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Monday  
July 11, 1988

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**Part II**

**Department of  
Transportation**

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**Federal Aviation Administration**

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**14 CFR Parts 23 etc.  
Cockpit Voice Recorders (CVR) and  
Flight Recorders; Final Rule**

**DEPARTMENT OF TRANSPORTATION****Federal Aviation Administration**

**14 CFR Parts 23, 25, 27, 29, 91, 121, 125, and 135**

[Docket No. 25530; Amdt. Nos. 23-35, 25-65, 27-22, 29-25, 91-204, 121-197, 125-10, 135-26]

[RIN 2120-AC48]

**Cockpit Voice Recorders (CVR) and Flight Recorders**

**AGENCY:** Federal Aviation Administration (FAA), DOT.

**ACTION:** Final rule; request for additional comments (Part 91 requirements).

**SUMMARY:** The FAA amends its regulations to require digital flight data recorders and cockpit voice recorders (CVRs) to be installed in a broad category of airplanes and rotorcraft operated by air carriers and commuters, as well as in selected aircraft operated in general aviation. The amendments are in response to legislation which mandates the FAA to amend its flight recorder and CVR requirements in accordance with recommendations from the National Transportation Safety Board (NTSB). The intent of this rulemaking is to provide more information to accident investigators in determining the causes of accidents and the measures needed to correct the causes. In addition, the FAA also requests additional comments regarding the general aviation requirements.

**DATES:** Effective date: October 11, 1988. Comments on the Part 91 requirements must be submitted on or before October 11, 1988. Compliance Date: October 11, 1991.

**ADDRESSES:** Comments on the Part 91 requirements should be mailed in triplicate to: Federal Aviation Administration, Office of the Chief Counsel, Attention: Rules Docket (AGC-10), Docket No. 25530, 800 Independence Avenue, SW., Washington, DC 20591. Comments delivered must be marked Docket No. 25530. Comments may be examined in Room 915G weekdays between 8:30 a.m. and 5 p.m., except on Federal holidays.

**FOR FURTHER INFORMATION CONTACT:** Frank Rock, Technical Analysis Branch [AWS-120], Aircraft Engineering Division, Office of Airworthiness, Federal Aviation Administration, 800 Independence Avenue SW., Washington, DC 20591; Telephone (202) 267-9567.

**SUPPLEMENTARY INFORMATION:****Background**

The FAA issued a notice of proposed rulemaking on flight recorder and CVR requirements on February 12, 1988 [Notice No. 88-1, 53 FR 4314]. The proposed rule was primarily based on recommendations from the NTSB issued on June 19, 1987. FAA rulemaking on these requirements was mandated by legislation on December 22, 1987, in the Appropriations Act, 1988, [Pub. L. 100-202] and on December 30, 1987, under the Airport and Airway Safety and Capacity Expansion Act of 1987, Title III, Section 303(c) [Pub. L. 100-223].

The Appropriations Act required the FAA to expand existing CVR and flight recorder requirements "to smaller sizes of commuter air carrier aircraft" and to require CVR and flight recorder "retrofits on certain types of existing commuter air carrier aircraft. . . ."

The Airport and Airway Safety and Capacity Expansion Act required the FAA to initiate rulemaking "to consider the use of cockpit voice recorders and flight data recorders on commuter aircraft and other aircraft, commensurate with the recommendations of the National Transportation Safety Board."

The NTSB issued its safety recommendations in response to a number of significant events which had occurred since its previous recommendations issued in August 1982. These events were FAA's flight recorder and CVR rule changes issued March 25, 1987; the technological development of solid-state flight data recorders (SFDR); the continued growth of the commuter air carrier industry; revisions to Part 23 of the Federal Aviation Regulations (FAR) (14 CFR Part 23) which defined a commuter category airplane and established certification requirements for commuter category airplanes; and the adoption by the International Civil Aviation Organization (ICAO) of revised flight recorder and CVR standards.

The FAA used the NTSB recommendations of June 19, 1987, as an appropriate background to discuss extending and updating its flight recorder and CVR rules. The rules on CVR and flight recorders had been last amended March 25, 1987 [Amendment Nos. 91-199, 121-191, 125-8, 135-23; 52 FR 9622]. In simplified terms, the 1987 amendments required that FAR Part 121 operators update certain of their airplanes over a specified time period with digital flight recorders that have 6, 11, or 17 data parameters depending on the date of type certification or manufacture. Parts 91 and 125 were also

amended by requiring that any operator who has installed approved flight recorders and approved CVRs shall keep the recorded information for at least 60 days after an accident or occurrence requiring immediate notification to the NTSB. The 1987 amendments extended Part 135 voice recorder requirements which applied to any turbojet airplane having a passenger seating configuration of 10 seats or more to any newly manufactured multiengine, turbine-powered airplane that was certificated to carry six or more passengers and required to have two pilots. The 1987 amendments did not require flight recorders for operations conducted under Part 135. They did not require voice recorders or flight recorders for operations conducted under Parts 91 and 125. They did not require flight recorders for helicopters.

The NTSB wanted broader application of the requirements than those established in the 1987 amendments, and the NTSB recommended that the requirements, including parameter requirements, be updated to cover technological improvements in CVR and flight recorder equipment. Through the aforementioned legislation, Congress agreed.

As stated in the preamble to the proposed rule and in the NTSB recommendations, the need for updated and expanded regulations on the installation and use of flight recorders and voice recorders is twofold. First, technological advances in cockpit equipment have greatly increased the potential for accumulating information on the flight characteristics of an aircraft at the time of an incident or accident. However, unless aircraft equipped with new electronic display systems (i.e., "glass cockpits") are also equipped with flight recorders that can capture the flight information and from which investigators can retrieve that information, the information is lost. Therefore, a major objective of this rulemaking is to upgrade the parameters and flight recorder and voice recorder standards to accommodate the most sophisticated systems now being installed in aircraft. Secondly, previous flight recorder and voice recorder requirements have not been applied to significant sectors of air transportation operations.

In recent years the commuter air carrier fleet has grown substantially and its growth is expected to continue. The 1987 annual report of the Regional Airline Association (whose membership consists primarily of commuter air carriers) estimates that more than 61 million passengers will be carried by

members of that association in 1997. The growth in commuter air transportation has resulted in newly manufactured aircraft designed specifically for the commuter market. While these new airplanes have a take-off weight in excess of 12,500 pounds, they often have a seating configuration of less than 30 passenger seats and payloads of 7,500 pounds or less, which means they are operated under Part 135. Until now Part 135 has had no flight recorder requirements. Therefore, vital accident data from commuter airline accidents has not been available.

The NTSB safety recommendation cites several recent commuter air carrier accidents in which investigations revealed a lack of information that would have been pertinent to determining the causes. Although the investigations produced a number of safety recommendations based on evidence of potentially hazardous conditions and practices, the specific flight crew actions or inactions, environmental conditions or equipment failures that may have caused the accidents could not be positively determined. Therefore, the NTSB's safety recommendations towards preventing recurrence could not be as definitive as possible. The NTSB has indicated that in these accidents if flight recorder information had been available, specific deficiencies in flight crewmembers' performance or mechanical failures or malfunctions could have been determined. Without flight recorder information, accident investigators are severely limited in definitively assessing causes. Therefore, the FAA has added flight recorder requirements to Part 135 and extended the voice recorder requirements in Part 135 to specific types of airplanes and rotorcraft.

Part 91 and Part 125 operations have had neither flight nor voice recorder requirements. The lack of information poses the same problem to investigators as in commuter operations. Therefore, this rulemaking extends flight recorder and voice recorder requirements to specific types of airplanes and rotorcraft being operated under Part 91 and specific types of airplanes operated under Part 125.

In addition to the above, the NTSB recommended that all newly manufactured aircraft and new cockpit voice recorder installations be designed to allow for uninterrupted recording from boom or mask microphones and headphones for each flight crewmember station and from an area microphone on dedicated channels of the CVR. The performance of CVR installations of this

kind where the audio signal of each crewmember station is continuously recorded on a dedicated channel provides much clearer recorded information for investigators than the standard cockpit area microphone (CAM). Therefore, this rulemaking includes amendments to Parts 23, 25, 121, 125, and 135, to require the NTSB recommended capability on newly manufactured aircraft and on aircraft on which new cockpit voice recorders are installed and to require the use of that capacity where it already exists.

In the interest of safety and in accordance with the Congressional mandate and NTSB recommendations, the FAA is extending and updating its regulations in flight recorders and voice recorders. This action is consistent with the requirements of section 601(b) of the FA Act that the FAA perform its powers and duties " \* \* \* in such manner as will best tend to reduce or eliminate the possibility of, or recurrence of, accidents \* \* \* "

Overall this rulemaking accomplishes the following significant changes:

- (1) It establishes flight recorder requirements for certain aircraft operated under Parts 91, 125, and 135.
- (2) It establishes cockpit voice recorder requirements for certain aircraft operated under Parts 91 and 125, and extends and revises voice recorder requirements under Part 135.
- (3) It upgrades the requirements and parameters for flight recorders to the level of the most sophisticated systems installed in aircraft. The new parameters and requirements affect certain aircraft operated under Parts 121, 125, and 135.
- (4) It requires uninterrupted sound recording capability in cockpit voice recorders under Parts 23 and 25 and specifies use of this capacity under the operating rules of Parts 121, 125, and 135.
- (5) It revises CVR and flight recorder airworthiness standards in Part 25; establishes flight recorder installation requirements in Parts 23, 27, and 29; and establishes CVR requirements in Parts 23 and 27.

#### Comment Discussion

The FAA received 52 comments on the NPRM. Thirty-one comments opposed the proposed rule; nine supported it; two supported it with reservations. The rest of the comments did not express opposition or support. At least 19 comments addressed specific issues raised by the proposed rule. The categories of commenters included airport authorities, state governments, operators of airplanes and helicopters, manufacturers, and foreign air

transportation companies. Of the associations representing air transportation interest groups, comments were received from the Air Line Pilots Association (ALPA), the Air Transport Association (ATA), General Aviation Manufacturers Association (GAMA), Airport Operators Council International, the National Air Transportation Association (NATA), and the Regional Airlines Association (RAA). Commenters who opposed the rule were primarily operators conducting operations under Part 135 (or Part 91), particularly operators of helicopters, as well as ATA and NATA. Categories of commenters supporting the rule were manufacturers, state governments, and airport authorities, the National Transportation Safety Board (NTSB), and the RAA.

Several commenters presented recommendations and raised concerns over specific requirements in the rule. The following categories of issues were raised and are discussed separately below:

- (1) Part 121 requirements
- (2) Part 91 and Part 135 requirements
- (3) Specific technical requirements
- (4) Comments beyond the Scope of the Notice.

#### Part 121 Requirements

The Air Transport Association (ATA) on behalf of its member airlines submitted a number of objections to the proposed changes in Part 121 and in some cases to the proposed parallel changes in Part 25. Several of ATA's objections were also raised by other commenters. Overall opposition to the proposed changes was based on two general arguments. First, the ATA argued that the Congressional language cited in the NPRM as a primary basis for the proposed changes did not identify Part 121 air carriers. Second, they argued that "the NTSB and FAA have not adequately justified the Part 121 proposals for further expansion of flight recorder requirements beyond those in Amendment 121-91." ATA also stated that the 45-day comment period was too short for its member airlines to "provide the type of technical and economic impact information needed to develop final credible technical and cost analyses," and recommended that the FAA withdraw and reconsider the proposed amendments to Parts 25 and 121.

ATA and others specifically commented on technical concerns with Part 121 proposals. Comments of a purely technical nature are dealt with elsewhere in this preamble. The

remaining Part 121 comments (mostly from ATA) are summarized as follows:

- Of the six new developments cited by FAA in Notice 88-1 as justification for the proposed additional requirements, none justify the proposed Part 121 changes.

- Notice 88-1 did not include any discussion on "major rule", "significant rule" requirements under Executive Order 12291 and DOT policy, respectively.

- There are significant differences between the FAA/NTSB proposed flight recorder parameters and the ICAO standards which ATA says are "recommended standards only" which are "in the process of being revised."

- Adoption of 32 parameter flight recorder requirements for newly manufactured airplanes rather than last year's requirement for 17 parameter flight recorder for newly manufactured airplanes will create an unnecessary administrative and logistics burden.

- The proposed additional parameters could exceed the capacity of digital flight data acquisition units "denying airline use of flight recorder information for routine maintenance and operations analyses, some of which are required by the FAA."

- The relationship of the proposed requirements to the rules adopted in Amendment 121-191 is confusing and potentially disruptive and costly to airline operations especially when considered with other FAA requirements already adopted or under consideration (e.g., windshear, TCAS requirements). Related to this ATA comment was a comment by McDonnell Douglas Aircraft Co. which indicated that changing "regulatory requirements on systems such as flight recorders on an annual basis \* \* \* makes planning very difficult and expensive."

ATA offered an alternative to the FAA proposal. ATA suggests that for a retrofit, additional parameters be required only when the airplane is already equipped with "an ARINC 717 digital flight data acquisition unit (DFDAU) with the ARINC buses containing the (a number to be later determined) additional parameters already converted to it." For newly manufactured airplanes ATA would follow the same pattern except that additional parameters above the 17 parameters of Amendment 121-191 would be recorded "on a space availability basis without impacting existing airline recording programs \* \* \*"

*The FAA's Response:* The FAA does not agree with ATA's interpretation of the Congressional mandate. Given the overall legislative history of Public Law

100-223, FAA believes that the Congressional intent is to ensure safety by making available to the NTSB whatever data is necessary for accident investigation if acquiring that data is technologically feasible. Congress stated this intent by ordering the FAA "to initiate a rulemaking proceeding to consider the use of cockpit voice recorders and flight data recorders on commuter aircraft and other aircraft, commensurate with the recommendations of the National Transportation Safety Board."

[Emphasis supplied.] In its June 19, 1987, letter to the FAA, the NTSB stated its requirements which covered 14 CFR Parts 23, 25, 91, 121, and 135. FAA proposed to meet those requirements in Notice 88-1, as directed by Congress. Comments submitted by the Board did not indicate that the proposed Part 121 requirements exceeded the bounds of what the Board determines as necessary information for conducting accurate accident investigations.

ATA is correct that the normal paragraph addressing "major rule" under Executive Order 12291 and "significant rule" under DOT policy was omitted—inadvertently—from the NPRM. Nonetheless, the potential costs were fully discussed in the preamble (and in a full economic evaluation in the docket) and the substance of that discussion indicated that the proposed rule would not be considered major under the Executive Order. Further, the overall preamble discussion made it clear that the proposals were significant within the meaning of the Department of Transportation's Regulatory Policies and Procedures.

The 1987 Amendments to Part 121 did not increase the parameters listed in Appendix B of that part. NTSB has stated in its recent recommendations that Appendix B should be updated to expand the parameters list and define new parameters, improved accuracies, ranges, and sampling intervals so that flight recorder standards are consistent with the capabilities of the most advanced electronic display systems. As stated by NTSB, "The introduction of the Airbus A320 with its fly-by-wire technology will present new challenges in accident investigation that will require post accident information of the quantity and quality that goes far beyond the current minimum standards of Appendix B."

