DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 121, 125, 129, and 135

[Docket No. 28109; Notice No. 96–7]

RIN 2120–AF–76

Revisions to Digital Flight Data Recorder Rules

AGENCY: Federal Aviation Administration, DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: This document proposes to revise and update the Federal Aviation Regulations to require certain operators to record additional digital flight data recorder (DFDR) parameters. These revisions follow a series of safety recommendations issued by the National Transportation Safety Board (NTSB) and the Federal Aviation Administration's (FAA) decision that the DFDR rules should be revised to upgrade recorder capabilities in most transport airplanes. These revisions would allow additional information to be collected to ensure more thorough accident or incident investigation and to enable industry to predict certain trends and make necessary modifications before an accident or incident occurs.

DATES: Comments on the proposed revisions to parts 121, 125, and 135 must be received by August 15, 1996. Comments on the proposed revisions to part 129 must be received by November 13, 1996.

ADDRESSES: Comments on this notice should be mailed, in triplicate to: Federal Aviation Administration, Office of Chief Counsel, Attention: Rules Docket (AGC–200), Docket No. 28109, 800 Independence Avenue SW., Washington, DC 20591. Comments delivered must be marked Docket No. 28109. Comments may also be submitted electronically to the following Internet address: nprmcmts@mail.hq.faa.gov. Comments may be examined in Room 915G weekdays, except on Federal holidays, between 8:30 a.m. and 5 p.m.

FOR FURTHER INFORMATION CONTACT: Frank Rock, Aircraft Engineering Division, Aircraft Certification Service, Federal Aviation Administration, 800 Independence Avenue SW., Washington, DC 20591, telephone (202) 267–9567.

SUPPLEMENTARY INFORMATION:

Comments Invited

Interested persons are invited to participate in the making of the proposed rule by submitting such written data, views, or arguments as they may desire. Comments relating to the environmental energy, federalism, or economic impact that might result from adopting the proposal in this notice are also invited. Substantive comments should be accompanied by cost estimates. Comments should identify the regulatory docket or notice number and should be submitted in triplicate to the Rules Docket address specified above. All comments received on or before the closing date for comments specified will be considered by the Administrator before taking action on this proposed rulemaking. The proposal contained in this notice may be changed in light of comments received. All comments received will be available, both before and after the closing date for comments, in the Rules Docket for examination by interested persons. A report summarizing each substantive public contact with FAA personnel concerned with this rulemaking will be filed in the docket. Commenters wishing the FAA to acknowledge receipt of their comments submitted in response to this notice must include a pre-addressed, stamped postcard on which the following statement is made: ''Comments to Docket No. 28109.'' The postcard will be date stamped and mailed to the commenter.

Availability of NPRM's

An electronic copy of this document may be downloaded using a modem and suitable communications software from the FAA regulations section of the Fedworld electronic bulletin board service (telephone: 703–321–3339), the Federal Register's electronic bulletin board service (telephone: 202–512–1661), or the FAA's Aviation Rulemaking Advisory Committee Bulletin Board service (telephone: 202–267–5948).

Internet users may reach the FAA's web page at http://www.faa.gov or the Federal Register's webpage at http://www.access.gpo.gov/su__docs for access to recently published rulemaking documents.

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

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

Background

Statement of the Problem

The NTSB has submitted recommendations to the FAA to require the recordation of additional parameters on certain flight data recorders. These recommendations were submitted in response to accidents involving two Boeing 737 aircraft that were operated by two different air carriers. Both airplanes were equipped with flight data recorders (FDR's), but in neither case did the FDR provide sufficient information about airplane motion and flight control surface positions during the accident sequence to enable the NTSB to determine a probable cause in either accident.

The history of aircraft accidents and the lack of information that has inhibited proper investigation of their causes is much broader than recent experience with the Boeing 737. Historical records of airplane incidents suggest that additional, reliable data for the entire fleet of transport category airplanes is necessary to identify causes of these incidents before accidents occur. This proposed rule seeks to expand the data collection requirements to include all parameters that can cost-effectively be collected.

History of FDR Regulations

Since the original development of foil flight recorders, both the FAA and the NTSB have relied heavily on the data retrieved from them to aid in accident and incident investigation. The limited capability of the 6-parameter foil recorder made it virtually impossible to fully identify the probable cause of certain accidents, such as those related to windshear. Until the advent of more sophisticated flight data recorders, many accidents were assumed to be caused by pilot error since no other viable alternative could be identified. The high failure rate of those recorders and their limited recording capabilities led Congress to require the use of improved recorders.

On March 25, 1987, the FAA promulgated a final rule that required operators, by May 26, 1995, to install improved (11-parameter digital) flight data recorders [DFDR's] on all airplanes type certificated on or before September 30, 1969, and operated under part 121 of the Federal Aviation Regulations (52 FR 9622). The final rule, adopted as 14 CFR 121.343(c), was issued in response to a recommendation from the NTSB that was based on accident/incident files for January 1983 to February 1986

that revealed a high failure rate for metal foil flight recorders. The data revealed that 37 recorders (48 percent) had one or more malfunctioning parameters preceding the accident or incident, preventing the recording or readout of pertinent data.

On July 11, 1988, the FAA promulgated a final rule that required the recording of additional parameters for certain newer airplanes. Airplanes manufactured after May 26, 1989, and certain other airplanes were required to have a DFDR that would record 17 or more parameters.

In August 1991, the Air Transport Association (ATA) petitioned the FAA for an exemption from § 121.343(c). The ATA stated that the 1994 compliance date for the DFDR retrofit was inappropriate when considering the schedule for either retrofitting airplanes with nose abatement equipment or retiring airplanes in order to comply with the Stage 3 transition mandated in September 1991 (56 FR 48628, September 25, 1991). The FAA denied the ATA exemption request, stating that the Stage 3 transition rule did not mandate the retirement of any Stage 2 airplanes. The FAA pointed out that noise abatement equipment was expected to be available for virtually the entire active fleet.

In June 1992, the ATA again requested that the FAA extend the May 26, 1994, DFDR compliance date for its members and similarly situated operators. In the alternative, the ATA requested that the FAA establish a delayed DFDR retrofit schedule that coincided with the Stage 3 transition interim compliance dates to avoid having to install new DFDR's on airplanes that were scheduled to be retired. The ATA asserted that the compliance deadline would require its members to install DFDR's on Stage 2 airplanes that would be retired within 5½ years of the May 1994 compliance date to remain in compliance with the part 91 noise operating rule. The ATA asserted that this DFDR retrofit requirement for State 2 airplanes would impose substantial costs on them with little perceived benefit.

On January 29, 1993, the FAA granted an exemption to ATA members to operate certain Stage 2 airplanes equipped with DFDR's that have 6 rather than 11 operational parameters until the aircraft are retired, but no later than December 31, 1998.

On November 17, 1993, the ATA submitted a petition for rulemaking to amend § 121.343. The ATA stated that the exemption granted did not provide the scope of relief necessary for its members and similarly situated air carriers, and that a change to the rule was necessary. As justification for this proposed change, the ATA stated in its petition that there would be significant compliance costs and that there were problems with the technical requirements of DFDR installation.

In January 1994, to further support its petition, the ATA presented updated information indicating that conditions in the industry had changed further, and that meeting the May 26, 1994, compliance date would be impossible for a significant number of Stage 2 airplanes because of changes in fleet plans, and equipment availability and certification difficulties.

Although the FAA was unable to support the ATA position, the agency stated that some relief was needed from the combined impact of the Stage 3 transition and DFDR retrofit rules and the then-current equipment availability problems, at least as far as Stage 2 airplanes were concerned. Accordingly, in May 1994, the FAA amended § 121.343(c) to provide to part 121 operators up to one year of relief for the retrofit of Stage 2 airplanes that were subject to the noise transition requirements of 14 CFR part 91. The extension of the compliance date for 11-parameter DFDR's on Stage 2 airplanes to May 1995 was intended to allow operators to retire some of the affected airplanes as of the December 31, 1994, noise compliance deadline, and to acquire the necessary equipment for the remaining Stage 2 airplanes. No problems with meeting the 1995 compliance date were reported.

NTSB Recommendations

On February 22, 1995, the NTSB submitted recommendations A–95–25, A–95–26, and A–95–27, which recommended that the FAA require upgrades of the flight data recorders installed on certain airplanes to record certain additional parameters not required by the current regulations. As justification for these recommendations, the NTSB submitted background information. The full recommendation has been placed in the docket for this rulemaking and is summarized below.

On September 8, 1994, a USAir Boeing 737–300, flight 427, was on a scheduled passenger flight from Chicago, Illinois, to Pittsburgh, Pennsylvania. During the approach to Pittsburgh, the airplane suddenly rolled to the left and pitched down until it reached a nearly vertical attitude and struck the ground near Aliquippa, Pennsylvania. The airplane was destroyed; none of the 5 crewmembers or 127 passengers survived. The NTSB's investigation of this accident is continuing, and no probable cause has yet been determined.

On March 3, 1991, a United Airlines Boeing 737–291, flight 585, was on a scheduled passenger flight from Denver to Colorado Springs, Colorado. As the airplane was completing the turn to final approach, it rolled rapidly to the right and pitched down, reaching a nearly vertical attitude before it struck the ground. The airplane was destroyed; none of the five crewmembers or 20 passengers survived. In its report, the NTSB was unable to make a determination of probable cause of the accident.

Both airplanes were equipped with flight data recorders. In neither case did the recorder provide information about airplane motion and flight control surface positions during the accident sequence that the NTSB has stated would be important in determining a probable cause of the accident.

In the Colorado Springs accident, five flight data parameters—altitude, airspeed, heading, vertical acceleration, and microphone keying—were recorded by the FDR in accordance with § 121.343 for airplanes of its age. The FDR of the airplane involved in the Colorado Springs accident was not required to record other parameters that the NTSB has cited as critical to its accident investigation, including airplane pitch and roll attitude, engine thrust values, lateral and longitudinal acceleration, control wheel position, rudder pedal position, and the position of control surfaces such as the rudder, aileron, and spoiler.

The Aliquippa accident also involved a Boeing 737, but that airplane's FDR system had been retrofitted with six additional parameters in anticipation of the 1995 deadline for these enhancements. However, the additional parameters did not include information on the positions of cockpit controls, flight control surface position, lateral acceleration, or autopilot status parameters that the NTSB has stated hampered its continuing accident investigation. In a public hearing on the accident, conducted by the NTSB in Pittsburgh, Pennsylvania, on January 23–27, 1995, witnesses from the FAA, aircraft manufacturers, and airlines agreed that additional FDR parameters would have assisted the NTSB in determining the probable cause of this accident.

Had the airplanes involved in the Colorado Springs and Aliquippa accidents been equipped with enhanced FDR's, the NTSB stated that the information from the additional parameters would have allowed it to quickly identify any abnormal control

surface movements, configuration changes, or autopilot status changes that may have been involved in the loss of airplane control. This information from the additional parameters might also have allowed the NTSB to rule out certain factors, if warranted, and to focus its investigations on other areas.

The NTSB has stated that the additional data parameters recorded on some FDR's substantially aided its investigation of two regional airline accidents that occurred during 1994. The first accident occurred on October 31, 1994, while an American Eagle ATR–72–210, flight 4184, was on a scheduled flight from Indianapolis, Indiana, to Chicago, Illinois. The flight had been placed in a holding pattern over Roselawn, Indiana, because of weather delays at O'Hare Airport. The flight was cleared to remain in the holding pattern and to descend from 10,000 to 8,000 feet. The airplane rolled to the right, entered a steep descent, and struck the ground. None of the 64 passengers or 4 crewmembers survived. The NTSB's continuing investigation has not yet determined the probable cause of the accident; however, information from the enhanced FDR enabled the NTSB to identify, within hours after receiving the recorder in its laboratories, the key events leading to the airplane's departure from controlled flight and the events during its final descent.

The ATR–72 was equipped with an FDR that recorded 98 parameters, including vane angle of attack (VAOA), aileron bellcrank position, flap position, aileron trim position, and autopilot engagement status. The FDR data showed that, as the airplane was descending through 9,400 feet, the wing flaps began to retract and the airplane's VAOA increased. As the VAOA reached 5 degrees, the autopilot disengaged, and within ¼ second the ailerons deflected to near maximum travel in the right-wing-down direction. The FDR data also showed that the rolling moment was reversed when the VAOA was reduced to below 5 degrees and the ailerons deflected in the left-wing-down direction. The right rolling moment recurred as the VAOA again increased to 5 degrees and the ailerons deflected in the right-wing-down direction. Control of the airplane was not restored in time to prevent impact with the ground.

The data available from the ATR–72 FDR indicated to investigators that the airplane rolled as expected in response to aileron control surface movements, and that the aileron movements were correlated with increases in the airplane's angle of attack. As a result, the NTSB was able to focus its efforts on possible explanations for the aileron control surface movements and, within days of the accident, the NTSB issued safety recommendations to minimize the likelihood of similar occurrences in the future. As part of its continuing investigation, the NTSB is also examining readouts from FDR's with expanded parameters from seven other ATR airplanes that have reportedly encountered flight control anomalies, three of which have shown similarities to those recorded before the accident.

In the second accident, on February 1, 1994, an American Eagle Saab 340B, flight 3641, was approaching Baton Rouge, Louisiana, on a scheduled passenger flight from Dallas/Fort Worth, Texas. As the airplane descended through 9,000 feet, both engines failed. The flightcrew executed a forced landing at False River Air Park in New Roads, Louisiana, during which the airplane sustained substantial damage. A flight attendant received minor injuries during the emergency evacuation. The 2 pilots and 23 passengers aboard were not injured.

The FDR installed on the Saab 340B recorded 128 parameters. Data from the FDR showed that as the airplane descended through 9,040 feet, there was a rapid rise of both propellers' rotational speed to well above the maximum allowable revolutions per minute. Because the FDR was equipped to capture the positions of the engine power levers as well as the engine RPM's, the NTSB was able to determine that at the same time the propeller speed increased, the power levers moved from the flight idle gate position to aft of the ground idle detents. The airplane's approved flight manual prohibits such power lever movements while in flight. This flightcrew action explained the propeller overspeed, which resulted in dual engine failure. With the expanded FDR data, the NTSB was able to rule out alternative explanations for the propeller overspeed, including propeller system failures that previously had affected similar propellers installed in another turboprop regional airliner.

The importance of FDR data is not limited to investigations of catastrophic accidents. Flight recorder data from incidents, which are less serious but more common, can provide information to help prevent accidents involving similar circumstances. Following the Colorado Springs and Aliquippa accidents, the NTSB investigated 28 Boeing 737 incidents (U.S. operators) involving anomalous rudder activity or uncommanded roll oscillations. The FDR's aboard these incident airplanes, however, were not equipped to record flight control surface positions, flight control inputs, or lateral acceleration. Like 79 percent of all U.S.-registered Boeing 737's, the airplanes involved in the incidents were manufactured prior to May 26, 1989; consequently, they were required to record only the five basic FDR parameters. As a result, certain objective data were not available from the FDR's, and investigators had little more than the flightcrews' subjective recollections of these incidents to aid in determining cause.

In contrast to the investigations of 28 Boeing 737 incidents, for which important FDR data were not available, investigations of other incidents have been greatly aided by the availability of enhanced recorded information. These incidents involved airplanes equipped with a digital data bus that transmits information from many sensors to the onboard recording devices.

In 1993, a British Airways Boeing 747–436 experienced a nose-down pitching moment immediately after departure from London Heathrow Airport. The captain avoided ground contact by exerting substantial back pressure on his control column. The incident was investigated by the United Kingdom's Air Accidents Investigation Branch (AAIB). Use of information recorded by a Quick Access Recorder (QAR) was useful in the AAIB's investigation, and led to a recommendation that the FAA require modifications of Boeing 747 hydraulic systems and elevator power control units.

Between June and August 1993, an Air France Boeing 737–300 airplane experienced three rudder deflection anomalies. For each incident, approximately 206 flight data parameters were available to the French accident investigation authority. The data were recorded on QAR's, and available parameters included control surface positions, flight path data, acceleration in three axes, yaw damper, and autopilot modes. The NTSB is evaluating the data from these incidents for possible applicability to the Aliquippa and Colorado Springs accidents.

The data parameters currently required to be recorded on FDR's are based on the NTSB's accident investigation experience and the capacity of the recording devices. Historically, many accidents investigated by the NTSB focused on wind shear, takeoff overruns, and instances of controlled flight into terrain; fewer accidents may have involved the inflight loss of lateral or directional control. In response, FDR

parameter requirements focused on airplane performance (such as airspeed, altitude, and longitudinal acceleration) rather than on flight controls (such as rudder position and trim settings). However, recent accidents and incidents have persuaded the NTSB that more information about flight controls should be recorded by FDR's.

Among the additional flight control parameters cited as important by the NTSB are those that pertain to the positions of flight control inputs and control surface positions. Under current rules. Airplanes fitted with conventional flight controls are permitted to record either the cockpit control input (such as control wheel position) or the control surface position (such as the direction and amount of aileron deflection), if one can be derived from the other. However, in its investigations of the recent Boeing 737 accidents, the NTSB found that in some failure modes, flight control surfaces could move independently of cockpit flight control inputs. Also, under some conditions, additional information is needed by investigators to determine whether the controls on the flight deck caused the control surfaces to move, or vice versa. Consequently, the NTSB strongly recommends that FDR's should record both the control inputs and control surface positions.

Flight control trim information, including the positions of trim controls for roll and yaw, also has been found to be essential during recent accident investigations. For example, the aileron and rudder trim parameters provided answers to critical questions early in the investigation of the Roselawn accident. The airplane involved had previously experienced trim anomalies; the FDR revealed none on the accident flight.

Recent technological changes have made feasible the acquisition and storage of large amounts of data on FDR's. Today, even for older airplanes, many FDR systems are capable of recording additional parameters because of unused capacity in the flight recording system. In terms of flight recording systems, there are two general categories of airplanes in the current air carrier fleet: those that operate predominately with analog systems, and those that operate predominately with digital systems.

On an airplane that operates with an analog system, information from remotely located data sensors (for example, a rudder position sensor located in the tail section) is transmitted in an analog format to the FDR via dedicated wires. The information is then converted to digital format in the FDR or the flight data acquisition unit (FDAU).

On an airplane equipped with a digital data bus, information is transmitted in digital format from a multitude of sensors, along a single, high-capacity communications pathway (data bus). Information transmitted on the bus is provided to a number of systems, including flight management computers. cockpit displays, QAR's, and FDR's. Additional data can be fed from the bus to the FDR, based on information that is already on the bus for other purposes or added to the bus by new sensors.

During the public hearing on the Aliquippa accident, a major U.S. air carrier expressed concern about the costs of upgrading FDR's on the carrier's fleet. The NTSB recognized that enhanced FDR capability needs to be weighed against the costs. However, the Board also believes that the costs should be balanced against the remaining useful life and revenue-earning potential of an airplane.

The NTSB believes that transport category airplanes of a type that is still in production and operated under 14 CFR Parts 121, 125, or 135 should be retroffitted with the sensors and FDAU needed to record the parameters listed in its recommendation. Further, certain airplanes that are out of production but continue to be heavily used in U.S. airline fleets should also be retrofitted to record the parameters listed in its recommendation.

