of Management and Budget (OMB) control number.

International Compatibility

The FAA has reviewed corresponding International Civil Aviation Organization international standards and recommended practices and Joint Aviation Authorities requirements. TAWS is a new system recently developed by American industry. The FAA intends to work through the ICAO process to harmonize this rule with the international community.

Regulatory Evaluation Summary

Changes to Federal Regulations must undergo several economic analyses. First, Executive Order 12866 directs that each federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic effect of regulatory changes on small entities. Third, the Office of Management and Budget (OMB) directs agencies to assess the effect of regulatory changes on international trade. And fourth, Title II of the Unfunded Mandates Reform Act of 1995 requires each Federal agency, to the extent permitted by law, to prepare a written assessment of the effects of any Federal mandate in a proposed or final agency rule that may result in the expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of $100 million in any one year. In conducting these analyses, the FAA has determined that this rule is ''a significant regulatory action'' under section 3(f) of Executive Order 12866 and, therefore, is subject to review by the Office of Management and Budget. This rule is considered significant under the regulatory policies and procedures of the Department of Transportation (44 FR 11034, February 26, 1979). This rule will have a significant impact on a substantial number of small entities, will not constitute a barrier to international trade, and does not contain a Federal intergovernmental or private sector mandate that exceeds $100 million in any one year.

Economic Evaluation

Introduction to Cost/benefit Analysis

Since the publication of the NPRM, some important developments have occurred. The FAA received extensive cost information during the comment period (detailed information regarding the type of expenditures needed for specific airplane models and updated estimates of the size of the affected fleet) and developed alternatives to reduce costs while maintaining the increased level of safety expected from TAWS.

In response to the commenters, the FAA has examined ways to reduce costs for smaller operators and still maintain the incremental level of safety provided by TAWS. The FAA has determined that a TAWS unit with significantly less complexity will meet desired safety objectives at lower cost for all part 91, and for certain operators under part 135. The savings to part 91 operators alone will be well over $200 million.

The aviation industry has already moved to retrofit a large percentage of the existing fleet, and has placed orders that extend well into the future. The Air Transport Association (ATA) member airlines in particular have announced a voluntary program where they will equip their airplanes with TAWS. For domestic United States operators, there have already been nearly 4,500 TAWS deliveries. Over 2,200 TAWS units ordered are backlogged. Nearly half of the airplanes operating under part 121 are already in compliance with this rule. Given that ATA member airlines voluntarily committed to retrofit their in-service fleet and to order new airplanes equipped with TAWS, a significant portion of incremental compliance costs (and equivalent associated benefits) for current part 121 airplanes and all future equipment delivered (*i.e.,* future transport category airplanes) will not be counted in evaluating the regulatory impacts of this rulemaking.

The incremental benefits and costs of the rule depend on several fleet related factors. To determine the affected fleet the analysis begins with the existing fleet, subtracts expected retirements, subtracts voluntary compliance, and adds future airplane deliveries that will be impacted by the rule.

Estimates of lifecycle benefits were calculated on a per-airplane basis and summed over all affected airplanes to obtain an estimate of the expected fleet benefits. The calculations took into consideration passenger capacity, average load factors, proportion of fatalities given a CFIT accident, airplane value, and number of flight hours (see following discussion on part 121 for application of methodology).

The estimate of benefits and costs for TAWS is for the overall rulemaking. However, since the benefit and cost impacts vary so widely across operators and equipment, specific equipment costs and both benefits and costs for parts 121, 135, and 91 were analyzed separately and are presented accordingly. The part 135 benefits discussion is more detailed than that of parts 91 and 121, given the re-evaluation of the part 135 accident data included in this final rule.

Part 121

The FAA's database provides the estimate for the overall part 121 fleet of 6,907 airplanes, which includes 5,362 turbojets and 1,545 turboprops. The ATA membership fleet of 4,569 airplanes accounts for slightly more than 85 percent of the part 121 jet fleet. The ATA and the Regional Airline Association (RAA) provided the in-service part 121 fleet expense by equipment type incorporated in this analysis.

The FAA obtained information on the deliveries and orders for TAWS from AlliedSignal. As of May 31, 1999, AlliedSignal had delivered 2,881 TAWS units to United States domestic operators of part 121 passenger and cargo airplanes and to original equipment manufacturers (OEMs). The FAA reduced the OEMs' deliveries by fifty percent (to account for overseas sales) as a rough estimate of U.S. new equipment deliveries with TAWS units installed. For AlliedSignal's domestic backlog, the FAA included all operators' orders and excluded all OEMs' orders (*i.e.*, to be conservative, since exact information on overseas orders is not available). In total, 3,338 in-service part 121 airplanes have already been equipped with TAWS or have already placed orders with the manufacturer (based on data in mid-1999; several hundred more airplanes probably will have been equipped by the date of publication of the rule). Of the 3,338 airplanes counted as voluntarily complying, 3,173 are turbojets and 165 are large turboprops. Voluntary purchases of TAWS equipment before the implementation of the rule are not assumed to be an expense incurred due to regulation, but rather an independent industry decision to enhance operational safety. Thus, both the expected benefits and costs of this rule are reduced by the proportion of airplanes equipped with TAWS (or on order with TAWS included).

