CIVIL AERONAUTICS MANUALS—Volume II

U. S. Department of Commerce — Civil Aeronautics Administration

Civil Aeronautics Manuals and supplements thereto are issued by the Office of Flight Operations and Airworthiness, Civil Aeronautics Administration, for the guidance of the public and are published in the Federal Register and the Code of Federal Regulations.

Supplement No. 8 — **May 15, 1957**

SUBJECT: Civil Aeronautics Manual 14 dated May 1957, Second Edition.

Attached is a second edition of Civil Aeronautics Manual 14 which has been issued to include the Civil Air Regulations. No other changes have been made to the material contained in the manual dated August 20, 1956.

Remove and destroy:

Civil Aeronautics Manual 14, Aircraft Propeller Airworthiness, dated August 20, 1956.

Insert in lieu thereof:

Civil Aeronautics Manual 14, Aircraft Propeller Airworthiness, dated May 1957.

Roy Keeley

ROY KEELEY,
Director, Office of Flight Operations and Airworthiness.

Attachment.

Civil Aeronautics Manual 14

Aircraft Propeller Airworthiness

Second Edition

May 1957

Introductory Note

Civil Aeronautics Manuals are published by the Civil Aeronautics Administration to supplement and explain the Civil Air Regulations. This manual contains rules, policies, and interpretations of the Administrator of Civil Aeronautics which pertain to the current requirements of Part 14 of the Regulations of the Civil Aeronautics Board, as amended to December 15, 1956. This manual will be revised from time to time as a result of amendments to Part 14, and as new manual material is found necessary to keep the public informed on acceptable means of showing compliance with the requirements of Part 14.

CAA *rules* are issued pursuant to authority conferred upon the Administrator in the Civil Air Regulations. Such rules are mandatory and must be complied with.

CAA *interpretations* define or explain words and phrases of the Civil Air Regulations. Such interpretations are for the guidance of the public and will be followed by the Administration in determining compliance with the regulations.

CAA *policies* provide recommended methods of complying with the Civil Air Regulations. Such policies are for the guidance of the public and are not mandatory in nature.

The Administrator's rules, interpretations, and policies set forth acceptable procedures and practices for the guidance of the public in complying with the regulations. Other methods or practices which provide equivalent safety to those specified by the Administrator will also be acceptable. Any provisions which are shown to be inapplicable in a particular case may be modified upon request.

The text of this manual is arranged to set forth in bold type each numbered section of the Civil Air Regulations followed by related rules, policies, or interpretations of the Administrator. The Administrator's sections pertaining to a particular section of the Board's regulations are identified by consecutive dash numbers appended to the regulation section numbers. Thus, 14.10–1 means the first section of the Administrator's sections pertaining to section 14.10 of the Civil Air Regulations.

Civil Aeronautics Manuals and supplements thereto are published in the Federal Register which in turn is codified in the Code of Federal Regulations at the end of each year. Until such time as Federal Register material is picked up in the Code, reference to material published in the Register during a current year is cited by volume, page number, and date. Thus, 21 F. R. 5218, July 13, 1956, means volume 21 of the Federal Register, page 5218, published on July 13, 1956. The Federal Register citations are set at the end of each section as a matter of information.

This manual supersedes Civil Aeronautics Manual 14, dated August 20, 1956. This second edition is issued to include the Civil Air Regulations and in no way changes the manual material contained in the August 20, 1956, edition.

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Aircraft Propeller Airworthiness

Subpart A—General

Applicability and Definitions

14.0 *Applicability of this part.* This part establishes standards with which compliance shall be demonstrated for the issuance of and changes to type certificates for propellers [1] used on aircraft. This part, until superseded or rescinded, shall apply to all propellers for which applications for type certification are made after the effective date of this part (August 20, 1938).

[1] Applicable to both reciprocating and turbine engines, unless otherwise stated.

14.1 *Definitions.* As used in this part, terms are defined as follows:

(a) *Administration.*

(1) *Administrator.* The Administrator is the Administrator of Civil Aeronautics.

(2) *Applicant.* An applicant is a person or persons applying for approval of a propeller or any part thereof.

(3) *Approved.* Approved, when used alone or as modifying terms such as means, devices, specifications, etc., means approved by the Administrator. (See sec. 14.18.)

(b) *General design.*

(1) *Propeller.* A propeller includes all parts, appurtenances, and accessories thereof.[2]

[2] As defined in Section 1 of the Civil Aeronautics Act of 1938, as amended.

(2) *Propeller accessories.* Propeller accessories are those necessary for the control and operation of the propeller.

(3) *Pitch setting.* Pitch setting is the propeller blade setting determined by the blade angle measured in a manner, and at a radius, specified in the instruction manual for the propeller.

(4) *Fixed-pitch propeller.* A fixed-pitch propeller is a propeller the pitch setting of which cannot be changed except by processes constituting a workshop operation.

(5) *Adjustable-pitch propeller.* An adjustable-pitch propeller is a propeller the pitch setting of which can be conveniently changed in the course of ordinary field maintenance but which cannot be changed when the propeller is rotating.

(6) *Variable-pitch propeller.* A variable-pitch propeller is a propeller the pitch setting of which can be changed by the flight crew or by automatic means while the propeller is rotating.

