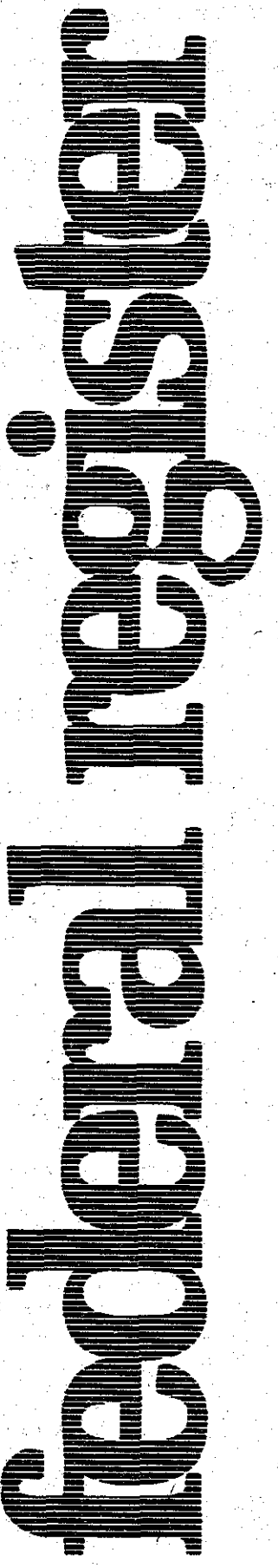
135-30



Tuesday
January 10, 1989

Part IV

Department of Transportation

Federal Aviation Administration

14 CFR Parts 1, 91, 121, 125, 129, and 135

Traffic Alert and Collision Avoidance System; Final Rule

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 1, 91, 121, 125, 129, and 135

[Docket No. 25355; Amdt. Nos. 1-35, 91-208, 121-201, 125-11, 129-17, and 135-29]

RIN 2120-AC34

Traffic Alert and Collision Avoidance System

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: These amendments require the installation and use of a Traffic Alert and Collision Avoidance System (TCAS) in large transport type airplanes and certain turbine powered smaller airplanes. The TCAS, which uses the Air Traffic Control Radar Beacon System transponder reply from other aircraft, will provide a collision avoidance capability that operates independently of the ground-based Air Traffic Control (ATC) system, and in areas where there is no ATC radar coverage. The Airport and Airway Safety and Capacity Expansion Act of 1987 directs the FAA to require the installation and operation of TCAS in commercial aircraft flying in the United States. The intended effect of this action is to minimize the possibility of midair collisions involving air carrier airplanes.

EFFECTIVE DATE: February 9, 1989.

Compliance Dates (Where Later Than Effective Date):

1. *Part 121.* TCAS II requirement for operations conducted under Part 121 with more than 30 passenger seats: December 30, 1991.

2. *Part 125.* TCAS II requirement for operations conducted under Part 125 with more than 30 passenger seats: December 30, 1991.

3. *Part 129.* TCAS I requirement for operations conducted under Part 129 with 10 to 30 passenger seats February 9, 1995. TCAS II requirement for operations conducted under Part 129 with more than 30 passenger seats: December 30, 1991.

4. *Part 135.* TCAS I requirement for operations conducted under Part 135 with 10 to 30 passenger seats: February 9, 1995.

FOR FURTHER INFORMATION CONTACT: Frank Rock, Aircraft Engineering Division, AIR-120, FAA, 800 Independence Avenue SW., Washington, DC 20591; Telephone (202) 267-9567.

SUPPLEMENTARY INFORMATION:

Background

Regulatory History

On August 21, 1987, the Federal Aviation Administration (FAA) issued Notice of Proposed Rulemaking (NPRM) No. 87-8 (52 FR 32268; August 26, 1987). The NPRM proposed to amend Parts 91, 121, 125, 129, and 135 to require the installation and use of a family of Traffic Alert and Collision Avoidance Systems (TCAS) onboard certain airplanes, as follows:

14 CFR part	Applicability	Equipment	Compliance
91	All	TCAS	Voluntary
121	Large airplanes	TCAS II/Mode S	3 years after effective date
125	....do	....do	3 years after effective date
129	Turbine powered airplanes/10 to 19 passenger seats.	TCAS I	5 years after effective date
	Turbine powered/20 to 30 seats	TCAS II/Mode S	4 years after effective date
	Turbine powered/30 seats or more	TCAS II/Mode S	3 years after effective date
135	Turbine powered/10 to 19 seats	TCAS I	5 years after effective date
	Turbine powered/20 seats or more	TCAS II/Mode S	4 years after effective date

All comments received in response to NPRM No. 87-8 were considered in adopting these amendments.

On December 30, 1987, the President of the United States signed the Airport and Airway Safety and Capacity Expansion Act of 1987, which, among other amendments, amended the Federal Aviation Act of 1958, Section 601, by adding a new section (f), titled "Collision Avoidance Systems." Title III, section 203 of that act states:

"SEC. 203. Aircraft Collision Avoidance Systems

"(a) Findings.—Congress finds that—

(1) the number of near midair collisions is an indication that additional measures must be taken to assure the highest level of air safety in the United States;

(2) public health and safety requirements necessitate the timely completion and installation of a collision avoidance system for use by commercial aircraft flying in the United States;

(3) the Traffic Alert and Collision Avoidance System promises to reduce the threat to life caused by midair collisions, particularly collisions between general aviation aircraft and commercial aircraft;

(4) the Traffic Alert and Collision Avoidance System will succeed only to the degree that other aircraft posing a collision threat use operating transponders with automatic altitude reporting capability; and

(5) the Federal Aviation Administration should continue at a deliberate pace the development of additional technologies, including the collision avoidance system known as TCAS III, to ensure the safe separation of aircraft.

"(b) General Rules.—Section 601 is amended by adding at the end the following new subsection:

(f) Collision Avoidance Systems.—

(1) Development and Certification.—

(A) Standards.—The Administrator shall complete development of the collision avoidance system known as TCAS II so that such system will be operable under visual and instrument flight rules and will be upgradeable to the performance standards applicable to the collision avoidance system known as TCAS III.

(B) Schedule.—The Administrator shall develop and implement a schedule for development and certification of the collision avoidance system known as TCAS II which will result in completion of such certification not later than 18 months after the date of the enactment of this subsection.

(2) Installation.—The Administrator shall require by regulation that, not later than 30 months after the date of certification of the collision avoidance system known as TCAS II, such system be installed and operated on each civil aircraft which has a maximum passenger capacity of more than 30 seats and which is used to provide air transportation of passengers, including intrastate air transportation of passengers."

Airport and Airway Safety and Capacity Expansion Act of 1987, Pub. L. 100-223, section 203 (December 30, 1987).

The FAA has informed Congress that a schedule requiring a "complete" certification of TCAS II equipment within 18 months is extremely difficult because of the different equipment manufacturer designs to be approved; the number of different aircraft types and models; and the large number of commercial carriers requesting approval. Currently, the FAR require

that operators apply for a separate supplemental type certificate for each equipment manufacturer's design and each type/model aircraft. Since the ultimate goal of Congress is clearly the actual installation of TCAS, the FAA is promulgating this rule to require the air carriers to install the system prior to the 48-month overall deadline. Therefore, after consideration of the legislation and the particular circumstances, the FAA concluded that these amendments requiring certification and installation of TCAS within 48 months from the date of enactment of Pub. L. 100–223 (December 30, 1987) constitute compliance with that amendment to the FA Act.

Public Law 100–223 also mandated an FAA regulation requiring the use of altitude-encoding transponders in certain airspace and terminal areas. An automatic altitude-encoding transponder, designated as Mode C (or Mode S, since all Mode S transponders incorporate this feature), provides the air traffic controller with aircraft altitude in 100-foot increments. This information is displayed on the controller's radar screen with the data block for each tracked aircraft. The information is transmitted automatically in response to radar interrogations of the aircraft's radar transponder, and no communication with the pilot is required.

In response to Pub. L. 100–223 and previous FAA regulatory proposals, the agency adopted Amendment 91–203, *Transponder Automatic Altitude Reporting Capability Requirement*, in June 1988 (53 FR 23356, June 21, 1988). The rule requires the use of a Mode C transponder for all operations within and above a terminal control area (TCA) or airport radar service area (ARSA); within 30 miles of a TCA or within 10 miles of certain other airports; and above 10,000 feet above mean sea level (MSL).

A TCAS II or III unit receives information from the Mode C transponder on a target aircraft. The TCAS unit processes the information to provide the pilot of the TCAS airplane with altitude information on potentially conflicting aircraft and to provide vertical resolution advisories (RA's) (to climb or descend) to avoid the conflict. Mode C equipment installed on other aircraft is the only source of altitude information for a TCAS unit.

