

Memorandum

U.S. Department of Transportation
Federal Aviation Administration

Subject:	ACTION: Policy for Determining Compliance to 14 Code of Federal Regulations (CFR) §33.87	Date:	April 21, 2000
From:	Manager, Engine and Propeller Directorate Aircraft Certification Service	Reply to Attn. of:	Karen Grant, ANE-110: (781) 238-7119
To:	Manager, Aircraft Engineering Division, AIR-100 Manager, Aircraft Manufacturing Division, AIR-200 Manager, Brussels Aircraft Certification Staff, AEU-100 Manager, Engine Certification Office, ANE-140 Manager, Engine Certification Branch, ANE-141 Manager, Engine Certification Branch, ANE-142 Manager, Boston Aircraft Certification Office, ANE-150 Manager, New York Aircraft Certification Office, ANE-170 Manager, Airframe and Propulsion Branch, ANE-171 Manager, Rotorcraft Directorate, ASW-100 Manager, Rotorcraft Standards Staff, ASW-110 Manager, Airplane Certification Office, ASW-150 Manager, Rotorcraft Certification Office, ASW-170 Manager, Special Certification Office, ASW-190 Manager, Small Airplane Directorate, ACE-100 Manager, Small Airplane Standards Office, ACE-110 Manager, Atlanta Aircraft Certification Office, ACE-115A Manager, Propulsion Branch, ACE-140A Manager, Chicago Aircraft Certification Office, ACE-115C Manager, Propulsion Branch, ACE-118C Manager, Wichita Aircraft Certification Office, ACE-115W Manager, Propulsion Branch, ACE-140W Manager, Anchorage Aircraft Certification Office, ACE-115N Manager, Transport Airplane Directorate, ANM-100 Manager, Transport Standards Staff, ANM-110 Manager, Airframe and Propulsion Branch, ANM-112 Manager, Seattle Aircraft Certification Office, ANM-100S Manager, Propulsion Branch, ANM-140S Manager, Denver Aircraft Certification Office, ANM-100D Manager, Los Angeles Aircraft Certification Office, ANM-100L Manager, Propulsion Branch, ANM-140L	Policy No.	2000-33.87-R2

PURPOSE

This memorandum supersedes "Policy for Determining Compliance to 14 Code of Federal Regulations (CFR) § 33.87," issued April 20, 1998. This memorandum provides additional policy regarding the evaluation of transients as required by § 33.87(a)(8), adds another exception to the allowances for derivative engines, and clarifies the requirements for the additional testing allowed under § 33.87(a)(3).

The intent of this policy memorandum is to establish a standardized approach for compliance to § 33.87, to assist the Aircraft Certification Offices (ACOs) in the evaluation of applicant compliance to §33.87. This policy applies to all classes of turbine engines governed by part 33.

BACKGROUND

Recently, several engine manufacturers proposed the incorporation of more service representative type tests in place of the endurance cycle defined for engines in § 33.87. However, the intent of § 33.87 is not to simulate in-service operation, but to require an "accelerated severity test" to demonstrate a level of engine operability and durability within the approved engine ratings and limitations.

Since its origination in 1958, the test cycles and operating limits requirements of §33.87 have remained virtually unchanged. Yet a review of recent and past data shows that the FAA has accepted various alternative approaches to the very specific requirements of this rule, some of which are too far of a departure from the rule to continue to be acceptable as an alternative approach. An example of an unacceptable alternative approach is running the "more than one test" allowance of §33.87(a)(3) on multiple hardware sets instead of a compiled demonstration on one set of engine hardware.

Although it can be argued that the requirements of § 33.87 are arbitrary and outdated, industry has accumulated over 39 years of service experience based on the successful completion of a § 33.87 endurance test as part of the overall requirements of part 33.

