

(a) The engine must be designed using a design quality process acceptable to the FAA, that ensures the design features of the engine minimize the occurrence of failures, malfunctions, defects, and maintenance errors that could result in an IFSD, loss of thrust control, or other power loss.

(b) The design features of the engine must address problems shown to result in an IFSD, loss of thrust control, or other power loss in the applicant's other relevant type designs approved within the past 10 years, to the extent that adequate service data is available within that 10-year period. An applicant without adequate service data must show experience with and knowledge of problem mitigating design practices equivalent to that gained from actual service experience in a manner acceptable to the FAA.

(c) Except as specified in paragraph (f) of this section, the applicant must conduct a simulated ETOPS mission cyclic endurance test in accordance with an approved test plan on an engine that substantially conforms to the type design. The test must:

(1) Include a minimum of 3,000 representative service start-stop mission cycles and three simulated diversion cycles at maximum continuous thrust or power for the maximum diversion time for which ETOPS eligibility is sought. Each start-stop mission cycle must include the use of take-off, climb, cruise, descent, approach, and landing thrust or power and the use of thrust reverse (if applicable). The diversions must be evenly distributed over the duration of the test. The last diversion must be conducted within 100 cycles of the completion of the test.

(2) Be performed with the high speed and low speed main engine rotors independently unbalanced to obtain a minimum of 90 percent of the recommended field service maintenance vibration levels. For engines with three main engine rotors, the intermediate speed rotor must be independently unbalanced to obtain a minimum of 90 percent of the recommended production acceptance vibration level. The required peak vibration levels must be verified during a slow acceleration and deceleration run of the test engine cov-

ering the main engine rotor operating speed ranges.

(3) Include a minimum of three million vibration cycles for each 60 rpm incremental step of the typical high-speed rotor start-stop mission cycle. The test may be conducted using any rotor speed step increment from 60 to 200 rpm provided the test encompasses the typical service start-stop cycle speed range. For incremental steps greater than 60 rpm, the minimum number of vibration cycles must be linearly increased up to ten million cycles for a 200 rpm incremental step.

(4) Include a minimum of 300,000 vibration cycles for each 60 rpm incremental step of the high-speed rotor approved operational speed range between minimum flight idle and cruise power not covered by paragraph (c)(3) of this section. The test may be conducted using any rotor speed step increment from 60 to 200 rpm provided the test encompasses the applicable speed range. For incremental steps greater than 60 rpm the minimum number of vibration cycles must be linearly increased up to 1 million for a 200 rpm incremental step.

(5) Include vibration surveys at periodic intervals throughout the test. The equivalent value of the peak vibration level observed during the surveys must meet the minimum vibration requirement of § 33.201(c)(2).

(d) Prior to the test required by paragraph (c) of this section, the engine must be subjected to a calibration test to document power and thrust characteristics.

(e) At the conclusion of the testing required by paragraph (c) of this section, the engine must:

(1) Be subjected to a calibration test at sea-level conditions. Any change in power or thrust characteristics must be within approved limits.

(2) Be visually inspected in accordance with the on-wing inspection recommendations and limits contained in the Instructions for Continued Airworthiness submitted in compliance with § 33.4.

(3) Be completely disassembled and inspected—

(i) In accordance with the applicable inspection recommendations and limits