

8. Engine Endurance Test With Vibration

The ARAC Recommendations include a 3,000-cycle endurance test with main rotor unbalance. The Recommendations specify the minimum unbalance as being an “average value” of the peak vibration level observed during required vibration surveys. In section 33.200(c)(2)(iv), the term “average value” is being replaced by the term “equivalent value” to better address the concept of cumulative damage. For example, utilizing an average value could result in less cumulative damage due to vibration than if the 90% requirement was precisely maintained over the test duration. By computing and working to an equivalent value of rotor unbalance, cumulative damage will always be equal to or greater than a test conducted with a steady value of 90% unbalance. The equivalent value is a Miner’s rule summation calculation, and is further described in the companion AC.

Section-by-Section Discussion of the Proposal

Proposed New Appendix A, Paragraph A33.3(c), Extended Operations (ETOPS) Requirements

A proposed new Appendix A Paragraph A33.3(c) would define new engine condition monitoring requirements necessary for obtaining ETOPS type design eligibility approval.

Explanation

This section requires inclusion of a power assurance check methodology into the ICA for all engine models requiring ETOPS eligibility. A special requirement exists for engines to be installed in twin-engine aircraft applications, that being the power assurance method must be validated by test or experience.

Proposed Revision to Section 33.71(c)(4)—Oil Tanks

A proposed revision to section 33.71(c)(4) would define new oil tank design requirements necessary for obtaining ETOPS type design eligibility approval.

Explanation

See the explanation in paragraph 7 of this section, above.

Proposed Revision to Section 33.90—Initial Maintenance Inspection (IMI)

A proposed revision of section 33.90 would define requirements for utilizing ETOPS type design eligibility test data obtained during section 33.200 testing for section 33.90 compliance purposes.

Explanation

The fundamental requirements of section 33.90 are unchanged; except for the inclusion of a provision to allow utilization of data obtained under section 33.200 testing to show compliance to section 33.90 IMI.

Proposed New Section 33.200—Early Extended Operations (ETOPS) Eligibility and Test Requirements

A proposed new section 33.200 would define overall requirements for obtaining ETOPS type design eligibility approval.

Explanation

Compliance with this section results in an engine model that is eligible for two-engine ETOPS operation before the service experience required under 14 CFR part 25, Appendix L, Section II, paragraph (a) is achieved. The individual subparagraphs are discussed below:

Sections 33.200(a) and 33.200(b)

These sections require an applicant to establish a design quality process acceptable to the Administrator that will ensure that the type design minimizes the possibility of power loss failure events.

These rule sections require the applicant to use its best design practices, including all its corporate knowledge, skills and lessons learned in the design and manufacture of the engine. The intent is to eliminate from the design all known failures, malfunctions or design related maintenance errors experienced in other relevant FAA certified engines, and that are especially relevant to ETOPS. Such events include loss of thrust control, in-flight shutdown, or other power loss events.

Compliance may be shown by evidence acceptable to the Administrator that the applicant’s design quality assurance process has demonstrated the capability to eliminate causes of engine failures, malfunctions, and design related maintenance problems known to have occurred within the applicant’s commercial engine experience base. The applicant should also show that the design quality process would preclude the recurrence of that cause in the new design. Also, the design quality process and design features must address all applicable failures, malfunctions, and maintenance problems that could affect ETOPS even if they occurred on taxi, if such an event could have occurred in-flight.

The FAA will determine the extent of data required to be included in the

relevant experience assessment based on the following factors:

- (1) The manufacturer’s level of experience in certifying engines installed on Transport Category airplanes;
- (2) Recent experience certifying new engines;
- (3) Completeness of the manufacturer’s design practices and manuals used in the development of new engines; and
- (4) Any other factors that the manufacturer may want to present to the FAA for consideration.

If adequate data exists the time period of consideration will be the prior 10 years of applicant experience.

Section 33.200(c)

The intent of this testing is to simulate in-service operation; and to simulate the extent of time that the engine will operate at maximum continuous power for the longest diversion time in an ETOPS scenario, and at a level of engine vibration that exceeds expected service operation. The test is not intended to duplicate or repeat or replace the endurance test required by section 33.87.

Explanation

This 3,000-cycle test requirement simulates the typical field service operation expected to be encountered in the first 250,000 fleet hours (typically two years of service) and the extent of time that an engine will operate in the event of a diversion at maximum continuous power for the longest diversion time expected. In addition, the test is required to be conducted at a level of vibration for the complete test that exceeds expected service exposure. The new test is an important part of the early ETOPS eligibility determination for both the engine and propulsion system of the airplane. No other type of engine vibration testing can simulate the vibration induced by imbalance of its rotors running through the speed and power ranges experienced in service. The test is required to simulate 3,000 cycles of service operation (typically two years) in a short time span. This test is similar to that conducted for the original certification of the three engine types used on the B777 under the Special Conditions. Those tests were also a combination of engine cyclic endurance with high cycle fatigue (HCF) vibration induced by way of imbalancing the main rotors of the engine.

Section 33.200(d)

The purpose of this test is to establish thrust characteristics, and ensure that