The NTSB recommended that the FAA complete its rulemaking on FDR enhancements by December 31, 1995, and that upgrades be completed by January 1, 1998. Further, since Boeing 737 airplanes account for about 23 percent of the U.S. air carrier fleet, the NTSB recommends that FDR enhancement be accomplished sooner for these airplanes. The NTSB recommended that the FAA require all Boeing 737 airplanes operated under 14 CFR Parts 121 and 125 be equipped by December 31, 1995, with FDR's that record the parameters required by current regulations plus lateral acceleration, flight control inputs for pitch, roll, and yaw, and primary flight control surface positions for pitch, roll, and yaw.

The following recommendations were submitted by the NTSB to the Federal Aviation Administration:

I. Require that each Boeing 737 airplane operated under 14 CFR Part 121 or 125 be equipped, by December 31, 1995, with a flight data recorder system that records, as a minimum, the parameters required by current regulations applicable plus the following parameters: lateral acceleration, flight control inputs for pitch, roll, and yaw, and primary flight control surface positions for pitch, roll, and yaw. (Classified as Class I, Urgent Action) (Recommendation No. A–95–25)

II. Amend, by December 31, 1995, 14 CFR §§ 121.343, 125.225, and 135.152 to require that Boeing 727 airplanes, Lockheed L–1011 airplanes, and all transport category airplanes operated under 14 CFR Parts 121, 125, or 135 whose type certificates apply to airplanes still in production, be equipped to record on a flight data recorder system, as a minimum, the parameters listed in ''Proposed Minimum FDR Parameter Requirements for Airplanes in Service'' plus any other parameters required by current regulations applicable to each individual airplane. Specify that the airplanes be so equipped by January 1, 1998, or by the later date when they meet Stage 3 noise requirements but, regardless of Stage 3 compliance status, no later than December 31, 1999. (Classified as Class II, Priority Action) (Recommendation No. A–95–26)

III. Amend, by December 31, 1995, 14 CFR 121.343, 125.225, and 135.152 to require that all airplanes operated under 14 CFR Parts 121, 125, or 135, having 10 or more seats, and for which an original airworthiness certificate is received after December 31, 1996, record the parameters listed in ''Proposed FDR Enhancements for Newly Manufactured Airplanes'' on a flight data recorder having at least a 25-hour recording capacity. (Classified as Class II, Priority Action) (Recommendation No. A–95–27)

FAA Response to the NTSB Recommendation

The FAA responded to the above NTSB recommendations in a letter dated May 16, 1995, which is summarized below.

In response to Safety Recommendation A–95–25, the FAA stated that it agrees that Boeing 737 airplanes that operate under 14 CFR Part 121 or 125 should be equipped with flight data recorders that include, as a minimum, the parameters referenced in this safety recommendation. The proposed rule would require all Boeing 737 airplanes as well as certain other airplanes operated under 14 CFR Parts 121, 125, or 135 having 10 or more seats to be equipped to record the parameters that were specified by the NTSB.

The FAA received enough valid information from the public to determine that the schedule for retrofit completion by December 31, 1995,

could not be met. The proposed date would have imposed an extremely aggressive retrofit schedule that, if it were physically possible, would have resulted in substantial airplane groundings and very high associated costs. Furthermore, if operators had been required to retrofit all Boeing 737 airplanes before the end of 1995, each of these airplanes might have had to undergo a second retrofit to meet the expanded requirements that are being proposed in response to NTSB Recommendations A–95–26 and –27.

In response to NTSB recommendation A–95–26, the FAA agrees that airplanes still in production should be required to be equipped with DFDR's that record, as a minimum, the parameters listed in the NTSB recommendation.

In response to NTSB recommendation A–95–27, the FAA agrees that airplanes operated under parts 121, 125, or 135 having 10 or more seats for which an original airworthiness certificate is received after December 31, 1996, should record the parameters listed in ''proposed FDR Enhancements for Newly Manufactured Airplanes'' on a flight data recorder having at least a 25 -hour recording capacity.

On March 14, 1995, the FAA published in the Federal Register a notice of a public hearing, and solicited public comment pursuant to the NTSB recommendations. On April 20, 1995, the public hearing was held in Washington, DC. Eight speakers from the aviation community gave presentations. Copies of the presentations have been placed in the docket for this rulemaking.

After reviewing the comments submitted and listening to the presentations, the FAA determined that it would be beneficial to have aviation industry personnel assist in any related rulemaking efforts. On June 27, 1995, the FAA published a notice in the Federal Register that the Aviation Rulemaking Advisory Committee (ARAC) established the Flight Data Recorder Working Group (60 FR 33247), which included members representing the Air Transport Association, Aerospace Industries Association of America. General Aviation Manufacturers Association, Regional Airline Association, Air Line Pilots Association, and the FAA. The NTSB was invited to participate in working group efforts in an advisory capacity. The working group's task was to recommend to ARAC rulemaking proposals or other alternatives that would satisfactorily address the NTSB recommendations. The ARAC could then make one or more recommendations to the FAA, and the FAA would determine whether to issue a proposal based on the ARAC recommendation.

The ARAC DFDR working group first met in June 1995 in Washington, DC. Work continued on a draft proposed rulemaking until November, with members communicating by electronic mail, fax, telephone conference calls, and in person at subsequent working group meetings.

Several elements of the proposed rule were discussed many times, including the characteristics that would define various classes of aircraft (e.g., date of certification, date of manufacture, current FDR equipment installations and configurations, equipment availability), the inclusion of certain airplane types in the applicability of a new rule, the compliance times attached to each category of airplane described.

Despite numerous meetings and proposals, no consensus was reached as to the requirements that would be acceptable to the FAA, NTSB, airplane operators and airplane manufacturers. On November 15, 1995, the working group presented to the ARAC Executive Committee a summary of the work undertaken by the working group. The presentation highlighted the areas where consensus had not been reached, including some of the actual parameters that would be included in the final list of requirements and the differences between the proposed list and those required under the European Joint Aviation Requirements for Operations (JAR-Ops), whether airplanes with 10-19 passenger seats should be covered since they were not specifically mentioned in the NTSB recommendation, whether expected but not currently existing technology could be mandated in future requirements for new airplanes, and several issues concerning the cost figures used in the draft regulatory evaluation. The ARAC Executive Committee decided that each committee member would review the two versions of the proposed rulemaking document that were presented and make individual comments to be submitted to the FAA by December 1.

Comments from several ARAC Executive Committee members were forwarded to the FAA on December 4. The ARAC Executive Committee made no formal recommendation to the FAA concerning the proposed rule documents reviewed and discussed at the November 15 meeting. Of the comments received on December 4, the general comments are addressed here; specific comments as to the inclusion or exclusion of certain provisions from the proposed rule are included in the explanation of the proposed rule provisions below.

General Comments From the ARAC Executive Committee Members

Several members stated that the decision to propose to require up to 88 parameters for airplanes manufactured five years after the final rule is effective will create a disharmony with the European JAR-Ops and will create a disparity in the configuration of U.S. and European airplanes, limiting their exchange.

The FAA acknowledges that the proposed requirement to record 88 paramenters exceeds the 57 parameters being required by JAR-Ops, but no disharmony is created. The first 57 parameters (and their values in proposed Appendix M to part 121) were arranged so as to be the same as those rquired by JAR-Ops, at the suggestion and request of the working group members, including two U.S. manufacturers, they are considered harmonized. The fact that the U.S. requirement would exceed the European requirement is not disharmony, since there is no further JAR requirement with which the proposed rule could disagree. The 88 paramenters came from the NTSB recommendation already discussed, which served as a basis for implementing a rule change. The FAA never represented that the proposed rule would be limited to JAR-Ops, since the agency understood that this would not satisfy the NTSB recommendation. In fact, the original NSTB recommendation included more than 88 parameters. The number was reduced slightly through certain parameter combinations and their rearrangement to coincide with JAR-Ops.

The NTSB has also indicated to the FAA that at least some of the European manufacturers are already equipping their airplanes to record 88 or more parameters and that it does not anticipate a problem with the proposed requirement. Further, the NTSB is proposing through ICAO that the 88 parameters become the international standard; it is using the list and Appendix values developed for this proposed rule as its proposal to ICAO.

Some members commented that it is difficult to visualize the proposed DFDR upgrade scheme by reading the rule language alone, and proposed that a flow chart be included to assist with a rule overview. The FAA agrees and is including a chart in the form of a matrix, but cautions that the chart is a summary and should not be regarded as a substitute for the actual rule language. The chart can be found in this

document, immediately following the general discussion of the proposed rule.

At least one member recommends that a phased compliance schedule be adopted for upgraded DFDR installation, rather than the proposed 4-year compliance time to provide more flexibility to operators.

The FAA does not understand why a mandatory schedule of compliance (with a suggested 35% of an operator's fleet requiring the upgrade within 2 years) is considered more flexible than a simple final compliance date in four years—an operator may comply as early as it likes within the proposed 4 years. The FAA's experience with compliance schedules has not always been positive, and several other operator compliance schedules already exist for other requirements. Adding yet another schedule for DFDR equipment modifications could lead to several schedule conflicts and result in numerous requests for exemptions and extensions compromising the intent of each rule involved. Accordingly, the FAA does not consider an additional compliance schedule to be advisable.

Another comment suggesting that a 6-year compliance schedule be considered rather than 4 years is not addressed in this document because it was never proposed at the working group level, nor has any data been submitted as to the comparative costs of compliance. The FAA notes that longer compliance schedules almost always result in reduced costs. However, the proposed rule already exceeds the NTSB time recommendation for implementation of the upgrades, and the safety considerations of upgraded DFDR equipment are too serious to consider lengthening the proposed 4-year compliance time. The proposed compliance is the product of significant working group discussion and elimination of a 2-year alternative that was predicted to be nearly impossible because of equipment approval, availability and airplane down time. Without similar cost data from the commenter, a 6-year compliance time cannot be evaluated properly.

The comments concerning the proposed compliance time imply some disagreement with the provision that upgrades must be installed beginning at the next heavy maintenance check that occurs two years after the effective date of the final rule (but in any case within four years). That provision was added to prevent operators from waiting until the last minute to install upgrades, causing a logjam in scheduling and equipment availability; a similar provision was shown to have worked well when the last amendment to the DFDR rules was done in 1994. Further, at the working group meetings, this provision was not only acknowledged as necessary, the language was discussed and changed several times at the request of the member operators. Accordingly, the language that defines a heavy maintenance check as any time an airplane is scheduled to be out of service for 4 or more days and is scheduled to include access to major structural components is included in the proposed rule as a result of working group discussions and general agreement. No proposed phased compliance schedule or problem with the included provision was raised at the working group meetings.

Similarly, operators of small airplanes comment that the same heavy maintenance check provision is inappropriate for their operations. The FAA has changed the proposed rule to include the words ''or equivalent'' in the provision that relates to smaller airplanes, and specifically requests that if operators of these airplanes have a more appropriate way of describing their maintenance practices so as to achieve a similar result, they should submit that language as a comment to the proposed rule. This issue was not raised at the working group level during drafting of the proposed rule.

Several commenters stated that they felt that the proposed requirement to record lateral acceleration is unnecessary if both rudder pedal and rudder position are also recorded. The NTSB disagrees that lateral acceleration is redundant since it may show the effect of outside forces on an airplane that are separate from the effect of rudder movement. The NTSB cautions that the concern over lateral acceleration and rudder pedal and position is not limited to the accidents and incidents reported on the Boeing 737; the proposed requirement to record those parameters takes into account all airplane types and the critical nature of the information that such recordation may uncover. The NTSB also notes that the upgrade from dual to triaxial accelerometers may not necessarily be costly, as one commenter states, since at least one manufacturer has a ''trade-in'' program for that equipment. Manufacturers of this equipment are urged to supply the FAA with further data concerning the cost and availability of this equipment.

Commenters also expressed some confusion over the effect of the proposed rule on airplanes currently covered by exemption No. 5593, Stage 2 airplanes that are scheduled to be retired and are allowed to operate with 6-parameter recorders through 1998. The terms of the exemption were clear when granted—it was only to be used for airplanes that were scheduled to be retired by the end of 1998; it was not an exemption that could be used to delay the upgrade to an 11-parameter recorder that was due in 1995. Accordingly, since any airplane covered by the exemption should be retired before the proposed compliance date, this proposed rule should have no effect on the exempted airplanes.

As the FAA has stated previously, any airplane covered by the exemption that is not retired but is instead retrofitted to meet the Stage 3 noise requirements must also upgrade to an 11-parameter recorder before it is allowed to operate. If a decision to noise retrofit causes an airplane to have to undergo two DFDR retrofits—to an 11-parameter recorder to operate past 1998 and then to the requirement of this proposed rule—it is a decision of an individual operator, and will only result from a failure to effectively plan its fleet composition or by an abuse of the previous DFDR upgrade requirement and exemption No. 5593. The FAA does not intend to lengthen the term of the exemption for any operator.

Finally, more than one commenter objected to the change that would require the recordation of both pilot inputs and actual control surface positions. The current requirements call for one or the other to be recorded. Discussion of this issue consumed an appreciable amount of time in the working group, and covered the perceived need for the data and the cost and capability of recording both parameters (input and output). Although consensus was not reached, the FAA is including this provision in the proposed rule because the NTSB considers it among the most critical of the recommended parameters. As stated previously, NTSB investigations have shown that in some failure modes, flight control surfaces can move independent of cockpit flight controls. Under some conditions, additional information is necessary to determine whether flight deck controls caused the control surfaces to move, or if the movement of the control surface caused the cockpit controls to move. The FAA accepts the NTSB recommendation since the current practice of allowing one input to be recorded to demonstrate the movement of both the control surfaces and cockpit controls has been shown to be insufficient.

General Discussion of the Proposal

The FAA stresses that the ARAC working group provided valuable input to the proposed rule, and that many

issues were brought forth and the position of the members explained, even if consensus could not be reached on each issue. For example, there was basic agreement among the working group members as to the framework of the proposed rule, including the categories of airplanes to be upgraded in various phases. As described below, consensus could not be reached on the description of future-manufactured airplanes or the number of parameters that they would be required to record. Similarly, because of the considerable amount of time required to complete the economic analysis, the efforts of the working group were often well ahead of supporting economic data analysis, which included data that were supplied by the working group member organizations.

As noted previously, the ARAC did not formally recommend either version of the draft proposed rules it received from the working group. Accordingly, the FAA is promulgating this NPRM based on the recommendations of the NTSB and the results of the significant working group efforts that it can support.

If adopted, this proposed rule would amend the DFDR rules, and associated appendices, as they apply to airplanes operating under parts 121, 125, 129, and 135. The current regulations, depending on the age of the airplanes, require as a minimum that either 11 or 17 parameters be recorded in every airplane; in some cases, more parameters must be recorded. Proposed requirements for part 125 closely parallel part 121 requirements, except for minor differences in the age and configuration of affected airplanes. Part 129 does not currently have a DFDR requirement; however, the FAA is now proposing a DFDR requirement in part 129 for U.S.-registered airplanes. Proposed requirements for part 135 would apply only to newly manufactured airplanes that will be used in schedules service; there are not retrofit requirements proposed for on-demand, nonschedules airplanes.

The FAA recognizes that the program envisioned by the proposed rule would require a substantial financial undertaking by the airline industry. Accordingly, commenters are expressly invited to recommend alternative approaches that could reduce the cost burden. For example, are there certain airplanes or certain models of airplanes not discussed in this document that should be excluded from this proposed rule, and if so, what is the rationale for excluding these airplanes? Recognizing that a change in the proposed number of required parameters or the elimination of certain proposed parameters could significantly alter the costs involved, are there other, less costly means to obtain the information needed for accident and incident investigations? The FAA recognizes that cost could be reduced by further extending the compliance schedule; at the same time, NTSB needs critical information in a timely manner to complete its investigations effectively. If the compliance schedule is extended further, are there incentives that would encourage operators to comply earlier?

Commenters advocating a different regulatory approach are strongly encouraged to set forth specific recommendations and explain both the costs and benefits involved in the changes recommended. The FAA will weigh any recommendations with particular care, and it can do so only if meaningful cost and safety data are provided.

Part 121

The FAA proposes to amend § 121.344 and add a new § 121.344a. Current § 121.343 is not being revised because it is necessary to retain the current regulations for airplanes that are excluded from compliance with these proposed amendments. Airplanes specifically excluded from the proposed FDR upgrade include State 2 airplanes that are subject to the phased compliance rules of § 91.801(c). Following considerable analysis, the FAA has determined that, if they remain Stage 2, these airplanes do not have enough remaining useful life to justify the cost of FDR retrofit proposed by this document. The FAA has also proposed that certain other aircraft types that are no longer in production and are in limited use in air carrier operations be excluded because the cost associated with retrofitting these airplanes with new DFDR's would cause undue economic burden and would yield little safety return.

The proposed amendments to § 121.344 would require that all turbine-engine powered transport category airplanes—including airplanes having a seating capacity of 20–30 that were formerly operated under part 135—record at least 18 specified parameters, except for airplanes with more than two engines. In some cases, compliance would require a retrofit of a flight data recorder and/or the addition of sensors and wiring capable of recording the specified parameters, or a reprogramming of the current recorder to accommodate the specified parameters. Requirements for DFDR's on newer airplanes and newly manufactured airplanes are also being revised to require the recordation of additional parameters.

On December 20, 1995, the FAA published a final rule ''Commuter Operations and General Certification and Operations Requirements'' (60 FR 65832, FAA Docket No. 28154), which requires airplanes having a passenger seating configuration, excluding any required crewmember seat, of 10 to 19 seats to be operated under part 121. That rule did not address FDR's because this rulemaking project was in process. Proposed new § 121.344a would apply to those airplanes formerly operated under part 135.

Proposed § 121.344 would require Boeing 737 airplanes to be equipped with the expanded flight data recorder systems recommended by the NTSB as part of the retrofit of the overall active fleet. The FAA determined that compliance with the NTSB recommendation to retrofit these airplanes by December 31, 1995, would have resulted in substantial airplane groundings and very high associated costs. Furthermore, if operators had been required to retrofit all Boeing 737 airplanes before the end of 1995, each of these airplanes might have had to undergo a second retrofit to meet the expanded requirements depending on what is adopted as a result of NTSB Safety Recommendation A–95–26 and-27, discussed earlier in this document.

Accordingly, this proposed rule reflects the FAA's adoption of the ARAC working group suggestion that NTSB recommendations A–95–25 and A–95–26 be consolidated for rulemaking purposes.

Requirements for Transport Category Airplanes

Proposed § 121.344(a): This paragraph lists the operating parameters that would be required to be recorded by DFDR's required by this section. The list is consistent with both European standards and the parameters recommended by the NTSB in its ''Proposed FDR enhancements for newly manufactured airplanes.'' The ARAC working group used the European standards and the NTSB proposal as a basis for this list of parameters and made minor revisions to it that would apply to both new and in-service airplanes.