Discussion of Comments

Seventy commenters responded to Notice No. 87–8. Thirty-three respondents favor the proposed rule to require TCAS; however, seventeen from this group expressed reservations about the phase-in period and ten stated that the final rulemaking should be postponed.

A breakout of the respondents showed the following number of commenters by interest category:

Commercial aviation—6 foreign and 13 domestic carriers	19
Public comment—7 general public, 2 state representatives, and 1 consumer group	10
Government agencies—8 foreign and 2 domestic	10
Industry governing bodies	7
Industry/technical groups	9
Associations	8
Research organizations	2
Airframe manufacturers	4
Training/educational group	1
Total	70

Phase-In Period

Thirty-five commenters expressed concern regarding the phase-in period for TCAS. Of these, 12 requested an implementation time of 4 years minimum up to 7 years, with a 5-year period as the most popular timeframe mentioned.

Four commenters wanted a uniform time schedule for installation, instead of the uneven phase-in time proposed in the NPRM.

Only one person, a state government representative, mentioned shortening the phase-in period. That commenter wants TCAS installed as soon as possible.

Three commenters, including two manufacturers, expressed the opinion that the proposed deadline could be met.

Public Law 100–223 mandated the installation and operation of TCAS II on each civil aircraft that has a passenger capacity of more than 30 seats and that is used to provide air transportation of passengers including intrastate air transportation of passengers. The FAA cannot promulgate rulemaking contrary to the Public Law even in response to public comments to the proposed rule. Therefore, those comments proposing an extended phase-in time for aircraft with more than 30 passenger seats will not be addressed here.

The FAA agrees that those aircraft with 30 passenger seats or less and operated under FAR Parts 125 and 135 should not be required to have installed a TCAS II. Part 129 and Part 135 operators of turbine-powered aircraft with 10 to 30 passenger seats will be required to have a TCAS I system installed and operating.

While the technology required to build a TCAS I is fully developed, currently, there is no TCAS I design approved, and no manufacturer has built a TCAS I unit. There are three or four manufacturers considering the merits of developing a TCAS I design. One system is based on a passive design concept, another design is based on active interrogation, and a third concept is a combination of active/passive. These concepts have not been developed to a point where it can be judged whether any of the concepts will function as required. Considering the time required to develop, test, and obtain approval of TCAS I design and the time required to develop production facilities, coupled with user installation and training requirements, the need to allow additional calendar time became apparent. The additional time reflected in this final rule provides for the fabrication, certification, and operational evaluation of a TCAS I unit prior to installation on passenger carrying airplanes.

In consideration of the absence of an approved TCAS I system at this time, the compliance dates for TCAS I installation and operation have been extended from 5 years to 6 years for those aircraft operating under Parts 129 and 135 with 10 to 30 passenger seats. Additionally, the FAA will provide test data and certain test assistance, and will participate with interested manufacturers and users to evaluate and test TCAS I units in accordance with Technical Standard Order (TSO)-C118, and participate in a field evaluation of TCAS I units with Part 135 carriers.

Two manufacturers announced publicly at the Airlines Electronic Engineering Committee (AEEC) International Conference on TCAS Implementation, December 1 and 2, 1987, that their production of TCAS II systems can be adjusted to accommodate any air carrier installation schedules.

Postpone Final Rulemaking

Most commenters stated that the final rulemaking should be postponed until the results of the Limited Installation Program (LIP) system tests could be analyzed. The LIP, which continues the operational evaluation of TCAS II, requires analysis and periodic reporting to the FAA. The primary objective of the LIP is to evaluate the TCAS II preproduction units in air carrier service using line pilots. United Airlines, the first airline to apply for supplemental type certificate for installation of a TCAS II system for the LIP, completed their 6-month evaluation and currently is in the process of completing the data analysis. During the United evaluation a

total of 2,066 flight hours were logged on the two TCAS II equipped airplanes. The system generated a total of 933 traffic advisories (TA's) and 68 RA's. Northwest Airlines is scheduled to begin their LIP evaluation on or about September 1, 1988. Northwest will use two MD 80 airplanes for the evaluation.

The FAA believes that any fundamental problem existing would have shown up early in the LIP program. None has to date, nor has any major problem been identified in the Piedmont Phase I or II programs. (The 5-month evaluation of TCAS II on two Piedmont Airlines B–727 airplanes between November 1981 and May 1982 is referred to as Piedmont Phase I. The primary objectives of this evaluation were to assess the operation of TCAS in an air carrier operational environment and to develop an understanding of the potential effect of alerts on air carrier flight operations, flight crews, and ATC controllers and on the frequency of alerts and the circumstances under which they occur. The operational evaluation of TCAS II on a Piedmont Airlines B–727 airplane between March 1987 and January 1988 is referred to as Piedmont Phase II. The primary objectives of this operational flight evaluation were to assess the impacts of TCAS operation on flight crew workload; evaluate the impacts of TCAS on the ATC system and individual controllers; and obtain flight crew comments on the system's design parameters, displays, and operational procedures. The evaluation was also designed to provide additional data on the frequency of TCAS alerts and the circumstances under which TCAS alerts occur, evaluate the effectiveness of the flight crew training program, and identify and resolve equipment certification issues. See NPRM 87–8).

Most non-U.S. commenters expressed varying degrees of displeasure at the proposed unilateral action of the United States to mandate the installation and use in U.S. airspace of a collision avoidance system *in the absence of internationally agreed-upon technical specifications and operational procedures* for such an important system. These international standards, normally developed through the vehicle of the International Civil Aviation Organization (ICAO) for equipment such as this prior to introduction into the international aviation system, are designed to insure equipment interoperability and avoid equipage redundancy. Hence, most foreign observers would like to see the U.S. equipage/use requirement delayed and, at the very least, its application to foreign operators under 14 CFR Part 129 delayed until such international standards are in place (currently expected to occur in late 1990) and a sufficient period of time is permitted for system acquisition and installation.

With regard to the present status of the effort to standardize the Airborne Collision Avoidance System (ACAS—the international equivalent of the U.S. TCAS), ICAO is relying on the services of technical and operational experts provided by 15 countries and 4 international organizations—organized into the Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel (SICASP)—to develop these important technical equipment specifications and operational procedures, which will result in the safe and efficient use of this system internationally. United States participation in this effort has been very active and has included the FAA, the National Aeronautics and Space Administration (NASA), U.S. industry groups, and FAA's two major TCAS contractors, MITRE and Lincoln Labs. At the behest of U.S. and other participants, a concerted effort is being made by this group to complete its work at a spring 1989 meeting, at which time proposed ACAS international standards will be presented to ICAO's Air Navigation Commission and Council for final review and approval. Assuming no unexpected difficulties materialize during this review process, the most critical changes to ICAO documents—the technical ACAS equipment specifications in ICAO Annex 10—should become applicable internationally in late 1990.

Four commenters mentioned postponing the rule until after the Radio Technical Commission for Aeronautics (RTCA) Minimum Operational Performance Standards (MOPS) changes 6 and 7 were complete and Aeronautical Radio Inc. (ARINC) specifications were in final form. The RTCA MOPS, change 6, was not completed in time for publication in TSO C–119, TCAS II; therefore, the TSO references FAA Report No. DOT/FAA/SA–88/3, *Required Modifications to the Traffic Alert and Collision Avoidance System (TCAS II) Minimum Operational Performance Standards (MOPS).* When change 6 is approved by the RTCA Council, the TSO will be revised to reference RTCA DO–185 changes 1 through 6. Change 7 is not required for FAA approval.

One manufacturer recommended delaying the rule and holding the docket open until the LIP is finished and all reports are made available and the MITRE report 87W000157 is released and reviewed. The United Airlines LIP report has been completed and made available in the docket. The Mitre report 87W000157 was revised and adopted in the TSO.

Public law 100–223, section 203, does not permit compliance dates for TCAS II later than those adopted in this rule, and the FAA could not consider comments requesting later dates.

Technical Discussion

Thirty-three commenters included a discussion of TCAS, ACAS, Mode S, Mode C, or ATC technologies in their comments. Many in this group expressed the opinion that the technology still needed to be "fine tuned" before implementation. The FAA has provided for fine tuning of TCAS through the RTCA SC–147 committee working groups. The RTCA MOPS change 6 will contain additional fine tuning features, including simplification of the TCAS-to-TCAS coordination process, elimination of the advisory invalid indication, and many other recommendations.

