DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 33

[Docket No. 28107; Notice No. 95–3]

RIN 2120–AF57

Airworthiness Standards; Windmilling and Rotor Locking Tests, and Vibration and Vibration Tests

AGENCY: Federal Aviation Administration, DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: The Federal Aviation Administration (FAA) proposes to change the windmilling and vibration airworthiness standards for the issuance of original and amended type certificates for aircraft engines. This proposal resulted from an effort to harmonize the Federal Aviation Regulations with European requirements being drafted by the Joint Aviation Authorities (JAA). The proposed changes, if adopted, would create one set of common requirements, that would reduce the regulatory burden on the aviation industry worldwide by eliminating the need for applicants for type certificates to comply with different sets of standards when seeking certifications from the FAA and JAA.

DATES: Comments must be submitted on or before June 5, 1995.

ADDRESSES: Comments on this notice should be mailed in triplicate to: Federal Aviation Administration, Office of the Chief Counsel, Attention: Rules Docket (AGC–200), Docket No. 28107, 800 Independence Avenue, SW., Washington, DC 20591. Comments delivered must be marked Docket No. 28107. Comments may be inspected in Room 915G weekdays between 9:00 a.m. and 5:00 p.m., except on Federal holidays.

FOR FURTHER INFORMATION CONTACT: John Golinski or Thomas Boudreau, Engine and Propeller Standards Staff, ANE–110, Engine and Propeller Directorate, Aircraft Certification Service, FAA, New England Region, 12 New England Executive Park, Burlington, Massachusetts 01803–5299; telephone (617) 238–7119; fax (617) 238–7199.

SUPPLEMENTARY INFORMATION:

Comments Invited

Interested persons are invited to submit written data, views, or arguments on this proposed rule. Comments relating to the environmental, energy, federalism, or economic impact that might result from adopting the proposals in this notice are also invited. Substantive comments should be accompanied by cost estimates. Comments should identify the regulatory docket 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. Comments submitted in response to this notice must include a preaddressed, stamped postcard on which the following statement is made: ''Comments to Docket No. 28107.'' The postcard will be date stamped and mailed to the commenter.

Availability of NPRM's

Any person may obtain a copy of this NPRM by submitting a request to the Federal Aviation Administration, Office of Public Affairs, Attention: Public Inquiry Center, APA–200, 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

Part 33 of title 14 of the Code of Federal Regulations (14 CFR part 33, hereafter ''part 33'') prescribes airworthiness standards for the issuance of original and amended type certificates for aircraft engines. Part E of the Joint Aviation Requirements (JAR–E) prescribes corresponding airworthiness standards of the European Joint Aviation Authorities (JAA). While part 33 and JAR–E are similar, they differ in several respects. Non-uniform standards impose a regulatory burden on applicants seeking certification under both sets of standards in the form of additional costs and delays in the time required for certification.

As part of its commitment to promote harmonization of part 33 and JAR–E, the FAA, with the cooperation of the JAA, established the part 33/JAR–E Authorities Engine Group to compare part 33 and JAR–E. This group included regulatory representatives from France, Canada, Germany, the United Kingdom, and the United States. The basis for the comparison was part 33, as amended through Amendment 11, and JAR–E, as amended through Change 7. As its initial effort, the study group focused on gas turbine engines and concentrated on JAR–E items that appeared to be more stringent than part 33. The identified differences were categorized into lists 1 and 2. List 1 included twenty items where the differences appear to be sufficiently significant to cause the JAA to apply additional conditions to U.S. manufacturers seeking JAA certification. List 2 included requirements considered to be equivalent to the corresponding Federal Aviation Regulation (FAR) in part 33 based on FAA policy and practice.