For future airplanes, voluntary compliance has a substantial impact on the affected fleet. Excluding ATA member fleets, the remaining jets are 20 percent of the total part 121 jet fleet. The future new delivery jet forecast averages 280 per year. The estimated affected future jet fleet is then 20 percent of the anticipated deliveries. Voluntary compliance is much lower for part 121 turboprops than for jets. The proportion of total turboprop equipment not in compliance is nearly 70 percent. Nevertheless, 30 percent compliance results in a significant reduction in the incremental costs of future deliveries (*i.e.*, from the standpoint of a ''regulatory-required'' cost-impact). Future turboprop deliveries are estimated to average 100 per year with the annual affected amount equaling 69 or 70 airplanes. (This is a conservative assumption, since operators of much more than 30 percent of part 121 turboprops would probably elect to equip their new airplanes with the most current GPWS/TAWS equipment)

The part 121 affected fleet equals the remaining in-service part 121 airplanes (*i.e.*, after subtracting-out airplanes retired and airplanes under voluntary compliance) combined with newly manufactured airplanes estimated to be sold to operators who would not have voluntarily complied with this rule. The affected in-service part 121 fleet equals 2,709 airplanes (or, 6,907 existing fleet, minus 860 retirements, and minus 3,338 airplanes under voluntary compliance). The number of affected jets equals 1,644, large turboprops 710, and small turboprops 355. Over the 2001 through 2010 period, future new deliveries are 560 jet transports and 690 turboprop transports for a total of 1,250 airplanes. The total affected part 121 fleet thus equals approximately 4,000 airplanes.

There has been a reduction in the CFIT accident rate since 1974, when the FAA first required GPWS in part 121 and certain part 135 airplanes. However, some risks remain—in part due to differences in the capabilities of various generations of GPWS technologies. Risk reduction estimates for 14 CFR part 121 operations are based on the Volpe part 121/135 study and analyses of accident data by FAA and industry experts. These appraisals are true measures of risk reduction in that they fully consider the effect of TAWS on accident outcomes, rather than simply assume that all accidents will be prevented. The analysis is complicated by the fact that two vintages of GPWS technology were employed during the period being studied. Although the NPRM considered the TAWS impact in comparison to both early and current generation systems, this final rule analysis assumes that all the airplanes currently equipped with the basic system are in fact ''one level higher'' (*i.e.*, have the current GPWS), a significantly more conservative assumption resulting in lower benefits. Risk reduction estimates were calculated by dividing the number of preventable accidents for a particular airplane/GPWS combination by the corresponding number of flight hours.

From an evaluation of part 121 accidents during the 10-year period, 1986–1995, the Volpe part 121/135 study concludes that TAWS would have prevented 6 CFIT accidents involving turbojet airplanes and 2 CFIT accidents involving turboprops.

With respect to turbojets, only one accident involved an airplane equipped with current-generation GPWS. However, the Volpe part 121/135 study concludes that in three other cases (involving airplanes equipped with early-generation systems), current-generation GPWS would not have prevented the accident. TAWS would

have prevented all four accidents. Therefore, the FAA estimates the risk reduction potential of TAWS relative to current-generation GPWS is approximately 0.038 accidents per million flight hours (4 ÷ 104.7 million flight hrs.). With respect to the turboprops, both accidents would have been prevented by TAWS, but not by GPWS; the comparable risk reduction rate is 0.118 accidents per million flight hours (2 ÷ 16.972 million flight hrs.).

After estimating the expected benefits for the fleet, total estimated present value benefits depends on the expected life after installation. The total present value benefits of this rule for part 121 airplanes equal nearly $494 million.

The FAA accepts the costs provided by the ATA for jets and by the RAA for turboprops. The combination of retirements and voluntary compliance substantially changes the affected fleet, especially for the impact on ATA member fleets operating in part 121. The FAA includes as part 121 operations all RAA turbine-powered airplanes classified as large cargo and passenger airplanes with more than 30 seats, plus nearly all of the RAA classified part 121/135 passenger airplanes with 10 to 29 seats. Retirements reduce the proportion of older airplanes in the fleet; these airplanes have the highest average retrofit cost.

After retirements and voluntary compliance, the expected jet fleet to be retrofitted equals 1,644 airplanes. Over the time period 2001 to 2004, the present value expense of retrofitting this fleet equals $108,580,000. Similarly, the present value expense of retrofitting 355 10 to 29 seat airplanes is estimated to be $9,660,000. Finally, the present value expense to retrofit 30+ seat airplanes (includes large cargo) is estimated to be $25,390,000. Over the period of 2001 to 2004 total present value cost of retrofitting the affected fleet is equal to nearly $144 million.

In addition to retrofitting the existing fleet, new airplanes will also incur the cost of installing TAWS. The FAA received a wide range of estimates for the cost of installing TAWS on new airplanes. Whereas the ATA cost estimate for new production airplanes is nearly $25,000, this rule imposes only the additional cost above the current GPWS equipment. The FAA estimate of $13,000 incremental cost for jets equals an incremental price increase of $10,000 for the TAWS, plus $1,000 installation kit, plus additional labor of $2,000. Future turboprops would have had GPWS, so the incremental cost is the relevant estimate. The $3,800 turboprop incremental cost equals the incremental price increase of $2,000, plus $800 installation kit, plus additional labor of $1,000. There are no incremental costs incurred for training, maintenance, and fuel with TAWS versus GPWS.

Over a ten year horizon for new deliveries, the present value of incremental expense for jets is nearly $5 million and for turboprops nearly $2 million. If the horizon is extended an additional ten years, the present value for new deliveries increases by approximately $3.4 million. The total present value cost equals $144 million for retrofitted airplanes plus $7 million for new airplanes, or $151 million.

With estimated present value benefits of $494 million and present value costs of $151 million, the rule is clearly cost-beneficial for airplanes operated under part 121.

Part 135

Similar to the case with part 121, incremental benefits and costs depend on several fleet-related factors, *i.e.*, the existing fleet (and associated hours flown), expected retirements, voluntary compliance, and non-compliant airplane deliveries. For the purposes of this rulemaking, the cost/benefit analysis separates airplanes with 10 or more seats from those with 6 to 9 seats.