On October 1, 1974, the FAA published Amendment 6 to part 33, which revised § 33.87(a) and added subparagraphs (1) through (9) to update the requirements for turbine engines. For § 33.87(a)(8), the need to develop requirements to evaluate transient overshoots was based on the type of engine control used on turbine engines at that time. Predominantly, these controls were proportional hydromechanical control systems, which exhibited transient overshoot characteristics due to limitations in the methods for gain compensation. Today's controls have technology that includes proportional plus integral systems, permitting a high gain and compensation in the control loop and minimizing transient overshoot characteristics.

The intent of § 33.87(a)(8) is to define a method for certifying rotor speed and gas temperature transient overshoots associated with proportional hydromechanical control systems, while conducting the endurance test required by § 33.87. However, § 33.87(a)(8) has been used inappropriately to substantiate limits for gas temperature exceedances of periods up to 120 seconds. There have been cases in which transient limits greater than 30 seconds have been used as supplementary limitations for engine power setting purposes. Specifically, §33.87(a)(8) is intended to evaluate rotor speed and gas temperature transient overshoots for periods of 30 seconds or less. Paragraph E of this policy restates the intent of §33.87(a)(8) and identifies how rotor speed and gas temperature limits, other than transient overshoots, can be certified.

POLICY STATEMENT

The following are acceptable means of compliance with § 33.87 for several common cases:

A. New Type Certificate

Run the standard 150 hour endurance test as prescribed in § 33.87 with no deviations.

B. Amended Type Certificate

Run the standard 150 hour endurance test as prescribed in § 33.87, with no deviations, unless the following applies:

1. Derivative model with no, or minor, design changes and the same or lower ratings or operating limitations, such that the original 150 hour demonstration is still applicable.
2. Derivative model with design changes and the same or lower ratings or operating limitations. These changes, if viewed individually or in combination, would have no impact on engine operability or durability within the approved ratings and limitations; data from the original test would fully substantiate the proposed hardware changes.
3. Derivative model with major design changes and the same or lower ratings or operating limitations, for which the ACO has determined that a repeat demonstration of § 33.87 is needed to substantiate the design change. Run the standard 150 hour endurance test cycle as prescribed in § 33.87(b) through (f), as applicable, with no deviations. Compliance with all subparagraphs of § 33.87(a) is required. The ACO will determine which subparagraphs of §33.87(a) are affected by the proposed changes and require reevaluation by test and which subparagraphs have existing data from an applicable §33.87 test, from which compliance findings by similarity can be made.

For all other cases a standard 150 hour endurance test as prescribed in § 33.87, with no deviations, is required.

The above exceptions are based on the assumption that a 150 hour endurance test has been conducted on the original model or subsequent derivative model, in accordance with the requirements of § 33.87, such that data from that previous test would apply. If this is not the case, the ACO is requested to contact this office to determine an acceptable approach for compliance.

C. Major Design Change

If the ACO determines that the major design change will require a repeat demonstration of § 33.87, then the standard 150 hour endurance test cycle as prescribed in § 33.87(b) through (f), as applicable, with no deviations, must be run. Compliance with all subparagraphs of § 33.87(a) is required. The ACO will determine which subparagraphs of §33.87(a) are affected by the proposed changes and require reevaluation by test and which subparagraphs have existing data from an applicable §33.87 test, from which compliance findings by similarity can be made.

D. Engine Operating Limitations

Section 33.87(a)(3) allows multiple tests if all the associated limits to the engine operating condition being demonstrated (i.e., takeoff, maximum continuous, one engine inoperative (OEI), etc.), cannot be held simultaneously. If multiple tests are necessary, the expectation is that the additional test(s) will be run in accordance with the prescribed test sequences of § 33.87(b), (c), (d), (e), or (g), applicable to the operating condition being demonstrated, and will be run on the same engine hardware presented for certification. For example, for engines other than certain rotorcraft engines (§ 33.87(b)), testing the takeoff rating may require a second test to demonstrate the fan speed limit, having demonstrated core rotor speed limit at gas temperature limit simultaneously during the first test. The second test would run at fan rotor speed limit and gas temperature limit, simultaneously, in accordance with the test sequences defined in subparagraphs (b)(1), (b)(2)(ii), and (b)(5). This second demonstration would accumulate an additional 42.5 hours of testing, resulting in a total time for this endurance test of 192.5 hours on the same engine hardware.