One commenter postulated that the requirements for all aircraft to have "active TCAS systems would overload and violate the FAA's own requirement of limiting radio use for TCAS purposes to 1 percent of the total usage of the frequency that TCAS would operate on." This issue is not new. It was identified as one of the main development questions when, in 1982–84, the Beacon Collision Avoidance System (BCAS) design was extended to TCAS by increasing the ability to operate effectively under high density conditions. In the Lincoln Laboratory report that documents this development effort, "TCAS II: Design and Validation of the High-Traffic-Density Surveillance Subsystem," this issue is clearly identified (ATC–126, Feb-85, pages 2–6 to 2–9).

The TCAS II includes a provision called "Interference Limiting," the purpose of which is to insure that TCAS transmissions will not cause any degradation of any other systems operating in the 1030/1090 MHz frequency bands. During the TCAS development, it was recognized that a number of possible interference mechanisms needed to be considered: (1) Reception of TCAS interrogations by transponders, (2) reception of TCAS replies by ground-based ATCRBS equipment, and (3) self-suppression of the transponders on the TCAS aircraft. It was decided to place limits on TCAS transmissions in such a way as to give TCAS a low priority in these frequency bands. In doing this, a rather severe

limit of 2 percent was adopted as the maximum interference that can be contributed by all of the TCAS transmissions in a given area. The Interference Limiting standards were initially determined analytically from basic principles of physics. It was found that a relatively simple model could be implemented to provide the ability to adapt to any given density of aircraft and any percentage that are TCAS equipped. Subsequently, the interference limiting design was assessed by a large interference simulation of the 1030/1090 MHz bands. This simulation study was conducted by the Electromagnetic Compatibility Analysis Center (ECAC), making use of their experience in assessing many other similar interference issues. The simulation included a large number of aircraft, each with a given flight path, acting together with a large number of ground-based interrogators, with power levels, beamwidths, and other characteristics relating to operating conditions predicted for the 1995 timeframe. Two main conclusions resulted from this study. One was that the 2 percent interference allocation for TCAS was not exceeded. The other was that radio transmissions attributable to TCAS were completely insignificant in their effects on the performance of the ground-based ATCRBS equipment. As a result of this analysis and testing, the FAA concluded that there will not be a frequency interference problem.

One manufacturer submitted the following comments not previously addressed.

Comment: Equipment designs tested to date have not represented production TCAS II equipment. Representative equipment must be tested so that its acceptability in service can be assessed. Logic included in equipment tested, or to be tested (LIP), does not include corrective logic for "Altitude Crossover" or "TCAS-Invalid" deficiencies.

FAA response: The FAA will conduct flight tests of production units to validate the corrective logic.

Comment: Display requirements for "Glass Cockpits" will not be defined before mid-1988.

FAA response: The FAA defined and issued display requirements for "Glass Cockpits" in an advisory circular (AC) entitled *Airworthiness and Operational Approval of Traffic Alert and Collision Avoidance Systems (TCAS II) and Mode S Transponders*, AC No. 20-131, October 3, 1988.

Comment: Certification requirements, analysis, simulation, and flight test are not adequately defined, nor is a flight criticality level for TCAS II certification specified.

FAA response: As previously mentioned, AC No. 20-131 was published on October 3, 1988. It proposes acceptable certification criteria. The TCAS II system must be certified to the essential level, and the software programs to level 2 of RTCA DO-178A.

Comment: Certification requirements for compliance with foreign regulatory agency requirements for TCAS deactivation are unknown.

FAA response: There is a possibility that a foreign government may request a U.S. TCAS-equipped airplane to deactivate the TCAS system, which is provided for in the TCAS equipment standards. Section 91.1 of the FAR's provides for compliance with the foreign government regulatory requirements.

Comment: Certification requirements for U.S. carriers with airplanes dedicated to service abroad, such as Pan Am, are unknown.

FAA response: Public Law 100-223 requires installation "on each civil aircraft which has a maximum passenger capacity of more than 30 seats and which is used to provide air transportation of passengers. . . ." An air carrier operator who experiences hardship due to this regulation may petition for an exemption under section 601 of the FA Act of 1958.

Comment: The means of providing integrated TA's and RA's on older airplanes without color weather radar displays has not been economically addressed.

FAA response: The FAA minimum requirements specified in the TSO will require only a minimum of a three-target display. Any display beyond this minimum will be evaluated at the time of certification.

Comment: Required crew response to TA's and RA's should be specified. For TCAS to be effective, a standard mandatory response is necessary.

FAA response: The FAA does not believe that a mandatory response to TA's or RA's is necessary or appropriate. The AC for TCAS II certification and operation [AC No. 20-131; October 3, 1988] addresses crew training objectives.

Mode C

Five commenters addressed the issue of using Mode C. Generally, the respondents expressed the opinion that Part 125 aircraft should be allowed to use Mode C as an alternative to the TCAS II system, as the TCAS equipment costs would be prohibitive for such a class of operator. As previously mentioned, if the Part 125 operator's aircraft is configured for 30 passenger seats or less, then that aircraft is exempt from the TCAS requirement.

ICAO/PART 129 Foreign Carriers

The majority of comments mentioning ICAO (15) suggest that the FAA should coordinate TCAS implementation with Standards and Recommended Practices (SARPS) for international standardization. A standard for an ACAS generated by ICAO is especially important to foreign carriers. The FAA is actively participating with various ICAO technical groups through SICASP in an effort to generate this standard. The SICASP group will have been provided all FAA data concerning TCAS.

Of the comments addressing only the issue of TCAS implementation in Part 129 aircraft, two are against, two are for, and three request additional time to comply. Public law 100-223 did not exempt foreign air carrier operations, within U.S. airspace, from TCAS II requirements. The Congressional finding states that public health and safety requirements necessitate the timely completion and installation of a collision avoidance system for use by commercial aircraft flying in the United States. However, the FAA is extending the compliance time from 5 to 6 years for airplanes with 10 to 30 seats. These operators may elect to install TCAS I, II, or III. If they install a TCAS II or III unit, it must be compatible with TSO C-119.

Foreign air carrier aircraft with more than 30 passenger seats will be required to have installed and operating a TCAS II system, compatible with TSO C-119, when operating in the United States after December 30, 1991.

Upgrade TCAS II to TCAS III

In responding to the issue of upgrading TCAS II to TCAS III, most comments addressed the need for clarification. The respondents stated that the implied requirement for upgrading was questionable and should be more definitive. The upgrading has the support of one manufacturer, and another is supportive of the idea to require that TCAS III include the same operational criteria that will be used for TCAS II. One manufacturer stated that the "incentive to provide TCAS III growth is too vague to justify economic commitments."

Although the FAA has not required or proposed a compliance date for TCAS III, it will continue to develop, test, and evaluate TCAS III and provide data and technical support to RTCA for development of a TCAS III MOPS. Although the FAA may support a particular design for testing, it is more

important that it fosters the development of the MOPS. The FAA continues to support a LIP for TCAS III.

Other than the air-to-air coordination logic, the manufacturer has freedom of design of the TCAS systems. The FAA agrees with the commenter who expressed concerns regarding the interoperability of TCAS II and III. The TCAS II design shall not preclude the upgradeability to, nor the interoperability of, TCAS II and III. This rule does not mandate a TCAS III system. New rulemaking would have to be initiated for the requirement of TCAS III.

Training

Eight commenters were evenly divided concerning the need for standardized training prior to TCAS II implementation. Those who favor training requirements want training to focus on end-level performance, and do not believe that a specific technique is important. Training should focus also on difficulties involving the upgrade from TCAS II to TCAS III. The FAA intended the training requirements proposed in the NPRM to be training objectives, and the training program may not necessarily be limited to the proposed items. The training items, as proposed, appear in AC No. 20-131 dated October 3, 1988. The AC prescribes a means, but not the only means, of complying with the regulatory requirements.

Advisory Circular

Five commenters addressed the need to publish AC's regarding the TCAS system. Domestic industries that responded to this issue requested that such a circular be published 24 months in advance of the rule adoption. The FAA published AC No. 20-131 on October 3, 1988, to provide guidance for the installation and operational approval of TCAS III.

Product Liability

Several commenters, some foreign, addressed the issue of product liability. The commenters suggested that, as a result of the FAA's requirement to install a system designed and developed by the FAA, the Government will be subject to product liability claims for use of TCAS equipment. Some commenters further requested that the FAA voluntarily indemnify the regulated operators from such liability.

The FAA considers the TCAS requirement similar to other operating requirements involving the use of certain equipment, and the agency does not consider it necessary or beneficial to make any special provision for liability claims against the Government or regulated operators.