The part 135 fleet today is composed of 2,455 airplanes with 6 to 9 seats, and 334 airplanes with 10 or more seats. These airplanes are assumed to have a 4 percent retirement rate.

There have been 421 TAWS units delivered to domestic United States operators and original equipment manufacturers (OEMs) for 6 to 9 seat airplanes. Operators have purchased 118 units and have ordered an additional 5 units. Fifty percent of OEM deliveries (152 of 303 total units) are assumed to be delivered to the existing 6 to 9 seat part 135 fleet. Thus from a fleet of 2,455 airplanes, 275 are estimated to have voluntarily complied. For the part 135 airplanes with 10 or more seats (total fleet equals 334 airplanes), 25 TAWS units have been purchased by operators and an estimated 111 units by OEMs.

After subtracting airplanes that are estimated to be retired or in voluntary compliance, the affected in-service fleet is estimated to be 1,833 airplanes with 6 to 9 seats, and 171 airplanes with ten or more seats.

Future annual airplane deliveries are assumed to equal five percent of the affected in-service fleet. The affected fleet equals 3,616 airplanes through the year 2011.

One of the main criticisms of the part 135 cost/benefit analysis in the NPRM was that the FAA used parts 91 and 121 accident rates for 6 to 9 and 10 or more seat part 135 airplanes, respectively. The main reason for this was that most of the larger part 135 airplanes (those in scheduled service) involved in the CFIT accidents during the 1985 through 1996 analysis period were ''moved into'' part 121 as a result of the 1995 commuter rule; thus the FAA excluded most of these earlier ''part 135 accidents'' from the part 135 analysis. In addition, time constraints negated analysis of CFIT accidents involving both the larger and smaller part 135 airplanes. Since publication of the NPRM, the Volpe Center re-evaluated the accident data (docket contains accident analyses) involving part 135 airplanes, again with the emphasis of assessing the effectiveness of TAWS compared to current generation GPWS; the results of this analysis are incorporated in the benefits discussion that follows.

Previous data on hours flown is ''distorted'' as a result of the part 121/135 ''shifts'' described above. In addition, FAA fleet data show that there has been a significant decline in the number of 10 or more seat turboprops and turbojets; there are only 111 turbojets and 223 turboprops currently operating with 10 or more seats in part 135. Thus, historical data on hours flown had to be adjusted to reflect the definitional/regulatory change in the part 135 category. The current level of activity is the basis for evaluating future accident probabilities. The relatively few relevant part 135 accidents (*i.e.*, due to the re-classification described above) and concomitantly fewer postulated future accidents logically reflect the reduced level of activity.

As a proxy for hours flown by 6 to 9 and 10 or more seat part 135 airplanes (the data was and still is not available by these specific size categories), the FAA used recently revised data on air taxi operations from its 1997 General Aviation and Air Taxi Survey. The earliest year for which revised annual hours are available is 1991. Since 1991 is approximately the mid-point of the 1985–96 accident evaluation period, hours flown for 1991 was applied to the current number of part 135 airplanes in the two size categories to approximate total annual hours for the fleet during the particular year(s) of the accident(s).

Only one avoidable CFIT accident occurred involving a passenger-carrying turboprop with 10 or more seats (all are non-scheduled). That accident occurred in Beluga, Alaska on December 22, 1989, and involved a Piper PA–31 airplane with 10 passenger seats; only the pilot, who was killed, was on board—the airplane was destroyed. Only TAWS would have prevented this accident. Another accident involved a

cargo airplane; that accident occurred in Destin, Florida on May 16, 1991 and involved a Cessna CE–208B airplane with 2 cockpit seats; only one pilot, who was killed, was on board and the airplane was destroyed. Only TAWS would have prevented this accident. Even though most part 135 cargo airplanes are not covered by the TAWS rule, the FAA believes it is appropriate to include this accident in the analysis, since the same model airplane could just as well have been carrying passengers (circumstances involving a CFIT accident would not differ between a cargo-carrying vs. a passenger-carrying airplane).

Only one avoidable CFIT accident occurred involving part 135, 10 or more seat turbojets; the airplane involved was configured for cargo only. The accident occurred in Monroe, Louisiana on January 8, 1988, and involved a Learjet LJ–36A airplane with two cockpit crewmembers on board, both of whom were killed—the airplane was destroyed. Only TAWS would have prevented this accident. The FAA believes it is appropriate to include this accident in the analysis, since the same model airplane could just as well have been carrying passengers (see discussion above re turboprops also).

One avoidable CFIT accident occurred involving a passenger-carrying turboprop with 6 to 9 passenger seats (covered by the rule whether scheduled or non-scheduled). The accident occurred in Casper, Wyoming on December 22, 1989, and involved a Mitsubishi MU–2B–35 airplane with 6 passenger seats; 4 persons were on board and all were killed—the airplane was destroyed. TAWS (and current GPWS) would have prevented this accident.

Two avoidable CFIT accidents occurred involving passenger-carrying turbojets with 6 to 9 passenger seats (covered by the rule whether scheduled or non-scheduled). One accident occurred in Gulkana, Alaska on August 20, 1985, and involved a Learjet LJ–24D airplane with 8 passenger seats; 3 persons were on board and all were killed—the airplane was destroyed. TAWS (and current GPWS) would have prevented this accident. The second occurred in Juneau, Alaska on October 22, 1985, and also involved a Learjet LJ–24D airplane, this one with 6 passenger seats; 4 persons were on board and all were killed—the airplane was destroyed. TAWS (and current GPWS) would have prevented these accidents.

