Federal Aviation Administration
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area
Engine Harmonization Working Group

# Task 3 – Vibration Surveys

# Task Assignment

**DEPARTMENT OF TRANSPORTATION**

**Federal Aviation Administration**

## Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Subcommittee; Propulsion Harmonization Working Group

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

**ACTION:** Notice of establishment of Propulsion Harmonization Working Group.

**SUMMARY:** Notice is given of the establishment of the Propulsion Harmonization Working Group of the Transport Airplane and Engine Subcommittee. This notice informs the public of the activities of the Transport Airplane and Engine Subcommittee of the Aviation Rulemaking Advisory Committee.

**FOR FURTHER INFORMATION CONTACT:** Mr. William J. (Joe) Sullivan, Executive Director, Transport Airplane and Engine Subcommittee, Aircraft Certification Service (AIR-3), 800 Independence Avenue SW., Washington, DC 20591, Telephone: (202) 267-9554; FAX: (202) 267-5364.

**SUPPLEMENTARY INFORMATION:** The Federal Aviation Administration (FAA) established an Aviation Rulemaking Advisory Committee (56 FR 2190, January 22, 1991) which held its first meeting on May 23, 1991 (56 FR 20492, May 3, 1991). The Transport Airplane and Engine Subcommittee was established at that meeting to provide advice and recommendations to the Director, Aircraft Certification Service, FAA, regarding the airworthiness standards for transport airplanes, engines and propellers in parts 25, 33, and 35 of the Federal Aviation Regulations (14 CFR parts 25, 33, and 35).

The FAA announced at the Joint Aviation Authorities (JAA)—Federal Aviation Administration (FAA) Harmonization Conference in Toronto, Ontario, Canada, (June 2–5, 1992) that it would consolidate within the Aviation Rulemaking Advisory Committee structure an ongoing objective to "harmonize" the Joint Aviation Requirements (JAR) and the Federal Aviation Regulations (FAR). Coincident with that announcement, the FAA assigned to the Transport Airplane and Engine Subcommittee those projects related to JAR/FAR 25, 33, and 35 harmonization which were then in the process of being coordinated between the JAA and the FAA. The harmonization process included the intention to present the results of JAA/FAA coordination to the public in the form of either a Notice of Proposed Rulemaking or an advisory circular—an objective comparable to and compatible with that assigned to the Aviation Rulemaking Advisory Committee. The transport Airplane and Engine Subcommittee, consequently, established the Propulsion Harmonization Working Group.

Specifically, the Working Group's tasks are the following: The Propulsion Harmonization Working Group is charged with making recommendations to the Transport Airplane and Engine Subcommittee concerning the FAA disposition of the following subjects recently coordinated between the JAA and the FAA:

*Task 1—Bird Ingestion:* Update turbine engine bird ingestion requirements, including size and number of birds and pass/fail criteria (FAR 33.77)

*Task 2—Inclement Weather:* Update the inclement weather requirements for rain and hail in turbine engines (FAR 33.77).

*Task 3—Vibration Surveys:* Determine test requirements and pass/Fail criteria for turbine engine vibration tests (FAR 33.83).

*Task 4—Rotor Integrity:* Determine test requirements and pass/fail criteria for turbine, compressor, fan, and turbosupercharger rotor overspeed tests (FAR 33.27).

*Task 5—Turbine Rotor Overtemperature:* Clarify test and pass/fail requirements for turbine engine overtemperature tests to assure consistent certification criteria (FAR 33.88).

*Task 6—Windmilling:* Exmaine current turbine engine windmilling requirements and specify appropriate test and analysis requirements (FAR 33.92).

*Reports:*

A. Recommend time line(s) for completion of each task, including rationale, for Subcommittee consideration at the meeting of the subcommittee held following publication of this notice.

B. Give a detailed conceptual presentation on each task to the Subcommittee before proceeding with the work stated under items C and D, below. If task 1–6 require the development of more than one Notice of Proposed Rulemaking, identify what proposed amendments will be included in each notice.

C. Draft a Notice of Proposed Rulemaking for tasks 1–6 proposing new or revised requirements, a supporting economic analysis, and other required analysis, with any other collateral documents (such as Advisory Circulars) the Working Group determines to be needed.