In response to the NTSB recommendations, this rulemaking updates the parameter list to meet the requirements of the most advanced cockpit systems if installed and to require the best available flight recorder technology for newly manufactured

airplanes operated under Part 121. The requirement for flight recorder parameters in addition to the 17 required by the 1987 amendments applies only to aircraft manufactured after October 11, 1991, or those already equipped with specific ARINC equipment. This allows adequate time for the required installation of the latest flight recorder equipment as part of the manufacturing process which should cause no manufacturing delay and only minimal cost.

While ATA describes the proposed tie-in with existing ARINC 429 equipment (or an equivalent) as a retrofit requirement, it is not the normal mandatory type retrofit requirement applicable to all or certain specified airplanes operated under Part 121 or Part 135. The final rule clarifies the FAA intent in this regard (discussed under Technical Comments portion of this preamble) and as adopted the rule will apply only where stated equipment is already installed in an airplane and where data is readily available so that it can be accessed with virtually no burden on Part 121 operators, either in lost airplane time or other costs.

In consideration of other objections raised by ATA, that extending the parameters from 17 to 32 (or higher, by ATA's count) is too great a change too soon, that Part 121 operators are being required to make other equipment changes at the same time, and that the proposed parameters were not consistent with those recommended by ICAO, and in consideration of the comments submitted by the NTSB, the FAA has done the following: (1) Extended the effective date of the requirements to 3 years instead of the proposed 2 years; and (2) reduced the number of mandatory parameters to 28 and made the other highly desired parameters optional where feasible.

#### *Parts 91 and 135 Requirements*

Except for the Regional Airline Association's agreement with most of the proposed Part 135 amendments, virtually all of the operators who commented on these requirements opposed them. Specific technical comments are discussed below. Typical of the more general opposing comments was the comment of the North Dakota Aviation Council which stated that the FAA had "expanded the intent of Congress" in proposing CVR and flight recorder requirements for certain general aviation operations under Part 91 and on-demand operations under Part 135. The National Air Transportation Association (NATA) also accused the FAA of expanding the Congressional

mandate and further stated that nowhere in the proposal "can a case be made for a quantitative increase in safety benefit for requiring CVR's in the types of aircraft typically operated in the Part 135 charter fleet."

One commenter pointed out that a 2-year compliance period for the installation of CVR's is inadequate. From the commenter's viewpoint, most of the affected aircraft require a "heavy" inspection only every 5 to 6 years. It is during this inspection that it would be most appropriate to install the CVR.

Several commenters asserted that where an aircraft is newly manufactured to a type design of long standing, the attributes and operational history are already well known and it is unlikely that the NTSB will obtain the kind of information it seeks from accident investigations. These commenters also asserted that the past safety record did not justify the new requirements and that because of the nature of on-demand and general aviation operations the costs are disproportionate since they cannot be spread out over thousands of flight hours or hundreds of thousands of passengers boarded each year.

Some of the most vigorous comments adverse to the proposed requirements were received from helicopter operators. They, too, thought that the FAA had exceeded the Congressional mandate, that none of the cited accidents or other justification involved helicopters, and that the potential costs for helicopter operators far exceeded any potential benefits to the overall aviation industry.

The Regional Airlines Association stated that there is no justification for requiring retrofit of the 32-parameter flight data recorder on 20-30 seat airplanes under Part 135 when no such retrofit requirement was proposed for Part 121. RAA indicated that while the costs would be substantial, it could not provide specific estimates because they would vary from airplane to airplane depending on the amount of wiring already installed in the airplane.

*The FAA's Response:* As discussed previously, the FAA does not agree that it has exceeded the Congressional mandate or that the new CVR and flight recorder requirements for Part 91 operators and for non-scheduled Part 135 operators cannot be justified. Accident investigators face the same problems in determining the causes of accidents, whether the accidents involve scheduled commuter operations, nonscheduled operations, or general aviation operations. New airplanes used in all of these operations employ state-of-the-art avionics and control systems; yet operators have not been required under Parts 91 and 135 to install flight

recorders which would provide data to accident investigators. Post accident documentation, such as switch and instrument positions, that have proven vital in past investigations is not available with the new systems, thus increasing the difficulty in determining the cause of an accident.

Furthermore, many airplanes of the same type are used in Part 91 operations and in Part 135 operations. Therefore, any accident data collected from an accident of one of these airplane types has application for operations conducted under both parts. Also, an individual airplane may be used in operations conducted under both parts. If an airplane is used in operations under both parts, the Part 91 requirements would not be as burdensome as suggested by some commenters since in many cases the airplane would already be subject to Part 135 requirements. Also, because of the potential for use of an airplane type under both Parts 91 and 135, the used aircraft market ultimately benefits when airplanes are equipped so that they can move back and forth between different operating rules.

Accidents cited in the NPRM (which included operations conducted under Parts 91 and 135) illustrate the problems accident investigators encounter when aircraft are not equipped with flight or voice recorders. In such cases, investigators rely on interviews with fellow crewmembers, training records, FAA surveillance, cockpit standardization, and additional operational factors. Although the cause of an accident may be determined through these investigative efforts, the process may be long and costly in terms of lives and property. Time may be critical, particularly if the cause of an accident is an airworthiness factor.

The rule does recognize differences in accordance with the seating capacity of the aircraft. In Part 91, flight recorders are required for aircraft (both fixed-wing and rotorcraft) having a passenger seating configuration of 10 or more manufactured after October 11, 1991. The flight recorders must have 17 required parameters for airplanes and 22 for rotorcraft. In Part 135, flight recorders are required for aircraft (both fixed-wing and rotorcraft) having a passenger seating configuration of 10-19 seats that are brought onto the U.S. register after October 11, 1991. The flight recorders must have 17 parameters for airplanes and 22 for rotorcraft. In effect, Part 91 and Part 135 flight recorder requirements for these size aircraft apply only to newly manufactured aircraft. No retrofit of existing U.S.

registered aircraft of this size is required for flight recorders.

In Part 135, airplanes having a passenger seating configuration of 20 to 30 seats and rotorcraft having a passenger seating configuration of 20 or more seats must be equipped with flight recorders after October 11, 1991. This is a retrofit as well as a requirement for newly manufactured aircraft. The NTSB in its comment agreed that it might be impractical to require 20-30 passenger airplanes to be retrofitted with 32 parameter flight data recorders, as proposed. In light of all the information received, the FAA has changed § 135.152(b) to require that affected aircraft be retrofitted with either 11-parameter or 17-parameter flight recorders (depending on the type certification date), except that those airplanes manufactured after October 11, 1991, must be upgraded to 28 parameters.

Clearly the flight recorder requirements for the larger aircraft being operated under Part 135 are more stringent than those for the smaller aircraft. Most, if not all, nonscheduled operations conducted under Part 135 use aircraft with a passenger seating configuration of less than 20 seats. Such aircraft are not required to be retrofitted with flight recorders. However, they are required to be equipped with voice recorders. Since the cost of installing voice recorders is substantially less than that of flight recorders, the FAA does not expect the voice recorder requirements to impose a significant burden on small operators.

With regard to comments about the inadequacy of a 2-year period to reasonably accomplish the Part 91 retrofit of CVR's, the FAA concurs. Accordingly, the FAA has provided a 3-year period to effect this retrofit, recognizing, however, that some operators may not conduct a "heavy" inspection or overhaul in this period, the regulatory language provides that the Administrator, for good cause, may authorize extension of the compliance time to accommodate such maintenance schedules. A request for extension of the compliance time must be accompanied by a demonstration of good cause and must specify a date for the operator's completion of the retrofit of the CVR.

#### *Technical Comments*

A number of commenters provided detailed comments on the technical aspects of the new rules. Any such comments that address the substance of the rule are discussed below. Comments that point out printing errors, suggest non-substantive minor language

changes, or suggest changes to make the rules internally consistent were considered and the appropriate changes were made. However those changes are not discussed in detail.

A number of commenters pointed out that, although the preamble to Notice 88-1 specifically discusses a new requirement for "hot mic" recording, the rule language specifies types of microphones but does not contain a "hot mic" requirement. Suggestions for appropriate rule language were provided. To correct this omission in the final rule, §§ 23.1457(c)(5) and 25.1457(c)(5) have been added to make it clear that all sounds received by the microphone must be recorded without interruption. In addition, §§ 121.359(e), 125.227(e), and 135.151(c) have been changed to clarify that §§ 23.1457(c)(5) and 25.1457(c)(5) apply to airplanes manufactured after October 11, 1991, and to airplanes on which a new cockpit voice recorder has been installed after October 11, 1991. One commenter stated that proposed § 25.1459(e) is unnecessary. This new paragraph requires evaluation of novel or unique design or operational characteristics of new aircraft to determine if additional parameters should be recorded on the flight recorder for that aircraft. The commenter is correct that additional parameters could be proposed as Special Conditions for that aircraft. However, the language is being inserted into § 25.1459 as a rule of general applicability so that as part of a review of airworthiness requirements for initial certification, a review to assess the need for additional parameters will be conducted.

A commenter pointed out that, while proposed § 91.35(b)(1) requires aircraft manufactured after one year after the effective date to be prewired to accept any appropriate flight recorder, the proposed language does not specify the date by which such aircraft must be equipped with flight recorders. The FAA has reviewed proposed § 91.35(b)(1) and a parallel requirement proposed in § 135.152(a) and has concluded that, even though the requirement might provide an economic incentive to manufacturers to begin equipping airplanes to accept flight recorders, the safety benefit comes from the installation of the recorders. Therefore proposed §§ 91.35(b)(1) and 135.152(a) have not been included in the final rule.

One commenter questioned the justification for applying the proposed rules to helicopters. This commenter proposed that if CVR and flight recorder requirements are applied to any helicopters, they should be applied only

to large helicopters. The FAA does not agree that the large/small dividing line (small—12,500 pounds or less maximum certificated takeoff weight) is the appropriate determining factor for requiring or not requiring CVR and flight recorder equipment. As with airplanes, the FAA considers passenger seating configuration a more meaningful measure of the need for requiring safety information collection devices such as CVR and flight recorders.

A number of commenters stated that the language of proposed §§ 121.343(e) and 125.225(c) does not accomplish the objective stated in the preamble to Notice 88-1. Some commenters stated that the proposed rule language "equipped with an ARINC 429 digital data bus" is itself inaccurate. Others stated that even if an airplane does have the ARINC 429 equipment, that equipment may be used in such a way that it would not, without a major retrofit, provide access to the information in the additional parameters as suggested in the NPRM. The FAA's intent in following through on this NTSB recommendation was to take advantage of the full capability of more advanced technology equipment when that equipment is already installed. There is no intent to require any retrofitting costs beyond the minimal cost of accessing readily available data. The final rule has been redrafted so that it clearly carries out the original intent. It now states that when a large airplane is equipped with a digital data bus and ARINC digital flight data acquisition unit or equivalent the airplane must be "equipped with one or more approved flight recorders that utilize a digital method of recording and storing data and a method of readily retrieving that data from the storage medium." The rule, as adopted, also clarifies that only those parameters "available on the digital data bus" must be recorded.

As mentioned previously, the ATA and several other commenters questioned the number of new parameters that would be required under Appendix B to Part 121 for newly manufactured aircraft. Commenters suggested that there were inconsistencies between the FAA's proposed parameters, NTSB's recommended parameters, and ICAO recommended standards. Commenters also indicated that to meet the FAA proposed requirement would in many cases overload the system so that operators would have to sacrifice present usage of flight recorder systems to provide them with important safety-related, day-to-day operating information. At the same time some

commenters suggested additional parameters, not proposed, that normally would be considered beyond the scope of this rulemaking. In order to establish standards that most effectively use flight recorder capability, the FAA has decided to require 28 mandatory parameters under Part 121, Appendix B, Part 125, Appendix D, and Part 135, Appendix D for newly manufactured aircraft. The remaining parameters will be optional, to be accessed if the operator's system has adequate capacity. The non-mandatory parameters include additional parameters that were not proposed, such as TCAS, which were added at the recommendation of the NTSB.

The NTSB and other commenters raised questions concerning the adequacy of existing Technical Standard Orders (TSOs) for both cockpit noise recorders and flight recorders. While TSOs are necessarily relevant, they have not been made a part of this rulemaking. As part of its ongoing TSO program, the FAA will revise TSOs when changes are needed to upgrade the specifications for equipment required by this final rule. These efforts are already underway and are being coordinated with the Society of Automotive Engineers (SAE) and European Organization for Civil Aviation Electronics (EUROCAE).

Some commenters pointed out that the minimum 15-minute duration period for cockpit voice recorders proposed for § 91.35(e) is not consistent with the standard agreed to in Europe (EUROCAE). Others noted that proposed §§ 91.35(b)(2) and 135.152(b) would allow a flight data recorder with an 8-hour duration while the international community is considering a 10-hour minimum to be consistent with the current ICAO recommended practice. While the FAA recognizes that both proposed limits are less stringent than those mentioned by commenters (and less stringent than FAA's own minimums under Part 121), the FAA's intent is to apply CVR and flight recorder solid state technology and CVR and flight recorder requirements to general aviation operations at minimal cost. Since the technology is already available, the FAA anticipates that reasonably priced CVR and flight recorder equipment for general aviation aircraft will be available for installation well within the 3-year compliance period allowed in this rule.

One commenter objected to the requirement in proposed Appendix E to Part 135 that a rotorcraft with over 20 passengers have flight recorders with a 24-hour recording capacity. The

commenter stated that most rotorcraft operate essentially short-haul journeys and that, therefore, an 8 to 10-hour capacity should be adequate. The FAA agrees, but no change is needed since Appendix E does not require a 24-hour recording capacity. In Appendix E, the recorded time is not related to the time of individual flights, but to a 24-hour clock.

Several commenters objected to the requirements in §§ 121.359(e), 125.227(e), and 135.151(c) that when operating aircraft equipped to record uninterrupted audio signals received by a boom or mask microphone, flight crewmembers must use the boom microphone below 18,000 feet. Specific objections were as follows:

(1) The requirement would make better sense elsewhere in Part 121 where it would clarify that the boom microphone rather than the handheld microphone should be used when cockpit workload is high.

(2) Flight crewmembers might not be able to determine whether the CVR in a particular aircraft has a "hot mic" feature.

(3) It requires the boom microphone even though the smoke/oxygen mask microphone might be more appropriate.

(4) It would have an impact on those aircraft which have a separate hand microphone for the public address/cabin interphone systems.

(5) Hot boom microphones are needed since acceptable recordings are provided by directional fixed mikes and high quality area mikes.

(6) The requirement could affect flight safety by causing fatigue on flight schedules with successive short stops.

