

formalizing the process would be a positive step.

“Therefore, an additional paragraph has been added to the ETOPS regulation to require a minimum number of electrical generators. This requirement codifies the existing AC 120–42A electrical generator redundancy criteria. The intent of this requirement is to ensure future airplanes to be certified for ETOPS have an electrical generation system architecture equivalent to the 737, 757, 767, 777 and A310, 320, A330 era airplanes. Future airplane electrical system architectures may be significantly different from today’s airplanes, but the architecture must be equivalent from the perspective of robustness to independent failure scenarios.”

I(a)(3) Time Limited Systems

This paragraph would require that the applicant state the capability of most time limiting ETOPS significant system in the airplane flight manual.

Explanation

As stated previously for the revised paragraph 25.857(c)(2), this requirement would provide the information that the operators would need to comply with the applicable operating requirements. Advisory Circular 120–42A has two main categories of ETOPS approval (120 minutes and 180 minutes) based on demonstrated propulsion system reliability. The ETOPS approval, as stated in the airplane flight manual in currently approved ETOPS airplanes, identifies the maximum approved diversion time based as one of these two times. In order to qualify for the ETOPS type design approval, the applicant must design the airplane time-limited systems to support this maximum approved diversion time with an additional 15 minutes capability to allow for airplane holding, approach and landing.

In the context of proposed paragraph I(a)(3), we do not consider the propulsion system as a time-limited ETOPS significant system. Proposed Appendix L, section II(a), codifies the service experience method for ETOPS approval from AC 120–42A. Paragraph II(a)(4) of this section defines the required world fleet in-flight shutdown rate with each level of ETOPS operational approval. In this particular case, the level of ETOPS approval refers to the operational approval authority defined in the operating rules, not the time-limited system capability required in paragraph I(a)(3).

I(b) Propulsion System

I(b)(1) Fuel System Design

This paragraph would require design features to ensure that fuel necessary to complete an ETOPS mission will be available at the flow and pressure required for the engine, during a diversion for the longest time being approved for the airplane. The proposed rule includes a requirement for alerts to the crew when the fuel available to the engines falls below the level required to complete the mission which can occur because of fuel mismanagement, abnormal transfer between tanks, and fuel loss.

Explanation

Fuel system design and the ability of the crew to properly deal with fuel system malfunctions are arguably the most important issues facing the designer of ETOPS airplanes. The proposed rule (with corresponding AC guidance) addresses the need for:

- (1) Positive fuel pressure at the engine fuel pump (no suction feed);
- (2) Fuel availability following system failures (no hidden/trapped fuel, functional crossfeed valves, etc.); and
- (3) Flight deck alerts when fuel available to the engines falls below the level required to complete the mission.

The proposed requirements would codify the intent of paragraph 8.(b)(2)(iii) of AC 120–42A, paragraph (c)(3)(i)(C) of the Boeing 777 ETOPS special conditions, and items 7 and 8 of the type design provisions of the 207 minute ETOPS Policy Letter EPL 20–1.

There has been some discussion regarding newer generation airplanes (B777) and their system architecture being the standard by which operations beyond 180 minutes will be judged. Currently, all transport category aircraft are required to perform suction feed testing as part of basic part 25 certification, which requires the applicant to simulate an all Alternating Current (AC) power loss at the highest altitude the airplane is used in service (“service ceiling”). The testing is performed to demonstrate that in the event of an all AC power loss, there is still ability (at some safe altitude) to restart the engines after flameout on suction feed and generate thrust to a safe landing. This demonstration does not, however, provide any assurance that the engines can operate on suction feed for the long duration diversion times envisioned for ETOPS. The engines are certified with a minimum engine fuel pump inlet pressure limit of typically one-half pound per square inch (0.5 psi) above the ambient air pressure, or the fuel vapor pressure,

whichever is higher. Section 25.955 requires that the airplane fuel system deliver fuel to the engine at this minimum pressure for the maximum fuel flow required by the engine. Without the fuel boost pressure, airplanes cannot comply with § 25.955. The fuel system design requirements proposed in this notice are intended to ensure that continued operation on suction feed is not a practical possibility on ETOPS airplanes. Paragraph I(b)(1) would be applicable to all ETOPS airplanes irrespective of the number of engines.

Loss of normal electrical power to the boost pumps is the primary cause of the loss of fuel system boost pressure. A specific fuel feed capability requirement has been added for twin-engine ETOPS operations beyond 180 minutes that is intended to address the concerns about loss of fuel boost pressure raised in the development of the 207 minute ETOPS policy. The 207-minute policy included a provision to also address fuel cross-feed capability following the failure of normal electrical power. Proposed paragraph I(b)(1)(i) would require that the applicant design the airplane fuel system with a fuel boost pump in each main tank and the capability to operate at least one crossfeed valve by a back-up electrical generation source other than the primary engine driven or APU driven generators. There is an exception in the proposed rule for fuel system designs for situations when electrical power does not provide required fuel boost pressure or crossfeed valve actuation. Although this is a specific design requirement applicable to two engine airplanes for ETOPS beyond 180 minutes, the overall design objective underlying paragraph I(b)(1) is applicable to all ETOPS airplanes. The applicant may use the same design features required by paragraph I(b)(1)(i) as part of their compliance with paragraph I(b)(1) for airplanes not specifically covered by this subparagraph.

The other possible source of the loss of fuel boost pressure is mechanical failure of fuel system components. These include pump failures or performance degradation, valve failures, and plumbing failures causing internal or external fuel leaks that result in significant fuel pressure loss. Possible design alternatives to address mechanical failures as a source of loss of fuel system boost pressure are:

1. Redundancy (additional boost pumps, cross-feed valves, etc.)
2. Improved component reliability (including any instructions for continued airworthiness necessary to maintain that level of reliability)