

**DEPARTMENT OF TRANSPORTATION****Federal Aviation Administration****14 CFR Part 33**

[Docket No. 24922; Notice No. 92-14]

RIN 2120-AB76

**Airworthiness Standards: Aircraft Engines; Fuel and Induction Systems****AGENCY:** Federal Aviation Administration (FAA), DOT.**ACTION:** Notice of proposed rulemaking (NPRM).

**SUMMARY:** This notice proposes to require fail-safe design features in the fuel control systems used on reciprocating aircraft engines. Specifically, the proposal would require the fuel-air mixture control device and the throttle control device to move automatically to an acceptable position for continued safe operation if the aircraft control linkage to these devices becomes disconnected. The proposed requirements resulted from an analysis of a series of accidents attributed to loss of mixture or throttle control and from public comments on an Advance Notice of Proposed Rulemaking published in the *Federal Register* on February 28, 1986. This proposed rule is intended to improve safety by requiring the fuel mixture control device and the throttle control device to move automatically to an acceptable position for continued safe flight if the linkage to these devices becomes disconnected.

**DATES:** Comments must be received on or before February 17, 1993.

**ADDRESSES:** Comments on this notice should be mailed in triplicate, to: FAA, Office of the Chief Counsel, Attention: Rules Docket (AGC-10), Docket No. 24922, 800 Independence Avenue, SW., Washington, DC 20591. Comments delivered must be marked Docket No. 24922. Comments may be examined in room 915G, weekdays between 8:30 a.m. and 5 p.m., except federal holidays.

**FOR FURTHER INFORMATION CONTACT:** Locke Easton, Engine and Propeller Standards Staff, ANE-110, Engine and Propeller Directorate, Aircraft Certification Service, FAA, 12 New England Executive Park, Burlington, Massachusetts 01803; telephone (617) 273-7088.

**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 proposals in this notice are also invited. 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 proposals 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 preaddressed, stamped postcard on which the following statement is made: "Comments to Docket No. 24922." The postcard will be date stamped and mailed to the commenter.

**Availability of NPRM**

Any person may obtain a copy of this notice by submitting a request to the FAA, Office of Public Affairs, Attention: Public Inquiry Center, APA-430, 800 Independence Avenue, SW., Washington, DC 20591, or by calling (202) 267-3484. Communications must identify the notice 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, which describes the application procedure.

**Background***Statement of the Problem*

The FAA has determined that a disconnect of the control linkages on reciprocating engine fuel system mixture or throttle controls can result in loss of engine power or uncommanded inflight shutdown of the engine.

*History*

These proposals resulted from an analysis of a series of accidents attributed to loss of mixture or throttle control and from public comments received on an Advance NPRM published in the *Federal Register* on February 28, 1986 (51 FR 7224, Docket No. 24922, Notice No. 86-2). The

National Transportation Safety Board (NTSB) analyzed 54 aircraft accidents, attributed to problems with the carburetor mixture linkage, which occurred between 1971 and 1981. The NTSB concluded that in the majority of cases, slippage or failure of the mixture control linkage mechanism at the carburetor resulted in the mixture control moving to the idle cut-off position. One recommendation resulting from the NTSB evaluation was to amend part 33 of the FAR to require that the carburetor mixture control device move automatically to the full-rich position in the event that it becomes disconnected from the mixture control linkage. The NTSB also recommended that manufacturers be encouraged to provide retrofit kits for existing aircraft already in service.

The FAA reviewed accident and incident data in its files for the time period covered in the NTSB analysis concerning mixture control and throttle control problems and has concluded that problems are continuing at the same rate as noted in the NTSB study. There were several injury-causing accidents related to failure of mixture control linkages.

The number of accidents in which a problem with the throttle linkage was listed as a causal factor was found to be more than double those that listed a problem with the mixture control as a causal factor. There were personal injuries and a fatal accident related to the throttle control failure.

The FAA found that 71 accidents were caused by mixture and throttle control failures. Those accidents resulted in 1 fatality, 10 serious injuries, and 31 minor injuries. As a result, this proposed rule addresses both mixture and throttle control failures.

Notice No. 86-2 addressed mixture control failures. The notice proposed that if the mixture control linkage becomes disconnected, the mixture lever must move automatically to the full-rich position as recommended by the NTSB.

Sixteen commenters responded to Notice 86-2. Eleven commenters were in favor of the proposal, 2 were opposed, and 3 were partially in favor.