The parameters listed in this paragraph are presented in order of their priority. Where the rule requires the recording of additional parameters based on the capability of installed equipment, the additional parameters should be selected in the order given in this paragraph. In some instances, individual parameters need only be

recorded if the equipment needed is already installed in the airplane. For example, angle of attack, § 121.344(a)(32) need only be recorded if the sensor for that parameter is already installed. These parameters are designated ''when an information source is installed.'' In any instance, if a sensor is installed, the data must be made available to the FDR, unless it would compromise a critical function. Individual members of the ARAC working group suggested that something other than a ''critical function'' be used as a basis. After further consideration, the FAA has determined that the term critical function is well understood by aircraft manufacturers in terms of FDR functions, and no new terms will be introduced.

The introductory text to paragraph (a) also explains that when the phrase ''when an information source is installed'' is used, it indicates that no change in equipment was intended in requiring this parameter to be recorded. Although the parameters are listed in priority order in this paragraph, the ARAC considered that some of the parameters that carry the designated text should be required only when the recording system on the airplane is sufficient to record these parameters. Where recording one of the parameters that includes the noted phrase would require new equipment such as a DFDAU or recorder, that parameter is not required to be recorded.

Airplanes Manufactured on or Before October 11, 1991

Proposed § 121.344(b): Except for certain older airplanes (identified below), this paragraph establishes a final compliance date of [insert date 4 years from the effective date of the final rule], for all turbine-engine powered transport category airplanes manufactured on or before October 11, 1991. By that date, all affected airplanes must be equipped with a DFDR that is capable of recording the first 17 (or 18) parameters listed in § 121.344(a).

Proposed § 121.344(b)(1) would apply to airplanes that were not equipped with a flight data acquisition unit on [insert date of publication of NPRM], and currently record 11 parameters of flight data. The recordation of lateral acceleration, paragraph (a)(18), would be required for certain airplanes with more than two engines only if the capacity to record this parameter is available on the FDR. Information obtained during the rulemaking process indicated that for airplanes that were manufactured on or before October 11, 1991 that have more than two engines, the recording of lateral acceleration could exceed the capacity of installed recorders and would require an expensive equipment retrofit for the sake of one parameter.

These non-FDAU airplanes would be required to record these parameters within the ranges, accuracies, and intervals specified in current Appendix B to part 121. Although this rule would create a new Appendix M, these older airplanes would continue to use the values in Appendix B that are currently in effect in order to stay within the capacity of installed recorders and other data acquisition equipment.

Proposed § 121.344(b)(2) would apply to airplanes that were equipped with a FDAU on [insert date of publication of NPRM] and currently are required under § 121.343 to record 17 parameters of flight data. These airplanes would be required to record the parameters listed in paragraphs (a)(1) through (a)(22) by [insert date 4 years from publication of the NPRM]. This installation would be required at the next heavy maintenance check that occurs after 2 years from the effective date of the final rule, but no later than [insert date 4 years after date of final rule]. Airplanes with FDAU's would be required to record the parameters within the ranges, accuracies, resolutions and recording intervals specified in proposed Appendix M to part 121. Proposed new Appendix M provides the ranges, accuracies, resolutions, and recording intervals for all parameters listed in paragraphs (a)(1) through (a)(88). In some instances, the values for certain parameters have been increased over those in current Appendix B.

For all airplanes covered by proposed § 121.344(b), the parameters listed in paragraphs (a)(12) through (a)(17) may be recorded from a single source.

Proposed § 121.344(c)(1) would require that as of [insert date 4 years after effective date of final rule], all turbine-engine powered transport category airplanes that were manufactured on or before October 11, 1991, and that were equipped with a digital data bus and an ARINC 717 digital flight data acquisition unit (DFDAU) or its equivalent on [insert publication date of NPRM], record the parameters listed in paragraphs (a)(1) through (a)(22). Paragraph (c)(1) would also require that the parameters be recorded in accordance with the specifications in proposed Appendix M. This paragraph would also permit the parameters described in paragraphs (a)(12) through (a)(14) to be recorded from a single source.

Proposed § 121.344(c)(2) introduces the term ''recording system'' which includes the DFDAU or equivalent and the DFDR. This paragraph would require that, based on the capacity of the recording system, all additional parameters (beyond those required by (c)(1)) for which there is capacity on the recorder system must be recorded in the order given in paragraph (a) and in accordance with the values listed in Appendix M.

The term ''recording system'' was adopted to identify the components in question so as not to require upgraded equipment on airplanes retrofitted to meet the proposed requirements. Thus, additional parameters need only be recorded when such parameters are within the capacity of the flight data recordation system installed on any airplane. That term is used again later in the regulation.

Proposed § 121.344(c)(3) would require airplanes that were subject to § 121.343(e) to continue to meet the requirements of that section until compliance with paragraph (c)(1) is accomplished.

Paragraph (c) brings forward and upgrades the requirements of current § 121.343(e). That section was originally adopted to require airplanes that were capable of recording more than the minimum required parameters to do so. At the time it was adopted, § 121.343(e) referenced the ARINC 717 DFDAU because it was the ''state of the art,'' and the capability of recording additional parameters existed. The adoption of § 121.343(e) reflected the FAA's growing awareness that the information gained by recording additional FDR parameters was important. Accordingly, § 121.344(c) of the proposed rule requires that airplanes subject to that section continue to record those parameters that they are capable of recording, whether they are equipped with an ARINC 717 or an equivalent DFDAU. When these airplanes comply with proposed paragraph (c)(1), they would be recording the parameters listed in (a)(1) through (a)(22), plus all additional parameters they are capable of recording, and all of these must be recorded in accordance with proposed new Appendix M. These provisions are proposed to prevent a possible decrease in the number of parameters already being recorded before the compliance date of the proposed regulation.

Airplanes Manufactured After October 11, 1991

A significant portion of the work of the ARAC working group was focused on the requirements for airplanes not yet built. Airplanes for which no type certificate yet exists were seen as less of a problem. To that end, discussions focused on the ability of manufacturers

to re-engineer airplanes that are already type certificated, and the time needed to accomplish that engineering, get FAA approval of the change in type design, and incorporate it into airplanes on the production line. Significant discussion also occurred on the best way to describe the airplanes that were to be covered by future requirements. For example, a newer ''model'' of an airplane recently type certificated might already be in the works, with a significant investment in the engineering. Further, there is no standard industry terminology for what the ''next version'' of an already certificated airplane might be called. Finally, the number of parameters to be recorded by these future airplanes was also part of the discussion, and included consideration of flight data recorder requirements that will be included in the operating rules of the Joint Aviation Authorities of Europe (JAR-Ops).

The proposed regulation places airplanes manufactured after October 11, 1991, into three groups, with DFDR requirements increasing as age decreases. These airplane groups and the requirements that apply to each were the subject of considerable discussion within the ARAC working group.

Because there was little agreement on the terminology to be used or the time necessary to incorporate upgrades into future aircraft models at the least cost, the requirements that would apply to future production airplanes remained one of the most contentious issues in the working group.

The FAA began discussions with the recommendations of the NTSB that would require an upgrade to 88 parameters of recorded data for all airplanes manufactured after 1998, regardless of the date of type certification of models then in production. Representatives of airplane manufacturers on the working group indicated that this was unrealistic given the time needed to re-engineer airplanes in production, get FAA approval of the design changes, and incorporate the modifications into airplanes on the assembly line that had been on order, in some instances, years before the requirements were written. The ARAC industry members thus suggested an alternative requirement that would apply to airplanes that receive a new or amended type certificate beginning one year after the final rule becomes effective. This alternative would mean that airplanes produced under a type certificate that existed before that date might never be required to upgrade to 88 parameters, even if manufactured 10 years after the rule went into effect, if the type design were not amended. The NTSB considers this unacceptable, and describes it as a parallel to the current circumstances where technological development and capability have far outpaced current regulations. Further, the NTSF notes that a letter requirement will in the future place the FAA and the industry in the same circumstances that exist today in attempting to catch up with available technology.

There was also considerable debate within the working group over the recording equipment that might be necessary to record the 88 parameters of information proposed. Little hard data was available concerning whether the current 128-word recorders would be able to handle the 88-parameter requirement. Several members indicated that a 256-word recorder would likely be needed, and that since no such recorder was currently available or approved for use, no regulation that would require its use could be promulgated. Similarly, data were available to indicate that while there was no 256-word recorder currently available, the reason was that there was no current market for it. Informal inquiries by the NTSB to equipment manufacturers indicated that a 256-word recorder is well within the bounds of currently available technology, and may well already exist.

Taking into account the NTSB concern that all new airplanes be able to record the maximum number of parameters, balanced against the knowledge that airplanes in production cannot be re-engineered without sufficient lead time, the FAA has determined that FDR requirements for future airplane production will be based on the date of manufacture, but that the dates suggested by the NTSB cannot realistically be met without incurring overwhelming costs and unacceptable delays in production. Accordingly, the proposed rule would place the following requirements on newly manufactured airplanes.

The first group of airplanes, addressed in proposed § 121.344(d)(1), are those manufactured after October 11, 1991, but on or before [insert date three years from effective date, i.e. 2000] to record the parameters listed in paragraphs (a)(1) through (a)(34), and do so in accordance with Appendix M. Similar to the requirements for older airplanes, the parameters listed in paragraphs (a)(12) through (a)(14) could be recorded from a single source. Proposed § 121.344(d)(2) carries forward the requirements that all additional parameters that are within the capacity of the recording system must also be installed to take advantage of the latest advancements in technology and the capabilities of individual airplanes. Because this requirement will apply to airplanes recently produced, it is a retrofit requirement, but the effect of the retrofit is softened by limiting the requirement to the first 34 parameters.

The second group of airplanes, addressed in proposed § 121.344(e)(1), are those that will be manufactured after [insert date three years from effective date, i.e. 1999], but on or before [insert date five years from effective date, or 2001]. These airplanes would be required to record the parameters listed in paragraphs (a)(1) through (a)(57), and to do so in accordance with Appendix M. Proposed § 121.344(e)(2) carries forward the requirements that all additional parameters that are within the capacity of the recording system must also be installed to take advantage of the latest advancements in technology and the capabilities of individual airplanes.

This group of airplanes is considered to include the already engineered versions of currently certificated airplanes, and any airplane getting a new type certificate during this time period. The three year time period was considered by several members of the working group as sufficient lead time to incorporate the upgrades required. The number of parameters was chosen based on the recommendations of the NTSB and the 57 parameters that will be required to be recorded under JAR-Ops, which will become effective in 1998.

The third group of airplanes, addressed in proposed § 121.344(f), are those that would be manufactured after [insert date five years from effective date]. These airplanes would be required to record the parameters listed in paragraphs (a)(1) through (a)(88), and to do so in accordance with Appendix M.

As indicated in the previous discussion, this requirement would apply to all airplanes manufactured five years after the effective date of the rule. The FAA agrees with the NTSB that it is not acceptable to adopt a requirement that could allow airplanes with 57 parameters to be produced indefinitely. The concept of ''manufactured after'' was established in the FDR requirements of § 121.343 and is being used in other sections of this proposed rule. The ''manufactured after'' standard is viewed as being the most straightforward for the agency to administer and for the industry to comply with. Further, during the meetings of the ARAC working group, a lead time of five years was consistently mentioned as the working standard for new airplane design.

The FAA did raise another alternative that would require all 88 parameters to be recorded on any airplane for which a new, amended, or supplemental type certificate is applied for one year after the effective date of the final rule. That proposal would have included, by necessity, significant deviation authority for any changes to airplanes that did not affect the operational or performance characteristics of airplanes, or that did not provide sufficient opportunity to accomplish the necessary modifications. That proposal was made after considerable discussion regarding the lack of consistent terminology regarding new airplane models. In designing the proposal, the FAA looked to its experience in similar equipment upgrade requirements and concluded that it would be necessary for the agency to retain exclusive discretion as to what constituted enough of a change to an airplane design (by amended or supplemental type certificate) to cause the FDR upgrade requirements to apply, or for a deviation to be granted.

The FAA determined that, while that proposal had a sound regulatory foundation and would be triggered by well-established events that would not be the source of semantic debate, it would be unwieldy in practice and would lead to considerable extra work and expenditures for the agency and every future applicant for an amended or supplemental type certificate.

The proposed requirement to record 88 parameters may require the installation of the 256-word recorder described previously. The FAA is unable to accept the argument that simply because a 256-word recorder is not currently marketed or approved for installation in aircraft, it would not be available by the time the proposed requirement would take effect, five years after the effective date of a final rule. The FAA has experience in proposing requirements for new technology. For example, the technology for TCAS systems existed at the time the FAA promulgated a requirement for the equipment, but it was not commercially available in the format into which it eventually evolved. In a similar sense, air carriers strongly urged the FAA to authorize the use of predictive windshear technology in lieu of current reactive technology despite the fact that the technology was only expected to be available at some unspecified future date.

In this case, information available to the FAA and the NTSB suggests that the 256-word recorder that may be needed to record 88 parameters is close to being a reality, since the technology already exists. The FAA and NTSB expect the 256-word recorder to be commercially available as soon as some commercial demand exists. Neither the FAA nor NTSB can accept the argument of current unavailability as a basis for not imposing a more stringent requirement on future-production airplanes, and the FAA has received no evidence indicating that this position is not realistic. The FAA specifically requests comment on this issue concerning the probable availability of such equipment.

Except for paragraphs (j) and (l), the balance of proposed § 121.344 carries forward the rest of the requirements of § 121.343.

Proposed § 121.344(g) would duplicate current § 121.343(g), which requires an FDR's continuous operation from the time of an airplane's takeoff roll to its landing roll, except for a minor, nonsubstantive editorial change.

Proposed § 121.344(h) would duplicate § 121.343(h), which addresses the number of hours of recorded data that needs to be kept, and erasures of that data, except for minor, nonsubstantive editorial changes.

Proposed § 121.344(i) would duplicate current § 121.343(i), which addresses requirements pursuant to flight data in the event of an accident or occurrence that requires immediate notification of the NTSB, except for minor, nonsubstantive editorial changes.

Proposed § 121.344(j) addresses the equipment installation and correlation requirements of 14 CFR part 25 for transport category airplanes. This paragraph was rewritten to reflect current technology and the need for correlation data retention. No significant change in the duty of air carriers to retain this data is intended by this update of this regulation.

Proposed § 121.344(k) would duplicate current § 121.343(k), which requires an approved device to locate a flight data recorder under water, except for minor, nonsubstantive editorial changes.

Proposed § 121.344(l) would identify those airplanes to which these proposals would not apply.

Paragraph (l)(1) addresses Stage 2 airplanes that are scheduled to be retired under the noise transition regulations of Part 91. These airplanes would not have to be retrofitted with upgraded DFDR's prior to December 31, 1999. However, no Stage 2 airplane would be allowed to be operated after December 31, 1999, unless it meets the upgraded FDR requirements. Although the noise transition regulations allow for the possibility that some Stage 2 airplanes would be allowed to operate under certain limited waivers, the intent behind the noise operating rules differs significantly from the intent behind the FDR requirements. Accordingly, the FAA is not willing to allow the continued operation of these airplanes with 11-parameter recorders beyond the final noise compliance date regardless of an airplane's noise operating status, and the agency will not put itself in a position of having to forgo the safety considerations behind FDR upgrades as an economic matter if a change in circumstances causes a change in the noise operating rules whether by waiver or a change in the regulations. Noise waivers are not a certainty, and operators have been warned not to presume that they will be granted as a matter of course and to plan for full compliance. No such waiver is included in these proposed FDR requirements; the FAA views the grant of any such FDR waiver as encouraging operators to gamble on the availability of noise waivers as an excuse not to install upgraded flight data recorders, undermining the intent of both the noise transition and FDR upgrade rules.

Paragraph (l)(2) lists those airplanes that are out of production. After considering analysis of data presented by aircraft operators and manufacturers, the ARAC working group determined that the remaining economic life of these airplanes is insufficient to justify the cost associated with extensive DFDR retrofit. Further, the number of these airplanes in operation is sufficiently small and is declining, such that any safety return from expanded FDR's would be minimal. The FAA agrees in the selection of the aircraft types listed. The FAA also specifically requests that commenters submit other aircraft types, if any, that should be included in this list. Submissions for inclusion should include a detailed explanation of the reasons why these aircraft should be included on the list, and the number of aircraft that would be affected.

Specific Comments Concerning Proposed § 121.344

A significant comment was submitted through the ARAC Executive Committee from Trans World Airlines (TWA), which did not have a separate representative on the working group. In general, TWA expressed difficulty with the proposed requirements for certain of its older airplanes, the Lockheed L–1011 and the Boeing 747–100. TWA indicates that, to meet the requirements of the proposed rule, it would have to replace recording equipment in more than a third of its airplanes, and one of the premises of the working group was that significant equipment replacement would not be required for older

airplanes. To that end, TWA recommended several specific changes to the proposed rule language and Appendix values that would allow its Loral F800 flight data recorders to continue to be used.

The existence of older recording systems, including the Loral F800, was the subject of considerable discussion at the working group meetings. In an attempt to accommodate some of this older equipment, for example, § 121.344(b)(1)(i) was added to *not* require the recordation of lateral acceleration on airplanes with more than two engines unless recording that parameter could be accommodated on installed equipment. That provision was added to accommodate the Loral F800 recorder installed on the L–1011. The FAA is concerned that broader changes to the proposed rule—including revisions to the values in current Appendix B and a new category of aircraft that would change the established manufacturing-date groups—would weaken the intent of the rule by allowing loopholes and exceptions that would be almost impossible to track, and would result in an unmanageable number of different recording capabilities within the part 121 fleet. The FAA will not promulgate rules to accommodate one or two older pieces of equipment, especially when the intent of the rule is to upgrade equipment in airplanes that remain viable portions of the fleet.

However, the FAA is willing to make what accommodations are within the spirit of the rulemaking, as in the example cited above, where such accommodation does not change the effect of the rule in general on the rest of the fleet. Accordingly, while the agency will not consider changes to existing rules that are a step back from current requirements, TWA, and other operators that may find themselves in unique circumstances because of equipment configurations, are urged to comment specifically on provisions that they feel they will not be able to meet without undue burden, and to suggest limited provisions such as the one cited that may alleviate some of that burden.

A U.S. aircraft manufacturer commented through the ARAC Executive Committee that to record parameters (a)(58) through (a)(88) would ''require the installation of sensors [that have] a poor reliability history.'' The NTSB agrees that there is a question as to the reliability of control force sensors over the full range of forces, but it is this very unreliability of the current generation of sensors for control forces that has caused the NTSB to recomment that 88 parameters be recorded. The FAA requests comment from manufacturers and operators as to the current reliability rates for control force sensors, and what plans may exist for increasing their reliability before they would be required in five years.

Airplanes With 10–19 Passenger Seats

The February 1995 recommendations of the NTSB did not specifically address airplanes that carry 10–19 passengers. However, the adoption of new operating rules for certain airplanes formerly operated under part 135 has led to a need for the FAA to address FDR requirements for these airplanes. Since these airplanes will, in scheduled service, be operated under part 121, the FAA has determined that the FDR requirements that would apply to these airplanes are best provided in a separate section. Accordingly, the FAA is proposing the adoption of a new § 121.344a, to separate these requirements from those applicable to transport category airplanes and prevent confusion as to applicability and compliance times.