The FAA does not agree that area microphones provide recordings that are equal to boom microphones. Boom or mask microphones with uninterrupted signals produce the most audible recordings. The purpose of the requirement is to require boom microphones (or smoke/oxygen mask microphones if needed) at times when the continual recorded information would be most useful if an accident or incident occurred. Flight crewmembers should be able to tell whether CVR in a particular aircraft has a "hot mic" feature. The use of the boom microphone is not likely to be a cause of flight crewmember fatigue in short hop schedules. The causes of such fatigue are well documented—airport congestion, low altitude weather, the number of arrivals and takeoffs—factors which create a need for the use of hot mics. The requirement should not affect public address/cabin interphone communications which have a dedicated channel.

GAMA stated that except for the longitudinal acceleration and stabilizer trim position or pitch central position parameters, proposed Appendix D of Part 91 and Appendix B of Part 135 are consistent with Aerospace Standard AS 8039 which was produced by a Society of Automotive Engineers (SAE) committee formed at the suggestion of the FAA and other government agencies. The committee had concluded that the value of the potential information from the two excepted parameters would not justify the cost. GAMA also pointed out that the recommendation of the SAE committee had been unanimous except for the NTSB representative. The FAA has determined that these two parameters are justified, since the NTSB in its June 19, 1987, letter stated a need for the information that would be provided by these additional parameters.

One commenter objected to the requirement in § 91.35(d)(2) that the CVR be operating during the checklist action. The requirement would pose a problem for small aircraft that have no external source of power and that would have to rely on battery power to operate the CVR. The commenter stated that for some aircraft this would be impractical. The FAA does not agree that the requirement would be impractical. It is essential that checklist actions be recorded since in the event of an accident, investigators must determine if the checklist action was properly conducted. Determining the adequacy of the power source is a certification procedure and thus the manufacturer or operator would have to show during the certification process that CVR operation would not interfere with emergency or other power needs. This showing should not impose any significant additional burden since airplanes of the size to which this requirement applies would either operate off of an auxiliary power source or have adequate backup power available.

One commenter objected to the "Resolution Readout" column which was added to Appendix B—Airplane Flight Recorder Specifications. According to the commenter, these specifications increase resolution requirements beyond the capability of equipment currently being used. The commenter states that "Compliance with the higher orders of resolution will require more complicated software in the recorder system and in the readout equipment, effectively making all current equipment obsolete."

The resolution readout column is included to make the FAA flight recorder appendices consistent with the proposed ICAO recommended standard.

However, the resolution readout requirement is intended only for flight recorder equipment installed on newly manufactured airplanes. The final rule has been changed to make this clear by including a footnote to this column in each flight recorder appendix. Also, the new TSO for flight recorder standards will contain resolution requirements.

#### *Comments Beyond the Scope of the Notice*

The FAA received several comments which were recommendations or suggestions for considering alternatives or additions to the proposal. Some of these were requests that are beyond the scope of the notice while others appeared to be primarily informational. These types of comments are summarized below and responded to.

Two commenters requested that the rulemaking update maintenance requirements to cover flight recorders and cockpit voice recorders. The FAA does not consider that a specific amendment is needed in this regard because an air carrier's continued airworthiness maintenance program will automatically cover such equipment.

One commenter requested that the cockpit voice recorder requirements under Parts 91 and 135 include a requirement for underwater locator beacons to aid retrieval of the recorders from lakes and rivers. This requirement already exists for aircraft certification requirements.

One commenter requested that the rule include relief for continued aircraft operation if a flight recorder or CVR becomes inoperative. The commenter was concerned that a time lapse may occur between the revisions to the Master Minimum Equipment List (MMEL) and the compliance date, also that MMEL lists may vary depending on who has responsibility for the particular aircraft MMEL. This rulemaking does not deal with minimum equipment lists and the problem suggested by the commenter, if necessary, would be handled under normal MMEL procedures.

A comment from a manufacturer stated that the NPRM implied "different sets of data between engine manufacturers." The commenter suggested additional engine information to be recorded for each engine:

N2—High Rotor Speed  
EGT—Exhaust Gas Temperature  
TLA—Throttle Lever Position  
N1—Low Rotor Speed  
WF—Fuel Low  
CLA—Fuel Cutoff Lever Position

The commenter also suggested recording maintenance and status words from the electronic engine controls.

The FAA encourages including these additional parameters, as appropriate, but is not mandating them.

Construcciones Aeronauticas, S.A. (CASA) objected to the reference in the NPRM to two CASA C-212 accidents that occurred in 1987. CASA stated that some facts about the accident were incorrect in the NPRM and that the FAA should publish a correction. The FAA has checked the NTSB June 1988 recommendation letter and has determined that the NPRM accurately reflected the facts as they were stated by the NTSB in that letter.

A manufacturer of recorder equipment requested that the FAA consider the manufacturer's new type of cockpit recorder. Information on the recorder was submitted with the comment. The comment does not require an FAA response.

The Air Line Pilots Association (ALPA) comment, which was generally supportive of the proposal, requested a change in § 121.343(e) which requires that required flight recorders "must be operated continually from the instant the airplane begins to takeoff roll until it has completed the landing roll at an airport." ALPA stated that this provision "hampers the collection of valuable data which can be used in evaluating the DFDR data." ALPA requested that the language be changed to require recorder operation to begin at the time of engine start to the time of engine shutdown at the end of the flight in order to provide "steady state" information. Two other commenters also requested that recording cover the ground operation phase.

No revisions to § 121.343(e) were requested by NTSB or included in the proposed rule. The present Part 121 requirement was simply carried over to Part 91 and Part 135 requirements. A revision of the requirement is beyond the scope of this rulemaking action and would necessitate additional rulemaking proposals. However, most operators presently activate flight recorders at engine start and other operators who wish to record "steady state" data are encouraged to consider the ALPA comment.

ALPA also strongly opposes the "use of CVR recordings for any purpose other than pure accident investigation activities" and the "premature release" of CVR information during accident investigations.

One commenter stated a belief that "in recent years, because of the rapid growth of the airlines industry, training and experience levels have dropped

\*\*\*." The commenter stated that the FAA should require additional training and safety measures rather than additional equipment. The FAA does not believe the situation is an either/or; FAA has taken action on training and other safety measures, for example, its windshear training proposal [52 FR 20560, June 1, 1987]. In any event, consideration of additional pilot training and safety measures outside the area of recording equipment is beyond the scope of this rulemaking action.

#### *Summary of Rule Changes*

Significant changes between the proposed rule and the final rule are summarized below. These changes were discussed in the appropriate sections of the Comment Discussion above:

- (1) The compliance dates have been extended from 2 years to 3 years.
- (2) Pre-wiring requirements in § 91.35 and § 135.52 have been deleted.
- (3) The requirements for airplanes currently equipped with a digital data bus are clarified in §§ 121.343(e) and 125.225(c).
- (4) Certain of the parameters in Appendix B of Part 121 have been made optional.
- (5) Aircraft required to be upgraded under § 135.152(b) must meet the 11-parameter or 17-parameter flight recorder requirements (currently required of certain airplanes used under Part 121) except those manufactured after October 11, 1991.
- (6) Requirements pertaining to the use of boom microphones have been clarified.
- (7) The resolution readout column in each of the appendices has been made applicable only to aircraft manufactured after October 11, 1991.

The changes above were coordinated with the NTSB staff who have indicated agreement that this final rule meets the intent of the NTSB recommendations in its letter of June 19, 1987.

In addition to the above changes, Parts 23 and 27 have been revised to include airworthiness requirements for flight and voice recorders. In the proposal such airworthiness requirements were only in Parts 25 and 29, and all operators subject to flight and voice recorder requirements were referred to those parts. In the interest of consistency, the final rule includes airworthiness requirements for flight and voice recorders in Parts 23, 25, 27, and 29. References in the operating rule have been revised accordingly.

#### **Request for Additional Comments on Part 91 Requirements**

Notwithstanding that the Part 91 requirements have been incorporated in

this final rule, the FAA is still interested in receiving comments with respect to issues raised in Notice 88-1. The FAA is particularly interested in comments regarding the questions asked on page 4315 of the *Federal Register* publication of the notice (53 FR 4315). Therefore, a comment period of 90 days is being provided to allow the public to comment accordingly. The FAA will review all additional comments submitted and, within 1 year after the publication of this amendment in the *Federal Register*, will publish a document discussing all comments, presenting FAA findings based upon the comments, and proposing any revisions to the requirements contained herein, if necessary.

#### **Regulatory Evaluation Summary**

The complete regulatory evaluation of the final rule is available in the regulatory docket. A discussion of those comments addressing the regulatory evaluation of the notice and a summary of the final regulatory evaluation are presented below.

Comments addressing the regulatory evaluation generally expressed concern about the costs of the proposed regulations, but provided very little detail in support of their conclusions. This was true with respect to both direct acquisition and installation costs, and indirect costs from factors such as reduced payload or aircraft range.

Some commenters stated that the amendments would impose a severe economic burden on small companies operating small aircraft for hire. The FAA is aware that the amendments will result in economic impacts. However, the Department of Transportation has been directed by the Congress to take these actions.

Some commenters misinterpreted the significance of the 10-year analysis period to mean that the FAA expected operators to spread their retrofit costs over 10 years. FAA's cost estimates were for total program costs over 10 years. In developing these estimates, retrofit costs were concentrated in the first two years of the analysis period. However, the FAA has extended the compliance period from the proposed 2-year period to three years in the final rule, which should provide relief to many operators.

Some commenters expressed concern about the high cost of retrofitting their aircraft. However, it appears they misunderstood that certain proposed flight recorder requirements would apply to newly manufactured aircraft only. Further, concerns were expressed that a 32 parameter retrofit requirement



for 20 to 30 passenger seat aircraft operated under Part 135 would impose requirements that are more stringent than those requirements applicable to existing Part 121 aircraft. This issue has been resolved in the final rule by adopting requirements for existing 20 to 30 passenger Part 135 aircraft that are similar to the current Part 121 requirements.

One commenter stated that the FAA did not consider initial development and certification costs in its regulatory evaluation. However, the FAA did attempt to account for this by adding 10 percent to its equipment and installation cost estimates to provide for certification, start-up, and support equipment costs for proposals affecting aircraft operated under Parts 91, 125, and 135. This was not done for Part 121 because aircraft exist that meet the proposed requirements, and support equipment already is in service because of existing recorder requirements.

The regulatory evaluation of the final rule is very similar to the regulatory evaluation of the notice. Appropriate revisions have been made to reflect the extension of the compliance period from 2 years to 3 years, the easing of the flight recorder retrofit requirements originally proposed for larger Part 135 aircraft, and other minor clarifying changes.

Briefly, the costs of these rules result from the need to acquire, install, and maintain recorder equipment, as well as the cost of additional fuel consumption attributable to the additional weight of this equipment, and miscellaneous costs related to engineering and certification requirements, support equipment, and administrative start-up costs. The FAA estimates that the cost for all categories of aircraft affected by these rules will be approximately \$297 ± million (1987 dollars), or a present value of \$207 ± million when discounted back to the start of the ten-year analysis period using the 10 percent discount rate prescribed by the Office of Management and Budget. Other potential costs of this rule that have not been quantified include diminished payload carrying capability and/or reduced range that may affect some smaller aircraft as a result of the weight and volume of these recorders, as well as possible safety tradeoffs with other equipment, such as traffic alert and collision avoidance systems, ground proximity warning systems, weather radar, etc. Solid state technology potentially could avoid or reduce many of these costs and tradeoffs.

Flight recorders and cockpit voice recorders provide information only, which does not directly save lives or prevent accidents. Accidents and

casualties are prevented by other actions, such as improvements in aircraft design or operating procedures, which may result from information gained by recorders. Because the benefits of recorders are indirect, they have only been discussed qualitatively in this analysis.

Flight recorders have proven effective in determinations of aircraft structural, mechanical, and systems failures that have led to corrective actions such as aircraft modifications or changes in operating procedures. Flight recorders are extremely useful in identifying the responses of flight crews to hazardous situations, and they contribute substantially to human factors analysis. Flight recorders also help define more precisely those operational problems that need to be addressed through research and development programs, such as windshear encounters. Further, many lessons learned from flight recorders, especially those concerning human factors and operational problems, are not limited to the particular aircraft type involved in an accident. Rather, they provide safety insights that are beneficial to all pilots operating many different types of aircraft under various operating rules. Additionally, recorders will aid significantly in the analysis of those accidents that will inevitably be experienced by aircraft utilizing new technologies, such as fly-by-wire control systems, canards, and extensive use of composite materials in aircraft structures.

#### International Trade Impact Assessment

These amendments will have little or no impact on trade for either U.S. firms doing business in foreign countries or foreign firms doing business in the United States. The amendments will affect only U.S. air carriers and operators. Foreign air carriers are prohibited from operating between points within the United States; therefore, they would not gain any competitive advantage over the domestic operations of U.S. carriers. In international operations, foreign air carriers are not expected to realize any cost advantages over U.S. air carriers because many foreign countries have recorder requirements that are as stringent as those adopted in this final rule. Further, general aviation operations conducted in the United States are not in any direct competition with foreign enterprises. For these reasons, the FAA does not expect that these amendments will result in any trade impact.

#### Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily and disproportionately burdened by government regulations. The RFA requires agencies to review rules that may have "a significant economic impact on a substantial number of small entities."

Any small entity that operates any aircraft in the categories that are included in the amendments to Parts 91, 121, 125, and 135 would be affected by this rule. Some of these amendments could result in "a significant economic impact on a substantial number" of small entity operators and air carriers. Most manufacturers that certificate aircraft under Parts 25 and 29 are not small entities and therefore are not subject to the RFA.

The following analysis explains the reasons for this determination concerning operators and air carriers. In developing estimates of annualized net compliance costs, uniform annualized costs for capital investments have been determined by multiplying the amount of the investment by a capital recovery factor appropriate for the discount rate and period of the analysis. A capital recovery factor of .155, based upon a 10 percent discount rate over a 10-year period, has been used in this analysis. Threshold cost values and small entity size standards are those stated in FAA Order 2100.14A, *Regulatory Flexibility Criteria and Guidance*. Values have been adjusted to 1987 dollars.

The threshold values defining a significant economic impact for scheduled carriers are \$96,200 if the entire fleet has a seating capacity of over 60 seats, and \$53,800 for other scheduled carriers. The threshold value for an unscheduled operator is only \$3,800. Further, a small entity operator of aircraft for hire is defined as one which owns 9 or fewer aircraft.

The annualized cost for the least expensive requirement adopted in this final rule, a CVR retrofit, is approximately \$3,500 per aircraft. Therefore, an operator owning only one aircraft is very close to the \$3,800 threshold for unscheduled operators, and any operator owning more than one aircraft is well over the threshold. This would apply to virtually all small Part 135 operators affected by the rule. A similar argument can be made for Part 125 operators owning only one aircraft because they would be required to retrofit the far more expensive flight recorders as well as CVR's. It is possible that a substantial number of small

entities (defined as one-third of the small entities affected by the particular proposal) could incur significant economic impacts, particularly scheduled Part 135 operators (commuters) if they obtain between 6 and 9 new aircraft with 19 or fewer seats, or retrofit between about 4 and 9 aircraft with 20 to 30 seats. Further, any small unscheduled Part 121 operator purchasing one or more new aircraft not equipped with a digital data bus and digital flight data acquisition unit (DFDAU) will exceed the threshold for nonscheduled operators.