One commenter, who was partially in favor, opposed making proposal requirements retroactive to older aircraft. Another commenter, while favoring the proposal, suggested that emphasis be placed on improving the methods used by aircraft manufacturers during engine installation.

Four of the 11 commenters who were in favor of the proposal recommended adding a similar proposal regarding the throttle linkage. The NTSB has, as a

result of several accidents, also recommended a similar requirement for the throttle linkage. The FAA concurs with this recommendation.

Several commenters who were in favor of the proposal were concerned that full-rich mixture may not always be the desired mixture position after a linkage disconnect. The FAA recognizes that designing for a position other than full-rich may be preferable. Therefore, the proposed regulation has been modified to remove the requirement that full-rich is the only acceptable position following loss of mixture control.

Some commenters felt that the problem is primarily one of improper maintenance. While the FAA agrees that more attention to maintenance would improve the situation, a requirement based solely on maintenance action would not result in a viable solution. A maintenance approach to the problem would require repeated or periodic monitoring to assure that necessary action was taking place. Additionally, transferring responsibility from what is fundamentally a design consideration to a maintenance action does not improve airworthiness.

Another commenter stated that the problem is related to installation problems caused by the airframe manufacturer. The subject of installation requirements as they pertain to this problem is currently under review by the Small Airplane Certification Directorate. NPRM (Docket No. 26344, Notice 90-23; 55 FR 40598, October 3, 1990) proposes to amend 14 CFR 23.1143 "Engine Controls" for single engine airplanes be capable of continued safe flight and landing in event power or thrust control separates from engine fuel metering device.

A few of the commenters opposed to Notice 86-2 were concerned about the expense of design changes and modification if the proposal were made retroactive to existing engines. There was no intent to make the proposed rule retroactive. The rule, if adopted, would be applicable to engines for which application for certification is made after the effective date of the rule.

In consideration of the comments to the notice and additional data reviewed, the FAA has revised the proposed rule as contained in this NPRM.

#### NTSB Recommendations

##### *Recommendation A-82-130*

Amend 14 CFR 23.1147 "Mixture Controls," to require a means of assuring that a carburetor mixture control lever will move automatically to the full-rich position in the event it

becomes disconnected from the mixture control linkage.

##### *Recommendation A-82-131*

Encourage manufacturers of small, single engine airplanes to make available as service of accessory kits, carburetor mixture control level safety springs or their equivalent that will move the carburetor mixture control lever to the full-rich position in the event the lever becomes disconnected from the mixture control linkage.

#### Reference Material

Advance NPRM, Docket No. 24922; Notice No. 86-2, (51 FR 7224; February 28, 1986), Airworthiness Standards: Aircraft Engines Fuel and Induction System.

#### Current Requirements

There are currently no type certification requirements in FAR Part 33 similar to those proposed in this NPRM. The existing requirements of FAR part 23, § 23.1309(b), and comparable rules in FAR parts 27, and 29, require the aircraft design to prevent hazards to the aircraft in the event of a probable malfunction or failure. Also, FAR part 25, § 25.1309(b)(1) requires the design be such that the occurrence of any failure condition which would prevent the continued safe flight and landing of the airplane is extremely improbable. However, the FAA has determined that it is also appropriate to define and require the fail-safe provisions at the engine certification level. Therefore, the engine as certificated, should be designed and constructed to include a fail-safe condition when the control linkages disconnect at the engine-installation interface at the carburetor or fuel control.

#### General Discussion of the Proposals

##### *Section 33.35(f)(1)*

This proposed section would require that in the event of a mixture control linkage disconnect the mixture setting fail-safe position must provide "an acceptable operating mixture to allow continued safe flight." The FAA determined from analysis of service events and comments to the Notice 86-2 that a fail-safe position of full-rich may not always be the most desirable. Also, the proposal recognizes that with the mixture in the fail-safe position, it may still be possible to manipulate the throttle setting. The resultant mixture setting may not be optimum over the entire operational or environmental envelope for which the engine is certified. Therefore, the FAA proposes

that the manufacturer identify the approved fail-safe mixture in the installation manual and any operational limitations in the operating manual as required in § 33.5.

##### *Section 33.35(f)(2)*

The FAA determined from review of additional service data and comments from the notice that throttle control linkage failures occur at twice the frequency of mixture control linkage failures. Also, a review of records of aircraft accidents caused by mixture and throttle control failures showed that the cause of the one fatal accident was related to a throttle control linkage failure. Therefore, this proposal would require a fail-safe throttle setting in the event of a control linkage failure. That setting, or settings, which could vary with installation, must provide for engine limit protection and permit continued safe flight. In considering the landing phase, the FAA determined that variability in installation, operation, and environmental effects may make it difficult to define a setting which provides power for both safe flight and landing. It is conceivable that once safe flight to the nearest airport can be made with the throttle in a fail-safe position, the engine may need to be shut down to accomplish the landing. While this will not always be the case, it was determined to be beyond the scope of this proposal to attempt to cover all possible combinations of aircraft performance factors affecting the installation of an engine with a fail-safe throttle design.

