F/E DR81-66NE

Exemption 3372

Oct. 2, 1981

Mr. B. J. Shucktis
Manager - FAA Requirements
Aircraft Engine Engineering Division
General Electric Company
Neumann Way
Cincinnati, Ohio 45215

Dear Mr. Shucktis:

This is to advise that your petition for exemption from certain sections of Part 33 of the Federal Aviation Regulations, in connection with the type certification of your Model CF6-80A, A1, A2, and A3 turbofan engines, was granted on September 30, 1981. Enclosed is the Grant of Exemption document which includes the conditions and limitations associated with this exemption.

Sincerely,

/s/ Thomas McSweeny

Jerry Chavkin
Chief, Aircraft Engineering Division
Office of Airworthiness

Enclosure

cc: AWS-100
AWS-140
AWS-140:RBerman:dmm:10/2/81

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Exemption No. 3372

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
WASHINGTON, D.C. 20591

In the matter of the petition of GENERAL ELECTRIC COMPANY for an exemption from §§ 33.7(c)(17), 33.14, 33.23, 33.27, and 33.88 of the Federal Aviation Regulations	Regulatory Docket No. 21385

GRANT OF EXEMPTION

By letters dated February 17, August 21, and September 1, 1981, Mr. B. J. Shucktis, Manager - FAA Requirements, Aircraft Engine Engineering Division, General Electric Company, Neumann Way, Cincinnati, Ohio 45215, petitioned for an exemption from §§ 33.7(c)(17), 33.14, 33.23, 33.27, and 33.88 of the Federal Aviation Regulations (FAR) in connection with the type certification of its Model CF6-80A/A1/A2/A3 turbofan engines.

The pertinent FAR sections and the information submitted by the petitioner in support of its request for exemption are discussed below.

Section 33.7(c)(17), in pertinent part, requires that the time for first overhaul be established as an operating limitation for a newly certificated engine. In conjunction with § 33.7(c)(17), § 33.90 requires that the engine to be certificated must undergo a test run for the period of time established as the limitation on operation prior to the first overhaul under § 33.7(c)(17).

In lieu of establishing the time for first overhaul on the CF6-80 type certificate data sheet, the petitioner proposes that the results of the CF6-80 certification tests in conjunction with basic CF6 service experience and other test and development data be provided at the time of engine certification to establish an effective initial engine maintenance program for use by a Maintenance Review Board (MRB) which establishes the maintenance program for an aircraft as used by a particular airline.

In support of its request, the petitioner states that the proposed method of compliance will result in greater safety than compliance to the current regulation which is based on one test. General Electric will comply with the intent of § 33.90, and all CF6-80 flight test, development, and certification test experience will be utilized to establish an effective initial engine maintenance program. Seventeen million engine flight-hours of experience have

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shown that the reliability record of the earlier models of the CF6 engine family attests to the effectiveness of the engine/airplane maintenance programs approved under MRB procedures and confirms the excellence of the design technology incorporated into these engines. Since the CF6-80 engine utilizes the same state-of-the-art design technology and has many major components identical to those in the earlier model CF6 engines, the maintenance concepts which have evolved with the earlier engines appear directly applicable and indicate that an equivalent level of airworthiness will be achieved. The review process which accompanies the air carrier certification under Part 121 assures that any engine limitations are made known to the user and, therefore, satisfies the intent of § 33.7(c)(17) from which exemption is sought.

The petitioner further states that literal compliance with § 33.7(c)(17) would impose a significant economic burden on the commercial airline operators with a "time"-based total engine concept on each and every engine. The traveling public would benefit from the proposed compliance by the reduced maintenance costs associated with less unproductive activity than the current rules impose, such as excessive engine removals, teardowns, inspections, handling damage, and additional spare engines required. In this connection, the avoidance of unnecessary engine maintenance costs and scheduling difficulties will be reflected in lower costs to the traveling public, and granting the exemption would therefore be in the public interest.

Section 33.14, in pertinent part, requires the establishment of an operating limitation that specifies as a service life the number of start-stop stress cycles for each rotor disk and spacer. An initial service life may not exceed one-third of the maximum number of cycles that can be sustained without failure of the applicable disk or spacer. A service life may be extended by additional cyclic testing of three samples of a disk or spacer that has been operated to its approved service life in actual service. The life extension may be no greater than one-half of the additional cycles demonstrated by test.