Part 91 operators of aircraft affected by these proposals generally are not small entities, however, and therefore would not be subject to the RFA. For these reasons, the FAA has determined that these amendments may have a significant economic impact on a substantial number of those small entities operating under Parts 121, 125, and 135, and a regulatory flexibility analysis is required under the terms of the RFA. The final regulatory flexibility analysis follows below.

#### Final Regulatory Flexibility Analysis

As required by Section 604 of the RFA, the following analysis deals with the proposed flight recorder requirements as they relate to small operators.

#### A. Why Agency Action Is Taken

This rulemaking is in response to Congressional action and to several recommendations made by the NTSB. The reasons for agency action are detailed in the preamble and the regulatory evaluation.

Briefly, the advantages of additional recorded information has been demonstrated by those aircraft so equipped, and it is desirable that more specific information be obtained following an accident involving additional categories of aircraft than is possible under current regulations.

#### B. Summary of Issues Raised by Public Comments

Comments addressing those issues identified in the initial regulatory flexibility analysis as potentially affecting small entities primarily concerned the impact of the proposals on Part 135 operators. These commenters generally expressed concern that the proposals would impose unreasonable costs on operators in comparison to any safety benefits that might result. (Similar comments were received concerning Part 91

operations. However, those entities that conduct Part 91 operations in aircraft that will be affected by this rule generally are not small entities.)

In view of the data submitted, the final rule has been modified to extend the compliance period from 2 years to 3 years; and the flight recorder retrofit requirements for 20 to 30 passenger seat Part 135 aircraft have been reduced from the 32 parameters proposed, to only 11 or 17 parameters, depending upon the date of type certification (essentially, the same requirements as those currently in Part 121).

#### C. Alternatives to the Proposal

Other than those revisions discussed above, no alternatives to these proposals have been considered. The Secretary of Transportation has been directed by Congress to initiate a rulemaking that considers the recommendations of the National Transportation Safety Board to the Federal Aviation Administration concerning the use of cockpit voice recorders and flight data recorders on commuter and other aircraft. The FAA has concluded that Congress intended the NTSB to have available whatever data it needs for accident investigation purposes if acquiring that data is technologically feasible.

#### Federalism Implications

The regulations set forth in this notice are proposed under the authority in the Federal Aviation Act of 1958, as amended (49 U.S.C. 1301 et seq.). The FA Act has been interpreted to preempt State law regulating the same subject. Thus, in accordance with Executive Order 12612, it is determined that this proposed regulation does not have federalism implications requiring the preparation of a Federalism Assessment.

#### Conclusion

The FAA has determined that this amendment is not major under Executive Order 12291 but that it is significant under the Department of Transportation Regulatory Policies and Procedures (44 FR 11034, February 26, 1979). For the reasons discussed above, it also has been determined that the rule may have a significant economic impact on a substantial number of small entities.

#### List of Subjects

14 CFR Parts 23, 25, 27, and 29

Aircraft, Aviation safety, Safety,

#### 14 CFR Part 91

Air carriers, Aviation safety, Safety, Aircraft, Aircraft pilots, Pilots.

#### 14 CFR Part 121

Aviation safety, Safety, Air carriers, Aircraft, Aircraft pilots, Airplanes, Transportation, Common carriers.

#### 14 CFR Part 125

Aircraft, Airplanes, Airworthiness

#### 14 CFR Part 135

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

#### The Rule

Accordingly, the Federal Aviation Administration amends Parts 23, 25, 27, 29, 91, 121, 125, and 135 of the Federal Aviation Regulations as follows:

#### PART 23—AIRWORTHINESS STANDARDS: NORMAL, UTILITY, ACROBATIC, AND COMMUTER CATEGORY AIRPLANES

1. The authority citation for Part 23 is revised to read as follows:

Authority: 49 U.S.C. 1344, 1354(a), 1355, 1421, 1423, 1425, 1428, 1429, 1430; 49 U.S.C. 106(g) (Revised Pub L. 97-449, January 12, 1983).

2. By adding new § 23.1457 to read as follows:

#### § 23.1457 Cockpit voice recorders.

(a) Each cockpit voice recorder required by the operating rules of this chapter must be approved and must be installed so that it will record the following:

(1) Voice communications transmitted from or received in the airplane by radio.

(2) Voice communications of flight crewmembers on the flight deck.

(3) Voice communications of flight crewmembers on the flight deck, using the airplane's interphone system.

(4) Voice or audio signals identifying navigation or approach aids introduced into a headset or speaker.

(5) Voice communications of flight crewmembers using the passenger loudspeaker system, if there is such a system and if the fourth channel is available in accordance with the requirements of paragraph (c)(4)(ii) of this section.

(b) The recording requirements of paragraph (a)(2) of this section must be met by installing a cockpit-mounted area microphone, located in the best position for recording voice

communications originating at the first and second pilot stations and voice communications of other crewmembers on the flight deck when directed to those stations. The microphone must be so located and, if necessary, the preamplifiers and filters of the recorder must be so adjusted or supplemented, so that the intelligibility of the recorded communications is as high as practicable when recorded under flight cockpit noise conditions and played back. Repeated aural or visual playback of the record may be used in evaluating intelligibility.

(c) Each cockpit voice recorder must be installed so that the part of the communication or audio signals specified in paragraph (a) of this section obtained from each of the following sources is recorded on a separate channel:

(1) For the first channel, from each boom, mask, or handheld microphone, headset, or speaker used at the first pilot station.

(2) For the second channel from each boom, mask, or handheld microphone, headset, or speaker used at the second pilot station.

(3) For the third channel—from the cockpit-mounted area microphone.

(4) For the fourth channel from:

(i) Each boom, mask, or handheld microphone, headset, or speaker used at the station for the third and fourth crewmembers.

(ii) If the stations specified in paragraph (c)(4)(i) of this section are not required or if the signal at such a station is picked up by another channel, each microphone on the flight deck that is used with the passenger loudspeaker system, if its signals are not picked up by another channel.

(5) And that as far as is practicable all sounds received by the microphone listed in paragraphs (c) (1), (2), and (4) of this section must be recorded without interruption irrespective of the position of the interphone-transmitter key switch. The design shall ensure that sidetone for the flight crew is produced only when the interphone, public address system, or radio transmitters are in use.

(d) Each cockpit voice recorder must be installed so that:

(1) It receives its electric power from the bus that provides the maximum reliability for operation of the cockpit voice recorder without jeopardizing service to essential or emergency loads.

(2) There is an automatic means to simultaneously stop the recorder and prevent each erasure feature from functioning, within 10 minutes after crash impact; and

(3) There is an aural or visual means for preflight checking of the recorder for proper operation.

(e) The record container must be located and mounted to minimize the probability of rupture of the container as a result of crash impact and consequent heat damage to the record from fire. In meeting this requirement, the record container must be as far aft as practicable, but may not be where aft mounted engines may crush the container during impact. However, it need not be outside of the pressurized compartment.

(f) If the cockpit voice recorder has a bulk erasure device, the installation must be designed to minimize the probability of inadvertent operation and actuation of the device during crash impact.

(g) Each recorder container must:

(1) Be either bright orange or bright yellow;

(2) Have reflective tape affixed to its external surface to facilitate its location under water; and

(3) Have an underwater locating device, when required by the operating rules of this chapter, on or adjacent to the container which is secured in such manner that they are not likely to be separated during crash impact.

3. By adding § 23.1459 to read as follows:

**§ 23.1459 Flight recorders.**

(a) Each flight recorder required by the operating rules of this chapter must be installed so that:

(1) It is supplied with airspeed, altitude, and directional data obtained from sources that meet the accuracy requirements of §§ 23.1323, 23.1325, and 23.1327, as appropriate;

(2) The vertical acceleration sensor is rigidly attached, and located longitudinally either within the approved center of gravity limits of the airplane, or at a distance forward or aft of these limits that does not exceed 25 percent of the airplane's mean aerodynamic chord;

(3) It receives its electrical power from the bus that provides the maximum reliability for operation of the flight recorder without jeopardizing service to essential or emergency loads;

(4) There is an aural or visual means for preflight checking of the recorder for proper recording of data in the storage medium.

(5) Except for recorders powered solely by the engine-driven electrical generator system, there is an automatic means to simultaneously stop a recorder that has a data erasure feature and prevent each erasure feature from

functioning, within 10 minutes after crash impact; and

(b) Each nonejectable record container must be located and mounted so as to minimize the probability of container rupture resulting from crash impact and subsequent damage to the record from fire. In meeting this requirement the record container must be located as far aft as practicable, but need not be aft of the pressurized compartment, and may not be where aft-mounted engines may crush the container upon impact.

(c) A correlation must be established between the flight recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments. The correlation must cover the airspeed range over which the airplane is to be operated, the range of altitude to which the airplane is limited, and 360 degrees of heading. Correlation may be established on the ground as appropriate.

(d) Each recorder container must:

(1) Be either bright orange or bright yellow;

(2) Have reflective tape affixed to its external surface to facilitate its location under water; and

(3) Have an underwater locating device, when required by the operating rules of this chapter, on or adjacent to the container which is secured in such a manner that they are not likely to be separated during crash impact.

(e) Any novel or unique design or operational characteristics of the aircraft shall be evaluated to determine if any dedicated parameters must be recorded on flight recorders in addition to or in place of existing requirements.

**PART 25—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES**

1. The authority citation for Part 25 is revised to read as follows:

Authority: 49 U.S.C. 1344, 1354(a), 1355, 1421, 1423, 1424, 1425, 1428, 1429, 1430; 49 U.S.C. 106(g) [Revised Pub. L. 97-448, January 12, 1983].

2. By revising § 25.1457 (c) (1), (2), (3), and (4)(i) and adding a new paragraph (c)(5) to read as follows:

**§ 25.1457 Cockpit voice recorders.**

\* \* \* \* \*

(c) \* \* \*

(1) For the first channel, from each boom, mask, or hand-held microphone, headset, or speaker used at the first pilot station.

(2) For the second channel from each boom, mask, or hand-held microphone.

headset, or speaker used at the second pilot station.

(3) For the third channel—from the cockpit-mounted area microphone.

(4) \* \* \*

(i) Each boom, mask, or hand-held microphone, headset, or speaker used at the station for the third and fourth crew members; or

(5) As far as is practicable all sounds received by the microphone listed in paragraphs (c) (1), (2), and (4) of this section must be recorded without interruption irrespective of the position of the interphone-transmitter key switch. The design shall ensure that sidetone for the flight crew is produced only when the interphone, public address system, or radio transmitters are in use.

3. By revising § 25.1459 (a)(4) and adding a new paragraph (e) to read as follows:

**§ 25.1459 Flight recorders.**

(a) \* \* \*

(4) There is an aural or visual means for preflight checking of the recorder for proper recording of data in the storage medium.

(e) Any novel or unique design or operational characteristics of the aircraft shall be evaluated to determine if any dedicated parameters must be recorded on flight recorders in addition to or in place of existing requirements.

**PART 27—AIRWORTHINESS  
STANDARDS: NORMAL CATEGORY  
ROTORCRAFT**

1. The authority citation for Part 27 is revised to read as follows:

Authority: 49 U.S.C. 1344, 1354(a), 1355, 1421, 1423, 1425, 1428, 1429, 1430; 49 U.S.C. 106(g) (Revised Pub L. 97-449, January 12, 1983).

2. By adding new § 27.1457 to read as follows:

**§ 27.1457 Cockpit voice recorders.**

(a) Each cockpit voice recorder required by the operating rules of this chapter must be approved, and must be installed so that it will record the following:

(1) Voice communications transmitted from or received in the rotorcraft by radio.

(2) Voice communications of flight crewmembers on the flight deck.

(3) Voice communications of flight crewmembers on the flight deck, using the rotorcraft's interphone system.

(4) Voice or audio signals identifying navigation or approach aids introduced into a headset or speaker.

(5) Voice communications of flight crewmembers using the passenger loudspeaker system, if there is such a system, and if the fourth channel is available in accordance with the requirements of paragraph (c)(4)(ii) of this section.

(b) The recording requirements of paragraph (a)(2) of this section may be met:

(1) By installing a cockpit-mounted area microphone located in the best position for recording voice communications originating at the first and second pilot stations and voice communications of other crewmembers on the flight deck when directed to those stations; or

(2) By installing a continually energized or voice-actuated lip microphone at the first and second pilot stations.

The microphone specified in this paragraph must be so located and, if necessary, the preamplifiers and filters of the recorder must be adjusted or supplemented so that the recorded communications are intelligible when recorded under flight cockpit noise conditions and played back. The level of intelligibility must be approved by the Administrator. Repeated aural or visual playback of the record may be used in evaluating intelligibility.

(c) Each cockpit voice recorder must be installed so that the part of the communication or audio signals specified in paragraph (a) of this section obtained from each of the following sources is recorded on a separate channel:

(1) For the first channel, from each microphone, headset, or speaker used at the first pilot station.

(2) For the second channel, from each microphone, headset, or speaker used at the second pilot station.

(3) For the third channel, from the cockpit-mounted area microphone, or the continually energized or voice-actuated lip microphone at the first and second pilot stations.

(4) For the fourth channel, from:

(i) Each microphone, headset, or speaker used at the stations for the third and fourth crewmembers; or

(ii) If the stations specified in paragraph (c)(4)(i) of this section are not required or if the signal at such a station is picked up by another channel, each microphone on the flight deck that is used with the passenger loudspeaker system if its signals are not picked up by another channel.

(iii) Each microphone on the flight deck that is used with the rotorcraft's

loudspeaker system if its signals are not picked up by another channel.

(d) Each cockpit voice recorder must be installed so that:

(1) It receives its electric power from the bus that provides the maximum reliability for operation of the cockpit voice recorder without jeopardizing service to essential or emergency loads;

(2) There is an automatic means to simultaneously stop the recorder and prevent each erasure feature from functioning, within 10 minutes after crash impact; and

(3) There is an aural or visual means for preflight checking of the recorder for proper operation.

(e) The record container must be located and mounted to minimize the probability of rupture of the container as a result of crash impact and consequent heat damage to the record from fire.

(f) If the cockpit voice recorder has a bulk erasure device, the installation must be designed to minimize the probability of inadvertent operation and actuation of the device during crash impact.

(g) Each recorder container must be either bright orange or bright yellow.