Engines for which 30-second OEI and 2-minute OEI ratings are desired must repeat the test sequence defined in § 33.87(f) for a total time of not less than 120 minutes. If a second test is required to demonstrate

all the limits associated with the engine operating condition being validated for the OEI limits, then the total test time at the desired OEI conditions must not be less than 240 minutes.

Section 33.87(a)(3) also states that at least 100 percent of the value of all the parameters associated with a particular engine operating condition must be obtained during the series of runs specified in § 33.87(b) through (g), as applicable. If a parameter, such as speed, for a particular engine rating, such as maximum continuous, is not defined, then the maximum engine "redline" condition should be tested.

The limits included in the engine type certificate data sheet as required by § 33.7 must be less than or equal to what was demonstrated during the endurance test for each engine operating condition evaluated.

E. Transients

Section 33.87(a)(8) states that the transient conditions must be demonstrated during the acceleration cycles required by § 33.87(b) through (g), as applicable. Advisory circular (AC) 33-2B describes a transient as a rotor speed or gas temperature value that exceeds the approved limit for a period of 30 seconds or less for transients associated with the maximum continuous, takeoff, continuous one engine inoperative (OEI) and 30-minute OEI ratings. Transients associated with the 2.5 minute, 2 minute, and 30 second OEI ratings should be limited to very brief periods, on the order of 5 to 10 seconds maximum. These transient limits for rotor speed and gas temperature may not be used as supplementary limitations, regardless of their duration, for engine power setting purposes.

After a detailed review of the requirements of § 33.87(a)(8), this office has concluded that § 33.87(a)(8) is intended, and remains a suitable method, to evaluate rotor speed and gas temperature transient overshoots for periods of 30 seconds or less.

For time restrictions on rotor speed and gas temperature operating limits for which the intent of §33.87(a)(8) does not apply (e.g. for engine power setting purposes or for transients greater than 30 seconds), the maximum value of the operating limit must be demonstrated during the rated power or thrust conditions as required by paragraphs (b) through (g) of § 33.87, except as provided in §33.87(a)(5).

For example, an applicant requests the following limits be approved for a rated takeoff thrust condition for a turbofan engine:

	Rating	Redline Limit	Restricted Limit
Rotor Shaft Speed	Takeoff Thrust	6800 rpm	none
Gas Temperature	Takeoff Thrust	860 degrees C	865 degrees C for 60 seconds

In order for the FAA to approve the time restricted gas temperature limit, the applicant must demonstrate the 865 degrees C value during the test sequences defined in § 33.87 (b)(1), (b)(2)(ii), and (b)(5), for a total of 18.75 hours at the 865 degrees C.

CONCLUSION and RECOMMENDATIONS

The policy stated in this memorandum does not preclude endurance testing of the accessory gearbox or any accessory drive or mounting attachment on a separate rig as allowed in § 33.87(a)(6); does not prohibit the allowance of a 500 hour controlled flight test, as defined in AC 20-24B, as an acceptable alternative to the requirements of § 33.87(a)(4) for fuels and lubricants; and does not prevent the pursuit of an exemption in accordance with § 11.25.

This office recommends that the policy put forth in this memorandum be implemented upon receipt. Any applicant proposals outside the scope of this memorandum should be coordinated with this office.

A note of caution: Testing that has been FAA-approved in support of § 33.87, yet is outside the acceptable approaches defined within this memorandum, has resulted in confusion and ultimate rejection of that testing by the Joint Aviation Authorities (JAA) in support of Joint Aviation Requirements-Engines (JAR-E) 740. Presently, the requirements of § 33.87 and JAR-E 740 are generally accepted as equivalent. Thus, this office strongly recommends that the applicant be made aware that previous testing outside the policy put forth in this memorandum should be coordinated with the JAA early in the program, if JAA validation is desired. Additional testing to comply with JAR-E 740 may be required.

Original signed by Jay Pardee
April 21, 2000