In lieu of compliance with § 33.14, the petitioner proposes to establish rotor and spacer initial service lives by an analytical life prediction procedure. The proposed procedure would use a statistical analysis of disk and spacer material data, disk and spacer thermal and stress analyses, and service experience on similar designs. Life limits would be increased by utilizing a program of inspection, materials and structural integrity analyses, and equivalent severity cyclic testing that is acceptable to the Administrator. The petitioner states that it has used this procedure, which in the past has been Federal Aviation Administration (FAA) approved, during which time its engines have demonstrated excellent airworthiness while accumulating 17 million engine flight-hours. The petitioner argues that its proposed compliance provides a higher level of safety at lower cost to the operators and thus to the traveling public. The proposed procedure results in more accurate prediction of rotor life due to the use of all available information and a more representative simulation of aircraft service. Compliance with the requirements of § 33.14 will adversely impact airline spare part requirements and scheduling of engine removals and will require significant expenditures by General Electric and operators for test facilities and cycling of service disks and spacers.

Section 33.23, in pertinent part, requires that the maximum allowable loads for engine mounting attachments and related structure must be specified by the applicant and that the mounting attachments and related structure must be able

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to withstand the specified loads without failure, malfunction, or permanent deformation.

In lieu of showing compliance with § 33.23, the petitioner proposes to specify limit and ultimate loads for engine mounting attachments and related structure. As proposed, the engine mounting attachments and related structure would be required to withstand the specified limit loads without failure, malfunction, or permanent deformation but could exhibit permanent deformation without failure under the specified ultimate loads. In support of its request, the petitioner indicates that permanent deformation of the engine mounts and related structure should be permitted under conditions of ingestion of large foreign objects under § 33.77, severe engine failures under § 33.75, and engine rotor seizure under § 33.92. The provisions of § 33.23, however, preclude such deformation. The petitioner further asserts that compliance with the present regulation will result in a significant weight increase, increased engine cost, and increased airplane operating costs. Based on service experience, the petitioner argues that flight safety will not be improved by adherence to the present regulation.

Section 33.27, in pertinent part, requires that turbine and compressor rotors must have sufficient strength to withstand an overspeed condition. Demonstration of this strength is required by test, and § 33.27 permits several optional overspeed test methods. Following the overspeed tests, each rotor must be within the dimensional limits allowed by the type design for installation in an engine and may not be cracked.

In lieu of strict compliance with § 33.27, the petitioner proposes that, following the overspeed test, each rotor must be within dimensional limits approved by the FAA prior to the test for an overspeed condition and may not be cracked. The petitioner states that adherence to the present regulation would result in significant engine weight increases and would restrict its ability to produce efficient engine designs without a justifiable increase in the level of safety. The petitioner indicates that its current overspeed design and test methods are supported by 17 million flight-hours on General Electric turbofan engines of similar design. These methods utilize extensive materials, data, component testing, and photoelastic analysis. The petitioner states that the exemption would allow a more efficient engine design providing fuel savings and lower transportation costs without compromising the airworthiness of the engine.

Section 33.88, in pertinent part, requires that an engine must be run for 30 minutes at maximum rated r.p.m. and with the gas temperature 75° F. higher than the maximum operating limit. Following the run, the rotor must remain within the dimensional limits allowed by the type design and may not be cracked. The petitioner requests that compliance be permitted by a 5-minute test with all other requirements being met. The petitioner states that there is no record of disk failure attributable to excessive exhaust gas temperature on its engines. The petitioner argues that the maximum stress in the disk due to exhaust gas overtemperature will occur during the first 5 minutes of operation at the overtemperature condition. An additional 25 minutes of operation at the test temperature will not demonstrate additional disk capability.

The effect of continued operation at the maximum temperature limit plus 75 degrees will be deterioration of the turbine blades unless the engine is redesigned to provide additional turbine blade

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ultimate failure of turbine blades does not constitute an airworthiness hazard to a transport aircraft as does a turbine disk failure. Therefore, a provision for adequate turbine blade cooling to permit endurance of 30 minutes at the required temperature would constitute an overdesign; i.e., loss of engine efficiency without an improvement in safety. Adherence to the present regulation would, therefore, require redesign of the first-stage turbine blade of its engine to provide cooling and would increase fuel consumption and cost of the engine.