Proposed § 121.344a(a) would require all turbine-engine powered airplanes having a passenger seating configuration, excluding any required crewmember seat, of 10 to 19 seats that were brought onto the U.S. register after October 11, 1991, to be equipped with a DFDR that is capable of recording, at a minimum, the parameters required in § 135.152. This provision would carry over the current requirements of part 135 until the upgraded standard in the proposed rule is met.

By [4 years from the effective date of the final rule], those airplanes would be required to be equipped with a DFDR that is capable of recording the parameters listed in § 121.344 (a)(1) through (a)(11). In addition, these airplanes must record either three additional parameters of control input or control surface position. If capable of being recorded, these airplanes must also record the parameters described in § 121.344 (a)(19) through (a)(22).

As stated in the proposed rule language, parameter (a)(18) would not be required for airplanes with more than two engines, unless sufficient capacity is available on the existing recorder. Further, the parameters listed in paragraphs (a)(12) through (a)(17) would be permitted to be recorded from a single source. All of the parameters would be required to be recorded in accordance with the values listed in Appendix B to part 135, the standard in the current rule, unless the parameter to be recorded has no value indicated in that appendix. In that case, the values in Appendix B to part 121 would be used.

Consistent with current regulation, airplanes with 10 to 19 passenger seats that were brought onto the U.S. register on or before October 11, 1991, would not be required to comply with this regulation. The FAA has determined that the cost of retrofitting this fleet of airplanes would be substantial.

However, the FAA is concerned that all airplanes used in air carrier operations be equipped with FDR equipment. Accordingly, the FAA has determined that the already established date for installation of FDR equipment—airplanes brought onto the U.S. register after October 11, 1991—will remain the standard for FDR installation if these airplanes are operated under part 121.

Further, the FAA emphasizes that, consistent with current regulation, airplanes that may have been on the register on or before October 11, 1991, but were removed from the U.S. register, and brought back onto the U.S. register after October 11, 1991, would be required under this proposed rule to have a DFDR capable of recording the required 18 to 22 parameters. There has been at least one previous policy determination made concerning airplanes that have been removed from the U.S. register after 1991 and then brought back; that policy stated that compliance with the FDR rules of part 135 is not necessary because the airplane was on the register before October 11, 1991. After further consideration, however, the FAA has determined that this policy is inconsistent with the language of the regulation itself and with the intent of the recently adopted rules bringing part 135 scheduled commuters under part 121. Airplanes that have been operated without FDR's based on this policy determination will have to be retrofitted with the FDR equipment required under § 121.344a(a) by the compliance date proposed in that paragraph, as they would have if they remained under part 135.

Although the basic requirements for 10–19 seat airplanes are not identical to those for transport category airplanes in § 121.344, it was determined that some differences could exist without compromising safety. These airplanes currently are required to record 17 parameters of information under part 135.152; the 18 parameters to be recorded under the proposed rule differ slightly and will require that some FDR's be reprogrammed. The FAA found, however, that requiring an increase to the first 23 parameters would result in substantial costs. Since the NTSB recommendations do not

address these airplanes or any specific upgrade for their flight data recorders, a determination has been made that recordation of the first 18 parameters—or 22 where capable—is sufficient for this class of airplanes.

The ARAC Executive Committee submitted a comment from a member indicating that the applicability of proposed § 121.344a(a) should be changed to airplanes that were manufactured after October 11, 1991, rather than airplanes brought onto the U.S. register after that date. The FAA disagrees. This distinction by date of registration was maintained as established in part 135, and the use of the registration date has resulted in a specific set of airplanes to which these rules apply. A change in the applicability of the regulation now could cause airplanes that were previously required to have DFDR's to no longer need them, with the consequences of recorders being removed from in-service airplanes. A change in applicability under part 121 would also have the confusing effect of establishing different applicability provisions for the same airplanes, depending on the part under which they are operated. The FAA will not introduce such complication into the regulations nor promulgate a rule that would reduce the number of airplanes required to have DFDR's.

Another comment stated that the FAA is proposing to cover 10–19 seat airplanes operated under part 121 ''with no technical support * * * for their inclusion.'' The commenter suggests that the FAA ''abide by the NTSB recommendation and remove these'' airplanes from the proposed rule.

As stated previously, the NTSB recommendation was considered the starting point for this rulemaking action. The NTSB recommendation did not include consideration of the FAA's proposal to bring smaller aircraft operated in scheduled service under part 135 into part 121, so no recommendation for DFDR requirements on those airplanes could have been included. However, as part of the FAA's goal of regulating all scheduled operators under a single part, it would be inconsistent *not* to propose that all airplanes operated in part 121 service be covered by the same or comparable requirements. It is up to the FAA to determine the proper scope and consistency of its regulations, and the agency cannot be constrained by a recommendation of the NTSB that did not consider other ongoing agency actions and initiatives. The NTSB did not state that these airplanes *not* be covered—it simply never addressed them. Further, it is not clear what the commenter means as to the existence of ''technical support'' for a proposal that is but one part of an overall agency safety initiative.

Proposed § 121.344a(b) would require recorders on all turbine-engine powered airplanes having a passenger seating configuration, excluding any required crewmember seat, of 10 to 19 seats, that are manufactured after [insert date 3 yrs after effective date of final rule], to record the parameters listed in § 121.344 (a)(1) through (a)(57), as well as all additional parameters that are within the capacity of the recording system within the ranges, accuracies, resolutions, and recording intervals specified in Appendix M to part 121.

Proposed § 121.344a(c) would require recorders on all turbine-engine powered airplanes having a passenger seating configuration, excluding any required crewmember seat, of 10 to 19 seats, that are manufactured after [insert date 5 yrs after effective date of final rule], to record the parameters listed in § 121.344 (a)(1) through (a)(88), within the ranges, accuracies, resolutions, and recording intervals specified in Appendix M to part 121. This is the same requirement that would apply to transport category airplanes as proposed in § 121.344, and the same reasons for its adoption applies.

Proposed § 121.344a(d) would bring forward the appropriate references in current § 135.152(f), pursuant to airplanes only, which includes requirements for installation of flight recorders and correlation of flight data. Rotorcraft requirements would remain in § 135.152(f); they are not being addressed in this rulemaking.

Proposed § 121.344a(e) would require all airplanes subject to this section to also comply with paragraphs (g)–(k) of § 121.344.

Proposed § 121.344a(f) would identify those airplanes to which these proposals would not apply. Included are airplanes that are no longer in production. After considering analysis of data presented by aircraft operators and manufacturers, the ARAC working group determined that the remaining economic life of these airplanes is insufficient to justify the cost associated with extensive DFDR retrofit. Further, the number of these airplanes in operation is sufficiently small that any safety return from expanded FDR's would be minimal. The FAA agrees in the selection of the aircraft types listed. The FAA also specifically requests that commenters submit other aircraft types, if any, that should be included in this list. Submissions for inclusion should include a detailed explanation of the reasons why these aircraft should be included on the list, and the number of aircraft that would be affected.

New Appendix

Proposed Appendix M: This new appendix would correspond directly to the parameter list set forth in § 121.344(a), and would present the ranges, accuracies, resolutions, and recording intervals for each parameter. Values for these items were determined based on the capacity of current equipment and take into consideration the European standards. Where possible, the standards in Appendix M are the same as those in the European requirements.

Specific Comments Concerning Proposed Appendix M

Several specific changes to Appendix M were submitted in the comments from the ARAC Executive Committee. The addition of TSO C51a to the Accuracy column of the Pressure Altitude parameter was reviewed and accepted. One comment stated that the Heading parameter, which would require a true/mag discrete is unclear and that the two should be separated. A significant amount of time was expended in working group discussions on this topic, and the designation as it appears in the proposed Appendix was agreed to by working group members. A comment concerning Manual radio transmitter keying states that existing installations should only require a single discrete. That is all that is required, and only for air traffic communications. A further comment that language should be added to exclude digital voice and data transmissions is not being addressed because there is no requirement that digital data link transmissions be included as part of this parameter.

Part 125

The FAA proposes to add a new § 125.226 to require the existing airplane fleet operated under part 125 to be retrofitted with FDR's that record additional parameters. Requirements for DFDR's on newer airplanes and newly manufactured airplanes would also be revised to require that additional parameters be recorded. The preceding discussion for the proposed amendments to part 121 also applies to aircraft operated under part 125. The text in § 125.225 would remain unchanged because airplanes excluded from these proposed amendments would be required to continue to comply with that section.

Proposed Appendix E: This new appendix to part 125 would be identical

to the proposed Appendix M to part 121 above.

Part 129

The FAA proposes to add a new § 129.20, Digital Flight Data Recorders, to address flight data recorder regulations for U.S.-registered airplanes operated outside the United States. Although the NTSB recommendations did not apply to part 129 operators, the FAA has determined that U.S.-registered airplanes, regardless of where they are operated, should be required to comply with the same FDR requirements as though they were operated domestically. Accordingly, the proposed rule indicates that, depending on the airplane type, airplanes that are U.S.-registered but operated outside the United States must comply with the applicable flight data recorder regulations of part 121, 125, or 135. Descriptions of these requirements can be found above in the sections describing the proposed amendments to those parts. Consequently, the FAA proposes to revise the applicability of § 129.1(b) to include reference to the proposed § 129.20.

The period for public comment to the proposed part 129 amendment is no longer than that provided for the other proposals in this NPRM to allow sufficient time for international entities to comment. Therefore, the comment period for revisions to part 129 will be 120 days from the date of publication of the NPRM, and the final rule for any revisions to part 129 will be issued separately, although the compliance time adopted may be the same as that proposed for parts 121, 125, and 135.

Part 135

These proposed flight data recorder amendments would apply to turbine-engine-powered airplanes having a passenger seating configuration, excluding any required crewmember seat, of 10 to 30 seats, that are manufactured after [insert date 3 years after effective date of final rule] and operated under part 135. These requirements are being proposed to parallel the requirements for the same airplanes operated under part 121. These amendments would not apply to any airplane type certificated to be configured with nine or fewer passenger seats or any rotorcraft.

Proposed § 135.152(f)(1) would retain the requirement from current § 135.152(f). A new § 135.152(f)(2) is proposed that would update the correlation data requirements for newly manufactured airplanes.

Proposed new § 135.152(h) would list the parameters that apply to newly manufactured airplanes. This list is identical to the parameter list proposed in § 121.344.

Proposed § 135.152(i) would require all turbine-engine powered airplanes that are manufactured after [insert date three years after effective date of final rule] to record the parameters listed in paragraphs (h)(1) through (h)(57) of this part, as well as any additional parameters capable of being recorded on the installed FDR equipment, in accordance with proposed Appendix F to part 135.

Proposed § 135.152(j) would require all turbine-engine powered airplanes that are manufactured after [insert date 5 yrs after effective date of final rule], to record the parameters listed in paragraph (h)(1) through (88) of this section within the ranges, accuracies, resolutions, and recording intervals specified in Appendix F. This provision is identical as proposed in § 121.344a(c), since it would apply to the same airplanes, and the same reasons for its adoption applies.

Proposed Appendix F: This new appendix would correspond directly to the parameter list set forth in § 135.152(h), and would present the ranges, accuracies, resolutions, and recording intervals for each parameter. This proposed appendix is identical to proposed Appendix M to part 121.

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FLIGHT DATA RECORDER UPGRADE REQUIREMENTS

	Category 1 No FDAU*, mfd on or before 10/11/91	**Category 2** FDAU, mfd on or before 10/11/91	**Category 3** FDAU, mfd after 10/11/91	**Category 4** FDAU, mfd 3 (or 5) years after final rule
Current Parameters	11 parameters	17 parameters	Up to 29 parameters	29 parameters
Proposed parameters	17/18 parameters.	17 - 22 parameters	34 parameters	57 parameters (3 years) 88 parameters (5 years)
Airplanes	1929 airplanes over 30 seats; 727, 737, L-1011, DC-8, DC-9, F-28	1360 airplanes over 30 seats 704 turboprops A-320, 737, 747, 757, 767, DC-10, F-28, MD-80, ATR-42, EMB-120, SAAB 340, DHC-8	1036 airplanes over 30 seats 673 airplanes 10-19 seats 277 airplanes 20-30 seats 737, 747, 757, 767, 777, F-100, MD-11, MD-80, MD-88, MD-90, ATR-72	All newly manufactured airplanes Existing derivatives and any new type certificates

*FDAU = Flight Data Acquisition Unit

International Compatibility

The FAA has reviewed corresponding International Civil Aviation Organization regulations and Joint Aviation Authority regulations, where they exist. Any differences between those documents and these regulations are of a minor, technical nature, and are deemed insignificant. They would not adversely affect harmonization.

Paperwork Reduction Act

No information collection is required by this proposed rule.

Regulatory Evaluation Summary

Proposed changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic effect of regulatory changes on small entities. Third, the Office of Management and Budget directs agencies to assess the effect of regulatory changes on international trade. A regulatory evaluation of the proposal is in the docket.

Costs

To obtain representative and comprehensive information from which to develop the industry costs of this proposed rule, the FAA relied on the responses of ATA and RAA members to an air carrier cost survey developed by the ARAC working group. (The FAA augmented this information with adjusted costs analysis from the recently approved commuter rule.) The principle aggregate cost detailed in the cost survey were (1) equipment and inventory/spares; (2) engineering, installation, and other costs, inclusive of recurrent maintenance costs; and (3) aircraft out-of-service costs which reflect revenue losses resulting from unscheduled aircraft downtime.

The total turbojet fleet costs for air carriers operating under part 121 for the projected retrofits are $472.0 million ($420.4 million, discounted) if required to be done within a 2-year compliance time frame. For a 4-year compliance time frame, the FAA estimates the costs would be $308.9 million ($259.1 million, discounted). The equivalent total turboprop fleet costs for air carriers operating under part 121 are $39.0 million ($35.2 million, discounted) for the 2-year compliance time frame, and $30.4 million ($25.8 million, discounted) for the 4-year compliance time frame. The total 4-year compliance time frame costs for part 135, 10–19 seat aircraft required to now operate under part 121 are estimated to be $26.4 million ($22.3 million, discounted) and for part 135, 20–30 seat aircraft, $10.9 million ($9.2 million, discounted), or $37.3 million ($31.5 million, discounted) total part 135 costs. Thus, the total 4-year compliance time frame discounted costs for the proposed retrofits required under this proposed rule are $316.3 million.

With regard to the total turbojet fleet costs for air carriers operating under part 121, nearly one-half the total cost for the 2-year alternative represents the out-of-service costs or lost revenues that would be imposed by the shorter compliance time requirement. The other one-half of the total cost represents the basic costs which include capital investment and expenses. In the 4-year time frame, just over 20 percent of the total cost represents the out-of-service costs or lost revenues that would be imposed by this compliance time requirement. No similar assessment can be made for either the turboprop fleet or part 135 carriers that will now be required to operate under part 121. However, because the total turbojet fleet costs represent over 80 percent of the air carrier industry cost analyzed for this proposed rule, the two year time frame suggests itself to clearly be a more costly option than the four year time frame. The FAA's estimates of out of service costs by aircraft type are summarized in the appendix to the full Regulatory Evaluation. That document is available for review in the regulatory docket.

Benefits

DFDR's do not in and of themselves prevent accidents; they are used as an investigative tool when accidents or incidents occur. From the DFDR information, a greater understanding of the dynamics and probable causes of accidents and incidents can be obtained. With this knowledge, a ''fix'' can be made to reduce the chance of a similar occurrence in the future.

Due to the very nature of the DFDR requirements (i.e., that we currently do not know how or why certain accidents occur), the FAA is not able to quantify the likely benefits that will ultimately result from this proposal. Nevertheless, the FAA has determined, particularly in light of the NTSB recommendations, that information concerning enhanced parameters can be collected cost-effectively. The FAA will be able to use incident information to reduce accidents of the nature that are currently of undetermined cause.

Benefit Cost Comparison

The FAA cautions that the cost analysis detailed in the preceding sections is not necessarily exhaustive. The purpose of this rulemaking is to require the installation of DFDR's that provide more flight information about aviation accidents or incidents. This in turn, would allow industry to predict certain trends in order to make the necessary modifications prior to future accidents or incidents. Thus, it is assumed that as a result of this rulemaking the quantity and quality of information is increased about those accidents for which the NTSB currently cannot determine the probable cause. To the extent that this occurs, then the FAA would take appropriate additional action to prevent a recurrence of those kinds of accidents.

Future FAA actions could take the form of Advisory Circulars, Airworthiness Directives, or possibly, additional rulemakings. The costs of these follow-on FAA actions could vary from negligible costs to considerable costs of some unknown amount. The costs of such future follow-on actions by the FAA should be taken into consideration as part of the costs of this rulemaking. However, the costs of potential future actions have not been included because the costs of such follow-on actions cannot be estimated. It should be understood, therefore, that, to the extent that the cost of the follow-on actions are more than negligible, the current costs estimates would tend to underestimate the total cost of this rulemaking.

Initial Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily or disproportionately burdened by Federal regulations. The RFA requires regulatory agencies to review rules which may have ''a significant economic impact on a substantial number of small entities.'' For this proposed rulemaking, a ''small entity'' is an operator of aircraft for hire owning, but not necessarily operating, nine (9) aircraft or less. A ''substantial number of small entities'', as defined in FAA order 2100.14A-Regulatory Flexibility Criteria and Guidance, is a number (in this instance, the number of operators) which is not less than eleven and is more then one-third of the small entities subject to a proposed or existing rule.

A ''significant economic impact'' or cost threshold, is defined as an annualized net compliance cost level

that exceeds 1) $119,900 (1994 dollars) in the case of scheduled operators of aircraft for hire whose entire fleet has a seating capacity in excess of 60 seats; 2) $67,000 (1994 dollars) in the case of scheduled operators of aircraft for hire for which the entire fleet has a seating capacity less than or equal to 60 seats; and 3) $4,800 (1994 dollars) in the case of unscheduled operators of aircraft for hire.

The FAA has determined the annualized costs (20 years) for scheduled operators of large aircraft to be $9,128 per aircraft for the 2-year time frame and $5,611 per aircraft for the 4-year time frame. Multiplying each of these estimates by 9, (the upper bound of the small entity criteria) yields results of $82,155 and $50,501 for the 2-year and 4-year time frames, respectively. Each of these estimates is significantly below the minimum compliance cost criteria of $119,900 for scheduled operators of large aircraft.

The FAA has also determined the annualized costs (20 years) for scheduled operators of small aircraft to be $4,378 per aircraft for the 2-year time frame and $3,067 per aircraft for the 4-year time frame. The upper bound costs for consideration within the small entity (9 aircraft) criteria are $39,398 for the 2-year time frame and $27,603 for the 4-year time frame, respectively. Both are well below the minimum compliance cost of $67,000.

International Trade Impact Assessment

The FAA has determined that revisions to digital flight data recorder rules could have a significant impact on international trade. The FAA is of the opinion that while the proposed rule will not effect non-U.S. operators of foreign aircraft operating outside the United States, it could have a significant impact on the suppliers of materials required for retrofitting the affected aircraft in the domestic fleet. Domestic sources of the required retrofit products may not be able to meet the increased demand of the domestic air carriers for DFDR's as these air carriers increased orders to meet the tight compliance time-frame imposed by this proposed rule. Foreign producers may benefit by supplying the unfilled orders. The FAA welcomes comments on this issue from manufacturers and suppliers of the proposed retrofit materials as well as other interested parties.

