

TABLE 1—Continued

Date occurred	EE-1 #	Engine type	Affected system	Event description
9/16/1997	R-113	RR	ENGINE	IFSD—Engine shutdown at 400 feet after takeoff due to high- pressure compressor failure.

Reliability of 737NG

As part of the process of reviewing existing methods for ETOPS approval, the FAA also analyzed data from the initial in-service period for Boeing Models 737-600, 737-700, and 737-800 powered by CFM56-7 engines. As a group, these variants of the 737 were referred to as the 737 Next Generation, or “737NG.” Even though early ETOPS special conditions were not issued, the 737NG was chosen for this analysis because it followed an ETOPS approval process program that was very similar to what Boeing is proposing for the 777-300ER. Several months after entry into service, however, the 737NG did not exhibit an acceptable level of propulsion system reliability for ETOPS approval. Early ETOPS special conditions were intended to identify a design not suitable for ETOPS approval prior to type certification.

Boeing proposed in 1994, prior to the 777’s type certification, that the 737NG be certified as an early ETOPS airplane in a manner similar to the 777, but without all of the testing required in the 777 special conditions. Since the success of the 777 program was still an unknown at the time of Boeing’s request for the 737NG, the FAA did not agree to Boeing’s proposed changes to the airplane demonstration test requirement. Early ETOPS special conditions for the 737NG were never issued. Even so, Boeing proceeded with those elements of the 777 special conditions that the company had proposed to accomplish. These included the relevant experience assessment, design requirements assessment, 3000-cycle propulsion system ground test, and enhanced problem reporting and resolution.

Although the FAA never issued special conditions for the 737NG program, we agreed that the elements from the 777 special conditions that Boeing did accomplish justified a reduction in the service experience normally required for ETOPS type design approval, as outlined in AC 120-42A. Boeing presented the following information in support of its request for a reduction in service experience required for ETOPS certification.

- “Design involved lessons learned, similar to 777 Early ETOPS process.

- “APU most thoroughly tested in Allied Signal history—more than 3000-cycle ground test, including hot/cold exposure.

- “Propulsion system subjected to 3000-cycle ground test, intentionally unbalanced, with three 180-minute diversion cycles.

- “Flight testing included a Southwest Airlines 50-cycle demonstration, using airline crews and maintenance. During the Function and Reliability testing, 61 ETOPS cycles were conducted with three single engine 180-minute diversions.

- “A proposed ETOPS problem tracking and resolution system, similar to that used on the 777 that will remain in effect until the fleet attains 250,000 engine fleet hours.”

In its analysis of the 737NG approval process, the FAA noted that these program elements, at the time, had been accomplished with good results. The engines and airplane system had performed well during the test programs, with results comparable to the 777 test fleet (all engines). The in-service 737NG airplanes had achieved a 98.96% dispatch reliability rate after 45 days in service, better than any previous Boeing airplane. Boeing’s proposal included an accumulation of 15,000 fleet engine hours of service experience before requesting ETOPS approval. At that time, there would be three airplanes with more than 1000 flight cycles, the total 737NG fleet would have accumulated more than 20,000 flight cycles, and the high-time airplane/engines would have more than 2000 flight cycles. During the 737 NG approval process, the FAA concurred with Boeing’s proposal to require 15,000 hours of service experience based on the following:

- “The FAA has agreed to the concept that ETOPS at entry into service can be achieved by appropriate design and testing as evidenced by the 777 special conditions, which have now been validated through actual service experience,

- “The 737NG/CFM56-7B airframe/engine configuration is a derivative/evolution of the existing 737-300/400/500 which through extensive service experience has demonstrated exceptional reliability, and, is approved for 120-minute ETOPS,

- “Except for the lack of a dedicated 1000-cycle ETOPS test program, design and testing of the 737NG/CFM56-7B mirrors what was done on the 777 to satisfy Early-ETOPS approval.

- “The additional 15,000 engine hour in-service evaluation plus the fact that three 180-minute single engine diversions were performed during Function and Reliability testing more than compensates for the omission of a 1000-cycle test,

- “The satisfactory performance of the 737NG/CFM56-7B airframe/engine configuration during the certification testing, and

- “The proven ability of Boeing to satisfactorily manage ETOPS airworthiness of the 777 fleet in the face of problems encountered in service. The 737NG proposal includes a problem tracking and resolution system that will remain in effect for a full 250,000 engine hours.”

The Model 737-700 was the first variant of the 737NG to enter service, in December 1997. Section 4.2 of the FAA-approved 120-minute ETOPS Airplane Assessment Report for the 737-700, Boeing Document Number D033A003, Revision B, states that the Model 737-700 was designed, manufactured, and tested for extended range operations at entry into service. The following additional supporting statements were also made.

a. “The 737-700 airplanes have been designed and manufactured based on regimented application of lessons learned from other ETOPS program experience as well as the in-service experience of earlier 737 models.

b. “The 737-700 airplane was subjected to a rigorous test program as described in following paragraphs. Production equivalent equipment where appropriate, was used to support test objectives. Equipment was production equivalent as defined at the time of the test.”

No significant propulsion system design problems occurred during any of the testing described above. Two inflight shutdowns did occur during certification flight testing. One was caused by an indication fault within the electronic engine control that was corrected with a simple software change. The other was caused by an inappropriate flight test condition.