U.S. Department
of Transportation

Federal Aviation Administration

Advisory Circular

Subject:	MATERIAL STRENGTH PROPERTIES AND MATERIAL DESIGN VALUES	**Date:** 8/6/03 **Initiated by:** ANM-115	**AC No:** 25.613-1 **Change:**

1. PURPOSE. This advisory circular (AC) provides guidance for demonstrating compliance with the airworthiness standards that specify the requirements for material strength properties and material design values. This guidance is applicable to transport category airplanes for which a new, amended, or supplemental type certificate is requested.

2. APPLICABILITY.

a. The guidance provided in this document is directed to airplane manufacturers, modifiers, foreign regulatory authorities, and Federal Aviation Administration transport airplane type certification engineers and their designees.

b. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The Federal Aviation Administration will consider other methods of demonstrating compliance that an applicant may elect to present. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. On the other hand, if we become aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation or design changes as a basis for finding compliance.

c. This material does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements.

3. RELATED FAR SECTIONS. Section 25.613 of 14 CFR part 25.

4. RELATED ADVISORY CIRCULARS.

- Advisory Circular (AC) 25.571-1C, Damage-Tolerance and Fatigue Evaluation of Structure; and
- AC 20-107A, Composite Aircraft Structure.

5. DEFINITIONS.

a. Material Strength Properties. Material properties that define the strength related characteristics of any given material. Typical examples of material strength properties are ultimate and yield values for compression, tension, bearing, shear, etc.

b. Material Design Values. Material strength properties that have been established based on the requirements of § 25.613 (b), or by other means as defined in this AC. These values are generally statistically determined based on enough data that, when used for design, the probability of structural failure due to material variability will be minimized. Typical values for moduli are used.

c. Airplane Operating Envelope. The operating limitations defined by the applicant under subpart G of part 25.

6. BACKGROUND. Metallic material strength properties and design values for airplanes manufactured in the U.S. have traditionally been based on those contained in Military Handbook (MIL-HDBK)-5. For materials not listed in that handbook, the statistical procedures in the handbook were normally used by U.S. manufacturers to determine design values. European manufacturers additionally used design values and methods specified in ESDU 00932, Metallic Data Handbook, or other equivalent approved material data. Until Amendment 25-72 to part 25 of the FAR, the "A" or "B" material design values listed in MIL-HDBK-5, or those listed in MIL-HDBK-17, -23, or Army-Navy-Commerce (ANC) -18, were required to be used, unless specific FAA approval was granted for other approaches. Sections 25.613 and 25.615 were amended in 1992, combining them into one requirement, § 25.613, and deleting the reference to MIL-HDBK-5. As part of the revision, the requirement to use A and B allowables of the military handbook was replaced by a requirement to attain certain levels of probability and confidence for strength, with the statistical method unspecified. Those probability and confidence levels apply to metallic as well as non-metallic materials. AC 20-107A contains information regarding compliance with § 25.613 for composite materials, and the use of MIL-HDBK-17.

On January 31, 2003 the Metallic Materials Properties Development and Standardization (MMPDS) Handbook was first published as the replacement document for MIL-HDBK-5. On that date both MMPDS-01 and MIL-HDBK-5J were published, and are technically equivalent. Henceforth, changes to the technical data in these documents will be promulgated as revisions to the MMPDS Handbook, under the cognizance of the FAA, and there will be no further revisions to MIL-HDBK-5. In using this Advisory Circular, MMPDS data may be accepted in lieu of MIL-HDBK-5 data, as they are considered to be technically equivalent.

7. DISCUSSION.

a. Statistically Based Design Values. Design values required by § 25.613 should be based on sufficient testing to assure a high degree of confidence in the values. In all cases, a statistical analysis of the test data should be performed.

(1) The A and B properties published in MIL-HDBK-5 or ESDU 00932 are acceptable, as are the statistical methods specified in the applicable chapters/sections of those handbooks. Other methods of developing material design values may be acceptable to the FAA.

(2) The test specimens used for material property certification testing should be made from material produced using production processes. Test specimen design, test methods, and testing should:

(a) Conform to universally accepted standards such as those of the American Society for Testing Materials (ASTM), European Aerospace Series Standards (EN), International Standard Organization (ISO), or other national standards acceptable to the FAA; or

(b) Conform to those detailed in the applicable chapters/sections of MIL-HDBK-5, MIL-HDBK-17, ESDU 00932, or other accepted equivalent material data handbooks; or

(c) Be accomplished in accordance with an approved test plan which includes definition of test specimens and test methods. This provision would be used, for example, when the material design values are to be based on tests that include effects of specific geometry and design features as well as material.

(3) The FAA may approve the use of other material test data after review of test specimen design, test methods, and test procedures that were used to generate the data.

b. Consideration of Environmental Conditions. The material strength properties of a number of materials, such as non-metallic composites and adhesives, can be significantly affected by temperature as well as moisture absorption. For these materials, the effects of temperature and moisture should be accounted for in the determination and use of material design values. This determination should include the extremes of the conditions encountered within the airplane operating envelope. For example, the maximum temperature of a control surface may include effects of direct and reflected solar radiation, convection and radiation from a black runway surface, and the maximum ambient temperature. Environmental conditions other than those mentioned may also have significant effects on material design values for some materials and should be considered.

c. Use of Higher Design Values Based on Premium Selection. Design values greater than those determined under § 25.613(b) may be used if a premium selection process is employed in accordance with § 25.613(e). In that process, individual specimens are tested to determine the actual strength properties of each part to be installed on the aircraft, to assure that the strength will not be less than that used for design.

(1) If the material is known to be anisotropic, then testing should account for this condition.

(2) If premium selection is to be used, the test procedures and acceptance criteria should be specified on the design drawing.

d. Other Material Design Values. Previously used material design values, with consideration of the source, service experience, and application, may be approved by the Administrator on a case-by-case basis (e.g., "S" values of MIL-HDBK-5 or ESDU 00932).

e. Material Specifications and Processes. Materials should be produced using production specifications and processes accepted by the FAA.

/s/ Vi L. Lipski
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