

3. Enlarged main fuel tank capacity (to minimize the effect of loss of boost pressure in other fuel tanks)

4. A time-limited engine fuel inlet pressure limit at which the engine can demonstrate acceptable operation and integrity for the longest diversion time for which the airplane manufacturer is requesting approval.

Each of these design alternatives has advantages and disadvantages that the manufacturer would need to consider in designing an airplane to comply with the proposed rule.

We intend that the proposed paragraph I(b)(1) would preclude all causes of loss of system boost pressure in extended operations. This is consistent with the overall safety objectives established by the part 25 airworthiness standards for potentially catastrophic failure conditions.

Proposed paragraph I(b)(1)(ii) would require flight deck alerts when the fuel available to the engines falls below that required to complete the mission. The FAA's intent is that the required flight deck alerts would give flight crews clear warning of impending fuel exhaustion with enough time to safely land the airplane before the condition becomes critical. As a minimum, the manufacturer would have to design the flight deck alerts to address the types of failures or human errors that have resulted in airline fuel exhaustion events in service.

Examples of fuel exhaustion events include an Air Canada Boeing 767 that landed on an abandoned runway after both engines flamed out from fuel exhaustion. In this case, the normal low fuel alerts did not function because of a fuel quantity indication system failure. The fuel exhaustion was caused by the crew not receiving a low fuel alert, in combination with an unapproved airplane dispatch and a fueling error. An Air Tran Airbus A330 landed in the Azores following flameout of both engines caused by fuel exhaustion due to an unrecognized engine fuel leak. The AC provides guidance on critical fuel system alerts derived from these types of fuel loss events that have occurred in the current generation of aircraft.

I(b)(2) APU design

If operation of an auxiliary power unit (APU) were needed to comply with the ETOPS requirements, the applicant would have to demonstrate that the APU has adequate reliability for that operation. Also, if in-flight start and run capability is necessary, the APU in-flight operating envelope would have to extend to the maximum operating altitude of the airplane or 45,000 feet, whichever is lower.

Explanation

The electrical system reliability standard contained in AC 120-42A envisions three independent alternating current (AC) electrical generators. Besides the two engine driven generators, an auxiliary power unit (APU) could drive a third generator to meet this standard. Auxiliary power units are separately controlled small engines that are installed on an aircraft to power services when the main aircraft engines are not running. Airlines normally use an airplane APU at the gate to provide electrical power for onboard lighting and an air source for the air conditioning system between flights. Besides this normal function, the FAA may allow an airline to use an APU powered electrical generator during a revenue flight when a main engine generator is not working.

The electrical system reliability requirements proposed in this notice do not specifically require three independent generators except for airplanes being certified for ETOPS diversion times greater than 180 minutes. Current two engine aircraft that the FAA has approved for ETOPS would only be able to comply with the proposed requirement for electrical system reliability by having three independent generators. Other required aircraft system functions also may be powered by an APU. Proposed paragraph I(b)(2) of the rule would require that if the applicant is going to rely on the APU for compliance with the ETOPS requirements:

- (1) The APU has to have adequate reliability; and
- (2) If it must be started and run in-flight, the APU must demonstrate that it has the capability to start and perform its intended function up to the maximum operating altitude of the airplane, or 45,000 feet, whichever is lower.

The major reason for wanting high altitude APU in-flight start capability is to avoid having flight level changes that would cause the flight to have to cross through established flight track systems just to start the APU. Also, once the flight leaves the established track system it can be very difficult, or impossible to re-enter the track system, reducing the pilot's flexibility to fly the optimum flight plan. Having an in-flight start capability up to 45,000 feet mitigates these concerns.

"Adequate" reliability consumed much of the Working Group's discussion time during development of the rule. This term can only be placed in context by understanding the overall electrical and pneumatic system

architecture of the airplane. For instance, if an applicant has installed generators with inadequate reliability, their mean time between failure (MTBF) may require an extremely reliable APU generator in order to comply with the electrical system reliability objectives of § 25.1309. This would drive the applicant into a significant APU reliability demonstration program. The reverse could also be true. An electrical system may have generators with an excellent MTBF of 100,000 hours with additional non-APU back-up sources. In this case, the "required" reliability of the APU would be less than for current airplane electrical systems with APU driven generators. However, the applicant would have to present a convincing system level reliability analysis backed by validated component reliability data before the FAA would accept an assumption of lower APU reliability from that required for today's airplanes.

An APU has traditionally been used only to "back-up" the electrical system, and the proposed new regulatory and advisory material focuses on this function. No current aircraft utilizes an APU to provide "back-up" pneumatic system capability to meet ETOPS significant system reliability standards. However, the associated advisory circular addresses the possible operational need for APU pneumatics on the ground to power the cabin air conditioning system following an airplane diversion. If the APU is necessary as a bleed source to comply with section 25.1309 or the new section 25.1535, the applicant would have to define the operating envelope of where it can perform this intended function. The FAA requires this for any APU required function under the existing airworthiness standards of part 25. Currently most APUs can only provide both bleed air and electrical power at lower cruise altitudes, and cannot provide enough bleed air to power an air conditioning pack at the airplane service ceiling. The applicant would have to fully account for the use of a "limited" ETOPS APU operating envelope in substantiating compliance with section 25.1309 or section 25.1535. In accounting for a limited APU operating envelope, the applicant would have to address the operational implications, including air traffic control, of having to descend to a lower altitude in order to use the required APU function.

ARAC recommended the following language for paragraph I(b)(2): "If operation of the APU installation is required to comply with this appendix, the applicant must * * *". Except for