3. By adding new § 27.1459 to read as follows:

**§ 27.1459 Flight recorders.**

(a) Each flight recorder required by the operating rules of Subchapter G of this chapter must be installed so that:

(1) It is supplied with airspeed, altitude, and directional data obtained from sources that meet the accuracy requirements of §§ 27.1323, 27.1325, and 27.1327 of this part, as applicable;

(2) The vertical acceleration sensor is rigidly attached, and located longitudinally within the approved center of gravity limits of the rotorcraft;

(3) It receives its electrical power from the bus that provides the maximum reliability for operation of the flight recorder without jeopardizing service to essential or emergency loads;

(4) There is an aural or visual means for preflight checking of the recorder for proper recording of data in the storage medium;

(5) Except for recorders powered solely by the engine-driven electrical generator system, there is an automatic means to simultaneously stop a recorder that has a data erasure feature and prevent each erasure feature from functioning, within 10 minutes after any crash impact; and

(b) Each nonejectable recorder container must be located and mounted so as to minimize the probability of container rupture resulting from crash

impact and subsequent damage to the record from fire.

(c) A correlation must be established between the flight recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments. This correlation must cover the airspeed range over which the aircraft is to be operated, the range of altitude to which the aircraft is limited, and 360 degrees of heading. Correlation may be established on the ground as appropriate.

(d) Each recorder container must:

- (1) Be either bright orange or bright yellow;
- (2) Have a reflective tape affixed to its external surface to facilitate its location under water; and
- (3) Have an underwater locating device, when required by the operating rules of this chapter, on or adjacent to the container which is secured in such a manner that they are not likely to be separated during crash impact.

#### **PART 29—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY ROTORCRAFT**

1. The authority citation for Part 29 is revised to read as follows:

Authority: 49 U.S.C. 1344, 1354(a), 1355, 1421, 1423, 1424, 1425, 1428, 1429, 1430; 49 U.S.C. 106(g) (Revised Pub. L. 97-449, January 12, 1983).

2. By adding new § 29.1459 to read as follows:

##### **§ 29.1459 Flight recorders.**

(a) Each flight recorder required by the operating rules of Subchapter G of this chapter must be installed so that:

(1) It is supplied with airspeed, altitude, and directional data obtained from sources that meet the accuracy requirements of §§ 29.1323, 29.1325, and 29.1327 of this part, as applicable;

(2) The vertical acceleration sensor is rigidly attached, and located longitudinally within the approved center of gravity limits of the rotorcraft;

(3) It receives its electrical power from the bus that provides the maximum reliability for operation of the flight recorder without jeopardizing service to essential or emergency loads;

(4) There is an aural or visual means for preflight checking of the recorder for

proper recording of data in the storage medium; and

(5) Except for recorders powered solely by the engine-drive electrical generator system, there is an automatic means to simultaneously stop a recorder that has a date erasure feature and prevent each erasure feature from functioning, within 10 minutes after any crash impact.

(b) Each nonejectable recorder container must be located and mounted so as to minimize the probability of container rupture resulting from crash impact and subsequent damage to the record from fire.

(c) A correlation must be established between the flight recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments. This correlation must cover the airspeed range over which the aircraft is to be operated, the range of altitude to which the aircraft is limited, and 360 degrees of heading. Correlation may be established on the ground as appropriate.

(d) Each recorder container must:

- (1) Be either bright orange or bright yellow;
- (2) Have a reflective tape affixed to its external surface to facilitate its location under water; and
- (3) Have an underwater locating device, when required by the operating rules of this chapter, on or adjacent to the container which is secured in such a manner that it is not likely to be separated during crash impact.

#### **PART 91—GENERAL OPERATING AND FLIGHT RULES**

1. The authority citation for Part 91 is revised to read as follows:

Authority: 49 U.S.C. 1301(7), 1303, 1344, 1348, 1352 through 1355, 1401, 1421 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).

2. By amending § 91.35 by redesignating paragraph (b) as (f) and adding new paragraphs (b), (c), (d), and (e), to read as follows:

##### **§ 91.35 Flight recorders and cockpit voice recorders.**

\* \* \* \* \*

(b) No person may operate a U.S. civil registered, multiengine, turbine-powered airplane or rotorcraft having a passenger seating configuration, excluding any pilot seats, or 10 or more that has been manufactured after October 11, 1991, unless it is equipped with one or more approved flight recorders that utilize a digital method of recording and storing data and a method of readily retrieving that data from the storage medium, that are capable of recording the data specified in Appendix E, for an airplane, or Appendix F, for a rotorcraft, of this part within the range, accuracy, and recording interval specified, and that are capable of retaining no less than 8 hours of aircraft operation.

(c) Whenever a flight recorder, required by this section, is installed, it must be operated continuously from the instant the airplane begins the takeoff roll or the rotorcraft begins lift-off until the airplane has completed the landing roll or the rotorcraft has landed at its destination.

(d) Unless otherwise authorized by the Administrator, after October 11, 1991, no person may operate a U.S. civil registered, multiengine, turbine-powered airplane or rotorcraft having a passenger seating configuration of six passengers or more and for which two pilots are required by type certification or operating rule unless it is equipped with an approved cockpit voice recorder that:

(1) Is installed in compliance with § 23.1457(a) (1) and (2), (b), (c), (d), (e), (f), and (g); § 25.1457(a) (1) and (2), (b), (c), (d), (e), (f), and (g); § 27.1457(a) (1) and (2), (b), (c), (d), (e), (f), and (g); or § 29.1457(a) (1) and (2), (b), (c), (d), (e), (f), and (g) of this chapter, as applicable; and

(2) Is operated continuously from the use of the check list before the flight to completion of the final check list at the end of the flight; and

(e) In complying with this section, an approved cockpit voice recorder having an erasure feature may be used, so that at any time during the operation of the recorder, information recorded more than 15 minutes earlier may be erased or otherwise obliterated.

3. By adding Appendices E and F to read as follows:

APPENDIX E—AIRPLANE FLIGHT RECORDER SPECIFICATIONS

Parameters	Range	Installed system <sup>1</sup> minimum accuracy (to recovered data)	Sampling interval (per second)	Resolution <sup>4</sup> read out
Relative Time (From Recorded on Prior to Takeoff)	8 hr minimum	±0.125% per hour	1	1 sec.
Indicated Airspeed	V <sub>so</sub> to V <sub>D</sub> (KIAS)	±5% or ±10 kts., whichever is greater. Resolution 2 kts. below 175 KIAS.	1	1%. <sup>3</sup>
Altitude	-1,000 ft. to max cert. alt. of A/C	±100 to ±700 ft. (see Table 1, TSO C51-a).	1	25 to 150 ft.
Magnetic Heading	360°	±5°	1	1°
Vertical Acceleration	-3g to +6g	±0.2g in addition to ±0.3g maximum datum.	4 (or 1 per second where peaks, ref. to 1g are recorded).	0.03g.
Longitudinal Acceleration	±1.0g	±1.5% max. range excluding datum error of ±5%.	2	0.01g.
Pitch Attitude	100% of usable	±2°	1	0.8°
Roll Attitude	±60° or 100% of usable range, whichever is greater.	±2°	1	0.8°
Stabilizer Trim Position, or Pitch Control Position	Full Range	±3% unless higher uniquely required	1	1%. <sup>3</sup>
Engine Power, Each Engine:	Full Range	±3% unless higher uniquely required	1	1%. <sup>3</sup>
Fan or N <sub>1</sub> Speed or EPR or Cockpit indications Used for Aircraft Certification OR.	Maximum Range	±5%	1	1%. <sup>3</sup>
Prop. speed and Torque (Sample Once/Sec as Close together as Practicable).			1 (prop Speed) 1 (torque)	1%. <sup>3</sup> 1%. <sup>3</sup>
Altitude Rate <sup>2</sup> (need depends on altitude resolution).	±8,000 fpm	±10%. Resolution 250 fpm below 12,000 ft. indicated.	1	250 fpm. below 12,000. 0.8%. <sup>3</sup>
Angle of Attack <sup>2</sup> (need depends on altitude resolution).	-20° to 40° or of usable range	±2°	1	
Radio Transmitter Keying (Discrete)	On/Off		1	
TE Flaps (Discrete or Analog)	Each discrete position (U, D, T/O, AAP) OR Analog 0-100% range	±3°	1	1%. <sup>3</sup>
LE Flaps (Discrete or Analog)	Each discrete position (U, D, T/O, AAP) OR Analog 0-100% range	±3°	1	1%. <sup>3</sup>
Thrust Reverser, Each Engine (Discrete)	Stowed or full reverse		1	
Spoiler-Speedbrake (Discrete)	Stowed or out		1	
Autopilot Engaged (Discrete)	Engaged or Disengaged		1	

<sup>1</sup> When data sources are aircraft instruments (except altimeters) of acceptable quality to fly the aircraft the recording system excluding these sensors (but including all other characteristics of the recording system) shall contribute no more than half of the values in this column.

<sup>2</sup> If data from the altitude encoding altimeter (100 ft. resolution) is used, then either one of these parameters should also be recorded. If however, altitude is recorded at a minimum resolution of 25 feet, then these two parameters can be omitted.

<sup>3</sup> Per cent of full range.

<sup>4</sup> This column applies to aircraft manufactured after October 11, 1991

APPENDIX F—HELICOPTER FLIGHT RECORDER SPECIFICATION

Parameters	Range	Installed system <sup>1</sup> minimum accuracy (to recovered data)	Sampling interval (per second)	Resolution <sup>3</sup> read out
Relative Time (From Recorded on Prior to Takeoff)	4 hr minimum	±0.125% per hour	1	1 sec.
Indicated Airspeed	V <sub>m</sub> in to V <sub>D</sub> (KIAS) (minimum airspeed signal attainable with installed pitot-static system).	±5% or ±10 kts., whichever is greater.	1	1 kt.
Altitude	-1,000 ft. to 20,000 ft. pressure altitude	±100 to ±700 ft. (see Table 1, TSO C51-a).	1	25 to 150 ft.
Magnetic Heading	350°	±5°	1	1°
Vertical Acceleration	-3g to +6g	±0.2g in addition to ±0.3g maximum datum.	4 (or 1 per second where peaks, ref. to 1g are recorded).	0.05g.
Longitudinal Acceleration	±1.0g	±1.5% max. range excluding datum error of ±5%.	2	0.03g.
Pitch Attitude	100% of usable range	±2°	1	0.8°
Roll Attitude	±60° or 100% of usable range, whichever is greater.	±2°	1	0.8°
Altitude Rate	±8,000 fpm	±10% Resolution 250 fpm below 12,000 ft. indicated.	1	250 fpm below 12,000.
<i>Engine Power, Each Engine</i>				
Main Rotor Speed	Maximum Range	±5%	1	1%. <sup>2</sup>
Free or Power Turbine	Maximum Range	±5%	1	1%. <sup>2</sup>
Engine Torque	Maximum Range	±5%	1	1%. <sup>2</sup>

APPENDIX F—HELICOPTER FLIGHT RECORDER SPECIFICATION—Continued

Parameters	Range	Installed system <sup>1</sup> minimum accuracy (to recovered data)	Sampling interval (per second)	Resolution <sup>2</sup> read out
<i>Flight Control Hydraulic Pressure</i>				
Primary (Discrete).....	High/Low.....		1.....	
Secondary-if applicable (Discrete).....	High/Low.....		1.....	
Radio Transmitter Keying (Discrete).....	On/Off.....		1.....	
Autopilot Engaged (Discrete).....	Engaged or Disengaged.....		1.....	
SAS Status-Engaged (Discrete).....	Engaged or Disengaged.....		1.....	
SAS Fault Status (Discrete).....	Fault/OK.....		1.....	
<i>Flight Controls</i>				
Collective.....	Full range.....	±3%.....	2.....	1% <sup>2</sup>
Pedal Position.....	Full range.....	±3%.....	2.....	1% <sup>2</sup>
Lat. Cyclic.....	Full range.....	±3%.....	2.....	1% <sup>2</sup>
Long. Cyclic.....	Full range.....	±3%.....	2.....	1% <sup>2</sup>
Controllable Stabilator Position.....	Full range.....	±3%.....	2.....	1% <sup>2</sup>

<sup>1</sup> When data sources are aircraft instruments (except altimeters) of acceptable quality to fly the aircraft the recording system excluding these sensors (but including all other characteristics of the recording system) shall contribute no more than half of the values in this column.  
<sup>2</sup> Per cent of full range.  
<sup>3</sup> This column applies to aircraft manufactured after October 11, 1991.

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

1. The authority citation for Part 121 is revised to read as follows:

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

2. By amending § 121.343 by redesignating existing paragraphs (e), (f), (g), (h), and (i) as (g), (h), (i), (j), and (k), and by revising the introductory clause of paragraph (a) and by adding two new paragraphs, (e) and (f), to read as follows:

**§ 121.343 Flight recorders.**

(a) Except as provided in paragraphs (b), (c), (d), (e), and (f) of this section,

\* \* \* \* \*

(e) After October 11, 1991, no person may operate a large airplane equipped

with a digital data bus and ARINC 717 digital flight data acquisition unit (DFDAU) or equivalent unless it is equipped with one or more approved flight recorders that utilize a digital method of recording and storing data and a method of readily retrieving that data from the storage medium. Any parameters specified in Appendix B of this part that are available on the digital data bus must be recorded within the ranges, accuracies, resolutions, and sampling intervals specified.

(f) After October 11, 1991, no person may operate an airplane specified in paragraph (b) of this section that is manufactured after October 11, 1991, nor an airplane specified in paragraph (a) of this section that has been type certificated after September 30, 1969, and manufactured after October 11, 1991, unless it is equipped with one or more flight recorders that utilize a digital method of recording and storing data and a method of readily retrieving that data from the storage medium. The parameters specified in Appendix B of this part must be recorded within the

ranges, accuracies, resolutions, and sampling intervals specified.

3. Section 121.359 is amended by redesignating existing paragraph (e) as paragraph (f) and adding new paragraph (e) to read as follows:

**§ 121.359 Cockpit voice recorders.**

\* \* \* \* \*

(e) For those aircraft equipped to record the uninterrupted audio signals received by a boom or a mask microphone, the flight crewmembers are required to use the boom microphone below 18,000 feet mean sea level. No person may operate a large turbine engine powered airplane or a large pressurized airplane with four reciprocating engines manufactured after October 11, 1991, or on which a cockpit voice recorder has been installed after October 11, 1991, unless it is equipped to record the uninterrupted audio signal received by a boom or mask microphone in accordance with § 25.1457(c)(5) of this chapter.