Applicability

Thirty-six commenters addressed this issue. Four of the comments were sent by private individuals, nine were sent by foreign agencies, and the remainder were submitted by domestic (U.S.) industries. The primary concern expressed was that TCAS I should be required for Part 135 operators, but not TCAS II. Many commenters expressed the opinion that there is no justification for the use of the TCAS system over other collision avoidance systems. As previously stated, the FAA relaxed the TCAS requirement and compliance times proposed in the NPRM for Part 135 operators. Additionally, the FAA will evaluate passive/active TCAS I systems.

Foreign operators stated that it was necessary to continue to allow ATCRBS to be used, due to the cost of installing and operating Mode S, and that the installation of the TCAS system should be limited to new U.S.-registered aircraft. Many comments addressed the need for uniform installation of the TCAS system, and a few respondents expressed the opinion that Mode C should be mandatory in all aircraft.

The FAA addressed the Mode C requirement in another rulemaking action, "Transponders With Automatic Altitude Reporting Capability Requirement," Amendment No. 91-203 (53 FR 23356; June 21, 1988). Mode S is a necessary component of TCAS II. The Mode S air-to-air data link provides TCAS II with the coordination procedures necessary for the proper RA in a TCAS to TCAS conflict. The TCAS I does not require a Mode S transponder to be installed.

The introduction of TCAS I and II is expected to reduce substantially the threat of midair collision. To equip only new U.S.-registered aircraft would be inconsistent with the requirements of Pub. L. 100-223 and would delay the benefits of a TCAS program. A high degree of protection can be realized for those operators with the expanded requirement for Mode C in general aviation aircraft and TCAS II in air carrier aircraft. Concerns were raised about the size, weight, and interfacing of the new equipment, and some comments cited the need to test representative equipment to assess its service acceptability. Some commenters stated that the display of aircraft was an essential component in the Minimum Equipment List (MEL). The FAA promulgates minimum standards and evaluates manufacturers' designs to those standards. Size, weight, and interface are market place decisions. Service acceptability will be assessed in that the system is compatible with other TCAS designs with respect to coordination logic and human factor considerations. The FAA evaluates the display systems for minimum requirements and functional compatibility during the certification evaluation in the aircraft.

Nine commenters expressed concerns relative to Part 125 aircraft. Four of these respondents stated that Part 125 aircraft should be exempt from the rule or be allowed to maintain the existing ATCRBS system requirements. The Congressional mandate covers all commercial aircraft with passenger seating configuration of more than 30 seats. With respect to aircraft with 30 seats or less, the FAA agrees with the comments. Under the rule adopted, those aircraft operating under the provisions of Part 125 in nonrevenue passenger service, with passenger seat configuration of 30 seats or less, will not be required to have a TCAS system installed.

Include All Aviation

Fifteen commenters stated that the only way to ensure maximum effectiveness of the proposed TCAS system is to extend the requirement to include Part 125, Part 129, Part 135, and military aviation aircraft. The final rule does include aircraft operating under these parts to varying degrees, but it does not apply to military aircraft. However, the U.S. Navy is studying the feasibility of using TCAS I on military trainers, and the FAA is cooperating with the Navy to pursue certification of a passive/active system for the Navy T-34C trainer aircraft.

One commenter questioned whether the rule is to apply to air cargo carriers. The Part 121 rule specifically addresses aircraft with passenger configuration of more than 30 seats. However, if there is a split cargo/passenger aircraft with more than 30 seats, the airplane must have a TCAS II installed; 10 to 30 seats, the airplane must have at least a TCAS I installed. However, the FAA will not require installation of a TCAS on a large combination cargo/passenger airplane simply because of the capability for increasing passenger capacity, if the aircraft is not operated with 10 or more passenger seats.

One commenter suggested issuing a supplemental NPRM that airworthiness regulations be amended to require TCAS and to adjust the requirement of Section 25.1309 to recognize the value of TCAS in reducing overall risk. The FAA does not believe this is necessary in that

all Part 25 aircraft are not required to have TCAS II installed according to the operating rules.

FAA Responsibility

Several comments received expressed a desire that configuration of the Collision Avoidance System (CAS) software be the responsibility of the FAA. The FAA does control the configuration of the CAS logic software by requirements in the TSO and subsequent installation approval. To change the software of the CAS logic would require the TSO holder to apply to the FAA for approval of a major change to the original approved design data. Deviations (major changes) to TSO's are only approved by the Aircraft Engineering Division of the Office of Airworthiness in Washington, DC.

Pilot Immunity for TCAS

There are several commenters who desire the FAA to grant blanket immunity to pilots for following or failing to follow an RA from the TCAS. The FAA cannot support this proposal from the industry for the following reasons:

(a) The pilot will always be ultimately responsible for his/her actions and must be held accountable for them. In the case of TCAS, there is no doubt that there may be instances where the pilot will be "off-altitude" in response to a TCAS-generated RA, and may indeed be involved in a near midair collision or an actual collision. During the review process of the incident, as in all incidents, all factors will be considered, including the factors that are TCAS related, and a determination made. This is the only position that the FAA can take on this matter and it must be made clear to all operators of TCAS.

(b) The FAA has never granted blanket immunity to flightcrews for any operation regardless of the criticality of that operation. There is no legal precedent for granting such broad relief from responsibility. Section 91.3 of the FAR states, "The pilot in command of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft." Introducing TCAS into the National Airspace System does nothing to change this regulation.

Every consideration will be given to the flightcrew in the review process for TCAS-related incidents. All factors will be thoroughly reviewed and determination made as to responsibility.

Aviation Trust Fund

One commenter expressed the opinion that the FAA would be well advised to use the Aviation Trust Fund to upgrade and improve the existing ATC system. This comment is outside the scope of this NPRM.

Economic Considerations

Of the 32 comments received mentioning economic considerations, only two respondents, both elected government representatives, were of the opinion that the cost involved is minimal. Most commented that the economic impact is not adequately addressed. Specific concerns voiced include those from small operators who believe they will be forced out of business, and large airlines who believe that the upgrade from TCAS II to TCAS III will be costly. As previously mentioned, the FAA relaxed the time for compliance for airplanes having a seating capacity of 10 to 30 passenger seats. This change will definitely reduce the economic impact on small operators. Four commenters proposed less costly alternate systems to TCAS.

In the NPRM the FAA agreed to consider passive versus active TCAS I systems as long as the applicant can demonstrate that the passive system provides the equivalent level of safety as active TCAS I. To date, the FAA has received no valid data to show that a passive TCAS I can meet the safety intent of the rule, so this final action assumes an active TCAS I. If passive TCAS I can be demonstrated to meet the rule, than the FAA would be amenable to follow-on regulatory action to allow its use.

The FAA does not expect to mandate TCAS III at this time. The economic considerations for TCAS II are discussed in the regulatory impact analysis summary.

Other Comments Not Previously Addressed

One manufacturer suggested new standards for automatic altitude reporting be required similar to an ATA petition dated March 25, 1986. Although the FAA would have to agree that reduced altitude error does increase the accuracy of the projected flight path of the intruder aircraft during TCAS tracking, the safety analysis done on the current altitude encoder errors would conclude safe TCAS operation.

One commenter was concerned that there was no data on the performance characteristics of TCAS II in high wing with engines mounted on the wing. The FAA does not have any information or data that indicates there will be any adverse effect of TCAS operation on these aircraft. However, the FAA will conduct in-service evaluations in such aircraft to obtain system performance and aircraft performance information.

One commenter, James Pope, was critical of the FAA's TCAS program and supported an ACAS unit not dependent on radar transponders. Pope alleged that 770 lives have been lost in ACAS-preventable midair collisions during the development of TCAS. This commenter asserts that NPRM 87-8 must be promptly withdrawn and immediate action taken by FAA to certify the proven and ready-to-go ACAS.

This commenter has previously made these same allegations to the FAA which were subsequently investigated on two occasions by the General Accounting Office and found to be without basis. The FAA believes that it has previously provided detailed answers to the commenter's allegations, and does not believe it is necessary to give an indepth analysis here. Anyone wishing a copy of the investigative reports can contact the person identified under the section, **"FOR FURTHER INFORMATION CONTACT."**

Discussion of Rule

The FAA currently operates a complex network of facilities and subsystems designed to ensure the safe and efficient operation of the National Airspace System (NAS). Operations within the NAS and its many components are governed by an array of Federal Aviation Regulations (FAR) and procedures. Consequently, a wide variety of facilities and services are available. Nevertheless, the primary function of separating aircraft is predicated on the fundamental concepts of ground-based control and the see-and-avoid responsibility of the flightcrew.

Under the see-and-avoid concept, the level of safety is related to the ability of pilots, individually and collectively, to detect and avoid encounters with other aircraft. Although common sense and the FAR require continuous adherence to the principles of see-and-avoid, the concept does have limitations. The pilot's ability to acquire aircraft visually on collision courses is reduced under heavy workload conditions, in areas of high traffic densities, and when the aircraft is in conditions of poor visibility.

