

separate from the aircraft or operator. Therefore, compliance with these requirements does not constitute an operational or aircraft level approval for ETOPS operations.

Discussion of General Issues in Part 33 ETOPS Engine Testing

A 3,000-cycle test would be required for ETOPS engine eligibility. This test simulates 3,000 flights from engine startup to engine shutdown. A 3,000-cycle test was first required for the early ETOPS approval of two-engine aircraft under an FAA Early ETOPS Special Condition. However, prior to and subsequent to that Special Condition, other aircraft types with new engines, and others with derivative engine types, have successfully demonstrated the requisite level of reliability in service for ETOPS using normal certification procedures. However, the FAA considers that new two-engine airplane-engine combinations intended for immediate ETOPS operations should be required to undergo a cyclic endurance ground test to give confidence that the requisite level of reliability for such operations will be achieved at entry into service.

The technical basis for applying this test to two-engine airplanes rather than all airplanes, is that the allowable IFSD rate needed to maintain safe flight throughout the diversion and landing is an order of magnitude greater for a three or four engine aircraft as compared to a two-engine aircraft (assuming equivalent risk and flight duration). This also assumes that the aircraft can maintain safe flight throughout the diversion and land with one engine inoperative.

The FAA has concluded from a review of in-service experience that the 3,000-cycle engine and propulsion system test provides an adequate opportunity to discover cyclic-related failure modes associated with the design. However this is predicated upon an adequate post-test evaluation to identify conditions that could result in an in-flight shutdown, power loss, or inability to control engine thrust. An FAA review of the data from the 3,000-cycle tests for three new engine types has shown that most of the early in-service engine failure modes could have been discovered using a more thorough teardown inspection and analysis of a 3,000-cycle test engine and propulsion system hardware. This would include evaluating hardware condition against the required lessons learned analysis, and also to evaluate abnormal or other wear or distress conditions not currently

addressed in the Instructions for Continued Airworthiness (ICA).

In light of the FAA experience certifying and monitoring the Boeing 777, and in order to provide a consistent standard for post-test evaluation, the FAA proposes to require a complete teardown inspection of the engine hardware after completion of the test. The inspection would include an analysis of any abnormal conditions found. The analysis would consider the possible consequences of similar occurrences in service to determine if they might become sources of engine in-flight shutdowns, power loss, or inability to control engine thrust. The intent of this requirement is to identify potential sources of engine in-flight shutdowns or diversions and prevent these from occurring in the future.

The basic premise behind the engine demonstration tests required by this proposal is that the tests will provide a useful validation of the inherent level of reliability that was the product of an enhanced design and test process. The FAA's expectation for these tests is that significant failures will not occur. The probability of significant failures occurring on a single engine test program is so low that if any do occur, it would be indicative of a design that is not suitable for ETOPS approval. This expectation is addressed in the "type and frequency" requirement of the rule.

FAA General Changes to the ARAC Proposal for Part 33

The ARAC ETOPS recommendations for part 33 engine rulemaking addresses the Tasking Statement objectives for part 33 and incorporates the fundamental elements to achieve the Tasking Statement's stated objective. The FAA has concluded that the fundamental elements of the ARAC Recommendations, along with the identified changes, supports achieving the target level of safety and reliability necessary for safe ETOPS operations for engines installed in two-engine aircraft at entry-into-service.

However the FAA has identified a number of areas where the level of detail in the ARAC rule recommendation is not adequate to fully address a fundamental element, or has details that the FAA believes are inappropriate or lacking in adequate detail. Also, for the purpose of clarity, completeness, and terminology usage, and to follow required rule format, the ARAC rule recommendation has been reorganized within part 33.

FAA Changes From the ARAC Part 33 Rule Recommendations

1. Format and Organization

The Rule has been reformatted and reorganized to include all early ETOPS design, lessons learned, and test requirements under one specific rule. The rule number is 33.200, which resides in new part 33 subpart G, Special Requirements. The ARAC recommendations divided the ETOPS requirements between existing § 33.90 Initial Maintenance Inspection (IMI) and a specific ETOPS rule. Section 33.90 retains the provision to utilize the ETOPS testing for compliance purposes. The reorganization is generally as follows:

ARAC recommendation paragraph number	New paragraph number
33.90(a)	Same
33.90(b)	Same
33.90(b)(1)	33.200(c)(1)
33.90(b)(2)	33.200(c)(2)
33.90(b)(3)	33.200(f)
33.100(a)(1)	33.200(a)
33.100(a)(2)	33.200(b)
33.100(b)	33.200(c)/(d)/(e)

2. Revision of the 10-Year Limit on Service Data To Be Reviewed for the Lessons Learned Analysis From Section 33.200(b)

The ARAC proposal for section 33.200(b) limited the assessment of past design problems that have resulted in loss of thrust control, in-flight shutdown, or other power loss to "the applicant's other relevant type design approvals provided within the past ten years."

"Ten years" as used in the rule, is considered to be the time frame relevant to design/manufacture evolving technology for which the applicant must show that problems especially relevant to ETOPS have been addressed in the design for which early ETOPS eligibility is sought. For example, an early 1980's certified engine with a relatively lower level of reliability, would not be appropriate to use the applicant's experience base of lessons learned for compliance with section 33.200(b) for an engine certified in year 2000; a much better experience base would be engines certified from 1990, which as an industry group have very good reliability. The intent is to continuously build upon the improved reliability seen in today's engines into even higher levels of reliability."

The corresponding part 25 requirement proposed by ARAC does not contain such a time limit on the relevant experience assessment, nor