



U.S. Department  
of Transportation

**Federal Aviation  
Administration**

# Memorandum

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Subject: **ACTION**: Review and Concurrence, Equivalent Level of Safety Date: July 6, 2005

From: Manager, Chicago Aircraft Certification Office, ACE-115C Reply to Attn. of: K. Hosny  
847-294-7134

To: Manager, Engine and Propeller Directorate, ANE-100

We are requesting that your office review and provide concurrence with the proposed FAA Equivalent Level of Safety (ELOS) finding for the FJ44-3A-24 turbofan engine. This ELOS finding is for the heater electrical power supply of the combined total temperature/total pressure sensor. Title 14 of the Code of Federal Regulations, Section 33.28(b) requires that no failure of aircraft-supplied power will result in an unacceptable change in thrust or prevent continued safe operation of the engine. The FJ44-3A-24 engine is basically an FJ44-3A engine with a reduced thrust rating of 2,400 pounds. Thrust reduction was achieved through a software change to the control system. The control system is essentially the same system used on the FJ44-3A, FJ33-4A, and the FJ44-1AP engines.

## **Background:**

The FJ44-3A-24 turbofan engine is controlled by a dual channel Full Authority Digital Electronic Control (FADEC) that utilizes total temperature (TT2) and total pressure (PT2) sensors as control inputs. This data is used to schedule engine thrust as well as to determine engine acceleration and deceleration schedules. Each of the two FADEC channels receives TT2 and PT2 signals from an independent pair of sensors housed in a single probe which is mounted in the airframe inlet forward of the engine fan. The TT2/PT2 probe is electrically heated to provide de-ice and anti-ice capability necessary for demonstrating compliance with §33.68, Induction System Icing. Electrical power (nominal 28 Vdc) is supplied to the probe by the aircraft electrical bus (es). Consequently, literal compliance with the 33.28(b) requirement that the engine "Be designed and constructed so that any failure of aircraft-supplied power or data will not result in an unacceptable change in power or thrust, or prevent continued safe operation of the engine." cannot be shown.

## **Applicable Regulations:**

Section 33.28(b) (Electrical and electronic engine control systems) requires that the control system be designed and constructed so that any failure of aircraft-supplied power or data will not result in an unacceptable change in power or thrust, or prevent continued safe operation of the engine.

Section 33.68 (Induction system icing) requires that each engine must operate both on the ground at idle and throughout the flight power range in icing conditions without adverse effects on engine operation and without serious loss of thrust.

**FAA Position:**

The FJ44-3A-24 engine can show an equivalent level of safety to the literal requirements of 33.28(b) by working with the airframe manufacturer and requiring a minimum satisfactory level of system reliability for the power and data systems.

**Discussion:**

Regarding airframe supplied power, the FJ44-3A-24 engine is being certified for multi-engine installations only, therefore failure rates listed herein are based upon the fact that there are at least two dual elements TT2/PT2 probes in any aircraft installation. The Installation Instructions require that following limitations be met:

- The reliability of the aircraft supplied power to the two (or more) probe heaters is limited to a failure rate of not more than  $1 \times 10^{-8}$  per flight hour. To accomplish this, it is acceptable to utilize two main electrical buses with a failure rate of not more than  $1 \times 10^{-4}$  per flight hour each, with each bus supplying power to one probe heater under normal operating conditions.
- If there are two buses, an additional limitation requires that any single bus be capable of supplying power to all (two or more) probe heaters in the event of failure of the remaining bus (es).

If the TT2/PT2 probe heaters are shed from the electrical bus when all power generation has failed then the following aircraft air data requirements apply to the installation.

The FJ44-3A-24 engine FADEC is equipped to receive air data from the airframe via ARINC 429 data link. It is assumed that the engine TT2/PT2 probes lose heat with loss of all aircraft generated power. The Installation Instructions must identify that following failure of all aircraft generated power the following limitations must be met:

- At least one aircraft TT/PT probe to be powered by the battery.
- If required for proper and correct altitude information, the heater circuits for the aircraft's static pressure pickup ports also to be placed on battery power.
- The aircraft is not considered dispatchable when the heater circuit for the aircraft TT/PT probe powered by the aircraft battery is inoperative, and if required for proper and accurate operation, the heater circuits for the aircraft static pressure ports are inoperative. A No Dispatch message must be obvious to the flight crew under this condition. Therefore, if the aircraft's master minimum equipment list allows dispatch with an aircraft TT/PT heater circuit inoperative, it should only allow the heater circuit to the probe that is NOT on the aircraft's battery bus to be inoperative. If required for proper

and correct operation, the heater circuits for the static pickup ports associated with the TT/PT probe heater that is on the battery must be available for all dispatches.

- The air data system receiving TT/PT probe information from the probe on the battery to be powered by the aircraft's battery as well.
- The engine FADEC system must be able to receive a set (i.e., total temperature, and total pressure) of correct aircraft environmental information on an aircraft/engine digital data bus.

**ACO Recommendation:** The Chicago ACO concludes that the above power and data reliability limitations imposed on the airframe installation are sufficient to assure an equivalent level of safety to the requirements of 33.28(b).

Upon concurrence, ELOS number 8040-ELOS-05-NE-02 will be listed on the Type Certificate Data sheet as part of the certification basis for the FJ44-3A-24 engine model as follows:

Equivalent Level of Safety Findings:

33.28 Para. (b) Electrical and Electronic  
Engine Control Systems

ELOS No. 8040-ELOS-NE-02



Royace H. Prather  
Manager, Chicago Aircraft  
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Concur

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Date: 7/21/05



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Date: 7-25-05