



U.S. Department
of Transportation

**Federal Aviation
Administration**

Memorandum

Subject: **ACTION**: Policy for 14 CFR §33.15, Materials

Date: [DRAFT for public comments]

From: Manager, Engine and Propeller Directorate,
Aircraft Certification Service

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Policy No. ANE-2002-33.15-R0 [DRAFT]

To: Manager, Aircraft Engineering Division, AIR-100
Manager, Aircraft Manufacturing Division, AIR-200
Manager, Certification Procedures Branch, AIR-110
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, Airframe and Propulsion Branch, ACE-117A
Manager, Chicago Aircraft Certification Office, ACE-115C
Manager, Propulsion Branch, ACE-118C
Manager, Wichita Aircraft Certification Office, ACE-115W
Manager, Systems and Propulsion Branch, ACE-116W
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
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Manager, Denver Aircraft Certification Office, ANM-100D
Manager, Los Angeles Aircraft Certification Office, ANM-100L
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1. Purpose.

This policy provides guidance for §33.15 of Title 14 of the Code of Federal Regulations (14 CFR §33.15), Materials. This policy establishes minimum safety standards for the ultrasonic (UT) billet inspection of titanium (Ti) material used in the manufacturing of engine rotating components. This policy applies to all classes of turbine engines governed by part 33.

2. Related Documents.

- a. FAA Order 8110.4B, Type Certification Process, dated April 24, 2000.
- b. Titanium Rotating Components Review Team Report, issued May 1991.
- c. Society of Automotive Engineers (SAE) Document AMS 2628, Ultrasonic Immersion Inspection Titanium and Titanium Alloy Billet Premium Grade, issued October 1996.
- d. Advisory Circular (AC) 33.15-1, Manufacturing Process of Premium Quality Titanium Alloy for Rotating Engine Components, issued September 1998.

3. Background.

In 1989, an in-flight separation of a Ti fan disk led to the fatal DC10 hull loss accident in Sioux City, Iowa. The failure was attributed to a hard alpha anomaly in the Ti64 fan disk, a material anomaly caused by localized concentrations of interstitial impurities such as nitrogen, oxygen, or carbon. Due to this accident, the FAA established the Titanium Rotating Components Review Team (TRCRT) to review the design, manufacturing, inspection, and life management procedures of engine rotating parts and offer recommendations to improve their structural integrity.

a. The TRCRT report was issued in May 1991. The manufacturing inspection section of the report included a number of suggested improvements, including the following recommendations for inspection of Ti billet material:

(1) For UT inspections of billets and semi-finish-machined disks, engine manufacturers should require the highest standard (smallest flat-bottomed hole (FBH) or equivalent) practicable in the industry for the size of the part being inspected.

(2) Engine manufacturers should also require the use and retention of UT scan data, strip charts, or the electronic equivalent, for both billet and rectilinear, semi-finish-machined disks.

b. To address the TRCRT inspection recommendations, the FAA established the Engine Titanium Consortium (ETC) in 1993. The ETC consisted of representatives from Iowa State University, Honeywell, General Electric Aircraft Engines, and Pratt &

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Whitney. The ETC production inspection task concentrated on improved inspection of Ti billet. Two approaches to zoned inspection (multizone and phased array) were evaluated and improved to provide uniform sensitivity inspection at all billet depths. The ETC has demonstrated an approximate six-fold sensitivity improvement using the multizone system, compared to the FBH detectability of the conventional system. Currently, the U.S. has five multizone systems in a production environment, and Europe has one. In October 1996, the SAE Committee K issued AMS 2628, an industry-wide specification for Ti billet UT inspection. In September 1998, the FAA, working with the Aerospace Industries Association (AIA) Structures and Materials Committee (SMC), issued AC 33.15-1, which describes the manufacturing processes for rotor grade Ti alloys.

4. UT Minimum Standards for Ti Billet.

The FAA, in cooperation with industry, has developed a multi-faceted strategy to improve the safety of high-energy rotors. This strategy includes improving the UT billet inspection of Ti alloys used in fan disks and other critical rotating engine hardware. The following are the minimum required standards for this strategy:

- a. Perform UT inspection of all Ti alloy billets that are less than or equal to 12 inches in diameter using a system with demonstrated inspection sensitivity equivalent to, or better than, a #2 FBH at all billet depths. Perform the UT inspection in accordance with SAE Document AMS 2628 or an equivalent FAA accepted procedure;
- b. Perform UT inspection of all Ti alloy billets that are greater than 12 inches in diameter using a system with demonstrated inspection sensitivity equivalent to, or better than, a #3 FBH at all billet depths. Perform the UT inspection in accordance with SAE Document AMS 2628 or an equivalent FAA accepted procedure;
- c. Require the billet UT inspection system output to be electronic c-scan data, which can be acquired, retained, stored, and retrieved electronically.

5. Policy.

- a. All Aircraft Certification Offices (ACO) and Engine Certification Offices (ECO) evaluating an applicant's compliance with §33.15 should ensure that the applicant identifies the UT inspection requirements for Ti rotor billet material specified in paragraph 4 of this policy.
- b. The ACOs and ECO should ensure that an applicant demonstrating compliance to §33.15 includes the necessary conformities by the appropriate Manufacturing Inspection District Office (MIDO), to ensure proper implementation of these requirements before design approval, in accordance with Order 8110.4B.

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6. Effect of Policy.

a. The general policy stated in this document does not constitute a new regulation or create what the courts refer to as a “binding norm.” The office that implements policy should follow this policy when applicable to the specific project. Whenever an applicant’s proposed method of compliance is outside this established policy, it must be coordinated with the policy issuing office, e.g., through the issue paper process or equivalent. Similarly, if the implementing office becomes aware of reasons that an applicant’s proposal that meets this policy should not be approved, that office must coordinate its response with the policy-issuing office.

b. Applicants should expect that the certificating officials will consider this information when making findings of compliance relevant to new certificate actions. Also, as with all advisory material, this policy statement identifies one means, but not the only means, of compliance.

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