As noted earlier, lifecycle benefits per airplane equal the annualized benefit for that airplane (which is a function of seating capacity, load factor, annual flight hours, *etc.*) discounted over the number of remaining years of service life. Fleet benefits, in turn, are computed by summing per-airplane lifecycle benefits over all affected airplanes.

The results show benefits of $40.6 million for 6 to 9 seat airplanes and benefits of $47.9 million for 10 or more seat airplanes for total part 135 benefits of $88.5 million.

The cost of TAWS equipment for part 135 airplanes depends on the class of TAWS equipment required for the specific group of part 135 airplanes: Class B for airplanes with 6 to 9 seats and Class A for airplanes with ten or more seats. The Class B unit does not require an air data computer, radio altimeter, or a color display; these components (required in the units now identified as Class A) were largely responsible for the high compliance costs in the NPRM for airplanes with 6 to 9 seats. For newly produced 6 to 9 seat airplanes, the cost of TAWS equals the $7,000 unit price for TAWS plus $500 for installation. For existing 6 to 9 seat airplanes, the total retrofit cost is $12,500; this cost is comprised of a $7,000 price plus a dealer markup of $2,100, installation cost of $1,400, and an estimated STC cost of $2,000. The FAA estimates that the rule's incremental unit cost per 10 or more seat airplanes will equal the 10–29 seat part 121 turboprop unit cost of $34,400. For newly delivered airplanes with 10 or more seats, the incremental cost for TAWS is the additional cost above the GPWS that these airplanes would otherwise have been equipped with; this incremental unit cost equals $3,800, comprised of a price difference of $2,000, installation kit of $800, and installation labor of $1,000.

The total TAWS cost for part 135 operators equals the incremental unit cost multiplied by the affected fleet. The present value cost of approximately $18 million for the in-service 6 to 9 seat passenger airplanes, equals the affected fleet distributed equally over the four years multiplied by a unit cost of $12,500. Similarly, the present value cost of approximately $4.7 million for the in-service 10 or more passenger airplanes equals the affected fleet distributed equally over the four years multiplied by a unit cost of $34,400. Over the period 2000 to 2011, the incremental cost of 6 to 9 seat newly delivered airplanes equals approximately $7 million. Over the same period, the incremental cost for 10 or more seat newly delivered airplanes equals approximately $0.4 million. The total present value cost for part 135 airplanes is $30,121,000.

With present value benefits of approximately $88 million and present value costs of $30 million, the rule is clearly cost-beneficial for part 135 airplanes.

Part 91

The fleet referred to as the affected 14 CFR part 91 airplanes, for the purposes of this analysis, is an estimate of the total affected fleet of U.S.-registered turbine-powered airplanes that are not affected by 14 CFR parts 121 and 135. This fleet is estimated to be comprised of approximately 6,000 turbojets and 6,000 turboprops and includes general aviation airplanes operating under part 91 (corporate, business, personal, instruction, aerial application, and other), large airplanes (having a seating capacity of 20 or more or a maximum payload capacity of 6,000 pounds or more) operating under 14 CFR part 125, and U.S.-registered airplanes operating under 14 CFR part 129. Whereas the analysis of airplanes affected by parts 121 and 135 made use of specific airplane-category data, the analysis of the affected part 91 fleet uses aggregate-level estimates owing to the difficulty of gathering airplane or model specific data on airplanes operating under part 91.

Based on recent contacts with industry and government sources, the FAA projects that approximately 240 turboprops and 350 turbojets will be delivered each year to operators falling under the 14 CFR part 91 group. Benefit and cost estimates for newly manufactured airplanes are based on 10 years of deliveries. The conclusions of this report, with respect to the benefit/cost ratio for equipping newly manufactured airplanes, are not sensitive to these forecasts.

Some voluntary efforts to install TAWS systems in part 91 airplanes are already occurring. According to FAA certification officials and industry sources, STCs for TAWS have been approved for the Beech C90, the Canadair CL–601, the Falcon 900B, and the Gulfstream GV. Gulfstream and Bombardier will include TAWS as standard equipment on new Gulfstream V and Global Express long-range business jets. Orders for TAWS equipment for new part 91 airplanes total slightly more than 160 units, or approximately 30 percent of one year of deliveries.

Estimates of the benefits of the rule are based on a Volpe part 91 study of 44 accidents that met all of the following CFIT accident criteria: (1) Accident date between January 1, 1985 and December 31, 1994; (2) turbine-powered airplane having 6 or more

passenger seats operating under 14 CFR part 91 flight rules; (3) airplane in controlled flight at the time of accident; (4) all airplane systems operating normally at time of accident; and (5) pilot(s) not impaired.

Of the 44 accidents, 11 involved turbojets and 33 involved turboprops. Probable cause, as determined by the NTSB, was pilot error in all cases—principally through failure to maintain proper altitude, use of improper instrument flight rules or visual flight rules procedures, or poor planning/decision-making. Contributing factors included weather conditions and darkness in many cases. In two accidents, the NTSB assigned partial responsibility to FAA air traffic control problems. The 44 accidents resulted in 131 fatalities, 19 seriously injured passengers, and destruction of 37 airplanes and substantial damage to 7 airplanes.