D. Give a status report on each task at each meeting of the Subcommittee.

The Propulsion Harmonization Working Group will be comprised of experts from those organizations having an interest in the tasks assigned. A working Group member need not necessarily be a representative of one of the organizations of the parent Transport Airplane and Engine Subcommittee or of the full Aviation Rulemaking Advisory Committee. An individual who has expertise in the subject matter and wishes to become a member of the Working Group should *write* the person listed under the caption **FOR FURTHER INFORMATION CONTACT** expressing that desire, describing his or her interest in the task, and the expertise he or she would bring to the Working Group. The request will be reviewed with the Subcommittee and Working Group Chairs and the individual will be advised whether or not the request can be accommodated.

The Secretary of Transportation has determined that the information and use of the Aviation Rulemaking Advisory Committee and its subcommittees are necessary in the public interest in connection with the performance of duties of the FAA by law. Meetings of the full Committee and any subcommittees will be open to the public except as authorized by section 10(d) of the Federal Advisory Committee Act. Meetings of the Propulsion Harmonization Working Group will not be open to the public except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of Working Group meetings will be made.

Issued in Washington, DC, on December 4, 1992.

**William J. Sullivan,**

*Executive Director, Transport Airplane and Engine Subcommittee, Aviation Rulemaking Advisory Committee.*

[FR Doc. 92-30113 Filed 12-10-92; 8:45 am]

BILLING CODE 4910-13-M

# Recommendation Letter

**Boeing Commercial Airplane Group**
P.O. Box 3707
Seattle, WA 98124-2207

July 14, 1994
B-T01B-GRM-94-047

Mr. Anthony J. Broderick
Associate Administrator for Regulations and Certification, (AVR-1)
Department of Transportation
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington DC 20591
Tele: (202) 267-3131
Fax: (202) 267-5364

BOEING

Dear Mr. Broderick:

On behalf of the Aviation Rulemaking Advisory Committee, I am pleased to submit the enclosed recommendation for Rulemaking action on the following subjects:

| | | |
|---|---|---|
| 1. | 33.63 | Vibration |
| 2. | 33.74 | Windmilling |
| 3. | 33.83 | Vibration Test |
| 4. | 33.92 | Rotor Locking Test |

The enclosed package is in the form of a Notice of Proposed Rule Making, including preamble, draft rule, economic analysis and legal analysis. The package was developed by the Propulsion II Harmonization Working Group (WG) chaired by Paul K. Jodon of Textron Lycoming. The membership of the group is a good balance of interested parties in the U.S., Europe and Canada. The group is currently focusing on new issues tasked to the WG, but can be available if needed for docket review.

The enclosed package in line No's. 74 and 77 of FAA/JAA Harmonization Work Program. Scheduled performance to date is shown in the following table.

| | Tech Agreement | Req. for Support | Report to ARAC | Rec to FAA | Publish Notice | Publish Final |
|---|---|---|---|---|---|---|
| PLAN | 9-92 | 10-93 | 1-94 | 1-94 | 7-94 | 1-95 |
| ACTUAL | 9-92 | 10-93 | 3-94 | 7-94 | ----- | ----- |

The members of ARAC appreciate the opportunity to participate in the FAA Rulemaking process and fully endorse this recommendation.

BOEING

Sincerely,

Gerald R. Mack
Assistant Chairman
Transport Airplane & Engine Issues Group
Aviation Rulemaking Advisory Committee
Tele: (206) 234-9570, Fax: 237-0192, Mailstop: 67-UM

Enclosure

cc:

| | | |
|---|---|---|
| | M. Borfitz | (617) 238-7199 |
| | P. Jodon | (203) 385-2256 |
| | S. Miller | (206) 227-1100 |

# Acknowledgement Letter

JAUG 26 1994

Mr. Gerald R. Mack
Aviation Rulemaking Advisory Committee
Boeing Commercial Airplane Group
P.O. Box 3707
Seattle, WA 98124-2207

Dear Mr. Mack:

Thank you for your July 14 letter forwarding the Aviation Rulemaking Advisory Committee's (ARAC) recommendation for rulemaking on the subject of Airworthiness Standards; Windmilling and Rotor Locking Tests; and Vibration and Vibration Tests.