The second fundamental concept upon which the separation of aircraft is predicated is ground-based control. Through the issuance of instructions, clearances, and advisories, air traffic controllers ensure that prescribed separation standards are applied between aircraft. Since these instructions are based on known and projected flight information, this system does not rely totally on the pilot's ability

to acquire traffic visually to achieve acceptable levels of safety. In some segments of the NAS, such as terminal control areas, positive control is exercised, and operations in such airspace are conducted under ATC instructions. A terminal radar service area is an example of upgrading of the see-and-avoid concept and represents a complex control environment, since both controlled and uncontrolled aircraft are operating in the area. The overall collision avoidance system design must address the unique problems of such a mixed traffic environment.

The FAA's approach to TCAS is to encourage the development of a family of onboard collision avoidance systems, to demonstrate the operational and technical feasibility of the concept, and to support the development of national/international standards for the equipment. A principal objective of the TCAS approach is to provide a range of collision avoidance equipment alternatives for the full spectrum of airspace users ranging from small airplanes to large transport category airplane. The TCAS Program consists of the following three program elements: TCAS I, which provides only TA's; TCAS II, which provides TA's and RA's in the vertical plane only; and TCAS III, which provides TA's and RA's in both the vertical and the horizontal planes.

On December 30, 1987, the President of the United States signed Pub. L. 100-223 which among other provisions, amended the FA Act of 1958, Section 601, by adding a new paragraph (f) entitled "Collision Avoidance Systems." This new section requires TCAS II on "each civil aircraft which has a maximum passenger capacity of more than 30 seats and which is used to provide air transportation of passengers, including intrastate air transportation of passengers." The amendment does not provide for the exception of any class of civil operation or operator, U.S. or foreign, from the basic rule.

The rule adopted provides for the installation of appropriate TCAS units on airplanes used in commercial air carrier, selected air taxi/commuter operations, and on airplanes used by foreign carriers flying in the U.S. airspace. The categories of commercial aircraft for which TCAS I or II will be required are based on the provisions of Pub. L 100-223 and on the relative speed of the aircraft, the size of the aircraft, and the number of passengers per aircraft who would benefit from TCAS installation.

Aircraft operating exclusively under Part 91, General Operating and Flight Rules, are not required to have installed any TCAS equipment. However, if an operator or owner elects to install a TCAS unit, the system must be FAA approved and operated according to FAA prescribed procedures. The TCAS system installed must be shown to operate in the ATC system and in coordination with other FAA approved active TCAS systems.

Part 135 commuter and air taxi operators of turbine powered airplanes with 10 to 30 passenger seats will be required to install a TCAS I system to provide TA's from other transponder-equipped aircraft. These advisories should give bearing and distance from the TCAS-equipped airplane in the case where the other aircraft have only a Mode A transponder (no altitude reporting). If the intruder aircraft is Mode C- or Mode S-equipped, the TCAS I unit should also display altitude, which provides the pilot a sector both in the vertical as well as the horizontal plane to look for the threat aircraft. TCAS I, although not providing an RA, does provide sufficient alerting time for the pilot to visually acquire the threat aircraft and take evasive action if necessary. Although the RTCA MOPS has been approved for TCAS I, no system has been built to date. The FAA believes that development of collision avoidance equipment that can meet the TCAS I MOPS is well within the state of the art for equipment manufacturers and that adequate quantities to supply the commuter/air taxi fleet can be manufactured and installed during the time period prescribed.

Part 135 operators of 10 to 30 passenger seat turbine powered airplanes are required to have installed a TCAS I within 6 years after the effective date of the rule. Installation of TCAS I does not require the installation of a Mode S transponder.

Part 121 and 125 operators of large airplanes of more than 30 seats are required to have TCAS II and Mode S installed and operating by December 30, 1991. These operators may wish to upgrade to TCAS III units when they become available. Much research is necessary to develop TCAS III to the point that it can be type certificated. The ability to produce operational TCAS III units is many years away.

Part 129 foreign air carrier operators of turbine powered airplanes with passenger seating configurations of 10 to 30 are required to have installed and operating a TCAS I when operating in U.S. airspace 6 years after the effective date of this rule. Foreign air carrier operators of airplanes with more than 30 passenger seats are required to have installed and operating a TCAS II and Mode S transponder when operating in U.S. airspace after December 30, 1991. The FAA believes that this final rule will encourage affected foreign airplane operators, and their airworthiness authorities, to become familiar with the associated TSO's and RTCA documents that form the basis of approval and manufacture of a TCAS approved by the FAA. The TCAS systems approved by foreign airworthiness authorities must be compatible with and perform with the FAA-approved TCAS, transponders, and ATC system when operating in United States airspace.

Where the rules require a TCAS I or II unit, the intended minimum TCAS units are those complying with the requirements of TSO C-118 and TSO C-119 as appropriate, with the exception of Part 129 foreign air carrier operators. Where the rule specifies an approved TCAS, the installer may elect TCAS I, II, or III. Where the rule requires a TCAS II, the installer may elect TCAS II or III. There is no requirement, at this time, for the installation of a TCAS III system. The TCAS III system is being developed to enhance the basic TCAS II system by providing a more accurate surveillance capability and alternative escape maneuver selection in the horizontal plane. The FAA can envision that some operators may want to update their TCAS II units to TCAS III when available. The required TCAS III system design as will be defined in the applicable TSO and MOPS will permit the upgrading of a TCAS II unit to a TCAS III. In the applicable standards for TCAS II, whenever a choice exists between TCAS II and TCAS III elements (i.e., antenna, etc.), the TCAS III element will be specified in the TSO and MOPS. The FAA is committed to support the development of TCAS III. Any rulemaking concerning mandatory use of TCAS III will be handled separately from this rulemaking.

Flight Manual Requirements and Operational Approval

Where the rule requires TCAS to be used in air carrier service, operational approval must be obtained from the FAA at the time that certification (TC or STC) application is made. The applicant must submit for approval flight crew qualification, training program, and TCAS inoperative items to be included in the appropriate Master Minimum Equipment List.

Technical Standard Order

The RTCA Special Committee SC-147 has developed RTCA Document DO-197, Minimum Operational Performance Standards (MOPS) for An Active Traffic Alert and Collision Avoidance System I (Active TCAS I). This document forms

the basis of a TSO that will permit the active TCAS I to be manufactured under the TSO approval system.

The RTCA Document DO–185, Volume I and II, Changes 1 thru 5, *Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System (TCAS) Airborne Equipment* and FAA Report No. DOT/FAA/SA–88/3, *Required Modifications to the Traffic Alert and Collision Avoidance System (TCAS II) Minimum Operational Performance Standards (MOPS)* set forth standards for TCAS II equipment. These documents will also form the basis of a TSO to permit manufacturing under the TSO approval system. The TCAS III MOPS will be a new RTCA document separate from DO–185 but will identify a system functionally compatible and interchangeable with TCAS II. The three TCAS systems I, II, and III will be identified under the TSO system by different TSO numbers. Concurrent with the publication of this rule, the FAA is publishing TCAS I and TCAS II TSO's defining the minimum standards for such units.

While FAA research, to date, has focused on an active TCAS I, it has been suggested by some people that a passive (listen only) device may be able to meet the same objective intended by the active TCAS I units. While this regulatory action on a TCAS I TSO presupposes an active TCAS I, the FAA wishes to go on record as not being opposed to a passive TCAS I, as long as it meets the same safety objectives of DO–197.

TCAS Training Requirements

The introduction of TCAS into revenue service need have little impact on the existing regulations regarding required crew training, and therefore should not require a change to the existing training requirements. As specified in § 121.401, a Part 121 certificate holder is required to establish, obtain the appropriate initial and final approval of, and provide a training program that meets the requirements of Part 121, Subpart N, and insure that each crewmember is adequately trained to perform his/her assigned duties. Section 121.401 will have the effect of requiring training on TCAS. Section 121.415(g) requires that each crewmember qualify in any new equipment, including modifications to airplanes. Section 121.407(a)(3) requires that each airplane simulator and other training device be modified to conform with any modification to the airplane being simulated.

The pilot training program for TCAS should provide the flightcrew the necessary knowledge, skills, and abilities to safely conduct TCAS operations.