In August 1989, at the request of the Aerospace Industries Association (AIA) and the Association Europeene Des Constructeurs De Materiel Aerospatial (AECMA), the FAA and JAA met in Paris, France, with aerospace industry representatives to initiate a process for resolving List 1 comparison issues. At an FAA/JAA management meeting in June 1992, in Toronto, Canada, seven part 33 engine ''Harmonization's Terms of Reference'' were introduced. Two of these initiatives, windmilling and rotor locking test requirements, and vibration and vibration test requirements, were contained in the FAA/JAA List 1 of twenty items. They were the first engine harmonization initiatives for which consensus was reached by study groups from domestic and international industry and airworthiness authorities. In December 1992, the FAA requested the Aviation Rulemaking Advisory Committee (ARAC) to further evaluate the proposals (57 FR 58840). This task, in turn, was assigned to the Propulsion Harmonization Working Group of ARAC. On June 18, 1993, the working group reported to the ARAC, which recommended to the FAA that the FAA proceed with rulemaking. This NPRM and a corresponding notice of proposed amendment (NPA) to JAR–E reflect the ARAC recommendations.

General Discussion of the Proposals

The proposals in the NPRM would harmonize U.S. regulations with existing and proposed requirements of the European Joint Aviation Authorities, codify current industry practices, and clarify existing requirements. Specifically, whey would (1) Clarify the existing requirement that excessive vibratory stresses may not be induced

throughout the declared flight envelope of the engine; (2) require that continued windmilling following engine shutdown must not create a hazard for the airplane; (3) expand the scope of vibration tests; (4) expand the applicability of rotor locking tests; and (5) clarify rotor locking and vibration test requirements.

Windmilling and Rotor Locking Test Requirements

Section 33.74 Windmilling

Parts 23 and 25 of title 14 of the CFR prescribe the airworthiness standards for airplanes. Sections 23.903(e)(2) and 25.903(c) in part, state that for turbine engine installations, the means for stopping the rotation of any engine need be provided only where continued rotation could jeopardize the safety of the airplane. JAR–E presently provides a safety objective for windmilling without oil.

This proposal would add a new section to state specific windmilling requirements that are consistent with the safety objectives of the airplane requirements in §§ 23.903(e)(2) and 25.903(c), which address control of engine rotation. The proposed new requirements would ensure that windmilling following engine shutdown in flight would not create a hazard for the airplane.

This proposal was developed and agreed to by the ARAC Propulsion Harmonization working group. The proposed change contains language that would be common to the language proposed for JAR–E, thereby establishing equivalency and creating consistency between the two regulations. In addition, because an engine manufacturer must show compliance to the proposed § 33.74 which has safety objectives consistent with the corresponding airplane requirements for windmilling engines identified in §§ 23.903(e)(2) and 25.903(c), the engine manufacturer can provide this information directly to the airplane manufacturers to reduce the amount of analysis performed by the airplane manufacturers under §§ 23.903(e)(2) and 25.903(c), which could result in potential cost savings for the airplane manufacturers.

Section 33.92 Rotor Locking Tests

Section 33.92 currently specifies engine test requirements for engines installed on supersonic aircraft and also specifies an endurance test for turbine engine rotor stopping and locking devices. This proposal would delete the test requirements in § 33.92(a) and clarify the endurance test for rotor stopping and locking devices, that is applicable to all turbine engines that incorporate such a device. This proposed requirement will also be proposed in JAR–E, thereby harmonizing with part 33 and facilitating the harmonization of part 25 with JAR 25, by allowing deletion of JAR 25.903(c)(1), which addresses continued windmilling after loss of engine oil.

The proposed deletion of current § 33.92(a) is based on the service experience of the world's only supersonic commercial transport. The British/French Concorde has experienced a number of inflight engine shutdowns at supersonic speeds since 1974. In each of these incidents, because of the aerodynamic effect of drag and loss of thrust, speed was rapidly reduced to subsonic levels. Therefore, requirements for conducting prolonged engine windmilling tests at supersonic speeds are unnecessary.

The proposal would move the requirement that each engine incorporating a rotor locking device be shut down while operating at rated maximum continuous thrust from § 33.92(b)(1) to proposed § 33.92. Proposed revision § 33.92 would also require that the means for stopping and locking the rotor(s) must be operated as specified in the engine operating instructions.