A summary of the petition was published in the Federal Register on March 16, 1981 (46 FR 17002). No comments were received.

The FAA has reviewed the information submitted by the petitioner. Based on that review and a review of the procedures used by the General Electric Company for the type certification of its engines, which have resulted in a satisfactory service experience for those engines, the FAA believes that a grant of exemption from the requested portions of §§ 33.7(c)(17), 33.14, 33.23, 33.27, and 33.88 for the type certification of the CF6-80A/A1/A2/A3 engines will not adversely affect safety if certain conditions and limitations are met. The CF6-80 engine is a high bypass turbofan in the 50,000-pound thrust class, using a thermodynamic cycle and structure similar to that of the 45,000-pound thrust CF6-6/50 engines which have accumulated over 17 million engine hours in commercial service. Compliance with the FAR sections specified would result in a heavier, less fuel efficient engine design.

The intent of each of the petitioner's proposed alternate compliance procedures is the same as the pertinent parts of Notice of Proposed Rulemaking (NPRM) 80-21, Docket No. 16919, dated November 20, 1980. In this notice, the FAA proposes, in part, to amend FAR Part 33 to relieve certain requirements which have been determined to be overly restrictive. The proposed amendment changes FAR Part 33 to provide compliance flexibility or modify provisions which have been determined to require engine design features adding engine weight or inefficiency without improving air safety. The FAA agrees with the petitioner that compliance with the cited portions of §§ 33.7(c)(17), 33.14, 33.23, 33.27, and 33.88 should be permitted in a manner similar to that proposed by the petitioner.

Further, the FAA believes that a grant of exemption is in the public interest since it will permit the introduction at an early date of an engine having improved characteristics as previously stated without adversely affecting safety.

In consideration of the foregoing, I find that a grant of exemption, subject to certain conditions and limitations, would not adversely affect safety and is in the public interest. Therefore, pursuant to the authority contained in sections 313(a) and 601(c) of the Federal Aviation Act of 1958, delegated to me by the Administrator (14 CFR 11.53), the General Electric Company is granted an exemption as follows from the specified FARs to permit the type certification of the General Electric CF6-80A/A1/A2/A3 model turbofan engines:

1. From § 33.7(c)(17) to permit the type certification of the CF6-80A/A1/A2/A3 turbofan engines without establishing a time for first overhaul as an operating limitation provided that General Electric conducts all tests found necessary by the FAA to establish an initial

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engine maintenance/inspection program and makes available the results of such tests to aircraft MRBs or maintenance steering committees responsible for developing initial engine maintenance programs.

2. From § 33.14 provided that compliance with the following is shown: An operating limitation must be established that specifies as a service life the number of flight operating cycles for each rotor disk, shaft, and spacer of the compressor and turbine. A flight operating cycle consists of starting the engine, accelerating it to its maximum rated power or thrust, and decelerating and stopping the engine and represents engine usage during a typical airline flight. The number of flight operating cycles for a safe initial service life as well as for any future extension of a service life must be established by a prediction procedure approved by the Chief, Engineering and Manufacturing Branch, New England Region, that includes statistical analyses of disk, shaft, and spacer material data, disk, shaft, and spacer thermal and stress analyses, and service experience on similar designs.

3. From § 33.23 provided that compliance with the following is shown:

(a) The limit loads for engine mounting attachments and related structure must be specified. The engine mounting structure must be able to withstand the specified limit loads without failure, malfunction, or permanent deformation.

(b) The ultimate loads for engine mounting attachments and related structure must be specified. The engine mounting attachments and related structure must be able to withstand the specified ultimate loads without failure but may exhibit permanent deformation.

(c) In showing compliance with other provisions of Part 33 of the FARs that require consideration of the loads specified in § 33.23, ultimate loads must be considered.

4. From the requirement contained in the last sentence of § 33.27 provided that the petitioner establishes dimensional growth limits and that these limits be approved by the FAA prior to the overspeed test required by § 33.27(c). Following the test, each rotor must be within the approved dimensional limits and may not be cracked.

5. From § 33.88, to the extent necessary, to permit the running of the test specified in the section for 5 minutes instead of 30.

M. C. Beard
Director of Airworthiness

Issued in Washington, D.C., on September 30, 1981

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