(7) *Feathered pitch.* Feathered pitch is the propeller pitch setting which in flight, with the engines stopped, gives approximately the minimum drag and corresponds with a windmilling torque of approximately zero.

(8) *Reverse pitch.* Reverse pitch is the propeller pitch setting for any blade angle used beyond zero pitch (e. g. the negative angle used for reverse thrust).

14.1–1 *Definitions (CAA policies which apply to sec. 14.1).* Those technical terms used in the CAM material implementing this part which have special meanings are listed and defined as follows:

(1) *Blade angle.* This is the acute angle between the blade reference station airfoil section chord line and the plane of rotation. The blade reference station is normally located at 75 percent of the blade radius.

(2) *Manifold pressure.* The absolute pressure in inches of mercury in the intake manifold of the engine is the manifold pressure.

(3) *Maximum continuous rating.* This rating is composed of the power and r. p. m. limits for which the propeller is certificated for continuous operation.

(4) *Pitch.* The distance the propeller would advance in one revolution if it were moving along a helix having an angle equal to its blade angle is the geometric pitch of the blade.

(5) *Power.* This is the brake horsepower (b. hp.) delivered by the engine to the propeller.

(6) *Shank.* Shank is that portion of the blade which is used to attach the propeller blade to the hub. In the case of a fixed-pitch

propeller, the term "shank" applies to that portion at which the blade fairs into the hub.

(7) *Takeoff rating.* This is a rating composed of the power and r. p. m. limits for which the propeller is certificated for takeoff.

(Published in 21 F. R. 5218, July 13, 1956, effective Aug. 20, 1956.)

Certification

14.10 *Eligibility for type certificates.* A propeller shall be eligible for type certification under the provisions of this part if it complies with the airworthiness provisions hereinafter established or if the Administrator finds that the provision or provisions not complied with are compensated for by factors which provide an equivalent level of safety: *Provided,* That the Administrator finds no feature or characteristic of the propeller which renders it unsafe for use on aircraft.

14.11 *Designation of applicable regulations.* The provisions of this section shall apply to all propeller types certificated under this part irrespective of the date of application for type certificate.

(a) Unless otherwise established by the Board, the propeller shall comply with the provisions of this part together with all amendments thereto effective on the date of application for type certificate, except that compliance with later effective amendments may be elected or required pursuant to paragraphs (c), (d), and (e) of this section.

(b) If the interval between the date of application for type certificate and the issuance of the corresponding type certificate exceeds three years, a new application for type certificate shall be required, except that for applications pending on May 1, 1954, such three-year period shall commence on that date. At the option of the applicant, a new application may be filed prior to the expiration of the three-year period. In either instance the applicable regulations shall be those effective on the date of the new application in accordance with paragraph (a) of this section.

(c) During the interval between filing the application and the issuance of a type certificate, the applicant may elect to show compliance with any amendment of this part which becomes effective during that interval, in which case all other amendments found by the Administrator to be directly related shall be complied with.

(d) Except as otherwise provided by the Board, or by the Administrator pursuant to section 1.24 of this subchapter, a change to the type certificate (see sec. 14.13 (b)) may be accomplished, at the option of the holder of the type certificate, either in accordance with the regulations incorporated by reference in the type certificate pursuant to section 14.13 (c), or in accordance with subsequent amendments to such regulations in effect on the date of application for approval of the change, subject to the following provisions:

(1) When the applicant elects to show compliance with an amendment to the regulations in effect on the date of application for approval of a change, he shall show compliance with all amendments which the Administrator finds are directly related to the particular amendment selected by the applicant.

(2) When the change consists of a new design or a substantially complete redesign of a major component of the propeller and the Administrator finds that the regulations incorporated by reference in the type certificate pursuant to section 14.13 (c) do not provide complete standards with respect to such change, he shall require compliance with such provisions of the regulations in effect on the date of application for approval of the change as he finds will provide a level of safety equal to that established by the regulations incorporated by reference at the time of issuance of the type certificate.

(e) If changes listed in subparagraphs (1) through (3) of this paragraph are made, the propeller shall be considered as a new type, in which case a new application for type certificate shall be required and the regulations together with all amendments thereto effective on the date of the new application shall be made applicable in accordance with paragraphs (a), (b), (c), and (d) of this section.

(1) A change in number of blades;

(2) A change in the principle of pitch change operation;

(3) A change in design which the Administrator finds is so extensive as to require

a substantially complete investigation of compliance with the regulations.

14.12 *Recording of applicable regulations.* The Administrator, upon the issuance of a type certificate, shall record the applicable regulations with which compliance was demonstrated. Thereafter, the Administrator shall record the applicable regulations for each change in the type certificate which is accomplished in accordance with regulations other than those recorded at the time of issuance of the type certificate. (See sec. 14.11.)

14.13 *Type certificate.*

(a) An applicant shall be issued a type certificate when he demonstrates the eligibility of the propeller by complying with the requirements of this part in addition to the applicable requirements in Part 1 of this subchapter.[3]

[3] Prior to approval for use of a type certificated propeller on a certificated aircraft, the propeller will be required to comply with pertinent provisions of the applicable aircraft airworthiness parts of the regulations in this subchapter.

(b) The type certificate shall be deemed to include the type design (see sec. 14.14 (b)), the operating limitations for the propeller (see sec. 14.16), and any other conditions or limitations prescribed by the regulations in this subchapter.