I would like to thank the aviation community for its commitment to ARAC and its expenditure of resources to develop the recommendation. We in the Federal Aviation Administration (FAA) pledge to process the document expeditiously as a high-priority action.

Again, let me thank the ARAC and, in particular, the Propulsion II Harmonization Working Group for its dedicated efforts in completing the task assigned by the FAA.

Sincerely,

Original signed by:
Anthony J. Broderick

Anthony J. Broderick
Associate Administrator for
Regulation and Certification

# Recommendation

[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 33

[Docket No. XXXXX; Notice No. 94-XXX]

RIN NO. XXXX

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

AGENCY: Federal Aviation Administration, DOT.

ACTION: Notice of proposed rulemaking (NPRM).

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

DATES: Comments must be submitted on or before [Insert date 90 days after the date of publication in the **Federal Register**].

ADDRESSES: Comments on this notice should be mailed in triplicate to: Federal Aviation Administration, Office of the Chief Counsel, Attention: Rules Docket (AGC-10), Docket No. , 800 Independence Avenue, SW., Washington, DC 20591. Comments delivered must be marked Docket No. . 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, 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. Commenters submitted in response to this notice must include a preaddressed, stamped postcard on which the following statement is made: "Comments to Docket No. ." The postcard will be date stamped and mailed to the commenter.

Availability of NPRMs

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 NPRMs 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 issue of type certificates, and changes to those 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 hardship 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 "Harmonizations Terms of Reference" were introduced. Two of these initiatives, which were contained in the FAA/JAA List 1 of twenty items, are proposed in this rulemaking. These two initiatives relate to windmilling and rotor locking test requirements, and vibration and vibration test requirements. They are the first 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's Transport Airplane and Engine Issues Group. 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 reflects 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, they 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 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) of the FAR, 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 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 the engine manufacturer must show compliance to the proposed § 33.74 which has consistent safety objectives to 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).

Section 33.92 Rotor Locking Tests.

Section 33.92 currently specifies engine test requirements for engines installed on supersonic aircraft and also specifies and endurance test for turbine engine rotor stopping and locking devices. This proposal deletes the test requirements in § 33.92(a) and clarifies the

endurance test for rotor stopping and locking devices, which is applicable to all turbine engines that incorporate such a device. This proposed requirement will also be introduced in JAR-E, thereby assuring harmonization 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 relocate the requirement that each engine incorporating a rotor locking device be shutdown while operating at rated maximum continuous thrust from current § 33.92(b)(1) to proposed new § 33.92. Proposed § 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 new § 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 is incomplete in that it does not provide adequate information on how to run the test. Amplification is provided by the introduction 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 requirements for aircraft engines. This proposal would clarify the existing test 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 test 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 test 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 and their extent 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 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 § 33.83(a) to proposed § 33.83(b).

Section 33.83(b). This proposal would reorganize and elaborate existing requirements, introduce terminology relevant to flutter vibration, and achieve harmonization where differences currently exist between Part 33 and JAR-E. It 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 add to 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). This proposal would reword the existing test 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 harmonizing provision 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. U.S. engine manufacturers presently address and evaluate the effects of vibration characteristics through analysis in accordance with the requirements of § 33.75.

Section 33.83(e). Current § 33.83(b) requires that vibration stresses of rotor and stator components must 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 and state it in a new paragraph (e). This 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 amendment 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 must 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 analyses. 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 that would justify 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 proposed revisions and amendments, only one might result in additional costs. FAA has identified § 33.83(b) as the only proposed amendment that could require minor additional engine testing and engineering analysis, resulting in negligible compliance costs. The reference to experience, analysis, and component test in §33.83(a) should not impose additional costs since it incorporates current industry practice that is not subject to formal certification test requirements. 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 cost impacts 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 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 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 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 U.S. Instead, the proposed standards have been harmonized 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

14 CFR part 33

Aircraft, Aviation safety.