Regulatory Impact Analysis Summary

Introduction

This section summarizes the cost impact and benefit assessment of the final rule to amend Parts 1, 91, 121, 125, 129, and 135 of the Federal Aviation Regulations (FAR) to require the installation and use of a Traffic Alert and Collision Avoidance Systems (TCAS) in large transport airplanes and certain turbine-powered smaller airplanes. TCAS II, which utilizes a signal from existing transponders equipped with altitude encoding capability, provides collision avoidance guidance in the airplane independent of the ground Air Traffic Control (ATC) system. These amendments also require that all operators of TCAS-equipped airplanes have an FAA-approved training program for flight crewmembers. Finally, this rule requires that certain small aircraft be equipped with TCAS I, a simpler system providing collision alert warning but no flight guidance. The amendments are in response to legislation that mandates the FAA to require the installation and operation of TCAS in certain commercial airplanes flying in the United States.

These amendments stem from a Notice of Proposed Rulemaking (NPRM) published in the **Federal Register** on August 26, 1987. Comments on the proposal were submitted by individuals, foreign and domestic air carriers, air carrier and airplane pilot associations, foreign and domestic Government agencies, research and consultant organizations, avionics manufacturers, and the National Transportation Safety Board. Approximately half of the 70 respondents expressed support of the proposed rule to require TCAS. The remaining respondents, however, opposed certain proposed requirements and disagreed with the economic impact estimates presented in the preliminary regulatory analysis. The FAA has evaluated the public comments and made a final determination regarding their impact. The comments have caused the FAA to revise its estimates of economc impacts and increase compliance costs. The final rule amendments to Parts 121, 125, and 129 require that after December 30, 1991, no person may operate a large airplane that has a passenger seating configuration, excluding any pilot seat, of more than 30 seats unless it is equipped with an approved TCAS II and the appropriate class of Mode S transponder.

A substantial change in the final rule is the elimination of the requirement contained in the notice that airplanes operated under 14 CFR Parts 125, 129, and 135 having a passenger seating configuration of 20 to 30 seats be equipped with TCAS II. The final rule, therefore, requires that turbine-powered airplanes operated under Parts 129 and 135 having a passenger seating configuration of 10 to 30 seats, excluding pilot seats, be equipped with TCAS I under a longer than normal compliance period.

Cost-Benefit Analysis

Executive Order 12291 of February 17, 1981, requires that to the extent permitted by law, regulatory action not be taken unless the potential benefits to society for the regulation outweigh potential societal costs. This determination is normally made on the basis of a regulatory evaluation. In this case, however, the Congress may be said to have already determined that this final rule is in the public interest; that is, its collective public benefits outweigh its costs to the public, because Congress has required the rule be promulgated (The Airport and Airway Safety and Capacity Expansion Act of 1987: Pub. L. 100–223). Nevertheless, the FAA has prepared this conventional regulatory evaluation of the rule. The purpose of this evaluation is not to justify taking this rulemaking action (which has already been done through congressional action), but to estimate dollar costs and benefits to promote understanding of the impact of the rule.

Costs

The FAA finds that the revisions to Parts 1 and 91 will have no cost impact. The amendments, however, to Parts 121, 125, 129, and 135 will cause affected certificate holders to incur costs.

The FAA recognizes that there will be costs associated with the amendments to Part 129. These costs are likely to be similar to those incurred by affected Parts 121 and 135 certificate holders, but have not been quantified because the burden of compliance will not be directly borne by any sector of U.S. society.

The methods and assumptions used in this analysis to prepare the final cost and benefit estimates for the revisions to Parts 121, 125, and 135 have been developed by the FAA. Data used to develop cost estimates at the NPRM stage of rulemaking were obtained from manufacturers, air carriers, avionics repair facilities, and industry trade associations. The FAA has updated this information and conducted additional

research to respond to the comments concerning the economic impact estimates of various proposals. The information obtained has been used to formulate the final cost estimates of the rule. The cost and benefits calculated for the final rule are projected over the estimated 15-year life cycle of TCAS equipment. Therefore, this analysis compares the costs and benefits of TCAS II equipment for Parts 121 and 125 over a 15-year period of 1989 to 2003. To allow sufficient time for the development and certification, this rule does not require the use of TCAS I until 1996. Accordingly, to reflect the longer than normal compliance period, the analysis for Part 135 has been extended over the 15-year period of 1993 to 2007.

New § 121.356 will have an economic impact on the 3,365 existing airplanes expected to be in service in 1989 and 3,100 airplanes expected to be manufactured between 1989 and 2003 because these airplanes will be required to be equipped with a TCAS II system. The estimated cost of this requirement is $806.3 million in 1987 dollars and $543.0 million at a present worth discount rate of 10 percent over the 15-year period of 1989 to 2003.

The amendments to Part 121 will also require that air carriers develop and implement an FAA-approved TCAS II training program for their captains and first officers. The training program will require that air carriers install approved TCAS II aerodynamic data programs in their flight simulators and provide an additional one and a half hours of classroom instruction during initial training for their existing and newly-hired flightcrews. As part of the classroom instruction, certificate holders will be required to use a real time interactive device to complete transfer of system knowledge from the classroom to the cockpit. The estimated cost of modifying the 150 flight simulators currently in use by Part 121 certificate holders is $2.2 million in 1987 dollars and $2.0 million discounted at a present worth rate of 10 percent in the first year the rule is in effect. The cost of acquiring the small computers to be used as interactive training devices to transfer and reinforce classroom instruction is estimated to be $462 thousand in 1987 and $420 thousand discounted the first year the rule is in effect.

The estimated cost of requiring captains and first officers of the 149 affected Part 121 certificate holders to undergo additional classroom training is $24.5 million and $13.7 million discounted over the projected time period. Finally, the onetime cost of developing an FAA-approved TCAS II training program is estimated to be $3.7 million in 1987 dollars and $3.4 million discounted at a rate of 10 percent in the first year the rule is in effect. This analysis indicates that the total cost of compliance to Part 121 certificate holders with the equipment acquisition, installation, maintenance, and flight crewmember training requirements contained in this rule is estimated to have a present value of $562.5 million over the 15-year period of 1989 to 2003.

The addition of § 125.224 will require that airplanes with a passenger seating configuration, excluding any pilot seats, of more than 30 seats be equipped with TCAS II. The estimated cost of equipping the 22 airplanes now operating under the rule of Part 125 is $2.5 million in 1987 dollars and $2.3 over the 15-year period of 1989 to 2003.

The amendments to Part 135 will require that all turbine powered airplanes with 10 to 30 passenger seats be equipped with TCAS I. In addition, the rule will require that all operators of TCAS I equipped airplanes have an FAA-approved TCAS I training program for flight crewmembers.

The estimated cost of equipping 2,772 airplanes with TCAS I units is $34.1 million in 1987 dollars and $14.7 million discounted over the 15-year projected service life of the equipment of 1994 to 2008. The estimated cost of requiring the flightcrews of affected air taxi and commuter operators to undergo additional classroom training during the initial phase of flight training is $1.3 million in 1987 dollars and $0.7 million at a 10 percent present worth rate. Finally, affected Part 135 operators required to have an FAA-approved training program will incur a one-time cost estimated to be $1.0 million in 1987 dollars and $.9 million discounted at 10 percent the first year the rule is in effect. On the basis of the above, the aggregate impact of these amendments on affected air taxi and commuters is $36.5 million in 1987 dollars and $16 million when discounted at 10 percent over the 15-year period of 1993 to 2007.

Benefits

The TCAS rule is expected to provide potential benefits primarily in the form of improved safety to the aviation community and flying public. Such safety, for example, will take the form of reduced casualty losses (namely, fatalities and property damages) as the result of a lowered likelihood of midair collisions.

In general terms, the benefits of an effective airborne traffic alert and collision avoidance system in reducing the risk of midair collisions system in reducing the risk of midair collisions have been obvious for many years. As air traffic continues to increase and concentrate at terminal areas, the growing consensus of both the general public and most aviation professionals is that such a system would be a valuable safety addition. In 1987, Congress determined that requiring TCAS II in most large aircraft is in the public interest. Although experienced airspace system operators also agree that the system would be beneficial, accurately quantifying benefits is difficult because (fortunately) there have been few actual Part 121 midair collisions in recent years. At the time of the notice, the FAA developed a mathematical model to assess the increase in collision risk that would result from the projected growth in aviation traffic activity. The FAA used a "square law model" to forecast that four midair collisions involving a large airplane and 24 midair collisions of taxi and commuter airplanes would occur if no additional safety measures were taken to offset the affects of traffic growth. Since that time, the FAA has analyzed the issue further, and has concluded that although the "square law model" is simple to apply and yields specific results, the air traffic control system is too complex for the model to be expected to provide reasonably accurate results. For this reason, the FAA has changed the basis of its benefits analysis for the final rule. The fact is, that given the very few midair collisions involving large aircraft that have occurred in recent years, and given the air traffic control improvements that have occurred and will occur shortly (such as new Mode C requirements), it is not possible to reasonably forecast specific numbers of future midair collisions. Also, the FAA is unable to allocate specific numbers of future midair collisions that will be avoided in the future between the new Mode C requirements and this TCAS rule. Instead of attempting to do this, the FAA has chosen to estimate a range of midair collisions that may occur. Currently, the stage is set for a midair collision only when one or both pilots of two aircraft make a mistake *and* the ATC system fails *and* TCAS fails. In the enroute system, TCAS plays a somewhat stronger role where ATC radar coverage does not exist.