(c) The applicable provisions of this part recorded by the Administrator in accordance with section 14.12 shall be considered as incorporated in the type certificate as though set forth in full.

14.14 *Data required.*

(a) The applicant for a type certificate shall submit to the Administrator such descriptive data, test reports, and computations as are necessary to demonstrate that the propeller complies with the requirements of this part.

(b) The descriptive data required in paragraph (a) of this section shall be known as the type design and shall consist of such drawings and specifications as are necessary to disclose the configuration of the propeller and all the design features covered in the requirements of this part, such information on dimensions, materials, and processes as is necessary to define the structural strength of the propeller, and such other data as are necessary to permit by comparison the determination of the airworthiness of subsequent propellers of the same type.

14.14–1 *Type design data* [1] *(CAA policies which apply to sec. 14.14).* The data specified in paragraphs (a) through (i) of this section constitute the type design data which should be submitted in complying with section 14.14. [2]

(a) *Parts list.* No parts list need be submitted for fixed-pitch propellers. For all other type propellers, two copies of the parts list should be submitted, one copy of which, upon certification of the propeller, will be sealed and returned to the manufacturer.

(b) *Drawings.*

(1) For fixed-pitch propellers, two sets of drawings should be submitted, one set of which will be sealed and returned to the manufacturer upon certification of the propeller.

(2) Only one set of drawings for propellers other than the fixed-pitch type should be submitted by the manufacturer.

(3) The following drawings should be submitted. Other drawings in lieu of those listed are acceptable provided they disclose the same information.

(i) Complete propeller assembly.

(ii) Hub assembly.

(iii) Hub.

(iv) Blade retention structural parts.

(v) Blade assembly.

(vi) Blade design (if not disclosed in the blade assembly drawing).

(vii) Pitch control assemblies (if not disclosed in the propeller or hub assembly drawings).

(viii) Schematic pitch control diagram.

(ix) Such other drawings as the Administrator may find necessary to determine compliance with the requirements of this part.

(c) *Production specifications.*

(1) Specifications covering all materials used in the manufacture of the propellers.

[1] Vibration stress data is not acceptable for determining the airworthiness of a propeller with respect to power and r. p. m. ratings since vibratory stresses bear no relationship to the steady stresses present during operating conditions.

[2] The initial request for approval of a propeller should be accompanied by at least the drawings specified in section 14.14–1(b)(3)(i), (vi), and (viii), stress analyses as discussed in section 14.14–1(f) where applicable, and the proposed test program as specified in section 14.16–1.

(2) Specifications covering all processes used in the manufacture of the propellers.

(3) Military or SAE specifications need not be submitted, but should be referred to in all drawings and materials and process specifications where applicable.

(d) *Type test report.* The type test report, suitably identified by title and number and signed by a responsible representative of the applicant for the type certificate, should cover the items listed in this paragraph. The applicant's report number should appear on all pages of the report.

(1) Conclusions and/or recommendations for operating limitations, if any.

(2) Description of propeller, including all accessories, such as governor and synchronizer.

(3) Summary of test conditions and log. The report need not contain the complete test log.

(4) Calibration of test instruments when necessary.

(5) Test engine specification. At least enough information to unquestionably identify the engine, including such information as complete model number, takeoff and maximum continuous ratings and reduction gear ratio.

(6) Description of test setup if other than established test stand.

(7) Test irregularities, failures and forced stops due to the propeller.

(8) Description of the condition of the propeller at the teardown inspection, including the results of magnetic particle, dye penetrant, fluorescent penetrant and X-ray inspections.

(9) Changes in the propeller during testing and proposed changes as a result of testing.

(10) If the approved version of the propeller differs from the prototype (i. e., the test propeller) parts lists for both propellers should be included in the test report and appropriately identified.

(11) Photos of failed or worn parts of the test propeller. Photos of the assembled test propeller if it is unconventional or has special features. Photos of the test rig if other than established test stand.

(e) *Other reports.* The applicant should submit reports covering any special tests that may be required by section 14.155.

(f) *Stress analysis.* A stress analysis may be acceptable in lieu of type tests for a propeller which incorporates major components similar to those in an applicant's previously certificated propeller. The analysis should present a comparison of stresses in the new propeller to those in the older propeller.

(1) For a propeller which incorporates a hub similar to one previously certificated, and previously certificated blades, the analysis should include:

(i) Total bending moment and total centrifugal force which the blade imposes on the new hub and the old hub.

(2) For a propeller which incorporates blades similar to ones previously certificated, and a previously certificated hub and pitch changing mechanism, the analysis should include:

(i) Combined stresses for several stations along the blade for the new blade and the old blade.

(ii) Total centrifugal force twisting moments at representative blade angles for the new blades and the old blades to demonstrate the relative loading of the pitch change mechanism.

(iii) Total bending moment and total centrifugal force which the new blades and the old blades impose on the hub.

(g) *Reversible propeller failure analysis.* The failure analysis covered by section 14.103–1 should determine what types of failures or malfunctions are most likely to occur to all components of the reversing system, should disclose how such failures or malfunctions affect propeller pitch, and what design feature prevents unwanted travel of the propeller blades to a position substantially below the normal flight low pitch stop.