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration 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 continues to read as follows:

Authority: 49 U.S.C. App. 1354(a), 1355, 1421, 1423, 1425; 49 U.S.C. 106(g), and 14 CFR 11.49.

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. Section 33.74 is added to read as follows:

§ 33.74 Windmilling.

If the engine continues to windmill after it is shutdown 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 and their extent 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 on vibration characteristics 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.) shall be evaluated by test or analysis, or by reference to previous experience and 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 the materials' permitted variations in properties. The suitability of these stress margins must be justified for each part. 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 compliance 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: The engine must be shut down from rated maximum continuous thrust or power; 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 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

**DEPARTMENT OF TRANSPORTATION**

**Federal Aviation Administration**

**14 CFR Part 33**

**[Docket No. 28107; Amendment No. 33–17]**

**RIN 2120–AF57**

## Airworthiness Standards; Continued Rotation and Rotor Locking Tests, and Vibration and Vibration Tests

**AGENCY:** Federal Aviation Administration, DOT.

**ACTION:** Final rule.

**SUMMARY:** This amendment revises the Federal Aviation Administration's (FAA's) continued rotation and vibration certification standards for the issuance of original and amended type certificates for aircraft engines. This amendment is the result of an effort to harmonize the Federal Aviation Regulations (FAR's) with European requirements being drafted by the Joint Aviation Authorities (JAA). This amendment will provide nearly uniform requirements that will simplify international airworthiness approval, while maintaining a level of safety equivalent to that established by the current standards.

**DATES:** Effective July 5, 1996.

**FOR FURTHER INFORMATION CONTACT:** Marc Bouthillier, 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, MA 01803–5299; telephone (617) 238–7111; fax (617) 238–7199.

**SUPPLEMENTARY INFORMATION:**

Background

Part 33 of title 14 of the Code of Federal Regulations (14 CFR part 33) prescribes certification standards for the issuance of original and amended type certificates for aircraft engines. Part E of the Joint Aviation Requirements (JAR–E) prescribes the corresponding certification standards of the 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 continued rotation and rotor locking test requirements, and vibration and vibration test requirements, were identified as differences sufficiently significant to cause the JAA to apply additional conditions to U.S. manufacturers seeking JAA certification. The FAA requested the ARAC to further evaluate these initiatives and ARAC assigned the task to the Propulsion Harmonization Working Group. The task resulted in an ARAC recommendation to the FAA to proceed with rulemaking. The FAA issued a Notice of Proposed Rulemaking (NPRM), No. 95–3, published in the Federal Register (60 FR 12360, dated March 6, 1995). The proposal reflected the ARAC recommendations.

Discussion of Comments

All interested persons have been afforded an opportunity to participate in this rulemaking, and due consideration has been given to all comments received. The commenters represent domestic industry and foreign airworthiness authorities. Six commenters provided the FAA with comments to NPRM 95–3. Two of these six commenters expressed no objection to the proposals. The comments are grouped according to the applicable revised and new sections of part 33.

*Section 33.74 Continued Rotation*

Two commenters state that the term "windmilling" should be changed to "continued rotation," to be consistent with the existing wording of part 23 and part 25, and to encompass mechanical as well as aerodynamic effects.

The FAA agrees. The FAA has changed the term "windmilling" to "continued rotation," wherever it appears.

One commenter states that the wording of proposed 33.74 in the NPRM is awkward, and should be revised for clarity.

The FAA agrees. The FAA has rewritten this section to more clearly state the requirement. The phrase "any of the engine main rotating systems" replaces "engine", and the revised section now specifies that the standard does not apply when rotor locking systems are in place. In addition the phrase "and in the flight conditions expected to occur" replaces the phrase "likely to occur". The FAA has also made additional changes to revised § 33.74 as noted in response to other comments.

One commenter states that the term "typical installation" should be deleted, because the rule applies to all installations.

The FAA agrees. This term has been deleted from this section.

One commenter states that the term "for any reason" be either deleted or clarified, because this wording will require compliance for the case of a failed rotor locking devices, if installed.

The FAA agrees. The rule does not intend to consider a failed rotor locking device. The FAA has, therefore, added a clarifying statement to this effect. However, the term "for any reason" has been retained to cover all other reasons for an engine shutdown.

