



U.S. Department
of Transportation

**Federal Aviation
Administration**

Memorandum

Subject: ACTION: Request for Review and Concurrence with Equivalent Level of Safety (ELOS) for the Adam A500 to 14 CFR part 23, §23.161(d) Trim – Directional Trim Control during single engine climb; ACE-05-01

Date: January 4, 2005

From: Manager, Denver Aircraft
Certification Office, ANM-100D

Reply to: Melissa Sandow
Attn. of: (303) 342-1084

To: Manager, Small Airplane Directorate, ACE-100

This memorandum documents concurrence for the subject finding of Equivalent Level of Safety (ELOS). We request your office to review and concur with the proposed ELOS finding to CFR part 23, §23.161(d) - Trim. The proposed ELOS will allow for approval of the type design of the Adam A500 aircraft.

Background:

The Adam A500 is a multi-engine, centerline thrust aircraft weighing 7000 pounds. The initial Type Certificate (TC) will be limited to Day, visual flight rules (VFR). Adam will then apply for an amended TC to include night, instrument flight rules (IFR) with pressurization. In examining the rules that should be applicable to this aircraft, there were no specific regulations for a multi-engine aircraft with centerline thrust. When 14 CFR, part 23 was codified, it was assumed that multi-engine aircraft would have wing-mounted engines with large asymmetric thrust characteristics during one engine inoperative operation. One area of the rules, which didn't have a direct application to this aircraft, was 23.161(d) Trim. In fact, the difficulty of applying this rule resulted in advisory material being developed for single engine aircraft and multi-engine aircraft. However, this material did not fit a multiengine aircraft with centerline thrust. The advisory material discusses using fixed tabs for single engine aircraft and the requirement of rudder trim for multi-engine aircraft.

In order to show compliance with the trim regulation, a special set of tests were developed for the Adam A500 aircraft. The aircraft must be trimmable at $0.9 V_H$ per 14 CFR, part 23, §23.161(b) in a clean configuration, and also at V_Y in a single engine condition as required in 14 CFR, part 23, §23.161(d). Because the aircraft has no rudder trim, it must use a ground adjustable rudder tab for one condition, and then, must also meet trim requirements at the other speed point. In both cases the aircraft must be trimmed in pitch and roll and can only have residual rudder forces as called out from the table in 14 CFR, part 23, §23.143. This agreement between the applicant and the FAA was a compromise between the single engine requirements without rudder trim requirements and a multiengine aircraft that does require rudder trim. The FAA determined very early in the certification process that a centerline thrust aircraft does not necessarily require rudder trim because

large asymmetric conditions do not exist. These unique requirements were developed using the best judgment of the FAA team.

The FAA flight-tested the aircraft with both engines operating and with one engine inoperative. During the flight-testing, the trim runaway tests, flight control failure tests, and all of the trim tests for the aircraft resulted in no unsatisfactory conditions. While conducting the trim tests, the two additional conditions for directional trim were investigated. When the V_Y speed test was conducted, the slip-skid indicator was displaced about 1/8 to 1/4 to the right of center. In order to center the slip-skid indicator, a small increment of rudder trim was used, which was estimated at 5 – 10 pounds. The force was measured on a handheld force gauge and was found to be 36 pounds; thus, exceeding the limits called out in 14 CFR, part 23, §23.143 for prolonged rudder forces. The test aircraft was not equipped with dedicated rudder force instrumentation. In this condition the directional stability was very slightly out of trim, all other axis were perfectly trimmed, and the aircraft was stable and controllable with no apparent yawing or heading change. *For a centerline thrust multi-engine aircraft that will be flown only in Day, VFR conditions, the trim characteristics were found to be acceptable.*

Applicable Regulations:

The applicable regulation is 14 CFR part 23, §23.161(d), which states:

Sec. 23.161 - Trim.

- (d) In addition, each multiengine airplane must maintain longitudinal and directional trim, and the lateral control force must not exceed 5 pounds at the speed used in complying with Sec. 23.67(a), (b)(2), or (c)(3), as appropriate, with--]
- (1) The critical engine inoperative, and if applicable, its propeller in the minimum drag position;
 - (2) The remaining engines at maximum continuous power;
 - (3) The landing gear retracted;
 - [(4) Wing flaps retracted; and]
 - (5) An angle of bank of not more than 5°.

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Compensating Features: The Adam A500 is trimmable at all tested conditions except at one point that was developed from discussions with the Small Aircraft Directorate for a centerline thrust multi-engine aircraft. In this condition, with elevator and aileron trimmed, the slip-skid indicator was slightly to the right (1/8 to 1/4 of a ball width). This out of trim condition is not uncommon when flying any piston aircraft in a climb due to the torque affect. Most single engine aircraft, without rudder trim, have this slight out of trim rudder situation every time a climb is conducted. *For a centerline thrust multi-engine aircraft the trim characteristics were found to be acceptable. In addition the following items offer mitigation:*

1. *This aircraft will only be certified as Day VFR*
2. *Rudder trim will be required for the type design when it is certified as an IFR capable aircraft.*

Applicant Position: Based upon the background and the discussions provided for the design mitigations, an equivalent level of safety for the intent of 14 CFR part 23, §23.161(d) has been provided for these regulations via the flight-testing that showed no unacceptable behavior.

Recommendation:

We concur that the aircraft flight characteristics and compensating features provide an equivalent level of safety as envisioned in the regulations, and therefore, meet the requirements of 14 CFR part 23, §23.161(d).

Ronald F. May

Concurred by:

William J. Timberlake for
Manager, Standards Staff, ACE-110

12/29/04
Date

David R. Showers for
Manager, Small Airplane Directorate
Aircraft Certification Service, ACE-100

1/5/05
Date