##### *Section 33.35(g)*

This proposed section requires the fail-safe settings of the mixture and throttle controls to be demonstrated in order to show that the design functions as intended and that the operational response of the engine is adequately identified. The demonstration must be done "in a manner acceptable to the Administrator." It is not possible at this time to more specifically define how the demonstration may be accomplished. The many factors which must be considered will require each application to be evaluated on its own merits. Some of the factors which may have a bearing on how the demonstration would be conducted include, but are not limited to:

- (1) Installation type (fixed-pitch versus variable pitch propeller, helicopter, etc.).
- (2) Carburetor versus fuel injection.
- (3) Turbocharged/Supercharged.
- (4) Rate and range of mixture or throttle setting change.

(5) Use of redundant linkage designs or backup systems.

The FAA, in conjunction with industry and any comments received in the docket will develop advisory material on how to evaluate the range of design and operational considerations and how to demonstrate those various designs.

#### *Section 33.35(h)*

The FAA recognizes that the resulting designs under the requirements of this proposal may vary substantially depending on the engine design and intended application. Therefore, this proposed paragraph requires that all data relevant to the installation and operation of engines designed to meet this section must be available to the installing aircraft manufacturer and the responsible FAA aircraft certification office. As mentioned previously, the aircraft installation requirements for fail-safe system design further complement the requirements of this proposed section. They would also require the necessary installation interface data to be provided as part of the section 33.5 instructions for installing and operating the engine.

### **Regulatory Evaluation Summary**

#### *Introduction*

In addition to comments on the technical aspect of the proposed airworthiness standard, public comments concerning the economic impact, if any, of this proposal are specifically requested.

Notice 86-2 requested comments on the economic impact of the proposed requirement for the fuel mixture control lever. One commenter, representing a manufacturers' association, supplied input on anticipated cost. This commenter suggested that expense would be minimal for a new design but that retrofit or incorporation in current production could be more expensive. As mentioned under "History," the proposed regulations would not be applied retroactively.

This section summarizes a full regulatory evaluation of the proposed rule prepared by the FAA, which provides more detailed estimates of the economic consequences of this regulatory action. The full evaluation has been placed in the docket. It quantifies, to the extent practical, estimated costs of the proposed rule to the private sector, consumers, and Federal, state, and local governments, as well as its anticipated benefits and impacts.

Executive Order 12291 dated February 17, 1981, directs Federal agencies to promulgate new regulations or modify

existing regulations only if the potential benefits to society for the regulatory change outweigh the potential costs. The order also requires the preparation of a regulatory impact analysis of all "major" rules except those responding to emergency situations or other narrowly defined exigencies. A "major" rule is one that is likely to result in an annual effect on the economy of \$100 million or more, a major increase in consumer costs, or a significant adverse effect on competition.

The FAA has determined that this proposed rule is not "major" as defined in the executive order; therefore, a full regulatory analysis, which includes the identification and evaluation of cost reducing alternatives to the rule, has not been prepared. Instead, the agency has prepared a more concise document termed a regulatory evaluation that analyzes only this proposal without identifying alternatives. In addition to a summary of the regulatory evaluation, this section also contains a trade impact assessment and an initial regulatory flexibility determination as required by the Regulatory Flexibility Act of 1980.

The "baseline risk" that the proposed rule is intended to alleviate was calculated for the six-year period 1982 through 1987. During this period there were 71 accidents caused by fuel-mixture control and throttle control lever disconnections, resulting in one fatality, 10 serious injuries, 31 minor injuries, 11 destroyed aircraft, 59 substantially damaged aircraft, and 1 slightly damaged aircraft. Applying statistically-expected estimates of accident losses and corresponding unit costs to this accident history results in an average annual baseline risk of approximately \$11.0 million (1989 dollars).

#### **Benefits**

The benefits of the proposed rule were estimated by applying this annual baseline risk to the ten-year period 1993 through 2002. The forecast benefits are based on an estimate that 1,000 reciprocating engines would be affected by the proposed rule over the ten-year period. The reduction in baseline risk is estimated to be \$287,840 (nondiscounted) over the ten-year period, or \$125,529 when discounted to present value.