One commenter states that the term "flight conditions expected to occur" be included in the text of the rule.

The FAA agrees. The FAA has included this term in the rule.

Two commenters state that the term "hazard to the aircraft" should be deleted, and replaced by more definitive criteria.

The FAA agrees. The FAA has replaced this term with a more definitive criteria by referencing § 33.75. That criteria can be evaluated at the engine level, without the need for an aircraft installation assessment.

One commenter states that the proposed rule should also require determination of aircraft/engine interface loads associated with continued rotation with rotor unbalance, and submittal of these for engine certification.

The FAA disagrees. The FAA considers this comment to be beyond the scope of this rulemaking, because the proposal addresses only the continued rotation characteristics of the engine; it did not address aircraft structural requirements for various engine load conditions. Also, the commenter does not specify any criteria for evaluating aircraft/engine interface loads, which can only be evaluated when considering an entire airplane.

*Section 33.63 Vibration*

One commenter expressed concern with the apparent inference to structural assessments of the aircraft due to engine dynamic loads. The commenter suggests that this part of the proposal not be issued and that the appropriate ARAC Structures and Propulsion working groups be tasked to work the issue.

The FAA disagrees. The FAA considers this comment is beyond the scope of this rulemaking. The revision

to § 33.63 clarifies, but does not alter, the original intent of a requirement that was promulgated as a Civil Air Regulation on June 15, 1956. The practical application of this requirement is to demonstrate those peak vibratory stresses of engine components do not exceed the material endurance limit for all normal engine operation (i.e., does not consider engine failure conditions that would be evident to the crew). The requirement of parts 23.939, 25.939, 27.939, and 29.939 further ensures that the installation of the engine to the aircraft will not result in excessive vibratory stresses of engine components for all normal engine operation. Additionally, the combined requirements of paragraphs 33.63 and 33.29(b) require that an indication of excessive vibration (rotor unbalance) be provided to the installer. These indications are provided to the crew to alert them of conditions beyond what is considered normal engine operation so that immediate corrective actions can be taken. It has never been the intent of this requirement nor is it the intent of the revised requirement to establish the abnormal engine environment for designing aircraft structures. In a separate and unrelated task, the FAA has chartered the ARAC Loads and Dynamic Harmonization Working Group to assess whether the current aircraft structural requirements adequately address the engine dynamic loads resulting from turbine engine failures.

*Section 33.83 Vibration test*

Section 33.83(a)

One commenter states that additional clarification be provided on the intended means of measuring vibration stresses. The commenter states that the requirements infer direct measurements of vibratory stresses can only be measured using strain gauges.

The FAA disagrees. Typically, vibration stresses are measured directly. However, in certain instances, indirect measurements of blade deflections can supplement direct measurements of vibratory stresses. Further clarification of the intended measurements is not needed as the regulation retains language that is understood by engine manufacturers and is basically unchanged since its inception as a Civil Air Regulation on June 15, 1956.

Section 33.83(b)

One commenter suggested editorial changes to emphasize that the vibration surveys cover the ranges of physical and corrected rotation speeds.

The FAA agrees. The paragraph has been revised to better define the intent of the harmonized vibration requirements.

One commenter states the phrase "throughout the declared flight envelope" was used redundantly in proposed paragraphs 33.83(a) and 33.83(b).

The FAA disagrees. Revised paragraph 33.83(a) contains general vibration test requirements while revised paragraph 33.83(b) contains more specific test requirements. The defining term "throughout the declared flight envelope" is needed in both paragraphs.

One commenter states that alternative wording is needed to the speed extension requirements of proposed paragraph 33.83(b). The commenter further states that the surveys should be extended sufficiently to reveal the maximum stress value but limiting the rotational speed extension to no more than an additional 2 percentage points.

The FAA agrees. The FAA will incorporate the wording recommended by the commenter to better define the intent of the speed extension requirement.

Section 33.83(c)

One commenter states that the proposal eliminates those requirements specific to accessory drives and mounting attachments, and also asks whether the FAA is still concerned about accessory drives and mounting attachments.