The Volpe part 91 study determined that current-technology ground proximity warning systems could have prevented 33 of the 44 accidents (the 33 GPWS-preventable accidents accounted for 96 fatalities, 17 serious injuries, 18 minor injuries, 27 destroyed airplanes, and 6 substantially-damaged airplanes). Of the 11 accidents that were not likely to have been prevented by current-technology GPWS, the study found that 9 accidents could have been prevented by TAWS. In total, therefore, TAWS could have prevented 42 of the 44 accidents (all 33 of the accidents preventable by GPWS and the additional 9). The 42 TAWS-preventable accidents accounted for 126 fatalities, 19 serious injuries, 26 minor injuries, 35 destroyed airplanes, and 7 substantially damaged airplanes. Total part 91 present value benefits are $720.2 million. Adjusting (i.e., reducing) these estimated benefits by the 10 percent of the part 91 fleet voluntarily complying, results in benefits of approximately $648 million.

While there are some nonrecurring costs, most of the total system costs include the equipment with installation, and the operating and maintenance costs. The equipment cost is $7,000 for in-service or newly manufactured airplanes. The Class B TAWS unit (requiring significantly less interface with existing/or needed upgraded avionics) dramatically reduces the expense to part 91 operators from that reported in the NPRM. Installation cost is $3,500 for in-service airplanes and $500 for newly manufactured airplanes. The part 91 total present value cost is $164.2 million.

With estimated present value benefits of $648 million and present value costs of $164 million, the rule is clearly cost-beneficial for part 91 airplanes.

Conclusions

On the basis of the preceding analyses, the FAA concludes that, for each of the groups of affected airplanes operating under parts 121, 135, and 91, the benefits of TAWS exceed their costs. Total present value benefits of the rule are $1.23 billion, approximately 3.6 times the cost of $345 million. The benefit/cost ratios for the groups that are composed primarily of smaller airplanes (parts 91 and 135, which have a large number of 6 to 9 seat airplanes) are high in large part because of the development of the less costly Class B TAWS equipment that will be in effect under this final rule.

Final Regulatory Flexibility Determination and Analysis

The Regulatory Flexibility Act of 1980 establishes ''as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation.'' To achieve that principle, the Act requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The Act covers a wide range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule will have a ''significant economic impact on a substantial number of small entities.'' If the determination is that it will, the agency must prepare a regulatory flexibility analysis as described in the Act.

Recently, the Office of the Small Business Administration (SBA) published new guidance for the use of Federal agencies in responding to the requirements of the Regulatory Flexibility Act, as amended. Application of that guidance to this rule indicates that it will have a significant impact on a substantial number of small entities. Accordingly, a full regulatory flexibility analysis was conducted.

1. A description of the reasons why action by the agency is being considered

The agency is considering this action in response to a history of controlled flight into terrain accidents, NTSB recommendations, and subsequent analysis performed at the request of the agency. This rule is an implementation of the agency's mission to improve aviation safety.

2. A succinct statement of the objectives of, and legal basis, for the rule

The objective of this rule is to improve aviation safety by requiring the installation or retrofit of terrain awareness and warning systems on turbine-powered airplanes with six or more passenger seats.

The legal basis for the rule derives from Title 49 U.S.C. 44701 which authorizes the FAA Administrator to promote the safety of flight of civil aircraft in air commerce by prescribing, in part, minimum standards governing the design and construction of aircraft, aircraft engines, and propellers, as may be required in the interest of safety.

3. A description of the projected reporting, recordkeeping, and other compliance requirements of the proposed rule

Recordkeeping will be minimal. Recordkeeping and other compliance requirements will be similar to those for radio-navigation equipment that is currently in use.

4. An identification, to the extent practicable, of all relevant federal rules that may duplicate, overlap, or conflict with the final rule

The FAA is unaware of any federal rules that would duplicate, overlap, or conflict with the final rule.

5. A description and estimate of the number of small entities to which the rule will apply

Entities (both large and small) potentially affected by the rule include manufacturers of transport category airplanes (North American Industry Classification System (NAICS) code 336411 ''Aircraft Manufacturing''), manufacturers of ground proximity warning equipment (NAICS 334511 ''Search, Detection, Navigation, Guidance, Aeronautical, and Nautical Systems and Instruments Manufacturing''), scheduled air carriers (NAICS 48111 and 481112 ''Scheduled Passenger Air Transportation'' and ''Scheduled Freight Air Transportation''), and nonscheduled air carriers (NAICS 481212, 481211, and 48799, ''Nonscheduled Chartered Freight Air Transportation,'' ''Nonscheduled Chartered Passenger Air Transportation,'' and ''Scenic and Sightseeing Transportation, Other'').

More specifically, the rule will affect many small entities that operate turbine-powered airplanes seating six or more passengers under 14 CFR part 91 (*e.g.*, small businesses, governments, and

individuals). There are thousands of operators of such airplanes, and, therefore, potentially thousands of entities representing hundreds of industries, organizations, and institutions. Costs per entity will be dependent on the number of airplanes affected and the (comparatively modest) cost of purchasing and installing Class B TAWS equipment.

An additional group of small entities who operate under 14 CFR part 135 that is likely to be affected by this regulation consists of operators of charter/on-demand air travel services, small operators of scheduled air service, and fixed-base operators (who often provide unscheduled air taxi service). Charter/on-demand operators typically have relatively few employees and low annual revenues. For this analysis the FAA classifies entities with 1,500 or fewer employees as a ''small entity.'' There are believed to be only about 60 out of the approximately 2,800 part 135 operators that have more than 1,500 employees, so that more than 2,700 part 135 operators will be classified as ''small entities.'' Half of these entities have less than 8 or 10 employees. The actual financial impact of the rule on any one of these entities will depend on the number of affected airplanes operated and whether Class A or B TAWS equipment will be required on these airplanes.