(h) *Flight time data.* Where acceptable in the type certification of a propeller, flight time data should include a copy of the flight log certified to by the person flying the aircraft, and a statement of the estimated number of hours operated both at the maximum continuous rating and at the takeoff rating. The data should also include the model designations of the aircraft, the engine, and the propeller.

(i) *Referral to data previously submitted.* In lieu of submitting all of the data required for a new approval, the applicant may refer to data previously submitted by him, or if he is

the holder of a current right to the benefits of a previous approval or type certificate, he may refer to data previously submitted in connection with such approval or type certificate. In any case the applicant should identify the data referred to and establish that they are pertinent and equivalent to the data required for the new approval.

(Published in 21 F. R. 5219, July 13, 1956, effective Aug. 20, 1956.)

14.14–2 *Data required for military propellers (CAA policies which apply to sec. 14.14).* In addition to data specified in section 14.14–1 (a), (b), (c), (e), and (g), the applicant should submit the data specified in either paragraph (a) or paragraph (b) of this section.

(a) A copy of the official report which forms the basis of military approval.

(b) A letter from the military which includes the following information:

(1) Identification of the propeller.

(2) Identification of the engine upon which the endurance test was run.

(3) Duration and r. p. m. of overspeed test.

(4) Duration and rating at which the normal-rating endurance test was run.

(5) Duration and rating at which the flash performance endurance test was run.

(6) Number of pitch change cycles accomplished.

(7) Number of feathering cycles accomplished.

(8) Number of reversing cycles accomplished.

(9) Results of teardown inspection.

(10) Operating limitations if any.

(Published in 21 F. R. 5219, July 13, 1956, effective Aug. 20, 1956.)

14.15 *Inspections and tests.* Inspections and tests shall include all those found necessary by the Administrator to insure that the propeller complies with the applicable airworthiness requirements and conforms to the following:

(a) All materials and products are in accordance with the specifications in the type design,

(b) All parts of the propeller are constructed in accordance with the drawings in the type design,

(c) All manufacturing processes, construction, and assembly are as specified in the type design.

14.16 *Required tests.* The tests prescribed in this part shall be conducted to establish the propeller operating limitations, as chosen by the applicant, and the reliability of the propeller to operate within those limitations. The provisions of paragraphs (a) through (c) of this section shall be applicable.

(a) The applicant shall furnish all testing facilities, including equipment and competent personnel, to conduct the prescribed tests.

(b) An authorized representative of the Administrator shall witness such of the tests as are necessary to verify the test report.

(c) The Administrator shall establish propeller operating limitations determined on the basis of the propeller operating conditions demonstrated during the tests.

14.16–1 *Required tests (CAA policies which apply to sec. 14.16).* The applicant should submit for approval his proposed type test program. The data submitted should include:

(a) How each test will be conducted.

(b) Identification of propeller and accessories being tested.

(c) Identification of engine used.

(d) Location of tests and teardown inspection.

(Published in 21 F. R. 5220, July 13, 1956, effective Aug. 20, 1956.)

14.16–2 *Testing facilities (CAA policies which apply to sec. 14.16 (a)).* The testing equipment available for conducting the tests specified in sections 14.151 through 14.155 should be:

(a) An engine capable of developing at least the power and speed for which certification of the propeller is desired.

(b) A suitable engine mount.

(c) An accurate tachometer, which should be calibrated before and after testing or checked with a stopwatch and revolution counter during testing.

(d) A suitable manifold pressure gage if the test is not run at full throttle (not required for fixed-pitch wood propeller tests). The manifold pressure connection should be permanently located so that the manifold pressure is a uniform indication of power. All test values

should be on a basis of dry absolute manifold pressure which is obtained by subtracting the vapor pressure from the observed absolute manifold pressure.

(Published in 21 F. R. 5220, July 13, 1956, effective Aug. 20, 1956.)

14.16–3 *Propeller operating limitations*[3] *(CAA policies which apply to sec. 14.16 (c)).*

(a) The following operating limitations will be established as determined from tests conducted for type certification:

(1) Maximum continuous power and r. p. m.

(2) Takeoff power and r. p. m.

(3) When applicable, avoidance of continuous operation at or between certain r. p. m.

(4) When applicable, special limitations imposed due to functional or structural considerations, such as minimum engine oil pressure necessary and life limit.

(b) Requests for increases in power and/or r. p. m. ratings up to a maximum of 10 percent above the values substantiated by actual tests, provided there are no structural changes in the propeller, should be accompanied by substantiating test data or stress analysis as covered in section 14.14–1 (e), (f) and (h). Requests for increases greater than 10 percent should be substantiated in a manner satisfactory to the Administrator.

(Published in 21 F. R. 5220, July 13, 1956, effective Aug. 20, 1956.)

14.17 *Production certificates.* (For requirements with regard to production certificates see Part 1 of this subchapter.)

14.18 *Approval of materials, parts, processes, and appliances.*

(a) Materials, parts, processes, and appliances shall be approved upon a basis and in a manner found necessary by the Administrator to implement the pertinent provisions of the regulations in this subchapter. The Administrator may adopt and publish such specifications as he finds necessary to administer this regulation, and shall incorporate therein such portions of the aviation industry, Federal, and military specifications respecting such materials, parts, processes, and appliances as he finds appropriate.

NOTE: The provisions of this paragraph are intended to allow approval of materials, parts, processes, and appliances under the system of Technical Standard Orders, or in conjunction with type certification procedures for a propeller, or by any other form of approval by the Administrator.