The proposed revision to § 33.92 would clarify the endurance test requirements currently identified in § 33.92(b) by establishing that following rotor locking, the rotor(s) must be held stationary for five minutes while being subjected to the maximum torque that could result from continued flight in this condition. The harmonization review has established that the current requirement does not provide adequate information on how to run the test. Clarification is provided by the addition of a five minute test to confirm the durability of the system.

Vibration and Vibration Test Requirements

Section 33.63 Vibration

Section 33.63 currently contains vibration design and construction standards for aircraft engines. This proposal would clarify the existing text by adding the term ''declared flight envelope'' to ensure that excessive vibration stresses are not induced at all intended airborne and non-airborne conditions of operation. This proposal would harmonize the vibration requirements.

Section 33.83 Vibration Test

Section 33.83 prescribes the testing requirements that turbine engines must undergo to establish the aerodynamically induced system vibration (flutter) as well as the mechanically induced vibration characteristics of components that could induce failure. This proposal would delete the existing text and replace it with harmonized requirements. The harmonized requirements address some conditions that are currently being addressed by analysis in § 33.75.

Section 33.83(a). This proposal would replace the current text with new harmonized text to clarify the existing requirement that all components in each engine that may be subject to mechanically or aerodynamically induced vibratory excitations must undergo vibration surveys. These engine surveys shall be based upon an appropriate combination of experience, analysis, and component test and should address, as a minimum, blades, vanes, rotor discs, spacers, and rotor shafts. Substantive pre-certification activity (tests and analyses) is necessary for determining which engine components require verification by the engine certification process. The proposal retains the current practice of the FAA and JAA of limiting formal certification test requirements to only the final engine or major assembly rig vibration test.

The proposal would replace the phrase ''at the maximum inlet distortion limit'' with ''throughout the declared flight envelope'' to clarify that the engine must be tested to cover all intended airborne and non-airborne conditions of operation. Using the term ''declared flight envelope'' better describes the airworthiness objective of this section. This change results in no foreseen additional burden on applicants because industry practice has been to conduct vibration surveys throughout the declared flight envelope. This proposal would also move the requirement specifying the range of rotor speeds and power or thrust of the vibration surveys from current § 33.83(a) to proposed revised § 33.83(b).

Section 33.83(b). This proposal would revise this paragraph to reorganize and elaborate on existing requirements, introduce terminology relevant to flutter vibration, and achieve harmonization where differences currently exist between Part 33 and JAR–E. The proposed paragraph (b) would require the vibration tests to cover the ranges of physical rotor speeds, corrected rotor speeds, and engine power or thrust corresponding to operations throughout

the declared flight envelope from idling speed up to 103 percent of the maximum rotor speed permitted for rating periods of 2 minutes or longer, and up to 100 percent of all other rotor speeds. The proposal would also add to the revised paragraph (b) a requirement that if there is any indication of a stress peak arising at high physical or corrected rotational speeds, the surveys shall be extended. If it becomes physically impossible to achieve these extended rotor speeds, it would have to be shown by analysis or other means that no harmful vibration exists. Engine manufacturing and build tolerances can result in peak stresses occurring at slightly different rotor speeds between engines and engine parts (i.e., blades) of the same type design. The speed extension, therefore, is intended to cover inherent engine-to-engine and blade-to-blade variations in vibratory response.

Section 33.83(c). The proposal would revise the current paragraph (c) and reword the existing text to harmonize and clarify the existing requirement. Current paragraph (c) requires that during the vibration test, each accessory drive and mounting attachment must be loaded with the load imposed by each accessory used only for aircraft service up to the limit load specified by the applicant for the engine drive or attachment point. The proposal would require that evaluations be made of the effects on vibration characteristics of operating with scheduled changes (including tolerances) to variable vane angles, compressor bleeds, accessory loading, the most adverse inlet air flow distortion pattern declared by the manufacturer, and the most adverse conditions in the exhaust duct(s).