Conclusion

For the reasons discussed in the preamble, and based on the findings in the Regulatory Flexibility Determination and the International Trade Impact Analysis, the FAA has determined that this proposed regulation would be a significant regulatory action under Executive Order 12866, and is considered significant under DOT Regulatory Policies and Procedures (44 FR 11034; February 26, 1979).

List of Subjects

14 CFR Part 121

Air carriers, Aviation safety, Reporting and recordkeeping requirements, Transportation

14 CFR Part 125

Aviation safety, Reporting and recordkeeping requirements

14 CFR Part 129

Air carriers, Aviation safety, Reporting and recordkeeping requirements

14 CFR Part 135

Aviation safety, Reporting and recordkeeping requirements

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend 14 CFR parts 121, 125, 129, and 135 of the Federal Aviation Regulations as follows:

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

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

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

2. Section 121.344 is revised to read as follows:

§ 121.344 Digital flight data recorders for transport category airplanes.

(a) Except as provided in paragraph (l) of this section, no person may operate under this part a turbine-engine-powered transport category airplane unless it is equipped with one or more approved flight recorders that use a digital method of recording and storing data and a method of readily retrieving that data from the storage medium. The operational parameters required to be recorded by digital flight data recorders required by this section are as follows; the phrase ''when an information source is installed'' following a parameter indicates that recording of that parameter is not intended to require a change in installed equipment:

(1) Time;

(2) Pressure altitude;

(3) Indicated airspeed;

(4) Heading—primary flight crew reference (if selectable, record discrete, true or magnetic);

(5) Normal acceleration (Vertical);

(6) Pitch attitude;

(7) Roll attitude;

(8) Manual radio transmitter keying, or CVR/DFDR synchronization reference;

(9) Thrust/power of each engine—primary flight crew reference;

(10) Autopilot engagement status;

(11) Longitudinal acceleration;

(12) Pitch control input;

(13) Lateral control input;

(14) Rudder pedal input;

(15) Primary pitch control surface position;

(16) Primary lateral control surface position;

(17) Primary yaw control surface position;

(18) Lateral acceleration;

(19) Pitch trim surface position or the parameters of paragraph (a)(82) of this section, if currently recorded;

(20) Trailing edge flap or cockpit flap control selection (except when the parameters of paragraph (a)(85) of this section apply);

(21) Leading edge flap or cockpit flap control selection (except when the parameters of paragraph (a)(86) of this section apply);

(22) Each Thrust reverser position (or equivalent for propeller airplane);

(23) Ground spoiler position or speed brake selection (except when the parameters of paragraph (a)(87) of this section apply);

(24) Outside or total air temperature;

(25) Automatic Flight Control System (AFCS) modes and engagement status, including autothrottle;

(26) Radio altitude (when an information source is installed);

(27) Localizer deviation, MLS Azimuth;

(28) Glideslope deviation, MLS Elevation;

(29) Marker beacon passage;

(30) Master warning;

(31) Air/ground sensor (primary airplane system reference nose or main gear);

(32) Angle of attack (when information source is installed);

(33) Hydraulic pressure low (each system);

(34) Ground speed (when an information source is installed);

(35) Ground proximity warning system;

(36) Landing gear position or landing gear cockpit control selection;

(37) Drift angle (when an information source is installed);

(38) Wind speed and direction (when an information source is installed);

(39) Latitude and longitude (when an information source is installed);
(40) Stick shaker/pusher (when an information source is installed);
(41) Windshear (when an information source is installed);
(42) Throttle/power lever position;
(43) Additional engine parameters (as designated in appendix M of this part);
(44) Traffic alert and collision avoidance system;
(45) DME 1 and 2 distances;
(46) Nav 1 and 2 selected frequency;
(47) Selected barometric setting (when an information source is installed);
(48) Selected altitude (when an information source is installed);
(49) Selected speed (when an information source is installed);
(50) Selected mach (when an information source is installed);
(51) Selected vertical speed (when an information source is installed);
(52) Selected heading (when an information source is installed);
(53) Selected flight path (when an information source is installed);
(54) Selected decision height (when an information source is installed);
(55) EFIS display format;
(56) Multi-function/engine/alerts display format;
(57) Thrust command (when an information source is installed);
(58) Thrust target (when an information source is installed);
(59) Fuel quantity in CG trim tank (when an information source is installed);
(60) Primary Navigation System Reference;
(61) Icing (when an information source is installed);
(62) Engine warning each engine vibration (when an information source is installed);
(63) Engine warning each engine over temp. (when an information source is installed);
(64) Engine warning each engine oil pressure low (when an information source is installed);
(65) Engine warning each engine over speed (when an information source is installed);
(66) Yaw trim surface position;
(67) Roll trim surface position;
(68) Brake pressure (selected system);
(69) Brake pedal application (left and right);
(70) Yaw or sideslip angle (when an information source is installed);
(71) Engine bleed value position (when an information source is installed);
(72) De-icing or anti-icing system selected (when an information source is installed);
(73) Computed center of gravity (when an information source is installed);
(74) AC electrical bus status;
(75) DC electrical bus status;
(76) APU bleed valve position (when an information source is installed);
(77) Hydraulic pressure (each system);
(78) Loss of cabin pressure;
(79) Computer failure;
(80) Heads-up display (when an information source is installed);
(81) Para-visual display (when an information source is installed);
(82) Cockpit trim control input position—pitch;
(83) Cockpit trim control input position—roll;
(84) Cockpit trim control input position—yaw;
(85) Trailing edge flap and cockpit flap control position;
(86) Leading edge flap and cockpit flap control position;
(87) Ground spoiler position and speed brake selection; and
(88) All cockpit flight control input forces (control wheel, control column, rudder pedal).

(b) For all turbine-engine powered transport category airplanes manufactured on or before October 11, 1991, by [four years from effective date of final rule]—

(1) For airplanes not equipped as of July 15, 1996 with a flight data acquisition unit (FDAU), the parameters listed in paragraphs (a)(1) through (a)(18) of this section must be recorded within the ranges and accuracies specified in Appendix B of this part, and—

(i) For airplanes with more than two engines, the parameter described in paragraph (a)(18) is not required unless sufficient capacity is available on the existing recorder to record that parameter;

(ii) Parameters listed in paragraphs (a)(12) through (a)(17) each may be recorded from a single source.

(2) For airplanes that were equipped as July 16, 1996 with a flight data acquisition unit (FDAU), the parameters listed in paragraphs (a)(1) through (a)(22) of this section must be recorded within the ranges, accuracies, and recording intervals specified in appendix M of this part. Parameters listed in paragraphs (a)(12) through (a)(17) each may be recorded from a single source.

(3) The approved flight recorder required by this section must be installed at the earliest time practicable, but no later than the next heavy maintenance check after [two years after effective date of final rule], and no later than [four years after the effective date of the final rule]. A heavy maintenance check is considered to be any time an airplane is scheduled to be out of service for 4 or more days and is scheduled to include access to major structural components.

(c) For all turbine-engine powered transport category airplanes manufactured on or before October 11, 1991—

(1) That were equipped as of July 16, 1996 with one or more digital data bus(es) and an ARINC 717 digital flight data acquisition unit (DFDAU) or equivalent, the parameters specified in paragraphs (a)(1) through (a)(22) of this section must be recorded within the ranges, accuracies, resolutions, and sampling intervals specified in appendix M of this part by [4 years after effective date of the final rule]. Parameters listed in paragraphs (a)(12) through (a)(14) each may be recorded from a single source.

(2) Commensurate with the capacity of the recording system (DFDAU or equivalent and the DFDR), all additional parameters for which information sources are installed and which are connected to the recording system, must be recorded within the ranges, accuracies, resolutions, and sampling intervals specified in appendix M of this part by [4 years after effective date of the final rule].

(3) That were subject to § 121.343(e) of this part, all conditions of § 121.343(e) must continue to be met until compliance with paragraph (c)(1) of this section is accomplished.

(d) For all turbine-engine-powered transport category airplanes that were manufactured after October 11, 1991,—

(1) The parameters listed in paragraph (a)(1) through (a)(34) of this section must be recorded within the ranges, accuracies, resolutions, and recording intervals specified in appendix M of this part by [4 years after the effective date of the final rule]. Parameters listed in paragraphs (a)(12) through (a)(14) each may be recorded from a single source.

(2) Commensurate with the capacity of the recording system, all additional parameters for which information sources are installed and which are connected to the recording system, must be recorded within the ranges, accuracies, resolutions, and sampling intervals specified in appendix M of this part by [4 years after effective date of the final rule].

(e) For all turbine-engine-powered transport category airplanes that are manufactured after [3 years after effective date of final rule]—

(1) The parameters listed in paragraph (a)(1) through (57) of this section must be recorded within the ranges, accuracies, resolutions, and recording intervals specified in appendix M of this part.

(2) Commensurate with the capacity of the recording system, all additional parameters for which information sources are installed and which are connected to the recording system, must be recorded within the ranges, accuracies, resolutions, and sampling intervals specified in appendix M of this part.

(f) For all turbine-engine-powered transport category airplanes that are manufactured after [5 years after effective date of final rule], the parameters listed in paragraph (a)(1) through (a)(88) of this section must be recorded within the ranges, accuracies, resolutions, and recording intervals specified in appendix M of this part.

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

(h) Except as provided in paragraph (i) of this section, and except for recorded data erased as authorized in this paragraph, each certificate holder shall keep the recorded data prescribed by this section, as appropriate, until the airplane has been operated for at least 25 hours of the operating time specified in § 121.359(a) of this part. 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 (i) of this section, no record need be kept more than 60 days.

(i) In the event of an accident or occurrence that requires immediate notification of the National Transportation Safety Board under 49 CFR part 830 of its regulations and the results in termination of the flight, the certificate holder shall remove the recorder from the airplane and keep the recorder data prescribed by this section, as appropriate, for at least 60 days or for a longer period upon the request of the Board or the Administrator.

(j) Each flight data recorder system required by this section must be installed in accordance with the requirements of § 25.1459 (a), (b), (d), and (e) of this chapter. A correlation must be established between the values recorded by the flight data recorder and the corresponding values being measured. The correlation must contain a sufficient number of correlation points to accurately establish the conversion from the recorded values to engineering units or discrete state over the full operating range of the parameter. Except for airplanes having separate altitude and airspeed sensors that are an integral part of the flight data recorder system, a single correlation may be established for any group of airplanes—

(1) That are of the same type;

(2) On which the flight recorder system and its installation are the same; and

(3) On which there is no difference in the type design with respect to the installation of those sensors associated with the flight data recorder system. Documentation sufficient to convert recorded data into the engineering units and discrete values specified in the applicable appendix must be maintained by the certificate holder.

(k) Each flight data recorder required by this section must have an approved device to assist in locating that recorder under water.

(l) The following airplanes need not comply with this section, but must continue to comply with applicable paragraphs of § 121.343 of this chapter, as appropriate:

(1) Airplanes that meet the Stage 2 noise levels of part 36 of this chapter and are subject to § 91.801(c) of this chapter, until January 1, 2000. On and after January 1, 2000, any Stage 2 airplane otherwise allowed to be operated under part 91 of this chapter must comply with the applicable flight data recorder requirements of this section for that airplane.

(2) General Dynamics Convair 580, General Dynamics Convair 600, General Dynamics Convair 640, de Havilland Aircraft Company Ltd. DHC–7, Fairchild Aircraft, Inc., FH 227, Fokker F–27 (except Mark 50), F–28 Mark 1000 and Mark 4000, Gulfstream Aerospace G–159, Lockheed Aircraft Corporation Electra 10–A, Lockheed Aircraft Corporation Electra 10–B, Lockheed Aircraft Corporation Electra 10–E, Maryland Air Industries, Inc. F27, Mitsubishi Heavy Industries, Ltd. YS–11, Short Bros. Limited SD3–30, Short Bros. Limited SD3–60.

3. Section 121.344a is added to read as follows:

§ 121.344a Digital flight data recorders for 10–19 seat airplanes.

(a) No person may operate a turbine-engine-powered airplane having a passenger seating configuration, excluding any required crewmember seat, of 10 to 19 seats, that was brought onto the U.S. register after October 11, 1991, unless it is equipped with one or more approved flight recorders that use a digital method of recording and storing data and a method of readily retrieving that data from the storage medium. On or before [4 years after the effective data of the final rule], airplanes brought onto the U.S. register after October 11, 1991, must comply with either the requirements in this section or the applicable paragraphs in § 135.152 of this chapter. In addition, by [4 years after the effective date of the final rule]—

(1) The parameters listed in §§ 121.344(a)(1) through 121.344(a)(11) must be recorded within the ranges, accuracies, and resolutions specified in appendix B of part 135 of this chapter, except that—

(i) Either the parameter listed in § 121.344(a)(12) or (a)(15) must be recorded; either the parameter listed in § 121.344(a)(13) or (a)(16) must be recorded; and either the parameter listed in § 121.344(a)(14) or (a)(17) must be recorded.

(ii) For airplanes with more than two engines, the parameter described in § 121.344(a)(18) must also be recorded if sufficient capacity is available on the existing recorder to record that parameter;

(iii) Parameters listed in §§ 121.344(a)(12) through 121.344(a)(17) each may be recorded from a single source;

(iv) Any parameter for which no value is contained in appendix B of part 135 of this chapter must be recorded within the ranges, accuracies, and resolutions specified in appendix B of this part.

(2) Commensurate with the capacity of the recording system (FDAU or equivalent and the DFDR), the parameters listed in sections 121.344(a)(19) through 121.344(a)(22) also must be recorded within the ranges, accuracies, resolutions, and recording intervals specified in appendix B of part 135 of this chapter.

(3) The approved flight recorder by this section must be installed as soon as practicable, but no later than the next heavy maintenance check or equivalent after [two years after effective date of final rule]. A heavy maintenance check is considered to be any time an airplane is scheduled to be out of service for 4 or more days and is scheduled to include access to major structural components.

(b) For all turbine-engine-powered airplanes having a passenger seating configuration, excluding any required crewmember seat of 10 to 19 seats, that are manufactured after [three years from effective date of final rule]—

(1) The parameters listed in sections 121.344(a)(1) through 121.344(a)(57) must be recorded within the ranges, accuracies, resolutions, and recording intervals specified in appendix M of this part.

(2) Commensurate with the capacity of the recording system, all additional

parameters listed in section 121.344(a) for which information sources are installed and which are connected to the recording system, must be recorded within the ranges, accuracies, resolutions, and sampling intervals specified in appendix M of this part by [4 years after effective date of the final rule].

(c) For all turbine-engine-powered airplanes having a passenger seating configuration, excluding any required crewmember seats, of 10 to 19 seats, that are manufactured after [5 years after effective date of final rule], the parameters listed in section 121.344(a)(1) through (a)(88) must be recorded within the ranges, accuracies, resolutions, and recording intervals specified in appendix M of this part.

(d) Each flight data recorder system required by this section must be installed in accordance with the requirements of section 23.1459 (a), (b), (d), and (e) of this chapter. A correlation must be established between the values recorded by the flight data recorder and the corresponding values being measured. The correlation must contain a sufficient number of correlation points to accurately establish the conversion from the recorded values to engineering units or discrete state over the full operating range of the parameter. A single correlation may be established for any group of airplanes—

(1) That are of the same type;

(2) On which the flight recorder system and its installation are the same; and

(3) On which there is no difference in the type design with respect to the installation of those sensors associated with the flight data recorder system. Correlation documentation must be maintained by the certificate holder.

(e) All airplanes subject to this section are also subject to the requirements and exceptions stated in sections 121.344(g) through 121.344(k).

(f) The following airplane types need not comply with this section, but must continue to comply with applicable paragraphs of section 135.152 of this chapter, as appropriate: Beech Aircraft—99 Series, Beech Aircraft 1300, Beech Aircraft 1900C, Construcciones Aeronauticas, S.A. (CASA) C–212, deHaviland DHC–6, Dornier 228, HS–748, Embraer EMB 110, Jetstream 3101, Jetstream 3201, Fairchild Aircraft SA–226.

4. Appendix M to part 121 is added to read as follows:

APPENDIX M TO PART 121.—AIRPLANE FLIGHT RECORDER SPECIFICATION

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per sampling Interval	Resolution	Remarks
1. Time or Relative Time counts.	24 Hrs, 0 to 4095	+/−0.125% Per Hour.	4	1 sec	UTC time preferred when available. Counter increments each 4 seconds of system operation.
2. Pressure Altitude	−1000 ft to max certificated altitude of aircraft. +5000 ft.	+/−100 to +/−700 ft (see table, TSO C124a or TSO C51a).	1	5′ to 35′	Data should be obtained from the air data computer when practicable.
3. Indicated airspeed or Calibrated airspeed.	50 KIAS or minimum value to Max V_{so}, and V_{so} to 1.2 $V_{.D}$.	+/−5% and +/−3%	1	1 kt	Data should be obtained from the air data computer when practicable.
4. Heading (Primary flight crew reference).	0−360° and Discrete ''true'' or ''mag''.	+/−2°	1	0.5°	When true or magnetic heading can be selected as the primary heading reference, a discrete indicating selection must be recorded.
5. Normal Acceleration (Vertical).	−3g to +6g	+/−1% of max range excluding datum error of +/−5%.	0.125	0.01g.	
6. Pitch Altitude	+/−75°	+/−2°	1 or 0.25 for airplanes operated under §121.344(f).	0.5°	A sampling rate of 0.25 is recommended.
7. Roll Altitude	+/−180°	+/−2°	1 or 0.5 for airplanes operated under §121.344(f).	0.5°	A sampling rate of 0.5 is recommended.
8. Manual Radio Transmitter Keying or CVR/DFDR synchronization reference.	On-Off (Discrete)		1		Preferably each crew member but one discrete acceptable for all transmission provided the CVR/FDR system complies with TSO C124a CVR synchronization requirements (paragraph 4.2.1 ED–55).
9. Thrust/Power on Each Engine—primary flight crew reference.	Full Range Forward	+/−2%	1 (per engine)	0.2% of full range.	Sufficient parameters (e.g. EPR, N1 or Torque, NP) as appropriate to the particular engine be recorded to determine power in forward and reverse thrust, including potential overspeed conditions.
10. Autopilot Engagement.	Discrete ''on'' or ''off''.		1.		