4. By revising Appendix B of Part 121 to read as follows:

APPENDIX B—AIRPLANE FLIGHT RECORDER SPECIFICATION

Parameters	Range	Accuracy sensor input to DFDR readout	Sampling interval (per second)	Resolution <sup>4</sup> readout
Time (GMT or Frame Counter) (range 0 to 4095, sampled 1 per frame).	24 Hrs.....	±0.125% Per Hour.....	0.25 (1 per 4 seconds).	1 sec.
Altitude.....	-1,000 ft to max certificated altitude of aircraft.	±100 to ±700 ft (See Table 1, TSO-C51a).	1.....	5' to 35' <sup>1</sup>
Airspeed.....	50 KIAS to V <sub>so</sub> and V <sub>so</sub> to 1.2 V <sub>so</sub> .....	±5%, ±3%.....	1.....	1 kt.
Heading.....	360°.....	±2°.....	1.....	0.5°.
Normal Acceleration (Vertical).....	-3g to +6g.....	±1% of max range excluding datum error of ±5%.	8.....	0.01g.
Pitch Attitude.....	-75°.....	±2°.....	1.....	0.5°.
Roll Attitude.....	±180°.....	±2°.....	1.....	0.5°.
Radio Transmitter Keying.....	On-Off (Discrete).....		1.....	
Thrust/Power on Each Engine.....	Full Range Forward.....	±2°.....	1 (per engine).....	0.2% <sup>2</sup>
Trailing Edge Flap or Cockpit Control Selection.	Full Range or Each Discrete Position.....	±3° or as Pilot's Indicator.....	0.5.....	0.5% <sup>2</sup>

APPENDIX B—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

Parameters	Range	Accuracy sensor input to DFDR readout	Sampling interval (per second)	Resolution <sup>4</sup> readout
Leading Edge Flap or Cockpit Control Selection.	Full Range or Each Discrete Position.....	±3° or as Pilot's Indicator.....	0.5.....	0.5% <sup>2</sup>
Thrust Reverser Position.....	Stowed, In Transit, and Reverse (Discrete).		1 (per 4 seconds per engine).	
Ground Spoiler Position/Speed Brake Selection.	Full Range or Each Discrete Position.....	±2% Unless Higher Accuracy Uniquely Required.	1.....	0.2% <sup>2</sup>
Marker Beacon Passage.....	Discrete.....		1.....	
Autopilot Engagement.....	Discrete.....		1.....	
Longitudinal Acceleration.....	±1g.....	±1.5% max range excluding datum error of ±5%.	4.....	0.01g.
Pilot Input and/or Surface Position—Primary Controls (Pitch, Roll, Yaw) <sup>3</sup> .	Full Range.....	±2° Unless Higher Accuracy Uniquely Required.	1.....	0.2% <sup>2</sup>
Lateral Acceleration.....	±1g.....	±1.5% max range excluding datum error of ±5%.	4.....	0.01g.
Pitch Trim Position.....	Full Range.....	±3% Unless Higher Accuracy Uniquely Required.	1.....	0.3% <sup>2</sup>
Glideslope Deviation.....	±400 Microamps.....	±3%.....	1.....	0.3% <sup>2</sup>
Localizer Deviation.....	±400 Microamps.....	±3%.....	1.....	0.3% <sup>2</sup>
AFCS Mode and Engagement Status.....	Discrete.....		1.....	
Radio Altitude.....	-20 ft to 2,500 ft.....	±2 Ft or ±3% Whichever is Greater Below 500 Ft and ±5% Above 500 Ft.	1.....	1 ft + 5% <sup>2</sup> above 500'
Master Warning.....	Discrete.....		1.....	
Main Gear Squat Switch Status.....	Discrete.....		1.....	
Angle of Attack (if recorded directly).	As installed.....	As installed.....	2.....	0.3% <sup>2</sup>
Outside Air Temperature or Total Air Temperature..	-50°C to +90°C.....	±2°C.....	0.5.....	0.3°C
Hydraulics, Each System Low Pressure.....	Discrete.....		0.5.....	or 0.5% <sup>2</sup>
Groundspeed.....	As installed.....	Most Accurate Systems Installed (IMS Equipped Aircraft Only).	1.....	0.2% <sup>2</sup>

If additional recording capacity is available, recording of the following parameters is recommended. The parameters are listed in order of significance:

Drift Angle.....	When available, As installed.....	As installed.....	4.....	
Wind Speed and Direction.....	When available, As installed.....	As installed.....	4.....	
Latitude and Longitude.....	When available, As installed.....	As installed.....	4.....	
Brake pressure/Brake pedal position.....	As installed.....	As installed.....	1.....	
Additional engine parameters:				
EPR.....	As installed.....	As installed.....	1 (per engine).....	
N1.....	As installed.....	As installed.....	1 (per engine).....	
N2.....	As installed.....	As installed.....	1 (per engine).....	
EGT.....	As installed.....	As installed.....	1 (per engine).....	
Throttle Lever Position.....	As installed.....	As installed.....	1 (per engine).....	
Fuel Flow.....	As installed.....	As installed.....	1 (per engine).....	
TCAS:				
TA.....	As installed.....	As installed.....	1.....	
RA.....	As installed.....	As installed.....	1.....	
Sensitivity level (as selected by crew).	As installed.....	As installed.....	2.....	
GPWS (ground proximity warning system).....	Discrete.....		1.....	
Landing gear or gear selector position.....	Discrete.....		0.25 (1 per 4 seconds).	
DME 1 and 2 Distance.....	0-200 NM.....	As installed.....	0.25.....	1 mi.
Nav 1 and 2 Frequency Selection.....	Full range.....	As installed.....	0.25.....	

<sup>1</sup> When altitude rate is recorded. Altitude rate must have sufficient resolution and sampling to permit the derivation of altitude to 5 feet.

<sup>2</sup> Per cent of full range.

<sup>3</sup> For airplanes that can demonstrate the capability of deriving either the control input on control movement (one from the other) for all modes of operation and flight regimes, the "or" applies. For airplanes with non-mechanical control systems (fly-by-wire) the "and" applies. In airplanes with split surfaces, suitable combination of inputs is acceptable in lieu of recording each surface separately.

<sup>4</sup> This column applies to aircraft manufactured after October 11, 1991

**PART 125—CERTIFICATION AND OPERATION: AIRPLANES HAVING A SEATING CAPACITY OF 20 OR MORE PASSENGERS OR A MINIMUM PAYLOAD CAPACITY OF 6,000 POUNDS OR MORE**

1. The authority citation for Part 125 is revised 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).

**§ 125.202 [Removed]**

2. By removing existing § 125.202.

3. By adding a new § 125.225, to read as follows:

**§ 125.225 Flight recorders.**

(a) Except as provided in paragraph (d) of this section, after October 11, 1991, no person may operate a large airplane type certificated before October 1, 1969, for operations above 25,000 feet altitude, nor a multiengine, turbine powered

airplane type certificated before October 1, 1969, unless it is equipped with one or more approved flight recorders that utilize a digital method of recording and storing data and a method of readily retrieving that data from the storage medium. The following information must be able to be determined within the ranges, accuracies, resolution, and recording intervals specified in Appendix D of this part:



- (1) Time;
- (2) Altitude;
- (3) Airspeed;
- (4) Vertical acceleration;
- (5) Heading;
- (6) Time of each radio transmission to or from air traffic control;
- (7) Pitch attitude;
- (8) Roll attitude;
- (9) Longitudinal acceleration;
- (10) Control column or pitch control surface position; and
- (11) Thrust of each engine.

(b) Except as provided in paragraph (d) of this section, after October 11, 1991, no person may operate a large airplane type certificated after September 30, 1969, for operations above 25,000 feet altitude, nor a multiengine, turbine powered airplane type certificated after September 30, 1969, unless it is equipped with one or more approved flight recorders that utilize a digital method of recording and storing data and a method of readily retrieving that data from the storage medium. The following information must be able to be determined with the ranges, accuracies, resolutions, and recording intervals specified in Appendix D of this part:

- (1) Time;
- (2) Altitude;
- (3) Airspeed;
- (4) Vertical acceleration;
- (5) Heading;
- (6) Time of each radio transmission either to or from air traffic control;
- (7) Pitch attitude;
- (8) Roll attitude;
- (9) Longitudinal acceleration;
- (10) Pitch trim position;
- (11) Control column or pitch control surface position;
- (12) Control wheel or lateral control surface position;
- (13) Rudder pedal or yaw control surface position;
- (14) Thrust of each engine;
- (15) Position of each thrust reverser;
- (16) Trailing edge flap or cockpit flap control position; and
- (17) Leading edge flap or cockpit flap control position.

(c) After October 11, 1991, no person may operate a large airplane equipped with a digital data bus and ARINC 717 digital flight data acquisition unit (DFDAU) or equivalent unless it is equipped with one or more approved flight recorders that utilize a digital method of recording and storing data and a method of readily retrieving that data from the storage medium. Any parameters specified in Appendix D of this part that are available on the digital data bus must be recorded within the ranges, accuracies, resolutions, and sampling intervals specified.

(d) No person may operate under this part an airplane that is manufactured after October 11, 1991, unless it is equipped with one or more approved flight recorders that utilize a digital method of recording and storing data and a method of readily retrieving that data from the storage medium. The parameters specified in Appendix D of this part must be recorded within the ranges, accuracies, resolutions and sampling intervals specified. For the purpose of this section, "manufactured" means the point in time at which the airplane inspection acceptance records reflect that the airplane is complete and meets the FAA-approved type design data.

(e) Whenever a flight recorder required by this section is installed, it must be operated continuously from the instant the airplane begins the takeoff roll until it has completed the landing roll at an airport.

(f) Except as provided in paragraph (g) of this section, and except for recorded data erased as authorized in this paragraph, each certificate holder shall keep the recorded data prescribed in paragraph (a), (b), (c), or (d) of this section, as applicable, until the airplane has been operated for at least 25 hours of the operating time specified in § 125.227(a) of this chapter. A total of 1 hour of recorded data may be erased for the purpose of testing the flight recorder or the flight recorder system. Any erasure made in accordance with this paragraph must be of the oldest recorded data accumulated at the time of testing. Except as provided in paragraph (g) of this section, no record need be kept more than 60 days.

(g) In the event of an accident or occurrence that requires immediate notification of the National Transportation Safety Board under 49 CFR Part 830 and that results in termination of the flight, the certificate holder shall remove the recording media from the airplane and keep the recorded data required by paragraph (a), (b), (c), or (d) of this section, as applicable, for at least 60 days or for a longer period upon the request of the Board or the Administrator.

(h) Each flight recorder required by this section must be installed in accordance with the requirements of § 25.1459 of this chapter in effect on August 31, 1977. The correlation required by § 25.1459(c) of this chapter need be established only on one airplane of any group of airplanes.

- (1) That are of the same type;
- (2) On which the flight recorder models and their installations are the same; and

(3) On which there are no differences in the type design with respect to the installation of the first pilot's instruments associated with the flight recorder. The most recent instrument calibration, including the recording medium from which this calibration is derived, and the recorder correlation must be retained by the certificate holder.

(i) Each flight recorder required by this section that records the data specified in paragraph (a), (b), (c), or (d) of this section must have an approved device to assist in locating that recorder under water.

4. By adding a new § 125.227, to read as follows:

**§ 125.227 Cockpit voice recorders.**

(a) No certificate holder may operate a large turbine engine powered airplane or a large pressurized airplane with four reciprocating engines unless an approved cockpit voice recorder is installed in that airplane and is operated continuously from the start of the use of the checklist (before starting engines for the purpose of flight) to completion of the final checklist at the termination of the flight.

(b) Each certificate holder shall establish a schedule for completion, before the prescribed dates, of the cockpit voice recorder installations required by paragraph (a) of this section. In addition, the certificate holder shall identify any airplane specified in paragraph (a) of this section he intends to discontinue using before the prescribed dates.

(c) The cockpit voice recorder required by this section must also meet the following standards:

(1) The requirements of Part 25 of this chapter in effect after October 11, 1991.

(2) After September 1, 1980, each recorder container must—

- (i) Be either bright orange or bright yellow;
- (ii) Have reflective tape affixed to the external surface to facilitate its location under water; and
- (iii) Have an approved underwater locating device on or adjacent to the container which is secured in such a manner that it is not likely to be separated during crash impact, unless the cockpit voice recorder and the flight recorder, required by § 125.225 of this chapter, are installed adjacent to each other in such a manner that they are not likely to be separated during crash impact.

(d) In complying with this section, an approved cockpit voice recorder having an erasure feature may be used so that, at any time during the operation of the

recorder, information recorded more than 30 minutes earlier may be erased or otherwise obliterated.

(e) For those aircraft equipped to record the uninterrupted audio signals received by a boom or a mask microphone the flight crewmembers are required to use the boom microphone below 18,000 feet mean sea level. No person may operate a large turbine engine powered airplane or a large pressurized airplane with four reciprocating engines manufactured

after October 11, 1991, or on which a cockpit voice recorder has been installed after October 11, 1991, unless it is equipped to record the uninterrupted audio signal received by a boom or mask microphone in accordance with § 25.1457(c)(5) of this chapter.

(f) In the event of an accident or occurrence requiring immediate notification of the National Transportation Safety Board under 49 CFR Part 830 of its regulations, which results in the termination of the flight,

the certificate holder shall keep the recorded information for at least 60 days or, if requested by the Administrator or the Board, for a longer period. Information obtained from the record is used to assist in determining the cause of accidents or occurrences in connection with investigations under 49 CFR Part 830. The Administrator does not use the record in any civil penalty or certificate action.

5. By adding a new Appendix D, to read as follows:

APPENDIX D—AIRPLANE FLIGHT RECORDER SPECIFICATION

Parameters	Range	Accuracy sensor input to DFDR readout	Sampling interval (per second)	Resolution <sup>4</sup> read out
Time (GMT or Frame Counter) (range 0 to 4095, sampled 1 per frame).	24 Hrs	±0.125% Per Hour	0.25 (1 per 4 seconds).	1 sec.
Altitude	-1,000 ft to max certificated altitude of aircraft.	±100 to ±700 ft (See Table 1, TSO-C51a).	1	5' to 35' <sup>1</sup> .
Airspeed	50 KIAS to V <sub>so</sub> , and V <sub>so</sub> to 1.2 V <sub>D</sub>	±5%, ±3%	1	1 kt.
Heading	360°	±2°	1	0.5.
Normal Acceleration (Vertical)	-3g to +6g	±1% of max range excluding datum error of ±5%.	8	0.01g.
Pitch Attitude	±75°	±2°	1	0.5°
Roll Attitude	±180°	±2°	1	0.5°
Radio Transmitter Keying	On-Off (Discrete)		1	
Thrust/Power on Each Engine	Full range forward	±2%	1	0.2% <sup>2</sup> .
Trailing Edge Flap or Cockpit Control Selection.	Full range or each discrete position	±3° or as pilot's Indicator	0.5	0.5% <sup>2</sup> .
Leading Edge Flap or Cockpit Control Selection.	Full range or each discrete position	±3° or as pilot's indicator	0.5	0.5% <sup>2</sup> .
Thrust Reverser Position	Stowed, in transit, and reverse (Discrete)		1 (per 4 seconds per engine).	
Ground Spoiler Position/Speed Brake Selection.	Full range or each discrete position	±2% unless higher accuracy uniquely required.	1	0.2% <sup>2</sup>
Marker Beacon Passage	Discrete		1	
Autopilot Engagement	Discrete		1	
Longitudinal Acceleration	±1g	±1.5% max range excluding datum error of ±5%.	4	0.01g.
Pilot Input and/or Surface Position-Primary Controls (Pitch, Roll, Yaw) <sup>3</sup>	Full range	±2° unless higher accuracy uniquely required.	1	0.2% <sup>2</sup>
Lateral Acceleration	±1g	±1.5% max range excluding datum error of ±5%.	4	0.01g.
Pitch Trim Position	Full range	±3% unless higher accuracy uniquely required.	1	0.3% <sup>2</sup> .
Glideslope Deviation	±400 Microamps	±3%	1	0.3% <sup>2</sup>
Localizer Deviation	±400 Microamps	±3%	1	0.3% <sup>2</sup>
AFCS Mode and Engagement Status	Discrete		1	
Radio Altitude	-20 ft to 2,500 ft.	±2 Ft or ±3% Whichever is Greater Below 500 Ft and ±5% Above 500 Ft.		1 ft + 5% <sup>2</sup> above 500'
Master Warning	Discrete		1	
Main Gear Squat Switch Status	Discrete		1	
Angle of Attack (if recorded directly)	As installed	As installed	2	0.3% <sup>2</sup>
Outside Air Temperature or Total Air Temperature.	-50°C to +90°C	±2°C	0.5	0.3°C.
Hydraulics, Each System Low Pressure	Discrete		0.5	or 0.5% <sup>2</sup>
Groundspeed	As installed	Most Accurate Systems Installed (IMS Equipped Aircraft Only).	1	0.2% <sup>2</sup>