(b) Any material, part, process, or appliance shall be deemed to have met the requirements for approval when it meets the pertinent specifications adopted by the Administrator, and the manufacturer so certifies in a manner prescribed by the Administrator.

14.19 *Changes in type design.* (For requirements with regard to changes in type design and the designation of applicable regulations therefor, see sec. 14.11 (d) and (e), and Part 1 of this subchapter.)

Identification and Instruction Manual

14.20 *Propeller identification data.* A certificated propeller, propeller blade, or propeller hub shall have displayed upon it conspicuously the identification data required by section 1.50 of this subchapter. The identification data shall be permanently attached upon a noncritical surface of the propeller, blade, or hub by means of a plate, stamping, engraving, etching, or other approved method. When such data are not visible when the propeller is assembled or installed on an aircraft, they shall also be painted or printed on the propeller, blade, or hub.

14.21 *Instruction manual.* The applicant shall prepare and make available an approved manual containing instructions for the installation, operation, servicing, maintenance, repair, and overhaul of the propeller.

NOTE: It is not intended to limit the form of the manual to a single document.

[3] The operating limitations together with diameter and pitch limits and general specifications for the propeller are published in the form of propeller specifications. (See Figures 1, 2, and 3.) Propeller specifications are available free of charge from the Civil Aeronautics Administration, Printing Services Branch, W-150, Washington 25, D. C.

Subpart B—Airworthiness

Design and Construction

14.100 *Scope.*

(a) The propeller shall not incorporate design features or details which experience has shown to be hazardous or unreliable. The suitability of all questionable design details or parts shall be established by tests.

(b) The design and construction provisions of this part shall be applicable to the propeller when it is installed, operated, and maintained in accordance with the instruction manual prescribed in section 14.21.

14.100–1 *Design features (CAA policies which apply to sec. 14.100).* Where applicable, the propeller should incorporate design features to comply with the requirements of pertinent portions of Parts 3 and 4b of this subchapter, regarding feathering and unfeathering, r. p. m. governing, de-icing, low pitch stops, r. p. m. and pitch controls, feathering controls, and reversing controls.

(Published in 21 F. R. 5220, July 13, 1956, effective Aug. 20, 1956.)

14.101 *Materials.* The suitability and durability of all materials used in the propeller shall be established on a basis of experience or tests. All materials used in the propeller shall conform to approved specifications which will insure their having the strength and other properties assumed in the design data.

14.102 *Durability.* All parts of the propeller shall be designed and constructed to minimize the development of an unsafe condition of the propeller between overhaul periods.

14.103 *Reversible propellers.* Reversible propellers shall be adaptable for use with a reversing system in an airplane so that no single failure or malfunctioning of the reversing system during normal or emergency operation will result in unwanted travel of the propeller blades to a position substantially below the normal flight low-pitch stop. Failure of structural elements need not be considered if the occurrence of such failure is expected to be extremely remote.

14.103–1 *Reversible propeller failure analysis (CAA interpretations which apply to sec. 14.103).* The words "reversing system" apply to the portion of the complete propeller reversing system incorporated into the propeller itself, and to the portions supplied by the applicant for installation into the aircraft. (For requirements with regard to the failure analysis, see sec. 14.14–1 (g).)

(Published in 21 F. R. 5220, July 13, 1956, effective Aug. 20, 1956.)

Tests

14.150 *General.* The tests and inspections prescribed in sections 14.151 through 14.157 shall be applicable to propellers, including all essential accessories. The propeller shall complete the prescribed tests without evidence of failure or malfunctioning.

14.150–1 *Essential accessories (CAA policies which apply to sec. 14.150).* All accessories and appurtenances intended for use with the propeller should be included in the tests required in sections 14.153, 14.154, and 14.155. These accessories and appurtenances include, but are not limited to:

(a) Propeller spinner.
(b) Propeller brakes.
(c) Propeller cuffs or fairings.
(d) De-icing fluid slinger rings.
(e) De-icing fluid distributing strips.

(Published in 21 F. R. 5220, July 13, 1956, effective Aug. 20, 1956.)

14.151 *Centrifugal load test.* The hub and blade retention arrangement of propellers with detachable blades shall be subjected to a centrifugal load equal to twice the centrifugal force to which the propeller is to be subjected in normal operation. Either one of the following two test methods shall be acceptable:

(a) A one-hour whirl test, or

(b) A static pull test.

14.151–1 *Centrifugal load test*[4] *(CAA policies which apply to sec. 14.151).*

(a) *Whirl test.* The complete propeller, or the propeller hub with weighted stub blades,

[4] So that it will not be necessary to repeat this test for new blade designs which would impose greater centrifugal loading on the retention system, it is suggested that the test selected be conducted at the greatest centrifugal loading anticipated.

The double centrifugal force loading for this test, the purpose of which is to substantiate the structural integrity of the blade retention arrangement, is based on the maximum continuous r. p. m. for which the propeller is to be certificated.

may be used in this test. If stub blades are used, they should produce the required centrifugal force at the test r. p. m. Any type of motive power may be used for this test. The propeller may be reduced in pitch any amount so as to reduce the power if desired.

(b) *Static pull test.* Stub blades used for this test need not be formed into airfoil sections, but should be flared out to provide adequate holding means to insure that any failure will occur in the blade retention arrangement.