The FAA disagrees. The FAA still has concerns on the integration requirements of accessory drives and mounting attachments and specific reference to accessory loading is retained in revised paragraph 33.83(c). New paragraph 33.83(f) provides for a more complete and thorough integration of the engine to the aircraft, including accessory drives and mounting attachments.

One commenter states that an additional subparagraph to paragraph 33.83(c) is needed to emphasize the requirement to evaluate factors that might induce or influence flutter vibration.

The FAA agrees. Flutter vibration was included in the discussion of proposed 33.83(b) in the NPRM. Revised 33.83(c) contains a new paragraph (c)(2) that defines the intent of the harmonized vibration requirements.

Section 33.83(d)

Two commenters state that proposed paragraphs 33.83 (d) and (e) need clarification to distinguish between the standard that applies to normal operation from that applicable to likely fault conditions. One suggests that the order of proposed paragraphs 33.83 (d) and (e) needs to be reversed.

The FAA agrees. The FAA has reversed order of new paragraphs 33.83 (d) and (e) and has added additional words to clarify which criterion applies in each condition.

One commenter suggested editorial changes to clarify that vibratory stresses are combined with steady stresses when comparing to the material's endurance limit.

The FAA agrees. The paragraph has been revised to better define the intent of the harmonized vibration requirements. The phrase "when combined with the appropriate steady state stresses" has been added to new paragraph 33.83(d).

One commenter states that proposed paragraph 33.83(e) appears to be a design not a performance requirement, and therefore, infers that this proposed paragraph is inappropriately included in the vibration test section.

The FAA disagrees. New paragraph 33.83(d) is the primary criterion for evaluating the results of tests and analyses conducted in accordance with revised paragraphs 33.83 (a), (b), and (c).

One commenter states that the standard requiring vibration stresses to be less than the endurance limits of the materials concerned should be relaxed to assess the vibration stresses against the endurance limits of the materials concerned.

The FAA does not agree. The commenter's suggestion allows for acceptance of vibration stresses greater than the endurance limits without any definitive limitation. All engines on an aircraft are subject to the same environmental and operating conditions. The standard requiring vibratory stresses of less than the endurance limit is necessary, therefore, to minimize the likelihood of having multiple engines on the same aircraft fail for the same root cause. The FAA recognizes that there may be instances where a particular vibration failure mode does not result in engine anomalies (such as, power loss, high vibrations sensed by the flight crew, limit exceeded) that could cascade into a hazardous condition. The FAA has determined that such instances are rare. The FAA can evaluate the merit of these instances on a case by case basis.

Section 33.83(e)

One commenter suggested editorial changes to clarify the assessment of fault conditions.

The FAA agrees. The paragraph has been revised to better define the intent of the harmonized vibration requirements. The phrase "of likely

fault conditions" has been replaced by the phrase "of excitation forces caused by fault conditions", and the phrase "on vibration characteristics" has been moved to the beginning of the paragraph.

One commenter states that the requirement to assess vibrations should not apply throughout the declared flight envelope for failure conditions. The commenter further states that it is excessive to require assessments throughout the declared flight envelope for failure conditions.

The FAA does not agree. The FAA does not intend that the requirements apply to all failure conditions. No assessments are required, for example, where the condition will quickly result in an engine shutdown or result in immediate symptoms that will necessitate flight crew actions. The FAA does intend, however, that assessments be made of typical fault conditions (such as, turbine nozzle guide vane burn-throughs, fuel nozzle blockage, minor foreign object damage) that may not be immediately detectable by the flight crew and that could cascade into a hazardous condition. Requiring assessments of typical fault conditions throughout the declared flight envelope is not considered excessive. The assessment criterion for fault conditions is to show only that no hazardous condition is created, where the stricter assessment criterion for normal operation requires that assessed vibratory stresses do not exceed the material's endurance limit.

Section 33.83(f)

One commenter suggested changing "installation documents" to read "installation instructions" to be consistent with § 33.5.

The FAA agrees. The noted editorial change has been incorporated.

Paperwork Reduction Act

In accordance with the Paperwork Reduction Act on 1990 (44 U.S.C. 3501 et seq.), there are no requirements for information collection associated with this rule.