The above factors tend to reduce the number of future midair collisions. On the other hand, steadily increasing traffic levels tend to increase the risk. In an attempt to estimate the range of midair collisions within which the actual number of future midair collisions of large aircraft will fall, the FAA

employed a Poisson distribution. Based on a history of two collisions in the recent past, the Poisson distribution indicates that there is a 60 percent probability two or more collisions in the future forecast period, and a 95 percent probability that the number will not exceed seven. The FAA believes that the range of two to seven is a reasonable expectation of the number of midair collisions involving a large aircraft during the next 15 years. In monetary terms, over the subject time period, this rule is expected to accrue potential benefits ranging between $207 million and $724 million (discounted, in 1987 dollars).

A similar analysis of the number of Part 135 midair collisions that may be avoided through TCAS I yields a range of 4 to 14 during the 15-year analysis period. Based on the moderate cost of TCAS I, this part of the rule is cost-beneficial throughout the range of potential midair collisions avoided. For example, in monetary terms, over the subject time period, this rule is expected to accrue potential benefits ranging between $27 million and $97 million (discounted, in 1987 dollars), compared to costs of $18 million (which included $2 million for the Mode C rule).

In view of the aforementioned discussion on benefits for Parts 121 (including Part 125) and 135, the FAA believes that a share of the potential benefits expected to accure from implementation of this rule must be attributed to the Mode C rule, though to what extent is not known. This situation is due to the belief that the benefits of the TCAS and Mode C rules are inextricably linked.

Comparison of Parts 121 and 135 Costs and Benefits

Addressing only 14 CFR Parts 121 and 135 costs and benefits of this TCAS rule, the cost of compliance is estimated to be $563 million and $18 million, respectively (discounted) in 1987 dollars. The benefits of this rule, however, are difficult to quantify for two reasons. The first is associated with the uncertainty of estimating the number of midair collisions that will occur in the future absent any improvements in the airspace system over and above what currently exists. This difficulty has already been discussed at length in the detailed regulatory evaluation and the FAA has chosen to consider ranges of 2 to 7 and 4 to 14 collisions involving Parts 121 and 135 operators, respectively, may occur in the forecast period.

The second reason benefits are difficult to forecast accurately is that at about the same time this rule becomes effective a separate rule will become effective expanding Mode C requirements. Both rules are aimed at reducing the risk of midair collisions and are inextricably linked. The FAA is unable at this time to document the separate impacts of these two rules in reducing the risk.

The FAA made an earlier estimate of the dollar value benefits associated with avoiding future midair collisions as part of its evaluation of the Mode C rule. That estimate was significantly lower than the updated estimate prepared for this rule. The difference is only partly explained by the fact that the Mode C rule estimate was for a 10-year period while the estimate for this rule covers a 15-year period into the future (to allow for the relatively long periods before compliance is required).

Both evaluations used a Poisson distribution model as a basis to estimate the number of future midair collisions that might be expected in the absence of any further airspace system improvements to prevent them. In the Mode C analysis, the FAA very conservatively accepted the low side of the distribution (two accidents) in calculating benefits. However, based on the belief that U.S. commercial aircraft operations are forecast to more than double during the analysis period, the FAA now believes that a better approach is to analyze a range of values.

In view of the difficulties discussed above, the FAA believes that the most realistic approach to comparing benefits and costs is to compare the total Part 121 costs of the TCAS rule plus the Mode C rule with the full estimated range of possible Part 121 benefits. In a similar manner, total Part 135 TCAS rule plus Mode C rule are compared to the total range of Part 135 benefits.

In the case of Part 121 operator, the cost of the Mode C rule is negligible because virtually all Part 121 aircraft are already in compliance with the rule. Table 1 shows the cost of saving one life through the range of estimated Part 121 midair collisions. As indicated in the table, these cost-per-life-saved figures are based on an estimated total Part 121 TCAS cost of $563 million and no attempt was made to allocate some benefits to the Mode C rule. (A similar exercise can be performed for Part 135 from Table 1.)

TABLE 1.—ESTIMATED TCAS II (PART 121) AND TCAS I (PART 135) COST OF SAVING LIVES

[1987 dollars]

Range of potential midair collisions		Estimated discounted benefits (TCAS plus Mode C rules) ($ millions)		Estimated cost of saving one life in ($ thousands)	
Part 121	Part 135	Part 121	Part 135	Part 121	Part 135
7	14	$724	$97	$710	$0
6	12	621	83	880	20
5	10	517	69	1,120	70
4	8	414	55	1,480	120
3	6	310	42	2,080	290
2	4	207	27	3,280	550
1	2	103	14	6,830	1,360

The FAA concludes that this TCAS rule is warranted because it will contribute to an overall enhancement of transport and commuter categories airplane safety and utility which will both promote and enhance public confidence in, and utilization of, the U.S. air transportation system. Although the FAA has not yet quantified the value of public confidence in air transportation, it believes there is a very real cost to the system when public confidence is reduced through media coverage of each major midair collision tragedy. The fragility of public confidence is difficult to quantify, but the potential benefits in this regard stemming from avoidance of a major midair collision is very real and substantial. For example, the near-to-midair term loss of passenger bookings following the publicity of a midair collision is readily acknowledged within the industry. Even a special Government safety review of a particular air carrier

can have a temporary adverse impact on yields. The qualitative nature of this consideration does not render it less significant as a factor in determining to proceed with the TCAS rulemaking action.

The Regulatory Impact Analysis that has been placed in the docket contains detailed information related to the potential costs and benefits of those amendments to Parts 121, 125, and 135 that are expected to accrue from implementation of this rule.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 requires a review of rules to assess their impact on small business. In consideration of the cost information discussion under the Regulatory Impact Analysis, the FAA concludes that these amendments to Parts 121, 125, and 135 will have a significant economic impact on a substantial number of small entities. However, the FAA finds that there are no viable alternatives for small air carriers to adopt that will reduce the cost of compliance yet achieve the levels of protection sought by these amendments. It can be pointed out, however, that the majority of small entities affected by this rule are Part 135 operators (small air taxis and small commuters). These small businesses will have 6 years to comply with this rule (as opposed to 3 years for Parts 121 and 125 operators). The average total cost impact of this rule on a small air taxi operator or small commuter for TCAS I units is estimated at $36,000 (or $4,700 annualized) and $76,000 (or $10,000 annualized), respectively, over the 15-year period 1989 to 2003. For Parts 121 and 125 operators, the average total cost for TCAS II units is estimated to be $734,000 (or $96,000 annualized) over the 15-year period.

International Trade Impact Statement

These amendments will have little or no impact on trade opportunities of U.S. firms doing business overseas or for foreign firms doing business in the United States. These rules will impose the same requirements on both domestic operators under Parts 121, 125, and 135 of the FAR and foreign air carriers subject to Part 129. The cost of compliance with these rule amendments to foreign carriers flying into the United States under Part 129 is likely to be very similar to the cost incurred by domestic operators. Thus, neither domestic nor foreign air carriers will be affected disproportionately by these amendments. These rules, therefore, will not cause a competitive fare disadvantage for U.S. carriers operating overseas or for foreign carriers operating in the United States.

Federalism Implications

The regulations adopted herein would not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government. Thus, in accordance with Executive Order 12612, it is determined that such regulations do not have federalism implications warranting the preparation of a Federalism Assessment.

Conclusion

For the reasons discussed in the preamble, and based on the findings in the Regulatory Flexibility Determination, and the International Trade Impact Analysis, the FAA has determined that this rule is a major rule under Executive Order 12291. In addition, in consideration of the cost information discussion under the Regulatory Impact Analysis, the amendments to Parts 121, 125, and 135 will have a significant economic impact on a substantial number of small entities. This rule is considered significant under *DOT Regulatory Policies and Procedures* (44 FR 11034; February 26, 1979). A regulatory impact analysis of this final rule, including a Regulatory Flexibility Determination and International Trade Impact Analysis, has been placed in the docket. A copy may be obtained by contacting the person identified under "**FOR FURTHER INFORMATION CONTACT**".