(Published in 21 F. R. 5220, July 13, 1956, effective Aug. 20, 1956.)

14.152 *Vibration test.* Propellers with metal blades and or metal hubs shall be subjected to a vibration test under sufficient conditions to establish the level of vibratory stresses in the blade and or hub when the propeller is operated under all conditions of rotational speed and engine power which are to be established for the propeller. The test shall be conducted on the same or equivalent engine and the test stand configuration on which the endurance tests are conducted.

14.153 *Endurance test.*

(a) *Fixed-pitch wood propellers.* Fixed-pitch wood propellers shall be subjected to one of the following endurance tests:

(1) A 10-hour endurance block test on an engine shall be conducted with a propeller of the greatest pitch and diameter for which certification is sought at the rated rotational speed.

(2) A 50-hour flight test shall be conducted in level flight or in climb. At least 5 hours of this flight test shall be conducted with the propeller operated at the rated rotational speed, and the remainder of the 50 hours shall be conducted with the propeller operated at not less than 90 percent of the rated rotational speed.

(3) A 50-hour endurance block test on an engine shall be conducted at the power and propeller rotational speed for which certification is sought.

(b) *Fixed-pitch metal propellers and adjustable-pitch propellers.* Fixed-pitch propellers with metal blades and adjustable-pitch propellers shall be subjected to one of the endurance tests prescribed in paragraphs (a) (2) and (3) of this section.

(c) *Variable-pitch propellers.* Variable-pitch propellers shall be subjected to one of the following endurance tests:

(1) A 100-hour endurance test shall be conducted on an engine of the same power and rotational speed characteristics as the engine or engines with which the propeller is intended to be used. The endurance test shall be conducted at the maximum continuous rotational speed and power rating of the propeller, except that, in the event a rotational speed(s) and power condition(s) is found to be critical on the basis of the vibration test prescribed in section 14.152, such portion of the 100 hours as the Administrator finds necessary, but not in excess of 50 hours, shall be conducted at the critical rotational speed(s) and power condition(s). If a take-off rating greater than the maximum continuous rating is to be established, a 10-hour block test in addition to the 100 hours shall be conducted at the maximum power and rotational speed for the take-off rating.

(2) The propeller shall be operated throughout the engine endurance tests prescribed in Part 13 of this subchapter.

14.153–1 *Endurance test (CAA policies which apply to sec. 14.153).* Endurance block tests should take into account air temperature, barometric pressure, humidity, engine manifold pressure or torquemeter or torque reaction stand readings, and engine r. p. m.

(a) *Continuity of test.* The endurance test may be continuous or in increments agreed upon between the propeller manufacturer and the Administrator.

(b) *Power output.* The engine power output should be at least equal to the manufacturer's official ratings (hp. and r. p. m.).

(1) The engine power output should be determined on torque reaction test stands, by calibrated propellers or by engine torquemeters. If a torque reaction stand is not used, an engine torquemeter should be used for power monitoring during the test.

(c) *Forced stop.* The test should be terminated upon evidence of any unusual vibration, hunting or noncontrollability of the propeller, a change in power or r. p. m. not attributable to general atmospheric conditions or any change in the readings descriptive of the propeller during the testing.

(1) The test should be terminated when any failure of the propeller or its essential accessories would result in an immediate forced landing of an aircraft. The failures should be corrected to the satisfaction of the Administrator before official type certification testing is resumed.

(2) The failure of the test stand equipment or engine accessories is not a forced stop.

(Published in 21 F. R. 5220, July 13, 1956, effective Aug. 20, 1956.)

14.154 *Functional test.* Variable-pitch propellers shall be subjected to the following functional tests as applicable. The same propeller as used in the endurance test shall be used in the functional tests and shall be driven by an engine mounted on a test stand or on an aircraft.

(a) *Manually controllable propellers.* 500 complete cycles of control shall be applied throughout the pitch and rotational speed ranges.

(b) *Automatically controllable propellers.* 1,500 complete cycles of control by means of automatic control mechanism shall be applied throughout the pitch and rotational speed ranges.

(c) *Feathering propellers.* 50 cycles of feathering operation shall be applied.

(d) *Reversible-pitch propellers.* 200 complete cycles of control shall be applied from the lowest normal pitch to the maximum reverse pitch. At the end of each cycle the propeller shall be operated in reverse pitch for a period of one minute at the reverse pitch maximum rotational speed and power.

14.155 *Special tests.* Such tests shall be conducted as the Administrator finds necessary to substantiate the use of any unconventional features of design, material, or construction.

14.156 *Teardown inspection.* After completion of the tests, the propeller shall be completely disassembled and a detailed inspection shall be made of the propeller parts to check for fatigue, wear, and distortion.

14.156–1 *Teardown inspections (CAA policies which apply to sec. 14.156).* The teardown inspection is one of the means for determining the airworthiness of the propeller and compliance with the requirements of this part. As a result of the inspection the administrator may require such revisions to the design or additional tests to establish the airworthiness of the propeller before approving the issuance of a type certificate.