Section 33.83(d) This proposal would add a new paragraph (d) that would require that the effects on vibration characteristics of likely fault conditions shall be evaluated by test, or analysis, or by reference to previous experience and be shown not to create a hazardous condition. Since U.S. engine manufacturers presently address and evaluate the effects of vibration characteristics through analysis in accordance with the requirements of § 33.75, this proposal would harmonize part 33 with JAR–E.

Section 33.83(e). This proposal would add a new paragraph (e). The current § 33.83(b) requires that vibration stresses of rotor and stator components be less, by a margin acceptable to the Administrator, than the endurance limit of the material from which these parts are made, adjusted for the most severe operating conditions. This proposal would slightly modify the text of the requirement by incorporating the standard industry practice of making due allowance for variations in material properties. Current industry practice is based on the FAA interpretation of the current requirement. The vibration stresses associated with the vibration characteristics determined under § 33.83 must be less than the endurance limits of the materials concerned, after making certain allowances. The suitability of these stress margins would have to be justified for each part and if it is determined that certain operating conditions, or ranges, need to be limited, operating and installation limitations would be established. The proposed new paragraph (e) would harmonize with existing JAR–E–650 provisions and conform with current component vibration testing practices.

Section 33.83(f). Proposed new paragraph (f) would require that compliance with § 33.83 be substantiated for each specific installation configuration that can affect the vibration characteristics of the engine. The proposed language would provide that if these vibrations cannot be fully investigated during engine certification, then the methods by which they can be evaluated and compliance shown shall be substantiated and defined in the installation documents required by § 33.5. The proposed amendment would codify current industry practice.

Paperwork Reduction Act

In accordance with the Paperwork Reduction Act of 1990 (44 U.S.C. 3501 *et seq.*), an evaluation of the paperwork burden of this proposal is not required since there are no recordkeeping or reporting requirements associated with this proposed rule.

Preliminary Regulatory Evaluation, Initial Regulatory Flexibility Determination, and Trade Impact Assessment

Proposed changes to Federal regulations must undergo several economic analysis. First, Executive Order 12866 directs that each Federal agency 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. In conducting these analyses, the FAA has determined that this rule (1) Would generate benefits outweighing its costs; (2) is not a ''significant regulatory action'' as defined in the Executive Order; (3) is not ''significant'' as defined in DOT's policies and procedures; (4) would not have a significant impact on a substantial number of small entities; and (5) would not constitute a barrier to international trade. These analyses, available in the docket, are summarized below.

Regulatory Evaluation Summary

Of the several proposals, only one might result in additional cost. The FAA has identified the requirements in proposed § 33.83(b) as the only one that could require minor additional engine testing and engineering analysis, resulting in negligible compliance costs. The reference to experience, analysis, and component tests in proposed § 33.83(a) should not impose additional costs since it incorporates current industry practice. The revised engine windmilling requirements of proposed new § 33.74 and the proposed amendments to § 33.92(a) could potentially result in cost savings to engine and transport airplane manufacturers. The FAA solicits comments from interested persons on the costs of the proposed rule.

The primary benefits of the proposed rule would be harmonization of airworthiness standards with the European Joint Aviation Requirements and clarification of existing standards. The resulting increased uniformity of standards would simplify airworthiness approval for import and export purposes and would avoid some of the costs that can result when manufacturers seek type certification under both sets of standards. While not readily quantifiable, the cost economies of harmonization would far exceed the minor incremental costs of the proposed rule.

Regulatory Flexibility Determinations

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 a Regulatory Flexibility Analysis if a proposed rule would have a significant economic impact, either detrimental or beneficial, on a substantial number of small entities. Based on thresholds in implementing FAA Order 2100. 14A, Regulatory Flexibility Criteria and Guidance, the FAA has determined that the proposed rule would not have a significant economic impact on a substantial number of small entities.

International Trade Impact Assessment

The proposed rule would not constitute a barrier to international trade, including the export of U.S. aircraft engines to foreign countries and the import of foreign aircraft engines into the United States. Instead, the proposed standards would harmonize with existing and proposed standards of foreign authorities, thereby lessening restraints on trade.

