

at certification would have precluded using accumulation of service experience, as outlined in AC 120-42A, as a means to meet ETOPS approval requirements. So an alternative method was devised that provided an adequate level of inherent airplane reliability for ETOPS. It is important to note that the requirements for certification of the airplane regarding the design's suitability for ETOPS operation, as described in those special conditions, relate to type certification approval only. Advisory Circular 120-42A contains guidance regarding operational and maintenance practices criteria that must be met by the operator before ETOPS operations can be conducted. It is incumbent upon the operator to apply for operational approval in accordance with appropriate guidance issued by the FAA for such approvals. Compliance with these special conditions does not constitute operational approval.

Special Conditions No. 25-ANM-84 contained the additional safety standards that the Administrator considered necessary to establish a level of safety equivalent to that provided by the airworthiness standards for transport category airplanes for non-ETOPS airplanes. Experience with those special conditions since issuance has provided the FAA with additional data to justify an amendment to Special Conditions No. 25-ANM-84 as described in this document.

Discussion

Boeing has requested the FAA to revise certain parts of the test requirements of Special Conditions No. 25-ANM-84 defined in paragraph (e). The FAA has concurred that some changes are justified based on an analysis of previous experience applying those special conditions to the original three engine types approved for installation on the Model 777 airplane. The specific changes to those requirements and the justification for each proposed change are discussed below.

Paragraph (e)(6) Engine Demonstration Test

The FAA has concluded from a review of in-service experience of the Model 777 series airplanes that the 3000-cycle engine and propulsion system test required by paragraph (e)(6) of Special Conditions No. 25-ANM-84 provides an adequate opportunity to discover cyclic-related failure modes associated with the design, provided that an adequate post-test evaluation is conducted to find conditions that could result in an inflight shutdown, power loss, or inability to control engine

thrust. An FAA review of the test data from the 3000-cycle tests for the three original engine types installed on the Model 777 series airplanes has shown that most of the early in-service Model 777 engine failure modes could have been discovered had Boeing and the engine manufacturers conducted a more thorough teardown inspection and analysis of the 3000-cycle test engine and propulsion system hardware. Part conditions noted in the teardown inspection reports for the three baseline Model 777 engine types did later occur in service, and they resulted in engine inflight shutdowns or airplane diversions. However, because the specific condition of those 3000-cycle test parts had been characterized as minor deviations from normal, no specific investigations into how they might progress in service had been required as a prerequisite for ETOPS approval.

Special Conditions No. 25-ANM-84 currently do not require a post-test teardown inspection. However, all three engine companies, in cooperation with Boeing, conducted post-test teardown inspections on the original baseline engines installed on the Model 777 series airplanes based on their own experience of what would constitute an adequate evaluation. In order to provide a consistent standard for a post-test evaluation of the 3000-cycle test hardware, the FAA considers that a change to paragraph (e)(6) to require a complete teardown inspection of the engine and airplane nacelle test hardware after completion of the test is necessary. The inspection must include an analysis of any abnormal conditions found. The analysis must consider the possible consequences of similar occurrences in service to determine if they might become sources of engine inflight shutdowns, power loss, or inability to control engine thrust. The intent of this change to paragraph (e)(6) is to require further design analysis to catch potential sources of engine inflight shutdowns or diversions.

For similar reasons, we consider that adding a new subparagraph (e)(7)(v) to require a post-test external and internal visual inspection of the airplane demonstration test engines and propulsion system hardware is needed. An analysis of the inspection results must identify any potential sources of engine inflight shutdown. Appropriate corrective actions must be performed in accordance with the provisions of the special conditions.

Boeing proposed to delete the word *complete* from the description of the airplane nacelle package required for the 3000-cycle test. The rationale for

this proposed change was that without the term *complete*, it is still understood that the test is intended to be a propulsion system test inclusive of the engine buildup items, but some allowance is made for configuration differences necessary to accommodate the test setup. The FAA is concerned that, without this qualifier, it is not clear what nacelle hardware must be installed for this test. It could be misinterpreted in such a way that, for instance, a functioning thrust reverser need not be installed. Therefore, the FAA has concluded that the word *complete* must remain in the requirement. However, we agree with Boeing that those configuration differences associated with test instrumentation and test stand interfaces with the engine nacelle package may be excluded, and we have added that qualification to the requirement in order to clarify this intent.

Paragraph (e)(7) Airplane Demonstration Test

Number of Test Airplanes: Boeing has proposed a change to paragraph (e)(7) to allow the use of more than one airplane to comply with the airplane demonstration test requirement (three test airplanes for the current Model 777-300ER program). Boeing's justification includes the argument that using multiple airplanes is an enhancement to the ETOPS validation program that takes into account airplane-to-airplane variation. The value of obtaining ETOPS data on multiple airplanes versus one is the increased sample size. The FAA agrees that increasing the number of test airplanes in the airplane demonstration test would provide a better evaluation of airplane-to-airplane variability. The limited experience obtained during the airplane demonstration test program is not really sufficient to evaluate end-of-life wear-out failure modes, so accumulating all of the time and cycles on one airplane is not necessary. The main program schedule benefit from using multiple flight test airplanes is that testing can be completed in a shorter period. The FAA agrees to a change to paragraph (e)(7) to require that one or more airplanes must complete the airplane demonstration test required by that paragraph.

Capability Demonstration vs.

Reliability Demonstration: The 1000-cycle airplane demonstration test requirement was developed with the intent of exposing the airplane to the conditions where the greatest numbers of inflight shutdowns occur. Most inflight shutdowns occur during takeoff and climb. The failure modes associated