APPENDIX M TO PART 121.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per sampling Interval	Resolution	Remarks
11. Longitudinal Acceleration.	+/−1g	+/−1.5% max. range excluding datum error of +/−5%.	0.25	0.01g.	
12a. Pitch Control(s) position (non-fly-by-wire systems.	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5 or 0.25, as applicable.
12b. Pitch Control(s) position (fly-by-wire systems).	Full Range	+/−2° Unless Higher Accuracy, Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	
13a. Lateral Control position(s) (non-fly-by-wire).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5 or 0.25, as applicable.
13b. Lateral Control positions(s) (fly-by-wire).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	
14a. Yaw Control positions(s) (fly-by-wire).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5.
14b. Yaw Control positions(s) (fly-by-wire).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	
15. Pitch Control Surface(s) Position.	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f)	0.2% of full range.	For airplanes fitted with multiple or split surfaces, a suitable combination of inputs is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5 or 0.25.
16. Lateral Control Surface(s) Position.	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f)	0.2% of full range.	A suitable combination of surface position sensors is acceptble in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5 or 0.25.
17. Yaw Control Surface(s).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	For airplanes with multiple or split surfaces, a suitable combination of surface position sensors is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5.
18. Lateral Acceleration.	+/−1g	+/−1.5% max. range excluding datum error of +/−5%.	0.25	0.01g.	
19. Pitch Trim Surface Position.	Full Range	+/−3% Unless Higher Accuracy Uniquely Required.	1	0.3% of full range.	

APPENDIX M TO PART 121.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per sampling Interval	Resolution	Remarks
20. Trailing Edge Flap or Cockpit Control Selection.	Full Range or Each Position (discrete).	+/−3° or as Pilot's indicator.	2	0.5% of full range.	Flap positin and cockpit control may each be sampled alternately at 4 second intervals, to give a data point every 2 seconds.
21. Leading Edge Flap or Cockpit Control Selection.	Full Range or Each Discrete Position.	+/−3° or as Pilot's indicator and sufficient to determine each discrete position..	2	0.5% of full range.	Left and right sides, or flap position and cockpit control may each be sampled at 4 second intervals, so as to give a data point every 2 seconds.
22. Each Thurst Reverser Position (or equivalent for propeller airplane).	Stowed, In Transit, and Reverse (Discrete).	.....	1 (per engine).	.....	Turbo-jet—2 discretes enable the 3 states to be determined, Turbo—prop—1 discrete.
23. Ground Spoiler Position or Speed Brake Selection.	Full Range or Each Position (discrete).	+/−2° Unless Higher Accuracy Uniquely Required.	1 0.5 for airplanes operated under §121.344(f).	0.2% of full range.	
24. Outside Air Temperature or Total Air Temperature.	−50°C to +90°C	+/−2°C	2	0.3°C.	
25. Autopilot/ Autothrottle/AFCS Mode and Engagement Status.	A suitable combination of discretes.	.....	1	.....	Discretes should show which systems are engaged and which primary modes are controlling the flight path and speed of the aircraft.
26. 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% above 500 ft.	For autoland/category 3 operations each radio altimeter should be recorded, but arranged so that at least one is recorded each second.
27. Localizer Deviation or MLS Azimuth.	+/−400 Microamps or available sensor range as installed, +/−62°.	As installed +/−3% recommended.	1	0.3% of full range.	For autoland/category 3 operations each system should be recorded but arranged so that at least one is recorded each second. It is not necessary to record ILS and MLS at the same time, only the approach aid in use need be recorded.
28. Glideslope Deviation or MLS Elevation.	+/−400 Microamps or available sensor range as installed, 0.9 to + 30°.	As installed +/−3% recommended.	1	0.3% of full range.	For autoland/category 3 operations each system should be recorded but arranged so that at least one is recorded each second. It is not necessary to record ILS and MLS at the same time, only the approach aid in use need be recorded.
29. Marker Beacon Passage.	Discrete ''on'' or ''off''.	.....	1	.....	A single discrete is acceptable for all makers.
30. Master Warning	Discrete	.....	1	.....	Record the master warning and record each 'red' warning that cannot be determined from other parameters or from the cockpit voice recorder.
31. Air/ground sensor (primary airplane system reference nose or main gear).	Discrete ''air'' or ''ground''.	.....	1 (0.25 recommended).		
32. Angle of Attack (If measured directly).	As installed	As Installed	2 or 0.5 for airplanes operated under §121.344(f).	0.3% of full range.	If left and right sensors are available, each may be recorded at 4 second intervals so as to give a data point each half second.
33. Hydraulic Pressure Low, Each System.	Discrete or available sensor range, ''low''or ''normal''.	+/−5%	2	0.5% of full range.	
34. Groundspeed	As Installed	Most Accurate Systems Installed.	1	0.2% of full range.	

APPENDIX M TO PART 121.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per sampling Interval	Resolution	Remarks
35. GPWS (ground proximity warning system).	Discrete ''warning'' or ''off''.	.....	1	.....	A suitable combination of discretes unless recorder capacity is limited in which case a single discrete for all modes is acceptable.
36. Landing Gear Position or Landing gear cockpit control selection.	Discrete	.....	4	.....	A suitable combination of discretes should be recorded.
37. Drift Angle	As installed	As installed	4	0.1°.	
38. Wind Speed and Direction.	As installed	As installed	4	1 knot, and 1.0°.	
39. Latitude and Longitude.	As installed	As installed	4	0.002°	Provided by the Primary Navigation System Reference. Where capacity permits Latitude/longitude resolution should be 0.0002°.
40. Stick shaker and pusher activation.	Discrete(s) ''on'' or ''off''.	.....	1	.....	A suitable combination of discretes to determine activation.
4l. Windshear Detection.	Discrete ''warning'' or ''off''.	.....	1		
42. Throttle/power lever position.	Full Range	+/−2%	1 for each lever	2% of full range	For airplanes with non-mechanically linked cockpit engine controls.
43. Additional Engine Parameters.	As installed	As installed	Each engine each second.	2% of full range	Where capacity permits, the preferred priority is indicated vibration level, N2, EGT, Fuel Flow, Fuel Cut-off lever position and N3, unless engine manufacturer recommends otherwise.
44. Traffic Alert and Collision Avoidance System (TCAS).	Discretes	As installed	1	.....	A suitable combination of discretes should be recorded to determine the status of—Combined Control, Vertical Control, Up Advisory, and Down Advisory. (ref. ARINC Characteristic 735 Attachment 6E, TCAS VERTICAL RA DATA OUTPUT WORD.)
45. DME 1 and 2 Distance.	0–200 NM	As installed	4	1 NM	1 mile.
46. Nav 1 and 2 Selected Frequency.	Full range	As installed	4	.....	Sufficient to determine selected frequency.
47. Selected barometric setting.	Full Range	+/−5%	(1 per 64 sec.)	0.2% of full range.	
48. Selected Altitude	Full Range	+/−5%	1	100 ft.	
49. Selected speed	Full Range	+/−5%	1	1 knot.	
50. Selected Mach ...	Full Range	+/−5%	1	.01.	
51. Selected vertical speed.	Full Range	+/−5%	1	100 ft/min.	
52. Selected heading	Full Range	+/−5%	1	1°.	
53. Selected flight path.	Full Range	+/−5%	1	1°.	
54. Selected decision height.	Full Range	+/−5%	64	1 ft.	
55. EFIS display format.	Discrete(s)	.....	4		Discretes should show the display system status (e.g., off, normal, fail, composite, sector, plan, nav aids, weather radar, range, copy.
56. Multi-function/Engine Alerts Display format.	Discrete(s)	.....	4	.....	Discretes should show the display system status (e.g., off, normal, fail, and the identity of display pages for emergency procedures, need not be recorded.
57. Thrust command	Full Range	+/−2%	2	2% of full range.	
58. Thrust target	Full Range	+/−2%	4	2% of full range.	
59. Fuel quantity in CG trim tank.	Full Range	+/−5%	(1 per 64 sec.)	1% of full range.	

APPENDIX M TO PART 121.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per sampling Interval	Resolution	Remarks
60. Primary Navigation System Reference.	Discrete GPS, INS, VOR/DME, MLS, Loran C, Omega, Localizer Glideslope.	.....	4	.....	A suitable combination of discretes to determine the Primary Navigation System reference.
61. Ice Detection	Discrete ''ice'' or ''no ice''.	.....	4.		
62. Engine warning each engine vibration.	Discrete	.....	1.		
63. Engine warning each engine over temp.	Discrete	.....	1.		
64. Engine warning each engine oil pressure low.	Discrete	.....	1.		
65. Engine warning each engine over speed.	Discrete	.....	1.		
66. Yaw Trim Surface Position.	Full Range	+/−3% Unless Higher Accuracy Uniquely Required.	2	0.3% of full range.	
67. Roll Trim Surface Position.	Full Range	+/−3% Unless Higher Accuracy Uniquely Required.	2	0.3% of full range.	
68. Brake Pressure (left and right).	As installed	+/−5%	1	.....	To determine braking effort applied by pilots or by autobrakes.
69. Brake Pedal Application (left and right).	Discrete or Analog ''applied'' or ''off''.	+/−5% (Analog)	1	.....	To determine braking applied by pilots.
70. Yaw or sideslip angle.	Full Range	+/−5%	1	0.5°.	
71. Engine bleed valve position.	Discrete ''open'' or ''closed''.	.....	4.		
72. De-icing or anti-icing system selection.	Discrete ''on'' or ''off''.	.....	4.		
73. Computed center of gravity.	Full Range	+/−5%	(1 per 64 sec.)	1% of full range.	
74. AC electrical bus status.	Discrete ''power'' or ''off''.	.....	4	.....	Each bus.
75. DC electrical bus status.	Discrete ''power'' or ''off''.	.....	4	.....	Each bus.
76. APU bleed valve position.	Discrete ''open'' or ''closed''.	.....	4.		
77. Hydraulic Pressure (each system).	Full range	+/−5%	2	100 psi.	
78. Loss of cabin pressure.	Discrete ''loss'' or ''normal''.	.....	1.		
79. Computer failure (critical flight and engine control systems).	Discrete ''fail'' or ''normal''.	.....	4.		
80. Heads-up display (when an information source is installed).	Discrete(s) ''on'' or ''off''.	.....	4.		
81. Para-visual display (when an information source is installed).	Discrete(s) ''on'' or ''off''.	.....	1.		
82. Cockpit trim control input position—pitch.	Full Range	+/−5%	1	0.2% of full range.	

APPENDIX M TO PART 121.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per sampling Interval	Resolution	Remarks
83. Cockpit trim control input position—roll.	Full Range	+/−5%	1	0.2% of full range.	
84. Cockpit trim control input position—yaw.	Full Range	+/−5%	1	0.2% of full range.	
85. Trailing edge flap and cockpit flap control position.	Full Range	+/−5%	2	0.5% of full range.	Trailing edge flaps and cockpit flap control position may each be sampled alternately at 4 second intervals to provide a sample each 0.5 second.
86. Leading edge flap and cockpit flap control position.	Full Range or Discrete.	+/−5%	1	0.5% of full range.	
87. Ground spoiler position and speed brake selection.	Full Range or Discrete.	+/−5%	0.5	0.2% of full range.	
88. All cockpit flight control input forces (control wheel, control column, rudder pedal).	Full Range Control wheel Control Column Rudder pedal	+/−5% +/−70 lbs. +/−85 lbs +/−165 lbs.	1	0.2% of full range.	For fly-by-wire flight control systems, where flight control surface position is a function of the displacement of the control input device only, it is not necessary to record this parameter.

PART 125 CERTIFICATION AND OPERATIONS: AIRPLANES HAVING A SEATING CAPACITY OF 20 OR MORE PASSENGERS OR A MAXIMUM PAYLOAD CAPACITY OF 6,000 POUNDS OR MORE

5. The authority citation for part 125 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701–44702, 44705, 44710–44711, 44713, 44716–44717, 44722.

6. Section 125.226 is added to read as follows:

§ 125.226 Digital flight recorders.

(a) Except as provided in paragraph (l) of this section, no person may operate under this part a turbine-engine-powered transport category airplane unless it is equipped with one or more approved flight recorders that use a digital method of recording and storing data and a method of readily retrieving that data from the storage medium. The operational parameters required to be recorded by digital flights data recorders required by this section are as follows; the phrase ''when an information source is installed'' following a parameter indicates that recording of that parameters is not intended to require a change in installed equipment:

(1) Time;

(2) Pressure altitude;

(3) Indicated airspeed;

(4) Heading—primary flight crew reference (if selectable, record discrete, true or magnetic);

(5) Normal acceleration (Vertical);

(6) Pitch attitude;

(7) Roll attitude;

(8) Manual radio transmitter keying, or CVR/DFDR synchorinization reference;

(9) Thrust/power of each engine—primary flight crew reference;

(10) Autopilot engagement status:

(11) Longitudinal acceleration;

(12) Pitch control input;

(13) Lateral control input;

(14) Rudder pedal input;

(15) Primary pitch control surface position;

(16) Primary lateral control surface position;

(17) Primary yaw control surface position;

(18) Lateral acceleration;

(19) Pitch trim surface position or the parameters of paragraph (a)(82) of this section, if currently recorded;

(20) Trailing edge flap or cockpit flap control selection (except when the parameters of paragraph (a)(85) of this section apply);

(21) Leading edge flap or cockpit flap control selection (except when the parameters of paragraph (a)(86) of this section apply);

(22) Each Thrust reverser position (or equivalent for propeller airplane);

(23) Ground spoiler position or speed brake selection (except when the parameters of paragraph (a)(87) of this section apply);

(24) Outside or total air temperature;

(25) Automatic Flight Control System (AFCS) modes and engagement status, including autothrottle;

(26) Radio altitude (when an information source is installed);

(27) Localizer deviation, MLS Azimuth;

(28) Glideslope deviation, MLS Elevation;

(29) Maker beacon passage;

(30) Master warning;

(31) Air/ground sensor (primary airplane system reference nose or main gear);

(32) Angle of attack (when information source is installed);

(33) Hydraulic pressure low (each system);

(34) Ground speed (when an information source is installed);

(35) Ground proximity warning system;

(36) Landing gear position or landing gear cockpit control selection;

(37) Drift angle (when an information source is installed);

(38) Wind speed and direction (when an information source is installed);

(39) Latitude and longitude (when an information source is installed);

(40) Stick shaker/pusher (when an information source is installed);

(41) Windshear (when an information source is installed);

(42) Throttle/power lever position;

(43) Additional engine parameters (as designated in appendix E of this part);

(44) Traffic alert and collision avoidance system;

(45) DME 1 and 2 distances;
(46) Nav 1 and 2 selected frequency;
(47) Selected barometric setting (when an information source is installed);
(48) Selected altitude (when an information source is installed);
(49) Selected speed (when an information source is installed);
(50) Selected mach (when an information source is installed);
(51) Selected vertical speed (when an information source is installed);
(52) Selected heading (when an information source is installed);
(53) Selected flight path (when an information source is installed);
(54) Selected decision height (when an information source is installed);
(55) EFIS display format;
(56) Multi-function/engine/alerts display format;
(57) Thrust command (when an information source is installed);
(58) Thrust target (when an information source is installed);
(59) Fuel quantity in CG trim tank (when an information source is installed);
(60) Primary Navigation System Reference;
(61) Icing (when an information source is installed);
(62) Engine warning each engine vibration (when an information source is installed);
(63) Engine warning each engine over temp. (when an information source is installed);
(64) Engine warning each engine oil pressure low (when an information source is installed);
(65) Engine warning each engine over speed (when an information source is installed);
(66) Yaw trim surface position;
(67) Roll trim surface position;
(68) Brake pressure (selected system);
(69) Brake pedal application (left and right);
(70) Yaw or sideslip angle (when an information source is installed);
(71) Engine bleed valve position (when an information source is installed);
(72) De-icing or anti-icing system selection (when an information source is installed);
(73) Computed center of gravity (when an information source is installed);
(74) AC electrical bus status;
(75) DC electrical bus status;
(76) APU bleed valve position (when an information source is installed);
(77) Hydraulic pressure (each system);
(78) Loss of cabin pressure;
(79) Computer failure;
(80) Heads-up display (when an information source is installed);
(81) Para-visual display (when an information source is installed);
(82) Cockpit trim control input position—pitch;
(83) Cockpit trim control input position—roll;
(84) Cockpit trim control input position—yaw;
(85) Trailing edge flap and cockpit flap control position;
(86) Leading edge flap and cockpit flap control position;
(87) Ground spoiler position and speed brake selection; and
(88) All cockpit flight control input forces (control wheel, control column, rudder pedal).

(b) For all turbine-engine powered transport category airplanes manufactured on or before October 11, 1991, by [four years from effective date of final rule]—

(1) For airplanes not equipped as of July 15, 1996 with a flight data acquisition unit (FDAU), the parameters listed in paragraphs (a)(1) through (a)(18) of this section must be recorded within the ranges and accuracies specified in appendix D of this part, and—

(i) For airplanes with more than two engines, the parameter described in paragraph (a)(18) is not required unless sufficient capacity is available on the existing recorder to record that parameter;

(ii) Parameters listed in paragraphs (a)(12) through (a)(17) each may be recorded from a single source.

(2) For airlines that were equipped as of July 15, 1996 with a flight data acquisition unit (FDAU), the parameters listed in paragraphs (a)(1) through (a)(22) of this section must be recorded within the ranges, accuracies, and recording intervals specified in appendix E of this part. Parameters listed in paragraphs (a)(12) through (a)(17) each may be recorded from a single source.

(3) The approved flight recorder required by this section must be installed at the earliest time practicable, but no later than the next heavy maintenance check after [two years after effective date of final rule], and no later than [four years after the effective date of the final rule]. A heavy maintenance check is considered to be any time an airplane is scheduled to be out of service for 4 or more days and is scheduled to include access to major structural components.

(c) For all turbine-engine powered transport category airplanes manufactured on or before October 11, 1991—

(1) That were equipped as of July 15, 1996 with one or more digital data bus(es) and an ARINC 717 digital flight data acquisition unit (DFDAU) or equivalent, the parameters specified in paragraphs (a)(1) through (a)(22) of this section must be recorded within the ranges, accuracies, resolutions, and sampling intervals specified in appendix E of this part by [4 years after effective date of the final rule]. Parameters listed in paragraphs (a)(12) through (a)(14) each may be recorded from a single source.

(2) Commensurate with the capacity of the recording system (DFDAU or equivalent and the DFDR), all additional parameters for which information sources are installed and which are connected to the recording system, must be recorded within the ranges, accuracies, resolutions, and sampling intervals specified in appendix E of this part by [4 years after effective date of the final rule].

(3) That were subject to § 125.225(e) of this part, all conditions of § 125.225(c) must continue to be met until compliance with paragraph (c)(1) of this section is accomplished.

(d) For all turbine-engine-powered transport category airplanes that were manufactured after October 11, 1991,—

(1) The parameters listed in paragraph (a)(1) through (a)(34) of this section must be recorded within the ranges, accuracies, resolutions, and recording intervals specified in appendix E of this part by [4 years after effective date of the final rule]. Parameters listed in paragraphs (a)(12) through (a)(14) each may be recorded from a single source.

(2) Commensurate with the capacity of the recording system, all additional parameters for which information sources are installed and which are connected to the recording system, must be recorded within the ranges, accuracies, resolutions, and sampling intervals specified in appendix E of this part by [4 years after effective date of the final rule].

(e) For all turbine-engine-powered transport category airplanes that are manufactured after [3 years after effective date of the final rule]—

(1) The parameters listed in paragraph (a)(1) through (57) of this section must be recorded within the ranges, accuracies, resolutions, and recording intervals specified in appendix E of this part.