If additional recording capacity is available, recording of the following parameters is recommended. The parameters are listed in order of significance:

Drift Angle	When available. As installed	As installed	4
Wind Speed and Direction	When available. As installed	As installed	4
Latitude and Longitude	When available. As installed	As installed	4
Brake pressure/Brake pedal position	As installed	As installed	1
Additional engine parameters:			
EPR	As installed	As installed	1 (per engine)
N1	As installed	As installed	1 (per engine)
N2	As installed	As installed	1 (per engine)
EGT	As installed	As installed	1 (per engine)
Throttle Lever Position	As installed	As installed	1 (per engine)
Fuel Flow	As installed	As installed	1 (per engine)
TCAS:			
TA	As installed	As installed	1

## APPENDIX D—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

Parameters	Range	Accuracy sensor input to DFDR readout	Sampling interval (per second)	Resolution <sup>4</sup> read out
RA	As installed	As installed	1	1 ml.
Sensitivity level (as selected by crew).	As installed	As installed	2	
GPWS (ground proximity warning system).	Discrete		1	
Landing gear or gear selector position.	Discrete		0.25 (1 per 4 seconds).	
DME 1 and 2 Distance.	0-200 NM	As installed	0.25	
Nav 1 and 2 Frequency Selection.	Full range	As installed	0.25	

<sup>1</sup> When altitude rate is recorded. Altitude rate must have sufficient resolution and sampling to permit the derivation of altitude to 5 feet.

<sup>2</sup> Percent of full range.

<sup>3</sup> For airplanes that can demonstrate the capability of deriving either the control input or control movement (one from the other) for all modes of operation and flight regimes, the "or" applies. For airplanes with non-mechanical control systems (fly-by-wire) the "and" applies. In airplanes with split surfaces, suitable combination of inputs is acceptable in lieu of recording each surface separately.

<sup>4</sup> This column applies to aircraft manufactured after October 11, 1991

### PART 135—AIR TAXI OPERATIONS AND COMMERCIAL OPERATORS

1. The authority citation for Part 135 is revised 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).

2. By amending § 135.151 by revising paragraph (a) and (b), and by adding new paragraphs (d) and (e) to read as follows:

#### § 135.151 Cockpit voice recorders.

(a) After October 11, 1991, no person may operate a multiengine, turbine-powered airplane or rotorcraft having a passenger seating configuration of six or more and for which two pilots are required by certification or operating rules unless it is equipped with an approved cockpit voice recorder that:

(1) Is installed in compliance with § 23.1457(a) (1) and (2), (b), (c), (d), (e), (f), and (g); § 25.1457(a) (1) and (2), (b), (c), (d), (e), (f), and (g); § 27.1457(a) (1) and (2), (b), (c), (d), (e), (f), and (g); or § 29.1457(a) (1) and (2), (b), (c), (d), (e), (f), and (g) of this chapter, as applicable; and

(2) Is operated continuously from the use of the check list before the flight to completion of the final check list at the end of the flight.

(b) After October 11, 1991, no person may operate a multiengine, turbine-powered airplane or rotorcraft having a passenger seating configuration of 20 or more seats unless it is equipped with an approved cockpit voice recorder that—

(1) Is installed in compliance with § 23.1457, § 25.1457, § 27.1457 or § 29.1457 of this chapter, as applicable; and

(2) Is operated continuously from the use of the check list before the flight to completion of the final check list at the end of the flight.

\* \* \* \* \*

(d) For those aircraft equipped to record the uninterrupted audio signals received by a boom or a mask microphone the flight crewmembers are required to use the boom microphone below 18,000 feet mean sea level. No person may operate a large turbine engine powered airplane manufactured after October 11, 1991, or on which a cockpit voice recorder has been installed after October 11, 1991, unless it is equipped to record the uninterrupted audio signal received by a boom or mask microphone in accordance with § 25.1457(c)(5) of this chapter.

(e) In complying with this section, an approved cockpit voice recorder having an erasure feature may be used, so that during the operation of the recorder, information:

(1) Recorded in accordance with paragraph (a) of this section and recorded more than 15 minutes earlier; or

(2) Recorded in accordance with paragraph (b) of this section and recorded more than 30 minutes earlier; may be erased or otherwise obliterated.

3. By adding a new § 135.152 to read as follows:

#### § 135.152 Flight recorders.

(a) No person may operate a multiengine, turbine-powered airplane or rotorcraft having a passenger seating configuration, excluding any pilot seat, of 10 to 19 seats, that is brought onto the U.S. register after October 11, 1991, unless it is equipped with one or more approved flight recorders that utilize a digital method of recording and storing data, and a method of readily retrieving that data from the storage medium. The parameters specified in Appendix B or C, as applicable, of this part must be recorded within the range accuracy, resolution, and recording intervals as specified. The recorder shall retain no less than 8 hours of aircraft operation.

(b) After October 11, 1991, no person may operate a multiengine, turbine-powered airplane having a passenger seating configuration of 20 to 30 seats or a multiengine, turbine-powered rotorcraft having a passenger seating configuration of 20 or more seats unless it is equipped with one or more approved flight recorders that utilize a digital method of recording and storing data, and a method of readily retrieving that data from the storage medium. The parameters in Appendix D or E of this part, as applicable, that are set forth below, must be recorded within the ranges, accuracies, resolutions, and sampling intervals as specified.

(1) Except as provided in paragraph (b)(3) of this section for aircraft type certificated before October 1, 1969, the following parameters must be recorded:

- (i) Time;
- (ii) Altitude;
- (iii) Airspeed;
- (iv) Vertical acceleration;
- (v) Heading;
- (vi) Time of each radio transmission to or from air traffic control;
- (vii) Pitch attitude;
- (viii) Roll attitude;
- (ix) Longitudinal acceleration;
- (x) Control column or pitch control surface position; and
- (xi) Thrust of each engine.

(2) Except as provided in paragraph (b)(3) of this section for aircraft type certificated after September 30, 1969, the following parameters must be recorded:

- (i) Time;
- (ii) Altitude;
- (iii) Airspeed;
- (iv) Vertical acceleration;
- (v) Heading;
- (vi) Time of each radio transmission either to or from air traffic control;
- (vii) Pitch attitude;
- (viii) Roll attitude;
- (ix) Longitudinal acceleration;

- (x) Pitch trim position;
- (xi) Control column or pitch control surface position;
- (xii) Control wheel or lateral control surface position;
- (xiii) Rudder pedal or yaw control surface position;
- (xiv) Thrust of each engine;
- (xv) Position of each thrust reverser;
- (xvi) Trailing edge flap or cockpit flap control position; and
- (xvii) Leading edge flap or cockpit flap control position.

(3) For aircraft manufactured after October 11, 1991, all of the parameters listed in Appendix D or E of this part, as applicable, must be recorded.

(c) Whenever a flight recorder required by this section is installed, it must be operated continuously from the instant the airplane begins the takeoff roll or the rotorcraft begins the lift-off until the airplane has completed the landing roll or the rotorcraft has landed at its destination.

(d) Except as provided in paragraph (c) of this section, and except for recorded data erased as authorized in this paragraph, each certificate holder shall keep the recorded data prescribed in paragraph (a) of this section until the aircraft has been operating for at least 8

hours of the operating time specified in paragraph (c) of this section. In addition, each certificate holder shall keep the recorded data prescribed in paragraph (b) of this section for an airplane until the airplane has been operating for at least 25 hours, and for a rotorcraft until the rotorcraft has been operating for at least 10 hours, of the operating time specified in paragraph (c) of this section. A total of 1 hour of recorded data may be erased for the purpose of testing the flight recorder or the flight recorder system. Any erasure made in accordance with this paragraph must be of the oldest recorded data accumulated at the time of testing. Except as provided in paragraph (c) of this section, no record need be kept more than 60 days.

(e) In the event of an accident or occurrence that requires the immediate notification of the National Transportation Safety Board under 49 CFR Part 830 of its regulations and that results in termination of the flight, the certificate holder shall remove the recording media from the aircraft and keep the recorded data required by paragraphs (a) and (b) of this section for at least 60 days or for a longer period upon request of the Board or the Administrator.

(f) Each flight recorder required by this section must be installed in accordance with the requirements of §§ 23.1459, 25.1459, 27.1459, or 29.1459, as appropriate, of this chapter. The correlation required by paragraph (c) of §§ 23.1459, 25.1459, 27.1459, or 29.1459, as appropriate, of this chapter need be established only on one aircraft of a group of aircraft:

- (1) That are of the same type;
- (2) On which the flight recorder models and their installations are the same; and
- (3) On which there are no differences in the type design with respect to the installation of the first pilot's instruments associated with the flight recorder. The most recent instrument calibration, including the recording medium from which this calibration is derived, and the recorder correlation must be retained by the certificate holder.

(g) Each flight recorder required by this section that records the data specified in paragraphs (a) and (b) of this section must have an approved device to assist in locating that recorder under water.

4. By adding new Appendices B, C, D, and E, to read as follows:

APPENDIX B—AIRPLANE FLIGHT RECORDER SPECIFICATIONS

Parameters	Range	Installed system <sup>1</sup> minimum accuracy (to recovered data)	Sampling interval (per second)	Resolution <sup>4</sup> read out
Relative time (from recorded on prior to takeoff).	8 hr minimum.....	±0.125% per hour.....	1.....	1 sec.
Indicated airspeed.....	V <sub>so</sub> to V <sub>D</sub> (KIAS).....	±5% or ±10 kts., whichever is greater. Resolution 2 kts. below 175 KIAS.	1.....	1% <sup>5</sup>
Altitude.....	-1,000 ft. to max cert. alt. of A/C.....	±100 to ±700 ft. (see Table 1, TSO C51-a).	1.....	25 to 150.
Magnetic heading.....	360°.....	±5°.....	1.....	1°.
Vertical acceleration.....	-3g to +6g.....	±0.2g in addition to ±0.3g maximum datum.	4 (or 1 per second where peaks, ref. to 1g are recorded).	0.03g.
Longitudinal acceleration.....	±1.0g.....	±1.5% max. range excluding datum error of ±5%.	2.....	0.01g.
Pitch attitude.....	100% of usable.....	±2°.....	1.....	0.8°.
Roll attitude.....	±60° or 100% of usable range, whichever is greater.	±2°.....	1.....	0.8°.
Stabilizer trim position..... Or Pitch control position.....	Full range..... Full range.....	±3% unless higher uniquely required..... ±3% unless higher uniquely required.....	1..... 1.....	1% <sup>5</sup> 1% <sup>5</sup>
<i>Engine Power, Each Engine</i>				
Fan or N <sub>1</sub> speed or EPR or cockpit indications used for aircraft certification. Or Prop. speed and torque (sample once/sec as close together as practicable).	Maximum range.....	±5%.....	1.....	1% <sup>5</sup>
Altitude rate <sup>2</sup> (need depends on altitude resolution).	±8,000 fpm.....	±10%. Resolution 250 fpm below 12,000 ft. indicated.	1 (prop speed), 1 (torque).	250 fpm. Below 12,000.
Angle of attack <sup>2</sup> (need depends on altitude resolution).	-20° to 40° or of usable range.....	±2°.....	1.....	0.8% <sup>5</sup> .
Radio transmitter keying (discrete).....	On/off.....	.....	1.....	.....
TE flaps (discrete or analog).....	Each discrete position (U, D, T/O, AAP)..... Or Analog 0-100% range.....	..... ±3°.....	1..... 1.....	..... 1% <sup>5</sup> .
LE flaps (discrete or analog).....	Each discrete position (U, D, T/O, AAP).....	.....	1.....	.....

APPENDIX B—AIRPLANE FLIGHT RECORDER SPECIFICATIONS—Continued

Parameters	Range	Installed system <sup>1</sup> minimum accuracy (to recovered data)	Sampling interval (per second)	Resolution <sup>4</sup> read out
	Or			
Thrust reverser, each engine (Discrete).....	Analog 0-100% range.....	±3°.....	1.....	1% <sup>3</sup>
Spoiler/speedbrake (discrete).....	Stowed or full reverse.....	.....	1.....	.....
Autopilot engaged (discrete).....	Stowed or out.....	.....	1.....	.....
	Engaged or disengaged.....	.....	1.....	.....

<sup>1</sup> When data sources are aircraft instruments (except altimeters) of acceptable quality to fly the aircraft the recording system excluding these sensors (but including all other characteristics of the recording system) shall contribute no more than half of the values in this column.

<sup>2</sup> If data from the altitude encoding altimeter (100 ft. resolution) is used, then either one of these parameters should also be recorded. If however, altitude is recorded at a minimum resolution of 25 feet, then these two parameters can be omitted.

<sup>3</sup> Per cent of full range.

