

(5) *Analysis Features*. The applicant must define specific new analyses, or enhanced analyses, that will be used to assure engine and airplane system design integrity. These analysis features may be derived from the requirements assessment of paragraph (c)(1) and the relevant service experience assessment of paragraph (c)(2).

(6) *Manufacturing, Maintenance, or Operational (Other) Features*. The applicant must define specific new, or enhanced, manufacturing processes or procedures, and maintenance or operational procedures that are being implemented to assure engine and airplane system integrity. These "other" features may be derived from the requirements assessment of paragraph (c)(1) of this section and the relevant service experience assessment of paragraph (c)(2).

(d) *Additional ETOPS Analysis Requirements*. (1) *Performance and Failure Analyses*. Engine and airplane performance and failure analyses required for certification must be expanded to consider ETOPS mission requirements, including exposure times associated with a 180-minute single-engine diversion and a subsequent 15-minute hold in the terminal airspace at the diversion airport. Consideration must be given to crew workload and operational implications of continued operation with failure effects for an extended period of time. The rationale and all assumptions used in the analyses must be documented, justified, and validated, including maintenance interval and maintainability assumptions.

(2) *Maintenance and Flight Operations Evaluation*. The Type Design Assessment Plan must contain a program to systematically detect and correct problems occurring as a result of improper execution of maintenance or flight operations. Corrective actions for any problems found must be identified and implemented through the Problem Tracking and Resolution System required by paragraph (f).

(3) *Manufacturing Variability*. The Type Design Assessment Plan must contain a program to minimize potential manufacturing problems. The plan should address early validation of tooling and procedures, as well as any related problems, as identified in paragraph (c)(2). Corrective actions for problems that impact the safe operation of the airplane must be identified and implemented through the problem tracking and resolution system required by paragraph (f).

(e) *Additional ETOPS Test Requirements*. As part of, or in addition to, the testing identified in paragraph

(c)(4), the following specific test requirements apply:

(1) *Configuration Requirements*. All testing defined in paragraph (e) must be conducted with the configuration proposed for certification, and must include sufficient interfacing system hardware and software to simulate the actual airplane installation.

(2) *Completion of Applicable Failure Analyses*. Failure analyses required for ETOPS type design approval must be submitted to the FAA prior to the start of the testing defined in paragraph (e).

(3) *Vibration Testing*. Vibration testing must be conducted on the complete installed engine configuration to demonstrate that no damaging resonances exist within the operating envelope of the engine that could lead to component, part, or fluid line failures. The complete installed engine configuration includes the engine, nacelle, engine mounted components, and engine mounting structure up the strut to wing interface.

(4) *New Technology Demonstration Testing*. Testing must be conducted to substantiate the suitability of any technology new to the applicant, including substantially new manufacturing techniques.

(5) *Auxiliary Power Unit Demonstration Test*. If requesting credit for APU backup electrical power generation, one auxiliary power unit (APU), of the type to be certificated with the airplane, must complete 3000 equivalent airplane operational cycles.

(6) *Engine Demonstration Test*. One engine of each type to be certificated with the airplane must complete 3000 equivalent airplane operational cycles. The engine must be configured with a complete airplane nacelle package for this demonstration, including engine-mounted equipment except for any configuration differences necessary to accommodate test instrumentation and test stand interfaces with the engine nacelle package. At completion of the engine demonstration test, the engine and airplane nacelle test hardware must undergo a complete teardown inspection. This inspection must be conducted in a manner to identify abnormal conditions that could become potential sources of engine inflight shutdown. An analysis of any abnormal conditions found must consider the possible consequences of similar occurrences in service to determine if they may become sources of engine inflight shutdowns, power loss, or inability to control engine thrust. Any potential sources of engine inflight shutdown identified must be corrected in accordance with paragraph (g)(2).

(7) *Airplane Demonstration Test*. In addition to the function and reliability testing required by 14 CFR 21.35(b)(2), for each engine type to be certificated with the airplane, one or more airplanes must complete flight testing which demonstrates that the aircraft, its components, and equipment, are capable of and function properly during long range operations and airplane diversions, including engine-inoperative diversions.

(i) The flight conditions must expose the airplane to representative operational variations based on the airplane's system and equipment design and the intended use of the airplane including:

(A) Engine inoperative maximum length diversions to demonstrate the airplane and propulsion system's capability to safely conduct a diversion.

(B) Non-normal conditions to demonstrate the airplane's capability to safely divert under worst case probable system failure conditions.

(C) Simulated airline operations including normal cruise altitudes, step climbs, and maximum expected flight durations out of and into a variety of departure and arrival airports.

(D) Diversions to worldwide airports representative of those intended as operational alternates.

(E) Repeated exposure to humid and inclement weather on the ground followed by long-range operation at normal cruise altitude.

(ii) The flight testing must validate expected airplane flying qualities and performance considering engine failure, electrical power losses, etc. The testing must demonstrate the adequacy of remaining airplane systems and performance and flightcrew ability to deal with an emergency considering remaining flight deck information following expected failure conditions.

(iii) The engine-inoperative diversions must be evenly distributed among the number of engines in the applicant's flight test program.

(iv) The test airplane(s) must be operated and maintained using the recommended operations and maintenance manual procedures during the airplane demonstration test.

(v) At completion of the airplane demonstration test, the test engines and engine-mounted equipment must undergo a complete external on-wing visual inspection. The engines must also undergo a complete internal visual inspection. These inspections must be conducted in a manner to identify abnormal conditions that could become potential sources of engine inflight shutdowns. An analysis of any abnormal conditions found must