There are estimated to be more than 100 part 121 air carriers engaged in carrying passengers. Out of this total, over half are estimated to be small entities, based on having 1,500 or fewer employees. The actual financial impact on these entities will depend on the number of affected airplanes and the cost of purchasing and installing Class A TAWS equipment. As noted in previous discussions, a significant portion of the part 121 fleet operators, primarily the members of the Air Transport Association, is expected to voluntarily install the equipment required by this rule. The entities voluntarily complying with the rule are assumed to bear no costs as a direct result of this rule.

6. Affordability Analysis

In response to public comments and small business concerns, the initial proposed rule has been modified to reduce the compliance costs for operators with airplanes operating only under part 91, and under part 135 with 6 and 9 passenger seats. Most of these operators are expected to be small entities and will benefit from a higher level of safety with the lower cost Class B TAWS equipment. In the initial NPRM regulatory evaluation, the expected compliance cost to part 91 operators was estimated to be between $27,000 and $30,000 per airplane. In the final rule, Class B TAWS compliance cost is estimated to be slightly more than $10,000 per airplane. As an estimate of affordability, for general aviation turboprops with from one to nine seats and one or two engines, average airplane values are estimated to be $679,000 and $572,000, respectively. Thus the Class B TAWS equipment for these airplanes will cost between 1.5 percent and 2.0 percent of these airplanes' values. While it is very difficult to specify how affordable this rule will be for a small entity, the requirement of Class B TAWS (rather than Class A TAWS) substantially reduces the compliance cost for many small entities. Small entities which will be required to install Class A TAWS equipment will incur significantly higher costs than those required to install Class B TAWS equipment. Lastly, those operators engaged in chemical/agricultural applications, parachuting, and firefighting are excluded from the requirements of this rule. Most of these entities have fewer than 1,500 employees and thus are classified as small entities under this analysis.

7. Competitiveness Analysis

In the aviation industry, particular commercial market segments tend to be served by airplanes with similar seat size that operate under the same part of the CFR. For those markets served only by operators who will install equipment having roughly equal cost, much of the full cost of this rule could be passed on to their customers. In this case, there will be no significant change in the competitiveness among operators. For a market where competitors operate similar size airplanes but with different avionics, the cost incurred as a result of this rule may differ significantly among operators. Operators of airplanes with older avionics who will be required to install Class A TAWS equipment are expected to incur higher costs than those operating airplanes with newer equipment. Depending upon the mix of equipment serving a market, operators with older avionics equipment may be less able to pass on most of the cost of this rule.

8. Disproportionality Analysis

It is not clear that this rule imposes systematically higher or lower proportionate cost increases on smaller, as opposed to larger entities. The compliance cost of the rule depends upon the affected airplanes and how they are operated. The net impact on profitability to an operator may be affected by the costs imposed on competitors by the rule. The cost to an operator rises as the number of airplanes increases. In terms of the number of airplanes, the rule imposes proportional costs on operators under part 91 and those operating airplanes with 6 to 9 seats under part 135. It is expected that these operators are primarily small entities. The retrofit of Class A TAWS equipment will cost more to operators of airplanes with older avionics equipment. The age of the avionics within an airplane is not necessarily related to the size of the entity that operates the airplane. Thus, the FAA can not specify whether this rule will have a disproportionate impact on small entities.

9. Description of Alternatives

The agency has considered a number of alternatives to the rule. The FAA finds that the rule chosen will achieve a level of safety that is equivalent to or greater than that of the alternatives considered, and do this at a lower cost to the affected entities.

The alternatives that have been considered can be grouped into three categories:

- Exclude small entities
- Extend compliance deadline for small entities
- Establish lesser technical requirements for small entities

The FAA concludes that the option to exempt small entities from all the requirements of the rule is not justified. In fact, as noted in the preamble and in Section II of this document, the accident history of part 91 operators (many of whom are small entities) forms the basis of the NTSB's recommendation to require ground proximity warning systems on smaller turbojet and turboprop airplanes. However, the final rule does permit the use of TAWS equipment that meets the requirements for Class B equipment in TSO–C151 in airplanes operating under part 91 and for airplanes having 6 to 9 passenger seats operating under part 135. This requirement is somewhat less stringent as well as being less costly than the Class A equipment required for part 121 operations and larger airplanes operating under part 135; both pieces of equipment provide the same level of safety for the TAWS functions.

The FAA also considered options that will lengthen the compliance period for small operators. The FAA believes that the equipment chosen requirement will place a modest burden on small entities that arises from making expenditures on equipment at an earlier date. Small entities will have four years from the effective date of the rule to complete

retrofit work. Delaying the compliance deadline beyond the current proposal would not have resulted in significantly lower downtime or certification costs. Rather, the additional cost incurred will equal the modest return on capital (that will be spent on TAWS equipment) that would have been realized during the short time that the operator might have postponed the retrofit. Lengthening the compliance period would have exposed airplane occupants to significant safety risks for a longer period of time.

Finally, the FAA is not in favor of compliance options that will permit non-TAWS technologies. For airplanes not equipped with any ground proximity warning system, TAWS units will provide up to 23% greater CFIT risk reduction over current-generation GPWS at very little additional cost. For operators of part 91 airplanes, the use of a TAWS that is made possible with the use of data provided by GPS and an encoding altimeter, as is now permitted under the revised rule, will provide the benefits of a TAWS at significantly lower cost than with alternative technologies. It is noted that, in the NPRM, the present value of total costs for the part 91 fleet was estimated to be $415 million. Under the final rule, these costs are estimated to be $164 million, less than 40 percent of the level that would have been imposed under the initially proposed rule. It is estimated that several thousand part 91 operators will be affected by this rule. Similarly, approximately 2,800 part 135 (air taxi and similar) operators will be affected, as will approximately 100 part 121 (air carrier) operators. The precise impact on a particular operator will depend on the number of turbine-powered airplanes operated and will be larger for operators with greater numbers of airplanes.