#### **Costs**

The costs of the proposed rule in terms of 1989 dollars is estimated to be \$105,000, consisting of \$100,000 in design costs and \$5,000 in engine hardware costs, or \$77,671 when discounted to present value. Therefore, the FAA finds the proposed rule to be cost-beneficial,

based on a benefit-to-cost ratio of 1.62 to 1.

### **Initial Regulatory Flexibility Determination**

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

The proposed rule would affect only a subset of newly manufactured engines; no existing engines would be required to be retrofitted. The proposed rule would therefore affect manufacturers of reciprocating engines and their parts. The FAA defines small aircraft engine and engine parts manufacturers as those businesses that are independently owned and operated and have no more than 375 employees. A substantial number of small entities is defined by the RFA as being a number which is not less than eleven.

In the United States there are only two manufacturers of reciprocating engines for aircraft. These two companies share nearly equally the market for newly manufactured reciprocating engines in the United States. Both are large companies and subsidiaries of larger entities and thus do not meet the small business threshold criteria.

In addition to the two manufacturers of reciprocating engines, there is one manufacturer of reciprocating engine carburetors in the United States which might be affected by the proposed rule. The threshold level of 11 small entities is not met.

The FAA, in this initial regulatory flexibility determination, finds that the proposed rule would not have a significant economic impact on a substantial number of small entities.

### **International Trade Impact Analysis**

The proposed rule would have little or no impact on trade opportunities either for U.S. firms doing business overseas or for foreign firms doing business in the U.S. Reciprocating engines in the United States, whether manufactured in the United States or abroad, for which application for certification is made after the effective date of the rule, would need to have the mixture control and throttle fail-safe mechanisms. In foreign markets, United States reciprocating engine manufacturers would have to meet the standards in those countries, so the proposed rule would have no effect. Furthermore, the number of

engines affected and the cost of compliance over the ten year period is no nominal that no substantial impact on foreign trade would be expected.

#### Federalism Implications

The regulations proposed herein would not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this proposal would not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

#### Conclusion

For the reasons discussed above, and based on the findings in the Regulatory Flexibility Determination and the International Trade Impact Analysis, the FAA has determined that this proposed regulation is not major under Executive Order 12291. In addition, the FAA certifies that this proposal, if adopted, will not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. This proposal is not considered significant under DOT Regulatory Policies and Procedures (44 FR 11034, February 26, 1979). An initial

regulatory evaluation of the proposal, including a Regulatory Flexibility Determination and Trade Impact Analysis, has been placed in the docket. A copy may be obtained by contacting the person identified under "**FOR FURTHER INFORMATION CONTACT.**"

#### List of Subjects in 14 CFR Part 33

Air transportation, Aircraft, and Aviation safety.

#### The Proposed Amendment

Accordingly, the FAA proposes to amend part 33 of the Federal Aviation Regulations (14 CFR part 33) as follows:

#### **PART 33—AIRWORTHINESS STANDARDS: AIRCRAFT ENGINES**

1. The authority citation for Part 33 is revised to read as follows:

**Authority:** 49 U.S.C. App. 1344, 1354(a), 1355, 1421, 1423, 1424, 1425; 49 U.S.C. 106(g).

2. Section 33.35 is amended by adding new paragraphs (f), (g), and (h) to read as follows:

#### **§ 33.35 Fuel and induction system.**

\* \* \* \* \*

(f) The fuel system of the engine must be designed and constructed such that—

(1) If the mixture control linkage becomes disconnected, the mixture setting must automatically move to a position which will provide an

acceptable operating mixture to allow continued safe flight.

(2) If the throttle control linkage becomes disconnected, the throttle setting must automatically move to a position which will allow the engine to continue to operate within its approved limits and provide sufficient power to allow continued safe flight.

(g) Operation under the conditions specified in paragraphs (f)(1) and (f)(2) of this section must be demonstrated in a manner acceptable to the Administrator as a part of this testing conducted under § 33.51, Operation test.

(h) The following information shall be specified in the approved instructions for installing and operating the engine required under § 33.51 for each mixture and throttle setting approved under this section:

(1) Mixture setting and throttle setting when the respective control linkage becomes disconnected.

(2) Range of power available and any altitude or environmental limitations which restrict that range of power.

(3) Engine operating procedures.

Issued in Washington, DC, on October 8, 1992.

**Thomas E. McSweeney,**  
*Acting Director, Aircraft Certification Service.*

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**BILLING CODE 4910-13-M**