(a) *Wood or composition propellers.* Wood propellers or those with blades of composition or of other than conventional wood or metal construction should be thoroughly examined for evidence of loosened or excessively cracked tipping, opened glue joints, cracks in the wood, local failure or cracking around the hub bolt holes, and slipping or crushing around the shank. Some flexural cracks in the metal tipping is considered normal. Plastic covered propellers should be inspected for cracks in the covering which would indicate a cracked lamination or open glue joint. Failures of these types are cause for the refusal to issue a type certificate.

(b) *Variable pitch propellers.* No vital part of the propeller should bear evidence of fatigue cracks or wear which would necessitate altering or replacing such part. Wear measurements should be made on parts that are visibly unduly worn. All unduly worn or cracked parts should be photographed for further study in determining the airworthiness of the propeller. No parts of the propeller should show evidence of impending failure.

(c) *Hub and control mechanism.* All ferrous parts of the hub and control mechanism should be given a magnetic particle inspection. All aluminum parts should be carefully inspected for cracks by a suitable process such as etching, anodizing, fluorescent penetrant or dye penetrant.

(d) *Aluminum alloy propellers and blades.* Aluminum alloy propellers or propeller blades should be thoroughly inspected for cracks and material defects by a suitable process such as etching, anodizing, fluorescent penetrant or dye penetrant. Particular attention should be given to critical sections such as fillets and points of abrupt curvature. The blades should then be inspected for cracks with a 4 to 6 power magnifying glass.

(e) *Steel blades.* Hollow steel blades and solid steel blades should be given a thorough visual and magnetic inspection for cracks and material defects in accordance with the manufacturer's established procedures and specifica-

tions. The magnetic inspection should be made only by a highly skilled operator. Any magnetic indication should be discussed with a representative of the Administrator since such indication may warrant a complete metallurgical examination.

(Published in 21 F. R. 5220, July 13, 1956, effective Aug. 20, 1956.)

14.157 ***Propeller adjustments and parts replacements.*** **During the tests, servicing and minor repairs of the propeller shall be permissible. If major repairs or replacement of parts are found necessary during the tests or in the tear-down inspection, the parts in question shall be subjected to such additional tests as are found by the Administrator to be necessary.**

Appendix A

Samples of Propeller Specifications

DEPARTMENT OF COMMERCE
CIVIL AERONAUTICS ADMINISTRATION

P-XXX-11
GREEN
All Wood Propellers
(Active)

July 18, 1955

PROPELLER SPECIFICATION

Propellers of models described herein conforming with these specifications and approved data on file with the Civil Aeronautics Administration are rated as airworthy for use in certificated aircraft in accordance with pertinent aircraft specifications and applicable portions of the Civil Air Regulations.

The propellers are of two-bladed, laminated wood construction, either varnished or plastic covered, with metal tipping. The takeoff rating is ten percent in excess of the maximum continuous rating. Propeller weight does not include the metal hub. The weight of metal hubs is given on the pertinent engine specification. These limitations apply to all propellers listed herein except as modified in the notes.

Manufacturer: Green Manufacturing Company, Anyville, Michigan

Model	Cert. Basis*	Maximum Continuous HP	Maximum Continuous RPM	Dia.	Std. Pitch	Hub Drilling No. Holes	Hub Drilling Dia. Holes	Hub Drilling Dia. Bolt Circle	Hub Dimensions Dia.	Hub Dimensions Thickness	Weight (lbs.)
69A	TC XXX	80	2700	69"	56"-30"	6	3/8"	4-3/8"	6"	3-1/4"	9
69F	TC XXX	80	2700	69"	56"-30"	6	3/8"	4"	6"	3-1/4"	9
69L	TC XXX	80	2700	69"	56"-30"	6	3/8"	4-3/8"	6"	3-1/4"	9
76CB	TC XXX	150	2600	76"	58"-48"	8	3/8"	5-1/4"	7"	4"	14
76CC	TC XXX	165	2800	76"	58"/48"	8	3/8"	5-1/4"	7"	4"	14
76FA	TC XXX	130	2550	76"	62"-54"	8	7/16"	5-1/4"	7"	4"	12
76FI	TC XXX	113	2200	76"	62"-54"	4	7/16"	5-1/4"	7"	4"	12
76HC	TC XXX	150	2600	76"	58"-48"	8	3/8"	5"	7"	4"	14
76Q	TC XXX	130	2550	76"	62"-54"	8	3/8"	5-1/4"	7-1/4"	4"	12
78FI	TC XXX	100	2375	78"	62"-48"	4	7/16"	5-1/4"	7"	4"	13
78M	TC XXX	120	2375	78"	62"-48"	8	3/8"	5-1/4"	7"	4"	13
78W	TC XXX	120	2375	78"	62"-48"	6	7/16"	4-5/8"	7"	4"	13

*Production basis. Production Certificate No. XX

NOTE 1. A dash number added to the model designation refers to the pitch in inches. The pitch must be within the approved limits listed on the specification.

NOTE 2. Bolt holes may be counter-drilled for mounting on hub flange having bolt-hole bushings.

NOTE 3. A letter following the propeller serial number indicates that the propeller is plastic covered.

....END....

Figure 1. Sample Propeller Specification for Wood Fixed-Pitch Propellers.

DEPARTMENT OF COMMERCE
CIVIL AERONAUTICS ADMINISTRATION

P-XXX-3
BLACK
S74R

June 2, 1955

PROPELLER SPECIFICATION

Propellers of models described herein conforming with these specifications and approved data on file with the Civil Aeronautics Administration are rated as airworthy for use in certificated aircraft in accordance with pertinent aircraft specifications and applicable portions of the Civil Air Regulations.