The FAA has determined that this rule will impact small entities, has analyzed the impact of this rule on small entities, and has made efforts to reduce the impact. There are literally thousands of firms with less than 1,500 employees that will be affected by this rule. More than 1,000 of these firms are expected to have fewer than 10 employees. In response to public comments and with the availability of new technology, the FAA will require a substantially less expensive and easier to install TAWS for part 91 and some part 135 operators. It is expected most of the reduced compliance cost will benefit small entities.

International Trade Impact Assessment

Recognizing that domestic regulations often affect international trade, the Office of Management and Budget directs Federal Agencies to assess whether or not a rule or regulation will affect any trade-sensitive activity. It is recognized that the rule could potentially affect international trade by burdening domestic businesses or air carriers with requirements that are not applicable to their foreign competitors. In general, the FAA believes potential international trade impacts associated with the rule will be negligible. Many domestic and foreign air carriers are already voluntarily installing TAWS equipment in recognition of the substantial safety benefits. A summary of potential impacts follows.

Potential impact to domestic airplane manufacturers.

The FAA believes that the rule will have a negligible effect on the competitive position of domestic airframe manufacturers. Under the rule, domestic manufacturers could continue to offer basic GPWS units on airplanes sold to foreign customers (if the airplane is not U.S.-registered). Foreign airframe manufacturers, on the other hand, will be required to equip airplanes sold to U.S. customers (operating under 14 CFR parts 91, 121, or 135) with TAWS.

Potential impact to domestic airplane leasing firms.

Domestic firms leasing aircraft to foreign operators may be adversely affected by the part 91 provisions of the rule. Domestic leasing companies, for liability reasons or to position themselves to lease to both 14 CFR part 121 and foreign carriers, often choose to maintain U.S.-registered fleets. Thus, their lease prices may reflect TAWS retrofit costs while the prices of foreign competitors may not. (In some cases, the lessee is directly responsible for modifications required by airworthiness directive or regulations—but in either case the disincentive effect is the same).

Given the small cost of TAWS relative to average airplane values, however, the FAA believes the potential international trade impact to be small. Also, TAWS equipped airplanes will be safer and thus more attractive to potential lessees—and their passengers. Increased patronage attributable to the operation of safer airplanes will also partially offset the costs of compliance.

Potential impact to domestic air carriers.

The potential impact to air carriers is, again, a function of the aircraft registration. Foreign air carriers operating U.S.-registered airplanes will be required to install TAWS as will U.S. air carriers. To this extent, operators of U.S. registered airplanes will have costs that may not be required of non-U.S. registered competitors. Again, however, TAWS equipment costs will be a very small fraction of in-service airplane values, provide a known safety feature, and represent a negligible portion of new airplane values. Also, CFIT accidents are a leading cause of commercial aviation fatalities worldwide. It is likely that knowledgeable passengers would pay the small difference in price to travel on an airplane equipped with TAWS. Voluntary industry initiatives to install enhanced ground proximity warning systems are consistent with the view that TAWS benefits far exceed its costs, and could have beneficial effects for domestic airlines competing for international passenger traffic.

Executive Order 13132, Federalism

The FAA has analyzed this final rule under the principles and criteria of Executive Order 13132, Federalism. The FAA determined that this action will not have a substantial direct effect on the States, or the relationship between the national Government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, the FAA has determined that this final rule does not have federalism implications.

Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (the Act), enacted as Pub. L. 104–4 on March 22, 1995 (the Act), codified in 2 U.S.C. 1501–1571, requires each Federal agency, to the extent permitted by law, to prepare a written assessment of the effects of any Federal mandate in a proposed or final agency rule that may result in the expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more (adjusted annually for inflation) in any one year. Section 204(a) of the Act, 2 U.S.C. 1534(a), requires the Federal agency to develop an effective process to permit timely input by elected officers (or their designees) of State, local, and tribal governments on a proposed ''significant intergovernmental mandate.'' A ''significant intergovernmental mandate'' under the Act is any provision in a Federal agency regulation that will impose an enforceable duty upon State, local, and tribal governments, in the aggregate, of $100 million (adjusted annually for inflation) in any one year. Section 203 of the Act, 2 U.S.C. 1533, which supplements section 204(a), provides that before establishing any regulatory requirements that might significantly or uniquely affect small governments, the agency shall have developed a plan that,

among other things, provides for notice to potentially affected small governments, if any, and for a meaningful and timely opportunity to provide input in the development of regulatory proposals or rules.

This final rule does not contain a Federal intergovernmental or private sector mandate that exceeds $100 million in any one year.

Environmental Analysis

FAA Order 1050.1D defines FAA actions that may be categorically excluded from preparation of a National Environmental Policy Act (NEPA) environmental assessment or environmental impact statement. In accordance with FAA Order 1050.1D, appendix 4, paragraph 4(j), this rulemaking action qualifies for a categorical exclusion.

Energy Impact

The energy impact of the notice has been assessed in accordance with the Energy Policy and Conservation Act (EPCA) P.L. 94–163, as amended (43 U.S.C. 6362) and FAA Order 1053.1. It has been determined that the final rule is not a major regulatory action under the provisions of the EPCA.

List of Subjects

14 CFR Part 91 and 135

Aircraft, Aviation safety.

14 CFR Part 121

Aircraft, Aviation safety, Safety.

