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Standard Specification for Design and Testing of Light Sport Aircraft Propellers¹

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1. Scope

1.1 This specification covers the establishment of the minimum requirements for the design, testing, and quality assurance of fixed-pitch or ground adjustable propellers for light sport aircraft. These propellers are used on light aircraft, and could be used with engines conforming to Practice F2339.

1.1.1 When applying the additions provided in Appendix X1, this specification also covers the establishment of the minimum requirements for the design, testing and quality assurance of in-flight adjustable propellers for light-sport aircraft.

1.2 This specification is intended for use by manufacturers of propellers for light sport aircraft.

1.3 This specification does not address the airframe installation requirements for propellers.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and to determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standard:*²

F2339 Practice for Design and Manufacture of Reciprocating Spark Ignition Engines for Light Sport Aircraft

¹ This specification is under the jurisdiction of ASTM Committee F37 on Light Sport Aircraft and is the direct responsibility of Subcommittee F37.70 on Cross Cutting.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3. Terminology

3.1 *Definitions:*

3.1.1 *blade, n*—the aerodynamic portion of a propeller which is rotated through and acts on the air.

3.1.2 *blade root, n*—the portion of the blade that interfaces with the hub and provides retention.

3.1.3 *conventional fixed pitch propeller, n*—a one-piece fixed pitch propeller that is constructed of material such as wood or metal that has no abrupt changes in material properties as the blades transition through the hub area.

3.1.3.1 *Discussion*—A propeller with wooden blades bonded to a metallic hub would not be conventional.

3.1.4 *fixed pitch propeller, n*—a propeller with no capacity for pitch setting adjustment.

3.1.5 *ground adjustable propeller, n*—a propeller whose pitch setting is adjustable only when the aircraft is on the ground and the propeller is not rotating.

3.1.6 *hub, n*—any device that retains the blades of a propeller assembly.

3.1.7 *pitch setting, n*—the propeller blade setting as determined by the blade angle measured in a manner, and at a radius, specified by the instruction manual for the propeller.

3.1.8 *propeller, n*—a device for propelling an aircraft that has blades on an engine-driven shaft and that, when rotated, produces by its action on the air, a thrust approximately perpendicular to its plane of rotation.

4. General

4.1 Each manufacturer who claims compliance to this specification must be able to show compliance with the applicable requirements of this specification.

4.2 Manufacturers must prepare and make available a list of acceptable engine-propeller combinations.

4.3 Manufacturers must prepare and make available an operating manual or manuals containing, at minimum, the following information:

4.3.1 An overall description of the propeller and its features.

4.3.2 The mass moment of inertia of the propeller about its rotational axis.

4.3.3 Instructions for installation of the propeller.

4.3.4 Instructions for operation of the propeller.

4.3.5 The maximum allowable engine power and rotational speed and any other propeller operating limitations found necessary by the manufacturer for the safe operation of the propeller.

4.3.6 For ground adjustable propellers, instructions for pitch adjustment and the minimum and maximum pitch settings allowed during operation.

4.3.7 Instructions for removal of the propeller.

4.4 Each manufacturer must prepare and make available a maintenance manual. The maintenance manual is intended to provide for continued safe and proper operation of the propeller throughout its life cycle and contains, at minimum, the following content:

4.4.1 A maintenance schedule that provides the recommended periods at which the propeller should be cleaned, adjusted, inspected, and tested.

4.4.2 The applicable damage and wear allowances.

4.4.3 Any applicable maintenance and overhaul instructions, which include the following:

4.4.3.1 A list of tools needed.

4.4.3.2 Skills or training required for personnel performing the work.

4.4.3.3 Inspections required.

4.4.3.4 Details of repair and overhaul sequence and methods.

4.4.3.5 Applicable testing requirements.

4.4.4 If a manufacturer deems it necessary to set mandatory replacement intervals of propellers or propeller components, the details of this requirement shall be stated in a separate, clearly distinguishable section entitled Life Limitations.

5. Design and Construction

5.1 *Design Features*—The propeller may not have design features that have been shown to be hazardous or unreliable unless the suitability of each questionable design detail or part can be established by tests.

5.2 *Materials*—The suitability and durability of materials used in the propeller must:

5.2.1 be established on the basis of in-service experience or tests; and

5.2.2 conform to documented specifications that ensure that strength and other material properties consistently meet or exceed those used in the initial design and qualification testing.

5.3 *Durability*—Each part of the propeller must be designed and constructed with consideration of likely in-service damage and wear. The propeller must be able to operate normally between inspection and overhaul periods at the maximum damage and wear limits published in the maintenance manual.

5.4 *Ground-Adjustable Propellers*—The adjustment system of a ground-adjustable propeller must be designed such that no single failure or malfunction in that system during normal or emergency operation will result in unacceptable changes in propeller blade pitch setting. Failure of structural elements need not be considered if the occurrence of such a failure is expected to be extremely remote.

5.5 *Propeller Strength and Endurance*—Propellers must be shown to have satisfactory endurance as well as stresses that do

not exceed values shown to be safe for continuous operation in accordance with the applicable requirements of Section 6, Tests and Inspections.

6. Tests and Inspections

6.1 *General*:

6.1.1 Each manufacturer must be able to show that the propeller concerned can complete the applicable tests and inspections of this section without evidence of failure or malfunction.

6.1.2 The minimum applicable testing and inspection requirements are outlined in Table 1 according to propeller material type.

6.2 *Strength Testing*:

6.2.1 Proof of strength must be shown for all propellers except conventional fixed pitch propellers.

6.2.2 On all other propellers, the blade root and blade retention system must be tested for 1 h at a load level equal to two times the centrifugal load that would be generated by the blade weight at maximum rated rotational speed. This may be done by either a whirl test or a static pull test. The required pull load for each blade must be carried by at least the inner 20 % of its span.

6.3 *Stress Measurement, Fatigue Strength, and Fatigue Analysis*—Vibration testing may be performed to allow reduced endurance test hours. This section does not apply to conventional fixed pitch wooden propellers.

6.3.1 The magnitude of the propeller vibration stresses, including any stress peaks and resonant conditions, throughout the operational envelope of the propeller shall be determined:

6.3.1.1 By direct measurement of stresses on a vibrationally representative engine, or

6.3.1.2 Comparison of the propeller to similar propellers installed on similar airplane installations for which these measurements have been made.

6.3.2 Through testing or analysis, the fatigue allowable for root, mid-blade and tip regions of the propeller blade shall be determined. This testing shall also account for normal in-service damage and wear.

6.3.3 Using the measured stresses and root, mid-blade, and tip fatigue allowables, a fatigue assessment shall be conducted to show that failure of the propeller will not occur between the declared propeller inspection intervals when using the declared inspection techniques.

6.4 *Endurance Testing*—The propeller shall undergo an endurance test on the intended engine or a vibrationally representative engine that is capable of providing the maximum rated power at the maximum rated propeller rotational speed and diameter. The propeller pitch may be adjusted as

TABLE 1 Applicable Section 6 Paragraphs for Testing and Inspection Requirements

Propeller Blade Material Type	Strength Testing	Fatigue (Vibration) Testing	Endurance Testing	Inspection/ Maintenance
Wood	6.2	6.3 optional	6.4	6.5 and 6.6
Composite	6.2	6.3 optional	6.4	6.5 and 6.6
Metal	6.2	6.3 required	6.4.1 or 6.4.3	6.5 and 6.6