(2) Commensurate with the capacity of the recording system, all additional parameters for which information sources are installed and which are connected to the recording system, must be recorded within the ranges, accuracies, resolutions, and sampling intervals specified in appendix E of this part.

(f) For all turbine-engine-powered transport category airplanes that are manufactured after [5 years after effective date of final rule], the parameters listed in paragraphs (a)(1) through (a)(88) of this section must be recorded within the ranges, accuracies, resolutions, and recording intervals specified in appendix E of this part.

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

(h) Except as provided in paragraph (i) of this section, and except for recorded data erased as authorized in this paragraph, each certificate holder shall keep the recorded data prescribed by this section, as appropriate, until the airplane has been operated for at least 25 hours of the operating time specified in § 121.359(a) of this part. 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 (i) of this section, no record need be kept more than 60 days.

(i) In the event of an accident or occurence that requires 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 recorder from the airplane and keep the recorder data prescribed by this section, as appropriate, for at least 60 days or for a longer period upon the request of the Board or the Administrator.

(j) Each flight data recorder system required by this section must be installed in accordance with the requirements of § 25.1459 (a), (b), (d), and (e) of this chapter. A correlation must be established between the values recorded by the flight data recorder and the corresponding values being measured. The correlation must contain a sufficient number of correlation points to accurately establish the conversion from the recorded values to engineering units or discrete state over the full operating range of the parameter. Except for airplanes having separate altitude and airspeed sensors that are an integral part of the flight data recorder system, a single correlation may be established for any group of airplanes—

(1) That are of the same type;

(2) On which the flight recorder system and its installation are the same; and

(3) On which there is no difference in the type design with respect to the installation of those sensors associated with the flight data recorder system. Documentation sufficient to convert recorded data into the engineering units and discrete values specified in the applicable appendix must be maintained by the certificate holder.

(k) Each flight data recorder required by this section must have an approved device to assist in locating that recorder under water.

(l) The following airplanes need not comply with this section, but must continue to comply with applicable paragraphs of § 125.225 of this chapter, as appropriate:

(1) Airplanes that meet the Stage 2 noise levels of part 36 of this chapter and are subject to § 91.801(c) of this chapter, until January 1, 2000. On and after January 1, 2000, any Stage 2 airplane otherwise allowed to be operated under part 91 of this chapter must comply with the applicable flight data recorder requirements of this section for that airplane.

(2) General Dynamics Convair 580, General Dynamics Convair 600, General Dynamics Convair 640, de Havilland Aircraft Company Ltd. DHC–7, Fairchild Aircraft, Inc., FH 227, Fokker F–27 (except Mark 50), F–28 Mark 1000 and Mark 4000, Gulfstream Aerospace G–159, Lockheed Aircraft Corporation Electra 10–A, Lockheed Aircraft Corporation Electra 10–B, Lockheed Aircraft Corporation Electra 10–E, Maryland Air Industries, Inc. F27, Mitsubishi Heavy Industries, Ltd. YS–11, Short Bros. Limited SD3–30, Short Bros. Limited SD3–60.

7. Appendix E to part 125 is added to read as follows:

APPENDIX E TO PART 125.—AIRPLANE FLIGHT RECORDER SPECIFICATION

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per Sampling Interval	Resolution	Remarks
1. Time or Relative Time Courts.	24 Hrs 0 to 4095 ...	+/−0.125% Per Hour.	4	1 sec	UTC time preferred when available. Counter increments each 4 seconds of system operation.
2. Pressure Altitude	−1000 ft to max certificated altitude of aircraft.+5000 ft.	1/−100 to +/−700 ft (see table, TSO C124a or TSO C51A).	1	5′ to 35′	Data should be obtained from the air data computer when practicable.
3. Indicated airspeed or Calibrated airspeed.	50 KIAS or minimum value to Max V_{SO}, and V_{SO} to 1.2 $V_{.D}$.	+/−5% and/−3%+	1	1 kt	Data should be obtained from the air data computer when practicable.
4. Heading (Primary flight crew reference.	0−360° and Discrete ‘‘true’’or ‘‘mag’’.	+/−2°	1	0.5°	When true or magnetic heading can be selected as the primary heading reference, a discrete indicating selection must be recorded.
5. Normal Acceleration (Vertical).	−3g to +6g	+/−1% of max range excluding datum error of +/−5%.	0.125	0.01g.	

APPENDIX E TO PART 125.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per Sampling Interval	Resolution	Remarks
6. Pitch Attitude	+/−75°	+/−2°	1 or 0.25 for airplanes operated under §121.344(f).	0.5°	A sampling rate of 0.25 is recommended.
7. Roll Attitude	+/−180°	+/−2°	1 or 0.5 for airplanes operated under §121.344(f).	0.5°	A sampling rate of 0.5 is recommended.
8. Manual Radio Transmitter Keying or CVR/DFDR synchronization reference.	On-Off (Discrete) none.		1		Preferably each crew member but one discrete acceptable for all transmission provided the CVR/FDR system complies with TSO C124a CVR synchronization requirements (paragraph 4.2.1 ED–55).
9. Thrust/Power on Each Engine—Primary flight crew reference.	Full Range Forward	+/−2%	1 (per engine)	0.2% of full range.	Sufficient parameters (e.g. EPR, N1 or Torque, NP) as appropriate to the particular engine be recorded to determine power in forward and reverse thrust, including potential overspeed conditions.
10. Autopilot Engagement.	Discrete ''on'' or ''off''.		1.		
11. Longitudinal Acceleration.	+/−1g	+/−1.5% max. range excluding datum error of +/−5%.	0.25	0.01g	
12a. Pitch Control(s) position (non-fly-by-wire systems.	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5 or 0.25, as applicable.
12b. Pitch Control(s) position (fly-by-wire systems).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	
13a. Lateral Control position(s) (non-fly-by-wire).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5 or 0.25, as applicable.
13b. Lateral Control position(s) (fly-by-wire).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	
14a. Yaw Control position(s) (non-fly-by-wire).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5.
14b. Yaw Control position(s) (fly-by-wire).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	

APPENDIX E TO PART 125.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per Sampling Interval	Resolution	Remarks
15. Pitch Control Surface(s) Position.	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	For airplanes fitted with multiple or split surfaces, a suitable combination of inputs is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5 or 0.25.
16. Lateral Control Surface(s) Position.	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	A suitable combination of surface position sensors is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5 or 0.25.
17. Yaw Control Surface(s) Position.	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	For airplanes with multiple or split surfaces, a suitable combination of surface position sensors is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5.
18. Lateral Acceleration.	+/−1g	+/−1.5% max. range excluding datum error of +/−5%.	0.25	0.01g.	
19. Pitch Trim Surface Position.	Full Range	+/−3% Unless Higher Accuracy Uniquely Required..	1	0.3% of full range.	
20. Trailing Edge Flap or Cockpit Control Selection.	Full Range or Each Position (discrete)..	+/−3° or as Pilot's indicator.	2	0.5% of full range.	Flap position and cockpit control may each be sampled alternately at 4 second intervals, to give a data point every 2 seconds.
21. Leading Edge Flap or Cockpit Control Selection.	Full Range or Each Discrete Position.	+/−3° or as Pilot's indicator and sufficient to determine each discrete position.	2	0.5% of full range.	Left and right sides, or flap position and cockpit control may each be sampled at 4 second intervals, so as to give a data point every 2 seconds.
22. Each Thrust Reverser Position (or equivalent for propeller airplane).	Stowed, In Transit, and Reverse (Discrete)..	.....	1 (per engine).	.....	Turbo-jet 2 discretes enable the 3 states to be determined, Turbo—prop—1 discrete.
23. Ground Spoiler Position or Speed Brake Selection.	Full Range or Each Position (discrete)..	+/−2° Unless Higher Accuracy Uniquely Required.	1, 0.5 for airplanes operated under §121.344(f).	0.2% of full range.	
24. Outside Air Temperature or Total Air Temperature.	−50°C to +90°C	+/−2° C	2	0.3° C.	
25. Autopilot/Autothrottle/AFCS Mode and Engagement Status.	A suitable combination of discretes.	.....	1	.....	Discretes should show which systems are engaged and which primary modes are controlling the flight path and speed of the aircraft.
26. 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% above 500 ft.	For autoland/category 3 operations. each radio altimeter should be recorded, but arranged so that at least one is recorded each second.
27. Localizer Deviation or MLS Azimuth.	+/−400 Microamps or available sensor range as installed +/−62°.	As installed +/−3% recommended.	1	0.3% of full range.	For autoland/category 3 operations. each system should be recorded but arranged so that at least one is recorded each second. It is not necessary to record ILS and MLS at the same time, only the approach aid in use need be recorded.

APPENDIX E TO PART 125.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per Sampling Interval	Resolution	Remarks
28. Glideslope Deviation or MLS Elevation.	+/−400 Microamps or available sensor range as installed. 0.9 to +30°.	As installed +/−3% recommended.	1	0.3% of full range.	For autoland/category 3 operations. each system should be recorded but arranged so that at least one is recorded each second. It is not necessary to record ILS and MlS at the same time, only the approach aid in use need be recorded.
29. Marker Beacon Passage.	Discrete ''on'' or ''off''.		1		A single discrete is acceptable for all markers.
30. Master Warning	Discrete		1		Record the master warning and record each ''red'' warning that cannot be determined from other parameters or from the cockpit voice recorder.
31. Air/ground sensor (primary airplane system reference nose or main gear).	Discrete ''air'' or ''ground''.		1 (0.25 recommended).		
32. Angle of Attack (If measured directly).	As installed	As Installed	2 or 0.5 for airplanes operated under §121.344(f).	0.3% of full range.	If left and right sensors are available, each may be recorded at 4 second intervals so as to give a data point each half second.
33. Hydraulic Pressure Low, Each System.	Discrete or available sensor range, ''low'' or ''normal''.	+/−5%	2	0.5% of full range.	
34. Groundspeed	As Installed	Most Accurate Systems Installed.	1	0.2% of full range.	
35. GPWS (ground proximity warning system).	Discrete ''warning'' or ''off''.		1		A suitable combination of discretes unless recorder capacity is limited in which case a singel discrete for all modes is acceptable.
36. Landing Gear Position or Landing gear cockpit control selection.	Discrete		4		A suitable combination of discretes should be recorded.
37. Drift Angle	As installed	As installed	4	0.1%.	
38. Wind Speed and Direction.	As installed	As installed	4	1 knot, and 1.0.	
39. Latitude and Longitude.	As installed	As installed	4	0.002°	Provided by the Primary Navigation System Reference. Where capacity permits Latitude/longitude resolution should be 0.0002°.
40. Stick shaker and pusher activation.	Discrete(s) ''on'' or ''off''.		1		A suitable combination of discretes to determine activation.
41. Windshear Detection.	Discrete ''warning'' or ''off''.		1.		
42. Throttle/power lever position.	Full Range	+/−2%	1 for each lever	2% of full range	For airplanes with non-mechanically linked cockpit engine controls.
43. Additional Engine Parameters.	As installed	As installed	Each engine each second.	2% of full range	Where capacity permits, the preferred priority is indicated vibration level, N2, EGT, Fuel Flow, Fuel Cut-off lever position and N3, unless engine manufacturer recommends otherwise.
44. Traffic Alert and Collision Avoidance System (TCAS).	Discretes	As installed	1		A suitable combination of discretes should be recorded to determine the status of—Combined Control, Vertical Control, Up Advisory, and Down Advisory. (ref. ARINC Characteristic 735 Attachment 6E, TCAS VERTICAL RA DATA OUTPUT WORD.)
45. DME 1 and 2 Distance.	0–200 NM;	As installed	4	1 NM	1 mile.
46. Nav 1 and 2 Selected Frequency.	Full range	As installed	4		Sufficient to determine selected frequency.
47. Selected barometric setting.	Full Range	+/−5%	(1 per 64 sec.)	0.2% of full range.	

APPENDIX E TO PART 125.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per Sampling Interval	Resolution	Remarks
48. Selected Altitude	Full Range	+/−5%	1	100 ft.	
49. Selected speed	Full Range	+/−5%	1	1 knot.	
50. Selected Mach	Full Range	+/−5%	1	.01.	
51. Selected vertical speed.	Full Range	+/−5%	1	100 ft/min.	
52. Selected heading	Full Range	+/−5%	1	1°.	
53. Selected flight path.	Full Range	+/−5%	1	1°.	
54. Selected decision height.	Full Range	+/−5%	64	1 ft.	
55. EFIS display format.	Discrete(s)		4		Discretes should show the display system status (e.g., off, normal, fail, composite, sector, plan, nav aids, weather radar, range, copy.
56. Multi-function/Engine Alerts Display format.	Discrete(s)		4		Discretes should show the display system status (e.g., off, normal, fail, and the identity of display pages for emergency procedures, need not be recorded.
57. Thrust command	Full Range	+/−2%	2	2% of full range.	
58. Thrust target	Full Range	+/−2%	4	2% of full range.	
59. Fuel quantity in CG trim tank.	Full Range	+/−5%	(1 per 64 sec.)	1% of full range.	
60. Primary Navigation System Reference.	Discrete GPS, INS, VOR/DME, MLS, Loran C, Omega, Localizer Glideslope.		4		A suitable combination of Discretes to determine the Primary Navigation System reference.
61. Ice Detection	Discrete ''ice'' or ''no ice''.		4.		
62. Engine warning each engine vibration.	Discrete		1.		
63. Engine warning each engine over temp..	Discrete		1.		
64. Engine warning each engine oil pressure low.	Discrete		1.		
65. Engine warning each engine over speed.	Discrete		1.		
66. Yaw Trim Surface Position.	Full Range	+/−3% Unless Higher Accuracy Uniquely Required.	2	0.3% of full range.	
67. Roll Trim Surface Position.	Full Range	+/−3% Unless Higher Accuracy Uniquely Required.	2	0.3% of full range.	
68. Brake Pressure (left and right).	As installed	+/−5%	1		To determine braking effort applied by pilots or by autobrakes.
69. Brake Pedal Application (left and right).	Discrete or Analog ''applied'' or ''off''.	+/−5% (Analog)	1		To determine braking applied by pilots.
70. Yaw or sideslip angle.	Full Range	+/−5%	1	0.5°	
71. Engine bleed valve position.	Discrete ''open'' or ''closed''.		4.		
72. De-icing or anti-icing system selection.	Discrete ''on'' or ''off''.		4.		
73. Computed center of gravity.	Full Range	+/−5%	(1 per 64 sec.)	1% of full range..	
74. AC electrical bus status.	Discrete ''power'' or ''off''.		4		Each bus.

APPENDIX E TO PART 125.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per Sampling Interval	Resolution	Remarks
75. DC electric bus status.	Discrete ''power'' or ''off''.	.....	4	.....	Each bus.
76. APU bleed valve position.	Discrete ''open'' or ''closed''.	.....	4.		
77. Hydraulic Pressure (each system).	Full Range	+/−5%	2	100 psi.	
78. Loss of cabin pressure.	Discrete ''loss'' or ''normal''.	.....	1.		
79. Computer failure (critical flight and engine control systems).	Discrete ''fail'' or ''normal''.	.....	4.		
80. Heads-up display (when an information source is installed).	Discrete(s) ''on'' or ''off''.	.....	4.		
81. Para-visual display (when an information source is installed).	Discrete(s) ''on'' or ''off''.	.....	1.		
82. Cockpit trim control input position—pitch.	Full Range	+/−5%	1	0.2% of full range.	
83. Cockpit trim control input position—roll.	Full Range	+/−5%	1	0.2% of full range.	
84. Cockpit trim control input position—yaw.	Full Range	+/−5%	1	0.2% of full range.	
85. Trailing edge flap and cockpit flap control position.	Full Range	+/−5%	2	0.5% of full range.	Trailing edge flaps and cockpit flap control position may each be sampled alternately at 4 second intervals to provide a sample each 0.5 second.
86. Leading edge flap and cockpit flap control position.	Full Range or Discrete.	+/−5%	1	0.5% of full range.	
87. Ground spoiler position and speed brake selection.	Full Range or discrete.	+/−5%	0.5	0.2% of full range..	
88. All cockpit flight control input forces (control wheel, control column, rudder pedal).	Full Range ..... Control wheel ..... Control Column ..... Rudder pedal	+/−5% ..... +/−70 lbs. ..... +/−85 lbs. ..... +/−165 lbs.	1	0.2% of full range.	For fly-by-wire flight control systems, where flight control surface position is a function of the displacement of the control input device only, it is not necessary to record this parameter.

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

8. The authority citation for part 129 continues to read as follows:

Authority: 49 USC 106(g), 40104–40105, 40113, 40119, 44701–44702, 44712, 44716–44717, 44722, 44901–44904, 44096.

9. In § 129.1, the first sentence of paragraph (b) is revised to read as follows:

§ 129.1 Applicability.

* * * * *

(b) Sections 129.14 and 129.20 also apply to U.S.-registered aircraft operated in common carriage by a foreign person or foreign air carrier solely outside the United States. * * *

10. Section 129.20 is added to read as follows:

§ 129.20 Digital flight data recorders.

No person may operate an aircraft under this part that is registered in the United States unless it is equipped with one or more approved flight recorders that use a digital method of recording and storing data and a method of readily retrieving that data from the storage medium. The flight data recorder must record the parameters that would be required to be recorded if the aircraft were operated under parts 121 or 135 of this chapter, and must be installed by the compliance times required by those parts, as applicable to the aircraft.

PART 135 AIR—TAXI OPERATORS AND COMMERCIAL OPERATORS

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

Authority: 49 USC 106(g), 40113, 44701–44702, 44705, 44709, 44711–44713, 44715–44717, 44722.

12. Section 135.152 is revised to read as follows:

§ 135.152 Flight recorders.

* * * * *

(f) (1) For airplanes manufactured on or before [3 years after effective date of final rule], and all other aircraft, 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:

(i) That are of the same type;

(ii) On which the flight recorder models and their installations are the same; and

(iii) 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.

(f) (2) For airplanes manufactured after [3 years after effective date of final rule], each flight data recorder system required by this section must be installed in accordance with the requirements of § 23.1459 (a), (b), (d), and (e) of this chapter, or § 25.1459 (a), (b), (d), and (e) of this chapter. A correlation must be established between the values recorded by the flight data recorder and the corresponding values being measured. The correlation must contain a sufficient number of correlation points to accurately establish the conversion from the recorded values to engineering units or discrete state over the full operating range of the parameter. Except for airplanes having separate altitude and airspeed sensors that are an integral part of the flight data recorder system, a single correlation may be established for any group of airplanes—

(i) That are of the same type;

(ii) On which the flight recorder system and its installation are the same; and

(iii) On which there is no difference in the type design with respect to the installation of those sensors associated with the flight data recorder system. Documentation sufficient to convert recorded data into the engineering units and discrete values specified in the applicable appendix must be maintained by the certificate holder.