The Amendment

In consideration of the foregoing, the Federal Aviation Administration amends parts 91, 121, and 135 of Title 14 Chapter 1, of the Code of Federal Regulations as follows:

PART 91—GENERAL OPERATING AND FLIGHT RULES

1. The authority citation for part 91 continues to read as follows:

Authority: 49 U.S.C. 106(g), 1155, 40103, 40113, 40120, 44101, 44111, 44701, 44709, 44711, 44712, 44715, 44716, 44717, 44722, 46306, 46315, 46316, 46504, 46506–46507, 47122, 47508, 47528–47531, articles 12 and 29 of the Convention on International Civil Aviation (61 stat. 1180).

2. Section 91.223 is added to read as follows:

§ 91.223 Terrain awareness and warning system.

(a) *Airplanes manufactured after March 29, 2002.* Except as provided in paragraph (d) of this section, no person may operate a turbine-powered U.S.-registered airplane configured with six or more passenger seats, excluding any pilot seat, unless that airplane is equipped with an approved terrain awareness and warning system that as a minimum meets the requirements for Class B equipment in Technical Standard Order (TSO)–C151.

(b) *Airplanes manufactured on or before March 29, 2002.* Except as provided in paragraph (d) of this section, no person may operate a turbine-powered U.S.-registered airplane configured with six or more passenger seats, excluding any pilot seat, after March 29, 2005, unless that airplane is equipped with an approved terrain awareness and warning system that as a minimum meets the requirements for Class B equipment in Technical Standard Order (TSO)–C151.

(Approved by the Office of Management and Budget under control number 2120–0631)

(c) *Airplane Flight Manual.* The Airplane Flight Manual shall contain appropriate procedures for—

(1) The use of the terrain awareness and warning system; and

(2) Proper flight crew reaction in response to the terrain awareness and warning system audio and visual warnings.

(d) *Exceptions.* Paragraphs (a) and (b) of this section do not apply to—

(1) Parachuting operations when conducted entirely within a 50 nautical mile radius of the airport from which such local flight operations began.

(2) Firefighting operations.

(3) Flight operations when incident to the aerial application of chemicals and other substances.

PART 121—OPERATING REQUIREMENTS; DOMESTIC, FLAG, AND SUPPLEMENTAL OPERATIONS

3. The authority citation for part 121 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 40119, 44101, 44701–44702, 44705, 44709–44711, 44713, 44716–44717, 44722, 44901, 44903–44904, 44912, 46105.

4. Section 121.354 is added to read as follows:

§ 121.354 Terrain awareness and warning system.

(a) *Airplanes manufactured after March 29, 2002.* No person may operate a turbine-powered airplane unless that airplane is equipped with an approved terrain awareness and warning system that meets the requirements for Class A equipment in Technical Standard Order (TSO)–C151. The airplane must also include an approved terrain situational awareness display.

(b) *Airplanes manufactured on or before March 29, 2002.* No person may operate a turbine-powered airplane after March 29, 2005, unless that airplane is equipped with an approved terrain awareness and warning system that meets the requirements for Class A equipment in Technical Standard Order (TSO)–C151. The airplane must also include an approved terrain situational awareness display.

(Approved by the Office of Management and Budget under control number 2120–0631)

(c) *Airplane Flight Manual.* The Airplane Flight Manual shall contain appropriate procedures for—

(1) The use of the terrain awareness and warning system; and

(2) Proper flight crew reaction in response to the terrain awareness and warning system audio and visual warnings.

5. Section 121.360 is amended by adding paragraph (g) to read as follows:

§ 121.360 Ground proximity warning-glide slope deviation alerting system.

* * * * *

(g) This section expires on March 29, 2005.

PART 135—OPERATING REQUIREMENTS: COMMUTER AND ON-DEMAND OPERATIONS

6. The authority citation for part 135 continues to read as follows:

Authority: 49 U.S.C. 106(g), 44113, 44701–44702, 44705, 44709, 44711–44713, 44715–44717, 44722.

7. Section 135.153 is amended by adding paragraph (f) to read as follows:

§ 135.153 Ground proximity warning system.

* * * * *

(f) This section expires on March 29, 2005.

8. Section 135.154 is added to read as follows:

§ 135.154 Terrain awareness and warning system.

(a) *Airplanes manufactured after March 29, 2002:*

(1) No person may operate a turbine-powered airplane configured with 10 or more passenger seats, excluding any pilot seat, unless that airplane is equipped with an approved terrain awareness and warning system that meets the requirements for Class A equipment in Technical Standard Order (TSO)–C151. The airplane must also include an approved terrain situational awareness display.

(2) No person may operate a turbine-powered airplane configured with 6 to 9 passenger seats, excluding any pilot seat, unless that airplane is equipped with an approved terrain awareness and

warning system that meets as a minimum the requirements for Class B equipment in Technical Standard Order (TSO)–C151.

(b) *Airplanes manufactured on or before March 29, 2002:*

(1) No person may operate a turbine-powered airplane configured with 10 or more passenger seats, excluding any pilot seat, after March 29, 2005, unless that airplane is equipped with an approved terrain awareness and warning system that meets the requirements for Class A equipment in Technical Standard Order (TSO)–C151. The airplane must also include an approved terrain situational awareness display.

(2) No person may operate a turbine-powered airplane configured with 6 to 9 passenger seats, excluding any pilot seat, after March 29, 2005, unless that airplane is equipped with an approved terrain awareness and warning system that meets as a minimum the requirements for Class B equipment in Technical Standard Order (TSO)–C151.

(Approved by the Office of Management and Budget under control number 2120–0631)

(c) *Airplane Flight Manual.* The Airplane Flight Manual shall contain appropriate procedures for—

(1) The use of the terrain awareness and warning system; and

(2) Proper flight crew reaction in response to the terrain awareness and warning system audio and visual warnings.

Issued in Washington, DC, on March 23, 2000.

Jane F. Garvey,

Administrator.

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