List of Subjects

14 CFR Part 1

Air carriers, Aircraft, Airplanes, Air safety, Aviation safety, Safety.

14 CFR Part 91

Air Traffic control.

14 CFR Part 121

Air carriers, Aircraft, Airspace, Air traffic control, Aviation safety, Safety.

14 CFR Part 125

Aircraft, Airplanes, Air traffic control.

14 CFR Part 129

Air carrier, Aircraft, Air traffic control.

14 CFR Part 135

Aircraft, Airplanes, Airspace, Air traffic control, Aviation safety, Safety.

The Amendments

In consideration of the foregoing, the Federal Aviation Administration amends Parts 1, 91, 121, 125, 129, and 135 of the Federal Aviation Regulations (14 CFR Parts 1, 91, 121, 125, 129, and 135) as follows:

PART 1—DEFINITION AND ABBREVIATIONS

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

Authority: 49 U.S.C. 1347, 1348, 1354(a), 1357(d), 1372, 1421 through 1430, 1432, 1442, 1443, 1472, 1510, 1522, 1652(e), 1655(c), 1657(f), 49 U.S.C. 106(g) (Revised Pub. L. 97-449, January 12, 1983).

2. Section 1.1 is amended by adding new definitions to read as follows:

§ 1.1 Definitions.

* * * * *

"TCAS I" means a TCAS that utilizes interrogations of, and replies from, airborne radar beacon transponders and provides traffic advisories to the pilot.

"TCAS II" means a TCAS that utilizes interrogations of, and replies from airborne radar beacon transponders and provides traffic advisories and resolution advisories in the vertical plane.

"TCAS III" means a TCAS that utilizes interrogation of, and replies from, airborne radar beacon transponders and provides traffic advisories and resolution advisories in the vertical and horizontal planes to the pilot.

* * * * *

3. Section 1.2 is amended by adding a new abbreviation as follows:

§ 1.2 Abbreviations and symbols.

* * * * *

"TCAS" means a traffic alert and collision avoidance system.

* * * * *

PART 91—GENERAL OPERATING AND FLIGHT RULES

4. The authority citation for Part 91 continues to read as follows:

Authority: U.S.C. 1301(7), 1303, 1344, 1352 through 1355, 1401 through 1431, 1471, 1472, 1502, 1510, 1522, and 2121 through 2125; Articles 12, 29, 31, and 32(a) of the Convention on International Civil Aviation (61 Stat. 1180); 42 U.S.C. 4321 et seq.; E.O. 11514; 49 U.S.C. 106(g) (Revised Pub. L. 97-449, January 12, 1983).

5. Section 91.26 is added to read as follows:

§ 91.26 Traffic alert and collision avoidance system equipment and use.

(a) *All airspace: U.S.-registered civil aircraft.* Any traffic alert and collision avoidance system installed in a U.S.-

registered civil aircraft must be approved by the Administrator.

(b) *Traffic alert and collision avoidance system, operation required.* Each person operating an aircraft equipped with an operable traffic alert and collision avoidance system shall have that system on and operating.

PART 121—CERTIFICATION AND OPERATIONS: DOMESTIC, FLAG, AND SUPPLEMENTAL AIR CARRIERS AND COMMERCIAL OPERATORS OF LARGE AIRCRAFT

6. The authority citation for Part 121 continues to read as follows:

Authority: 49 U.S.C. 1354(a,) 1355, 1356, 1357, 1401, 1421 through 1430, 1472, 1485, and 1502; 49 U.S.C. 106(g) (Revised Pub. L. 97–449, January 12, 1983).

7. Section 121.356 is added to read as follows:

§ 121.356 Traffic Alert and Collision Avoidance System.

(a) After December 30, 1991, no person may operate a large airplane that has a passenger seating configuration, excluding any pilot seat, of more than 30 seats unless it is equipped with an approved TCAS II traffic alert and collision avoidance system and the appropriate class of Mode S transponder.

(b) After February 9, 1995, no person may operate a combination cargo/passenger airplane that has a passenger seat configuration, excluding any pilot seat, of 10 to 30 seats unless it is equipped with an approved traffic alert and collision avoidance system.

(c) The appropriate manuals required by § 121.131 of this part shall contain the following information on the TCAS II System required by this section:

(1) Appropriate procedures for—

(i) The operation of the equipment; and

(ii) Proper flightcrew action with respect to the equipment.

(2) An outline of all input sources that must be operative for the TCAS to function properly.

PART 125—CERTIFICATION AND OPERATION: AIRPLANES HAVING A SEATING CAPACITY OF 20 OR MORE PASSENGERS OR A MAXIMUM PAYLOAD CAPACITY OF 6000 POUNDS OR MORE

8. The authority citation for Part 125 continues to read as follows:

Authority: 49 U.S.C. 1354, 1421 through 1430, and 1502; 49 U.S.C. 106(g) (Revised Pub. L. 97–449, January 12, 1983).

9. Section 125.224 is added to read as follows:

§ 125.224 Traffic Alert and Collision Avoidance System.

(a) After December 30, 1991, no person may operate a large airplane that has a passenger seating configuration, excluding any pilot seat, of more than 30 seats unless it is equipped with an approved TCAS II traffic alert and collision avoidance system and the appropriate class of Mode S transponder.

(b) The manual required by § 125.71 of this part shall contain the following information on the TCAS II system required by this section.

(1) Appropriate procedures for—

(i) The operation of the equipment; and

(ii) Proper flightcrew action with respect to the equipment.

(2) An outline of all input sources that must be operating for the TCAS II to function properly.

PART 129—OPERATIONS: FOREIGN AIR CARRIERS AND FOREIGN OPERATORS OF U.S.-REGISTERED AIRCRAFT ENGAGED IN COMMON CARRIAGE

10. The authority citation for Part 129 is revised to read as follows:

Authority: 49 U.S.C. 1346, 1354(a), 1356, 1357, 1421, 1502, and 1511; 49 U.S.C. 106(g) (Revised Pub. L. 97–449, January 12, 1983).

11. Section 129.18 is added to read as follows:

§ 129.18 Traffic Alert and Collision Avoidance System.

(a) After December 30, 1991, no foreign air carrier may operate in the United States a turbine powered airplane that has a maximum passenger seating configuration, excluding any pilot seat, of more than 30 seats unless it is equipped with—

(1) A TCAS II traffic alert and collision avoidance system capable of coordinating with TCAS units that meet the specifications of TSO C–119, and

(2) The appropriate class of Mode S transponder.

(b) After February 9, 1995, no foreign air carrier may operate in the United States a turbine powered airplane that has a passenger seating configuration, excluding any pilot seat, of 10 to 30 seats unless it is equipped with a traffic alert and collision avoidance system. If a TCAS II system is installed, it must be capable of coordinating with TCAS units that meet the specifications of TSO C–119.

PART 135—AIR TAXI OPERATORS AND COMMERCIAL OPERATORS

12. The authority citation for Part 135 continues to read as follows:

Authority: 49 U.S.C. 1354(a), 1355(a), 1421 through 1431, and 1502; 49 U.S.C. 106(g) (Revised Pub. L. 97–449, January 12, 1983).

13. Section 135.180 is added to read as follows:

§ 135.180 Traffic Alert and Collision Avoidance System.

(a) After February 9, 1995 no person may operate a turbine powered airplane that has a passenger seating configuration, excluding any pilot seat, of 10 to 30 seats unless it is equipped with an approved traffic alert and collision avoidance system.

(b) The airplane flight manual required by § 135.21 of this part shall contain the following information on the TCAS I system required by this section:

(1) Appropriate procedures for—

(i) The use of the equipment; and

(ii) Proper flightcrew action with respect to the equipment operation.

(2) An outline of all input sources that must be operating for the TCAS to function properly.

Issued in Washington, DC, on January 5, 1989.

T. Allan McArtor,

Administrator.

[FR Doc. 89–451 Filed 1–5–89; 4:15 am]

BILLING CODE 4910–13–M

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 1, 91, 121, 125, 129, and 135

Traffic Alert and Collision Avoidance System; Correction

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule, Correction; Amendment number.

SUMMARY: FAA is correcting an error in the Amendment number. In FR Doc. 89-451, published Tuesday, January 10, 1989, on page 940, please change Amendment number 135-29 to read 135-30.

FOR FURTHER INFORMATION CONTACT: Frank Rock, Aircraft Engineering Division; AIR-120, (202) 267-9567, 867-6941.

Michael D. Triplett,

Legal Technician, Program Management Staff, AGC-10.

[FR Doc. 89-1088 Filed 1-17-89; 8:45 am]

BILLING CODE 4910-13-M