Regulatory Evaluation, Regulatory Flexibility Determination, and Trade Impact Assessment

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. In conducting these analyses, the FAA has determined that this rule: (1) will generate benefits outweighing its costs; (2) is not a "significant regulatory action" as defined in the Executive Order; (3) is not "significant" as defined by DOT's policies and procedures; (4) will not have a significant impact on a substantial number of small entities; and (5) will not constitute a barrier to international trade. These analyses, available in the docket, are summarized below.

Regulatory Evaluation Summary

Of the several amendments, only one might result in additional cost. The FAA has identified the requirements in revised § 33.83(b) as the only amendment that could require minor additional engine testing and engineering analysis, resulting in minor additional compliance costs. The revised engine continued rotation requirements of new § 33.74 and the amendments to § 33.92(a) could potentially result in cost savings to engine and transport airplane manufacturers.

The primary benefits of the rule will be harmonization of airworthiness standards with the European Joint Aviation Requirements and clarification of existing standards. The resulting increased uniformity of standards will simplify airworthiness approval for import and export purposes and will 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 will far exceed the minor incremental cost of the rule.

Regulatory Flexibility Determination

The Regulatory Flexibility Act (RFA) of 1980 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 will have a significant economic impact, either detrimental or beneficial, on a substantial number of small entities. Based on FAA Order 2100.14A (Regulatory Flexibility Criteria and Guidance), which outlines procedures and criteria for implementing the RFA, the FAA has determined that the rule will not have a significant economic impact on a substantial number of small entities.

International Trade Impact Assessment

The rule will 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 U.S. Instead, the revised standards will harmonize with existing and proposed standards of foreign aviation authorities, thereby lessening restraints on trade.

Paperwork Reduction Act

In accordance with the Paperwork Reduction Act of 1990 (44 U.S.C. 3501 et Seq.), there are no requirements for information collection associated with this rule.

International Compatibility

The FAA has reviewed corresponding International Civil Aviation Organization international standards and recommended practices and Joint Aviation Authorities requirements and has identified no difference in these amendments and the foreign regulations.

Federalism Implications

The regulations adopted herein will 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 regulation will not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

Conclusion

For the reasons discussed above, the FAA has determined that this regulation (1) is not a "significant regulatory action" under Executive Order 12866; (2) is not a "significant rule" under DOT Regulatory Policies and Procedures (44 FR 11034, February 26, 1979); (3) will not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the RFA; and (4) will not substantially impact on international trade. A final regulatory evaluation of the regulation, including a final 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, Safety.

Adoption of the Amendment

Accordingly, the Federal Aviation Administration (FAA) amends 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. 106(g), 40113, 44701, 44702, 44704.

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 Continued rotation.

If any of the engine main rotating systems will continue to rotate after the engine is shutdown for any reason while in flight, and where means to prevent that continued rotation are not provided; then any continued rotation during the maximum period of flight, and in the flight conditions expected to occur with that engine inoperative, must not result in any condition described in § 33.75 (a) through (c).

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 rotational speed up to 103 percent of the maximum physical and corrected rotational speed permitted for rating periods of two minutes or longer, and up to 100 percent of all other permitted physical and corrected rotational speeds, including those that are overspeeds. If there is any indication of a stress peak arising at the highest of those required physical or corrected rotational speeds, the surveys shall be extended sufficiently to reveal the maximum stress values present, except that the extension need not cover more than a further 2 percentage points increase beyond those speeds.

(c) Evaluations shall be made of the following:

(1) 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); and

(2) The aerodynamic and aeromechanical factors which might induce or influence flutter in those systems susceptible to that form of vibration.

(d) Except as provided by paragraph (e) of this section, the vibration stresses associated with the vibration characteristics determined under this section, when combined with the appropriate steady stresses, must be less than the endurance limits of the materials concerned, after making due allowances for operating conditions for the 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.

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

(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 instructions required by § 33.5.

5. Section 33.92 is revised to read as follows:

### § 33.92 Rotor locking tests.

If continued rotation 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 May 29, 1996.

David R. Hinson,

*Administrator.*

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