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, including the findings in the Regulatory Evaluation and the International Trade Impact Assessment, the FAA has determined that this proposed regulation is not significant under Executive Order 12866. 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 International Trade Impact Assessment, 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

Aircraft, Aviation safety.

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend 14 CFR part 33 as follows:

PART 33—AIRWORTHINESS STANDARDS: AIRCRAFT ENGINES

1. The authority citation for part 33 continues to read as follows:

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

2. Section 33.63 is revised to read as follows:

§ 33.63 Vibration.

Each engine must be designed and constructed to function throughout its declared flight envelope and operating range of rotational speeds and power/thrust, without inducing excessive stress in any engine part because of vibration and without imparting excessive vibration forces to the aircraft structure.

3. A new section 33.74 is added to read as follows:

§ 33.74 Windmilling.

If the engine continues to windmill after it is shut down for any reason while in flight, continued windmilling of that engine must not result in damage that could create a hazard to aircraft representing a typical installation during the maximum period of flight likely to occur with that engine inoperative.

4. Section 33.83 is revised to read as follows:

§ 33.83 Vibration test.

(a) Each engine must undergo vibration surveys to establish that the vibration characteristics of those components that may be subject to mechanically or aerodynamically induced vibratory excitations are acceptable throughout the declared flight envelope. The engine surveys shall be based upon an appropriate combination of experience, analysis, and component test and shall address, as a minimum, blades, vanes, rotor discs, spacers, and rotor shafts.

(b) The surveys shall cover the ranges of power or thrust, and both the physical and corrected rotational speeds for each rotor system, corresponding to operations throughout the range of ambient conditions in the declared flight envelope, from the minimum rotor speed up to 103 percent of the maximum rotor speed permitted for rating periods of two minutes or longer, and up to 100 percent of all other permitted rotor speeds, including those that are overspeeds. If there is any indication of a stress peak arising at high physical or corrected rotational speeds, the surveys shall be extended in order to quantify the phenomenon and to ensure compliance with the requirements of § 33.63.

(c) Evaluations shall be made of the effects on vibration characteristics of operating with scheduled changes (including tolerances) to variable vane angles, compressor bleeds, accessory loading, the most adverse inlet air flow distortion pattern declared by the manufacturer, and the most adverse conditions in the exhaust duct(s).

(d) The effects of likely fault conditions (such as, but not limited to, out-of balance, local blockage or enlargement of stator vane passages, fuel nozzle blockage, incorrectly scheduled compressor variables, etc.) on vibration characteristics, shall be evaluated by test or analysis, or by reference to previous experience and shall be shown not to create a hazardous condition.

(e) The vibration stresses associated with the vibration characteristics determined under this section must be less than the endurance limits of the materials concerned, after making due allowance for operating conditions and permitted variations in properties of the materials. The suitability of these stress margins must be justified for each part evaluated. If it is determined that certain operating conditions, or ranges, need to be limited, operating and installation limitations shall be established.

(f) Compliance with this section shall be substantiated for each specific installation configuration that can affect the vibration characteristics of the engine. If these vibration effects cannot be fully investigated during engine certification, the methods by which they can be evaluated and methods by which compliance can be shown shall be substantiated and defined in the installation documents required by § 33.5.

5. Section 33.92 is revised to read as follows:

§ 33.92 Rotor locking tests.

If windmilling is prevented by a means to lock the rotor(s), the engine must be subjected to a test that includes 25 operations of this means under the following conditions:

(a) The engine must be shut down from rated maximum continuous thrust or power, and

(b) The means for stopping and locking the rotor(s) must be operated as specified in the engine operating instructions while being subjected to the maximum torque that could result from continued flight in this condition; and

(c) Following rotor locking, the rotor(s) must be held stationary under these conditions for five minutes for each of the 25 operations.

Issued in Washington, DC, on February 22, 1995.

Daniel P. Salvano,

Acting Director of Aircraft Certification Service.

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