<sup>4</sup> This column applies to aircraft manufacturing after October 11, 1991

APPENDIX C—HELICOPTER FLIGHT RECORDER SPECIFICATIONS

Parameters	Range	Installed system <sup>1</sup> minimum accuracy (to recovered data)	Sampling interval (per second)	Resolution <sup>3</sup> read out
Relative time (from recorded on prior to takeoff).	8 hr minimum.....	±0.125% per hour.....	1.....	1 sec.
Indicated airspeed.....	V <sub>min</sub> to V <sub>h</sub> (KIAS) (minimum airspeed signal attainable with installed pitot-static system).	±5% or ±10 kts., whichever is greater.....	1.....	1 kt.
Altitude.....	-1,000 ft. to 20,000 ft. pressure altitude.....	±100 to ±700 ft. (see Table 1, TSO C51-a).	1.....	25 to 150 ft.
Magnetic heading.....	360°.....	±5°.....	1.....	1°
Vertical acceleration.....	-3g to +6g.....	±0.2g in addition to ±0.3g maximum datum.	4 (or 1 per second where peaks, ref. to 1g are recorded).	0.05g.
Longitudinal acceleration.....	±1.0g.....	±1.5% max. range excluding datum error of ±5%.	2.....	0.03g.
Pitch attitude.....	100% of usable range.....	±2°.....	1.....	0.8°
Roll attitude.....	±60° or 100% of usable range, whichever is greater.	±2°.....	1.....	0.8°
Altitude rate.....	±8,000 fpm.....	±10% Resolution 250 fpm below 12,000 ft. indicated.	1.....	250 fpm below 12,000.
<i>Engine Power, Each Engine</i>				
Main rotor speed.....	Maximum range.....	±5%.....	1.....	1% <sup>2</sup>
Free or power turbine.....	Maximum range.....	+5%.....	1.....	1% <sup>2</sup>
Engine torque.....	Maximum range.....	±5%.....	1.....	1% <sup>2</sup>
<i>Flight Control—Hydraulic Pressure</i>				
Primary (discrete).....	High/low.....	.....	1.....	.....
Secondary—if applicable (discrete).....	High/low.....	.....	1.....	.....
Radio transmitter keying (discrete).....	On/off.....	.....	1.....	.....
Autopilot engaged (discrete).....	Engaged or disengaged.....	.....	1.....	.....
SAS status—engaged (discrete).....	Engaged/disengaged.....	.....	1.....	.....
SAS fault status (discrete).....	Fault/OK.....	.....	1.....	.....
<i>Flight Controls</i>				
Collective.....	Full range.....	±3%.....	2.....	1% <sup>2</sup>
Pedal position.....	Full range.....	±3%.....	2.....	1% <sup>2</sup>
Lat. cyclic.....	Full range.....	±3%.....	2.....	1% <sup>2</sup>
Long. cyclic.....	Full range.....	±3%.....	2.....	1% <sup>2</sup>
Controllable stabilator position.....	Full range.....	±3%.....	2.....	1% <sup>2</sup>

<sup>1</sup> When data sources are aircraft instruments (except altimeters) of acceptable quality to fly the aircraft the recording system excluding these sensors (but including all other characteristics of the recording system) shall contribute no more than half of the values in this column.

<sup>2</sup> Per cent of full range.

<sup>3</sup> This column applies to aircraft manufactured after October 11, 1991

APPENDIX D—AIRPLANE FLIGHT RECORDER SPECIFICATION

Parameters	Range	Accuracy sensor input to DFDR readout	Sampling interval (per second)	Resolution <sup>4</sup> read out
Time (GMT or Frame Counter) (range 0 to 4095, sampled 1 per frame).	24 Hrs.....	±0.125% Per Hour.....	0.25 (1 per 4 seconds).	1 sec.
Altitude.....	-1,000 ft to max certificated altitude of aircraft.	±100 to ±700 ft (See Table 1, TSO-C51a).	1.....	5' to 35' <sup>1</sup>
Airspeed.....	50 KIAS to V <sub>so</sub> , and V <sub>so</sub> to 1.2 V <sub>D</sub> .....	±5%, ±3%.....	1.....	1kt.
Heading.....	360°.....	±2°.....	1.....	0.5°

APPENDIX D—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

Parameters	Range	Accuracy sensor input to DFDR readout	Sampling interval (per second)	resolution <sup>1</sup> read out
Normal Acceleration (Vertical)	-3g to +6g	±1% of max range excluding datum error of ±5%.	8	0.01g
Pitch Attitude	±75°	±2°	1	0.5°
Roll Attitude	±180°	±2°	1	0.5°
Radio Transmitter Keying	On-Off (Discrete)		1	
Thrust/Power on Each Engine	Full range forward	±2%	1 (per engine)	0.2% <sup>2</sup>
Trailing Edge Flap or Cockpit Control Selection.	Full range or each discrete position	±3° or as pilot's indicator	0.5	0.5% <sup>2</sup>
Leading Edge Flap on or Cockpit Control Selection.	Full range or each discrete position	±3° or as pilot's indicator	0.5	0.5% <sup>2</sup>
Thrust Reverser Position	Stowed, in transit, and reverse (discretion).		1 (per 4 seconds per engine).	
Ground Spoiler Position/Speed Brake Selection.	Full range or each discrete position	±2% unless higher accuracy uniquely required.	1	0.22 <sup>2</sup>
Marker Beacon Passage	Discrete		1	
Autopilot Engagement	Discrete		1	
Longitudinal Acceleration	±1g	±1.5% max range excluding datum error of ±5%.	4	0.01g.
Pilot Input And/or Surface Position-Primary Controls (Pitch, Roll, Yaw) <sup>3</sup>	Full range	±2° unless higher accuracy uniquely required.	1	0.2% <sup>2</sup>
Lateral Acceleration	±1g	±1.5% max range excluding datum error of ±5%.	4	0.01g.
Pitch Trim Position	Full range	±3% unless higher accuracy uniquely required.	1	0.3% <sup>2</sup>
Glideslope Deviation	±400 Microamps	±3%	1	0.3% <sup>2</sup>
Localizer Deviation	±400 Microamps	±3%	1	0.3% <sup>2</sup>
AFCS Mode And Engagement Status	Discrete		1	
Radio Altitude	-20 ft to 2,500 ft	±2 Ft or ±3% whichever is greater below 500 ft and ±5% above 500 ft.	1	1 ft + 5% <sup>2</sup> above 500'
Master Warning	Discrete		1	
Main Gear Squat Switch Status	Discrete		1	
Angle of Attack (if recorded directly)	As installed	As installed	2	0.3% <sup>2</sup>
Outside Air Temperature or Total Air Temperature.	-50°C to +90°C	±2°C	0.5	0.3°C/
Hydraulics, Each System Low Pressure	Discrete		0.5	or 0.5% <sup>2</sup>
Groundspeed	As installed	Most accurate systems installed (IMS equipped aircraft only).	1	0.2% <sup>2</sup>

If additional recording capacity is available, recording of the following parameters is recommended. The parameters are listed in order of significance:

Drift Angle	When available. As installed	As installed	4	
Wind Speed and Direction	When available. As installed	As installed	4	
Latitude and Longitude	When available. As installed	As installed	4	
Brake pressure/Brake pedal position	As installed	As installed	1	
Additional engine parameters:				
EPR	As installed	As installed	1 (per engine)	
N1	As installed	As installed	1 (per engine)	
N2	As installed	As installed	1 (per engine)	
EGT	As installed	As installed	1 (per engine)	
Throttle Lever Position	As installed	As installed	1 (per engine)	
Fuel Flow	As installed	As installed	1 (per engine)	
TCAS:				
TA	As installed	As installed	1	
RA	As installed	As installed	1	
Sensitivity level (as selected by crew).	As installed	As installed	2	
GPWS (ground proximity warning system)	Discrete		1	
Landing gear or gear selector position	Discrete		0.25 (1 per 4 seconds).	
DME 1 and 2 Distance	0-200 HM;	As installed	0.25	1mi.
Nav 1 and 2 Frequency Selection	Full range	As installed	0.25	

<sup>1</sup> When altitude rate is recorded. Altitude rate must have sufficient resolution and sampling to permit the derivation of altitude to 5 feet.

<sup>2</sup> Per cent of full range.

<sup>3</sup> For airplanes that can demonstrate the capability of deriving either the control input or control movement (one from the other) for all modes of operation and flight regimes, the "or" applies. For airplanes with non-mechanical control systems (fly-by-wire) the "and" applies. In airplanes with split surfaces, suitable combination of inputs is acceptable in lieu of recording each surface separately.

<sup>4</sup> This column applies to aircraft manufactured after October 11, 1991

APPENDIX E—HELICOPTER FLIGHT RECORDER SPECIFICATIONS

Parameters	Range	Accuracy sensor input to DFDR readout	Sampling interval (per second)	Resolution <sup>2</sup> read out
Time (GMT)	24 Hrs	±0.125% Per Hour	0.25 (1 per 4 seconds).	1 sec.

## APPENDIX E—HELICOPTER FLIGHT RECORDER SPECIFICATIONS—Continued

Parameters	Range	Accuracy sensor input to DFDR readout	Sampling interval (per second)	Resolution <sup>2</sup> read out
Altitude.....	-1,000 ft to max certificated altitude of aircraft.	±100 to ±700 ft (See Table 1, TSO-C51a).	1.....	5' to 30'.
Airspeed.....	As the installed measuring system.....	±3%.....	1.....	1 kt.
Heading.....	360°.....	±2°.....	1.....	0.5°.
Normal Acceleration (Vertical).....	-3g to +6g.....	±1% of max range excluding datum error of ±5%.	8.....	0.01g
Pitch Attitude.....	±75°.....	±2°.....	2.....	0.5°.
Roll Attitude.....	±180°.....	±2°.....	2.....	0.5°.
Radio Transmitter Keying.....	On-Off (Discrete).....	±2°.....	1.....	0.25 sec.
Power in Each Engine: Free Power Turbine Speed and Engine Torque.	0-130% (power Turbine Speed) Full range (Torque).	±2%.....	1 speed 1 torque (per engine).	0.2% <sup>1</sup> to 0.4% <sup>1</sup> .
Main Rotor Speed.....	0-130%.....	±2%.....	2.....	0.3% <sup>1</sup> .
Altitude Rate.....	±5,000 ft/min.....	As installed.....	2.....	0.2% <sup>1</sup> .
Pilot Input—Primary Controls (Collective, Longitudinal Cyclic, Lateral Cyclic, Pedal).	Full range.....	±3%.....	2.....	0.5% <sup>1</sup> .
Flight Control Hydraulic Pressure Low.....	Discrete, each circuit.....	.....	1.....	.....
Flight Control Hydraulic Pressure Selector Switch Position, 1st and 2nd stage.	Discrete.....	.....	1.....	.....
AFCS Mode and Engagement Status.....	Discrete (5 bits necessary).....	.....	1.....	.....
Stability Augmentation System Engage.....	Discrete.....	.....	1.....	.....
SAS Fault Status.....	Discrete.....	.....	0.25.....	.....
Main Gearbox Temperature Low.....	As installed.....	As installed.....	0.25.....	0.5% <sup>1</sup> .
Main Gearbox Temperature High.....	As installed.....	As installed.....	0.5.....	0.5% <sup>1</sup> .
Controllable Stabilator Position.....	Full Range.....	±3%.....	2.....	0.4% <sup>1</sup> .
Longitudinal Acceleration.....	±1g.....	±1.5% max range excluding datum error of ±5%.	4.....	0.01g.
Lateral Acceleration.....	±1g.....	±1.5% max range excluding datum of ±5%.	4.....	0.01g.
Master Warning.....	Discrete.....	.....	1.....	.....
Nav 1 and 2 Frequency Selection.....	Full range.....	As installed.....	0.25.....	.....
Outside Air Temperature.....	-50°C to +90°C.....	±2°c.....	0.5.....	0.3°c.

<sup>1</sup> Per cent of full range.<sup>2</sup> This column applies to aircraft manufactured after October 11, 1991.

Issued in Washington, DC, on June 30, 1988.

T. Allan McArtor,

Administrator.

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# Corrections

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**PART 91—[CORRECTED]****§ 91.35 [Corrected]**

4. On the same page, in the third column, in § 91.35(b), in the fifth line, "seats or" should read "seats of"; and in § 91.35(c), in the third line, "continuously" was misspelled.

**Appendix E—[Corrected]**

5. On page 26146, Appendix E is corrected as follows:

a. In the first column, in the 19th entry, "Spoiler-Speedbrake (Discrete)" should read "Spoiler/Speedbrake (Discrete)".

b. In the second column, in the eighth entry, in the first line, "useable" was misspelled.

c. In the third column, in the second entry, in the first line, "ks." should read "kts."

d. In the fifth column, in the 2nd, 9th through 13th, and 15th through 17th entries, remove the period after the percent sign; and in the 7th entry, remove the period after the degree mark.

**Appendix F—[Corrected]**

6. On the same page, in Appendix F, in the second column, in the fourth entry, "350" should read "360".

**PART 121—[CORRECTED]****Appendix B—[Corrected]**

7. On page 26147, in Appendix B, make the following corrections:

a. In the second column, in the third entry, "1.2 <sub>D</sub>" should read "1.2 V<sub>D</sub>".

b. In the same column, in the sixth entry, "-75" should read "±75".

c. In the third column, the eighth entry should read ±2%.

d. In the fifth column, in the 2nd, 4th, 6th, and 8th entries, remove the period at the end of the entries.

8. On page 26148, in Appendix B, in the second column, in the next to last entry, "0-200 NM" should read "0-200 NM;".

**PART 125—[CORRECTED]****§ 125.225 [Corrected]**

9. On page 26149, in the first column, in § 125.225(b) introductory text, in the 15th line, "with" should read "within".

10. On the same page, in the third column, in § 125.225(i), in the third line, "paragraph" should read "paragraphs".

**Appendix D—[Corrected]**

11. On page 26150, in Appendix D, in the fifth column, in the 2nd, 8th through 10th, 15, and 20th entries, remove the period at the end of the entries; and in the 4th entry, "0.5." should read "0.5".

12. On page 26151, in Appendix D, in the second column, in the next to last entry, "0-200 NM" should read "0-200 NM;".

**PART 135—[CORRECTED]****Appendix B—[Corrected]**

13. On page 26152, in Appendix B, in the fifth column, in the 3rd, 4th, 7th, 8th, 13th and 14th entries, remove the period at the end of the entries; also, in the 12th entry, remove the period after "fpm".

**Appendix C—[Corrected]**

14. On page 26153, in Appendix C, in the fifth column, in the 10th through 12th and 14th through 17th entries, remove the period after the percent sign.

**Appendix D—[Corrected]**

15. On page 26154, in Appendix D, make the following corrections:

a. In the second column, in the eighth entry, "(discretion)" should read "(discrete)"; and in the 41st line, "HM" should read "NM".

b. In the fifth column, in the 3rd, 4th, and 6th entries, remove the period at the end of the entries; also, in the 16th entry, remove "/".

**Appendix E—[Corrected]**

16. On page 26155, in Appendix E, in the fifth column, in the 1st, 3rd, 5th, 6th, and 8th through 14th, and 17th entries, remove the period at the end of the entries.

For a Federal Aviation Administration correction to this document, see the Rules section of this issue.

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**DEPARTMENT OF TRANSPORTATION****Federal Aviation Administration**

14 CFR Parts 23, 25, 27, 29, 91, 121, 125, and 135

[Docket No. 25530; Amdt. Nos. 23-35, 25-65, 27-22, 29-25, 91-204, 121-197, 125-10, 135-26]

[RIN 2120-AC48]

**Cockpit Voice Recorders (CVR) and Flight Recorders***Correction*

In rule document 88-15179 beginning on page 26134 in the issue of Monday, July 11, 1988, make the following corrections:

1. On page 26139, in the first column, in the sixth complete paragraph, in the first line, insert "not" after "are".

2. On page 26142, in the first column, in the fourth complete paragraph, in the second line, "has" should read "have".

**PART 29—[CORRECTED]****§ 29.1459 [Corrected]**

3. On page 26145, in the second column, in § 29.1459(a)(5), in the fifth line, "date" should read "data".