* * * * *

13. In § 135.152, new paragraphs (h), (i), and (j) are added to read as follows:

* * * * *

(h) The operational parameters required to be recorded by digital flight data recorders required by paragraphs (i) and (j) of this section are as follows; the phrase ''when an information source is installed'' following a parameter indicates that recording of that parameter is not intended to require a change in installed equipment:

(1) Time;

(2) Pressure altitude;

(3) Indicated airspeed;

(4) Heading—primary flight crew reference (if selectable, record discrete, true or magnetic);

(5) Normal acceleration (Vertical);

(6) Pitch attitude;

(7) Roll attitude;

(8) Manual radio transmitter keying, or CVR/DFDR synchronization reference;

(9) Thrust/power of each engine—primary flight crew reference;

(10) Autopilot engagement status;

(11) Longitudinal acceleration;

(12) Pitch control input;

(13) Lateral control input;

(14) Rudder pedal input;

(15) Primary pitch control surface position;

(16) Primary lateral control surface position;

(17) Primary yaw control surface position;

(18) Lateral acceleration;

(19) Pitch trim surface position or the parameters of paragraph (h)(82) of this section, if currently recorded;

(20) Trailing edge flap or cockpit flap control selection (except when the parameters of paragraph (h)(85) of this section apply);

(21) Leading edge flap or cockpit flap control selection (except when the parameters of paragraph (h)(86) of this section apply);

(22) Each Thrust reverser position (or equivalent for propeller airplane);

(23) Ground spoiler position or speed brake selection (except when the parameters of paragraph (h)(87) of this section apply);

(24) Outside or total air temperature;

(25) Automatic Flight Control system (AFCS) modes and engagement status, including autothrottle;

(26) Radio altitude (when an information source is installed);

(27) Localizer deviation, MLS Azimuth;

(28) Glideslope deviation, MLS Elevation;

(29) Market beacon passage;

(30) Master warning;

(31) Air/ground sensor (primary airplane system reference nose or main gear);

(32) Angle of attack (when information source is installed);

(33) Hydraulic pressure low (each system);

(34) Ground speed (when an information source is installed);

(35) Ground proximity warning system;

(36) Landing gear position or landing gear cockpit control selection;

(37) Drift angle (when an information source is installed);

(38) Wind speed and direction (when an information source is installed);

(39) Latitude and longitude (when an information source is installed);

(40) Stick shaker/pusher (when an information source is installed);

(41) Windshear (when an information source is installed);

(42) Throttle/power lever position;

(43) Additional engine parameters (as designated in appendix F of this part);

(44) Traffic alert and collision avoidance system;

(45) DME 1 and 2 distances;

(46) Nav 1 and 2 selected frequency;

(47) Selected barometric setting (when an information source is installed);

(48) Selected altitude (when an information source is installed);

(49) Selected speed (when an information source is installed);

(50) Selected mach (when an information source is installed);

(51) Selected vertical speed (when an information source is installed);

(52) Selected heading (when an information source is installed);

(53) Selected flight path (when an information source is installed);

(54) Selected decision height (when an information source is installed);

(55) EFIS display format;

(56) Multi-function/engine/alerts display format;

(57) Thrust command (when an information source is installed);

(58) Thrust target (when an information source is installed);

(59) Fuel quantity in CG trim tank (when an information source is installed);

(60) Primary Navigation System Reference;

(61) Icing (when an information source is installed);

(62) Engine warning each engine vibration (when an information source is installed);

(63) Engine warning each engine over temp. (when an information source is installed);

(64) Engine warning each engine oil pressure low (when an information source is installed);

(65) Engine warning each engine over speed (when an information source is installed);

(66) Yaw trim surface position;

(67) Roll trim surface position;

(68) Brake pressure (selected system);
(69) Brake pedal application (left and right);
(70) Yaw or sideslip angle (when an information source is installed);
(71) Engine bleed valve position (when an information source is installed);
(72) De-icing or anti-icing system selection (when an information source is installed);
(73) Computed center of gravity (when an information source is installed);
(74) AC electrical bus status;
(75) DC electrical bus status;
(76) APU bleed valve position (when an information source is installed);
(77) Hydraulic pressure (each system);
(78) Loss of cabin pressure;
(79) Computer failure;
(80) Heads-up display (when an information source is installed);
(81) Para-visual display (when an information source is installed);
(82) Cockpit trim control input position—pitch;
(83) Cockpit trim control input position—roll;
(84) Cockpit trim control input position—yaw;
(85) Trailing edge flap and cockpit flap control position;
(86) Leading edge flap and cockpit flap control position;
(87) Ground spoiler position and speed brake selection; and
(88) All cockpit flight control input forces (control wheel, control column, rudder pedal).

(i) For all turbine-engine-powered airplanes with a seating configuration, excluding any required crewmember seat, of 10 to 30 passenger seats, manufactured after [3 years after effective date of the final rule]—

(1) The parameters listed in paragraphs (h)(1) through (h)(57) of this section must be recorded within the ranges, accuracies, resolutions, and recording intervals specified in appendix F of this part.

(2) Commensurate with the capacity of the recording system, all additional parameters for which information sources are installed and which are connected to the recording system, must be recorded within the ranges, accuracies, resolutions, and sampling intervals specified in appendix F of this part.

(j) For all turbine-engine-powered airplanes with a seating configuration, excluding any required crewmember seat, of 10 to 30 passenger seats, that are manufactured after [5 years after effective date of final rule], the parameters listed in paragraph (a)(1) through (a)(88) of this section must be recorded within the ranges, accuracies, resolutions, and recording intervals specified in appendix F of this part.

14. Appendix F to part 135 is added to read as follows:

APPENDIX F TO PART 135.—AIRPLANE FLIGHT RECORDER SPECIFICATION

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per sampling Interval	Resolution	Remarks
1. Time or Relative Time Counts.	24 Hrs 0 to 4095 ...	+/−0.125 Per Hour	4	1 sec	UTC time preferred when available. Counter increments each 4 seconds of system operation.
2. Pressure Altitude	−1000 ft to max certificated altitude of aircraft.+5000 ft.	+/−100 to +/−700 ft (see table, TSO C124a or TSO C51a).	1	5′ to 35′	Data should be obtained from the air data computer when practicable.
3. Indicated airspeed or Calibrated airspeed.	50 KIAS or minimum value to Max V_{so} and V_{so} to 1.2 V_D.	+/−5% and +/−3%	1	1 kt.	Data should be obtained from the air data computer when practicable.
4. Heading (Primary flight crew reference).	0−360° and Discrete ''true'' or ''mag''.	+/−2°	1	0.5°	When true or magnetic heading can be selected as the primary heading reference, a discrete indicating selection must be recorded.
5. Normal Acceleration (Vertical).	−3g to +6g	+/−−1% of max range excluding datum error of +/−5%.	0.125	0.01g	
6. Pitch Attitude	+/−75°	+/−2°	1 or 0.25 for airplanes operated under §121.344(f).	0.5°	A sampling rate of 0.25 is recommended.
7. Roll Attitude	+/−180°	+/−2°	1 or 0.5 for airplanes operated under §121.344(f).	0.5°	A sampling rate of 0.5 is recommended.
8. Manual Radio Transmitter Keying or CVR/DFDR synchronization reference.	On-Off (Discrete) ...	.....	1	.....	Preferably each crew member but one discrete acceptable for all transmission provided the CVR/FDR system complies with TSO C124a CVR synchronization requirements (paragraph 4.2.1 ED–55).
9. Thrust/Power on Each Engine—primary flight crew reference.	Full Range Forward	+/−2%	1 (per engine)	0.2% of full range.	Sufficient parameters (e.g. EPR, N1 or Torque, NP) as appropriate to the particular engine be recorded to determine power in forward and reverse thrust, including potential overspeed conditions.

APPENDIX F TO PART 135.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per sampling Interval	Resolution	Remarks
10. Autopilot Engagement.	Discrete ''on'' or ''off''.	.....	1.		
11. Longitudinal Acceleration.	+/−1g	+/−1.5% max. range excluding datum error of +/−5%.	0.25	0.01g	
12a. Pitch Control(s) position (non-fly-wire systems.	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5 or 0.25, as applicable.
12b. Pitch Control(s) position (fly-by-wire systems).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	
13a. Lateral Control position(s) (non-fly-by-wire).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5 or 0.25, as applicable.
13b. Lateral Control position(s) (fly-by-wire).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	
14a. Yaw Control Position(s) (non-fly-by-wire).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5.
14b. Yaw Control Position(s) (fly-by-wire).	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	
15. Pitch Control Surface(s) Position.	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	For airplanes fitted with multiple or split surfaces, a suitable combination of inputs is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5 or 0.25.
16. Lateral Control Surface(s) Position.	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.2% of full range.	A suitable combination of surface position sensors is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5 or 0.25.
17. Yaw Control Surface(s) Position.	Full Range	+/−2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	For airplanes with multiple or split surfaces, a suitable combination of surface position sensors is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5
18. Lateral Acceleration.	+/−1g	+/−1.5% max. range excluding datum error of +/−5%.	0.25	0.01g.	

APPENDIX F TO PART 135.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per sampling Interval	Resolution	Remarks
19. Pitch Trim Surface Position.	Full Range	+/−3% Unless Higher Accuracy Uniquely Required.	1	0.3% of full range.	
20. Trailing Edge Flap or Cockpit Control Selection.	Full Range or Each Position (discrete).	+/−3° or as Pilot's indicator.	2	0.5% of full range.	Flap position and cockpit control may each be sampled alternately at 4 second intervals, to give a data point every 2 seconds.
21. Leading Edge Flap or Cockpit Control Selection.	Full Range or Each Discrete Position.	+/−3° or as Pilot's indicator and sufficient to determine each discrete position.	2	0.5% of full range.	Left and right sides, or flap position and cockpit control may each be sampled at 4 second intervals, so as to give a data point every 2 seconds.
22. Each Thrust Reverser Position (or equivalent for propeller airplane).	Stowed, In Transit, and Reverse (Discrete)..	.....	1 (per engine)	.....	Turbo-jet—2 discretes enable the 3 states to be determined Turbo-prop-1 discrete.
23. Ground Spoiler Position or Speed Brake Selection.	Full Range or Each Position (discrete).	+/−2° Unless Higher Accuracy Uniquely Required.	1 or 0.5 for airplanes operated under §121.344(f).	0.2% of full range.	
24. Outside Air Temperature or Total Air Temperature.	−50°C to +90°C	+/−2° C	2	0.3° C.	
25. Autopilot/ Autothrottle/AFCS Mode and Engagement Status.	A suitable combination of discretes.	.....	1	.....	Discretes should show which systems are engaged and which primary modes are controlling the flight path and speed of the aircraft.
26. 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% above 500 ft of full range.	For autoland/category 3 operations, each radio altimeter should be recorded, but arranged so that at least one is recorded each second.
27. Localizer Deviation or MLS Azimuth.	+/−400 Microamps or available sensor range as installed +/−62°.	As installed +/−3% recommended.	1	0.3% of full range.	For autoland/category 3 operations, each system should be recorded but arranged so that at least one is recorded each second. It is not necessary to record ILS and MLS at the same time, only the approach aid in use need to be recorded.
28. Glideslope Deviation or MLS Elevation.	+/−400 Microamps or available sensor range as installed. 0.9 to + 30°.	As installed +/−3% recommended.	1	0.3% of full range.	For autoland/category 3 operations, each system should be recorded but arranged so that at least one is recorded each second. It is not necessary to record ILS and MLS at the same time, only the approach aid in use need to be recorded.
29. Marker Beacon Passage.	Discrete ''on'' or ''off''.	.....	1	.....	A single discrete is acceptable for all markers.
30. Master Warning	Discrete	.....	1	.....	Record the master warning and record each 'red' warning that cannot be determined from other parameters or from the cockpit voice recorder.
31. Air/ground sensor (primary airplane system reference nose or main gear).	Discrete ''air'' or ''ground''.	.....	1 (0.25 recommended).		
32. Angle of Attack (If measured directly).	As installed	As Installed	2 or 0.5 for airplanes operated under §121.344(f).	0.3% of full range.	If left and right sensors are available, each may be recorded at 4 second intervals so as to give a data point each half second.
33. Hydraulic Pressure Low, Each System.	Discrete or available sensor range, ''low'' or ''normal''.	+/− 5%	2	0.5% of full range.	

APPENDIX F TO PART 135.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per sampling Interval	Resolution	Remarks
34. Groundspeed	As Installed	Most Accurate Systems Installed.	1	0.2% of full range.	
35. GPWS (ground proximity warning system).	Discrete ''warning'' or ''off''.	.....	1	.....	A suitable combination of discretes unless recorder capacity is limited in which case a single discrete for all modes is acceptable.
36. Landing Gear Position or Landing gear cockpit control selection.	Discrete	.....	4	.....	A suitable combination of discretes should be recorded.
37. Drift Angle	As installed	As installed	4	0.1°.	
38. Wind Speed and Direction.	As installed	As installed	4	1 knot, and 1.0°.	
39. Latitude and Longitude.	As installed	As installed	4	0.002°	Provided by the Primary Navigation System Reference. Where capacity permits Latitude/longitude resolution should be 0.0002°.
40. Stick shaker and pusher activation.	Discrete(s) ''on'' or ''off''.	.....	1	.....	A suitable combination of discretes to determine activation.
41. Windshear Detection.	Discrete ''warning'' or ''off''.	.....	1.		
42. Throttle/power lever position.	Full Range	+/− 2%	1 for each lever	2% of full range	For airplanes with non-mechanically linked cockpit engine controls.
43. Additional Engine Parameters.	As installed	As installed	Each engine each second.	2% of full range	Where capacity permits, the preferred priority is indicated vibration level, N2, EGT, Fuel Flow, Fuel Cut-off lever position and N3, unless engine manufacturer recommends otherwise.
44. Traffic Alert and Collision Avoidance System (TCAS).	Discretes	As installed	1	.....	A suitable combination of discretes should be recorded to determine the status of—Combined Control, Vertical Control, Up Advisory, and Down Advisory. (ref. ARINC Characteristic 735 Attachment 6E, TCAS VERTICAL RA DATA OUTPUT WORD.)
45. DME 1 and 2 Distance.	0–200 NM;	As installed	4	1 NM	1 mile.
46. Nav 1 and 2 Selected Frequency.	Full range	As installed	4	.....	Sufficient to determine selected frequency.
47. Selected barometric setting.	Full Range	+/− 5%	(1 per 64 sec.)	0.2% of full range.	
48. Selected Altitude	Full Range	+/− 5%	1	100 ft.	
49. Selected speed	Full Range	+/− 5%	1	1 knot.	
50. Selected Mach ...	Full Range	+/− 5%	1	.01.	
51. Selected vertical speed.	Full Range	+/− 5%	1	100 ft/min.	
52. Selected heading	Full Range	+/− 5%	1	1°..	
53. Selected flight path.	Full Range	+/−5%	1	1°.	
54. Selected decision height.	Full Range	+/− 5%	64	1 ft.	
55. EFIS display format.	Discrete(s)	.....	4	.....	Discretes should show the display system status (e.g., off, normal, fail, composite, sector, plan, nav aids, weather radar, range, copy.
56. Multi-function/Engine Alerts Display format.	Discrete(s)	.....	4	.....	Discretes should show the display system status (e.g., off, normal, fail, and the identity of display pages for emergency procedures, need not be recorded.
57. Thrust command	Full Range	+/− 2%	2	2% of full range.	
58. Thrust target	Full Range	+/−2%	4	2% of full range.	
59. Fuel quantity in CG trim tank.	Full Range	+/−5%	(1 per 64 sec.)	1% of full range.	

APPENDIX F TO PART 135.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per sampling Interval	Resolution	Remarks
60. Primary Navigation System Reference.	Discrete GPS, INS, VOR/DME, MLS, Loran C, Omega, Localizer Glideslope.	.....	4	.....	A suitable combination of discretes to determine the Primary Navigation System Reference.
61. Ice Detection	Discrete ''ice'' or ''no ice''.	.....	4.		
62. Engine warning each engine vibration.	Discrete	.....	1.		
63. Engine warning each engine over temp.	Discrete	.....	1.		
64. Engine warning each engine oil pressure low.	Discrete	.....	1.		
65. Engine warning each engine over speed.	Discrete	.....	1.		
66. Yaw Trim Surface Position.	Full Range	+/−3% Unless Higher Accuracy Uniquely Required.	2	0.3% of full range.	
67. Roll Trim Surface Position.	Full Range	+/−3% Unless Higher Accuracy Uniquely Required.	2	0.3% of full range.	
68. Brake Pressure (left and right).	As installed	+/−5%	1	.....	To determine braking effort applied by pilots or by autobrakes.
69. Brake Pedal Application (left and right).	Discrete or Analog ''applied'' or ''off''.	+/−5% (Analog)	4	.....	To determine braking applied by pilots.
70. Yaw or sideslip angle.	Full Range	+/−5%	1	0.5°.	
71. Engine bleed valve position.	Discrete ''open'' or ''closed''.	.....	4.		
72. Deicing or anti-icing system selection.	Discrete ''on'' or ''off''.	.....	4.		
73. Computed center of gravity.	Full Range	+/−5%	(1 per 64 sec.)	1% of full range.	
74. AC electrical bus status.	Discrete ''power'' or ''off''.	.....	4	.....	Each bus.
75. DC electrical bus status.	Discrete ''power'' or ''off''.	.....	4	.....	Each bus.
76. APU bleed valve position.	Discrete ''open'' or ''closed''.	.....	4.		
77. Hydraulic Pressure (each system).	Full range	+/−5%	2	100 psi.	
78. Loss of cabin pressure.	Discrete ''loss'' or ''normal''.	.....	1.		
79. Computer failure (critical flight and engine control systems).	Discrete ''fail'' or ''normal''.	.....	4		
80. Heads-up display (when an information source is installed).	Discrete(s) ''on'' or ''off''.	.....	4.		
81. Para-visual display (when an information source is installed).	Discrete(s) ''on'' or ''off''.	.....	1.		
82. Cockpit trim control input position—pitch.	Full Range	+/−5%	1	0.2% of full range.	

APPENDIX F TO PART 135.—AIRPLANE FLIGHT RECORDER SPECIFICATION—Continued

[The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second]

Parameters	Range	Accuracy (sensor input)	Seconds per sampling Interval	Resolution	Remarks
83. Cockpit trim control input position—roll.	Full Range	+/−5%	1	0.2% of full range.	
84. Cockpit trim control input position—yaw.	Full Range	+/−5%	1	0.2% of full range.	
85. Trailing edge flap and cockpit flap control position.	Full Range	+/−5%	2	0.5% of full range.	Trailing edge flaps and cockpit flap control position may each be sampled alternately at 4 second intervals to provide a sample each 0.5 second.
86. Leading edge flap and cockpit flap control position.	Full Range or Discrete.	+/−5%	1	0.5% of full range.	
87. Ground spoiler position and speed brake selection.	Full Range or discrete.	+/−5%	0.5	0.2% of full range.	
88. All cockpit flight control input forces (control wheel, control column, rudder pedal).	Full Range ..... Control wheel ..... Control Column ..... Rudder pedal	+/−5% ..... +/−70 lbs. +/−85 lbs. +/−165 lbs.	1	0.2% of full range.	For fly-by-wire flight control systems, where flight control surface position is a function of the displacement of the control input device only, it is not necessary to record this parameter.

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Ava L. Robinson,

Special Assistant to the Director, Aircraft Certification Service.

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