The propellers are of fixed-pitch, single-piece, two-blade, aluminum alloy construction. The take-off rating is ten percent in excess of the maximum continuous rating. These limitations apply to all propellers listed herein except as modified in the notes.

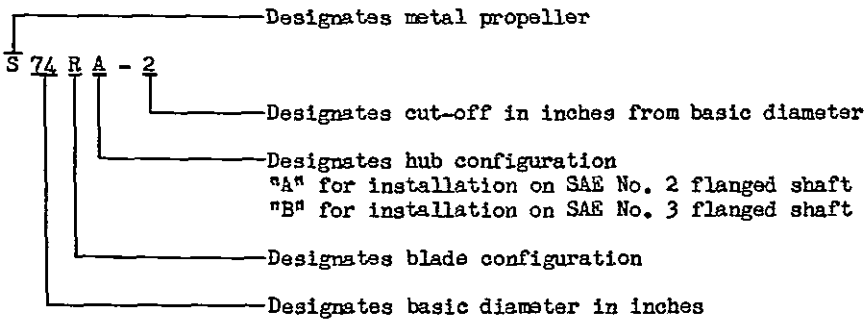
Manufacturer: Black Corporation, Hometown, Pennsylvania

Model	Max. Cont. HP	Max. Cont. RPM	Dia.	Std. Pitch	Hub Drilling No. Holes	Hub Drilling Dia. Holes	Hub Drilling Dia. Bolt Circle	Hub Dimensions Dia.	Hub Dimensions Thickness	Wt. Lbs. (Max. Dia.)
S74RA	165	2800	74"	70"-45"	6	25/64"	4-3/4"	6"	3-7/16"	29.5
S74RB	165	2800	74"	70"-45"	8	25/64"	5-1/4"	6-1/2"	3-7/16"	29.5

Certification basis: Type Certificate No. XXX
Production basis: Production Certificate No. XX

NOTE 1. Installation. These models are for installation on flanged propeller shaft ends (see NOTE 2. The front plate supplied by the engine manufacturer is not to be used. Installation is to be made with special steel bolts which are either furnished or specified by the propeller manufacturer.

NOTE 2. Model Designation.



NOTES 3, 4, 5, 6, 7 and 8. Not applicable.

Figure 2. Sample Propeller Specification for Metal Fixed-Pitch Propellers.

PROPELLER SPECIFICATION - Black Page 2 of 2 pages P-XXX-3

NOTE 9. Table of Propeller-Engine Combinations
Approved Vibrationwise for Use on Single-Engine Tractor Aircraft

The maximum and minimum propeller diameters that can be used from a vibration standpoint are shown below. No reduction below the minimum diameter listed is permissible since this figure includes the diameter reduction allowable for repair purposes.

Propeller Model	Engine Model	Max. Dia. (inches)	Min. Dia. (inches)	Placards
S74RA	Brown B-310	74	72	Avoid continuous operation between 2050 and 2250 rpm on the ground.
S74RB	National F-960 Series	73	71	None

....END....

Figure 2. Sample Propeller Specification for Metal Fixed-Pitch Propellers---Continued

DEPARTMENT OF COMMERCE
CIVIL AERONAUTICS ADMINISTRATION

P-XXX-6
EXCELL
227

September 7, 1955

PROPELLER SPECIFICATION

Propellers of models described herein conforming with these specifications and approved data on file with the Civil Aeronautics Administration are rated as airworthy for use in certificated aircraft in accordance with pertinent aircraft specifications and applicable portions of the Civil Air Regulations.

Manufacturer	Excell Propeller Company Bigtown, Ohio
Type	Constant speed;hydraulic. (See NOTES 3 and 4).
Engine shaft	SAE #20 spline.
Hub material	Alloy steel.
Blade material	See below.
No. of blades	Two.
Design series eligible	227-500, -600, -700 (See NOTES 1, 4, and 10).

Blades Eligible (See NOTE 2)	Maximum Continuous HP	Maximum Continuous RPM	Takeoff HP	Takeoff RPM	Diameter Limits	Approx. Max.Wt. Complete* (For reference only) (See NOTES 3 and 7)	Blade Construction
7425-0 to 7425-8	150	2700	150	2700	74" - 66" (-0 to -8)	54 lbs.	Varnished laminated birch veneer with fabric; and brass, Everdure, or stainless steel tipping.
7438-0 to 7438-6	215	2600	215	2600	74" - 68" (-0 to -6)	54 lbs.	Plastic covered laminated birch veneer with brass. Everdure, or stainless steel tipping.
7652-0 to 7652-8	225	3000	225	3000	76" - 68" (-0 to -8)	61 lbs.	Aluminum alloy
8482-0 to 8482-9	215 or 240	2600 or 1920	215 or 260	2600 or 2130	84" - 75" (-0 to -9)	62, 65 lbs.*	Special fabric base plastic; stainless steel or brass tipping.
8848-0 to 8848-10	240	2600	240	2600	88" - 78" (-0 to -10)	65 lbs.	Aluminum alloy
9387-0 to 9378-5	260	2330	230	2330	93" - 88" (-0 to -5)	64, 68 lbs.**	Aluminum alloy

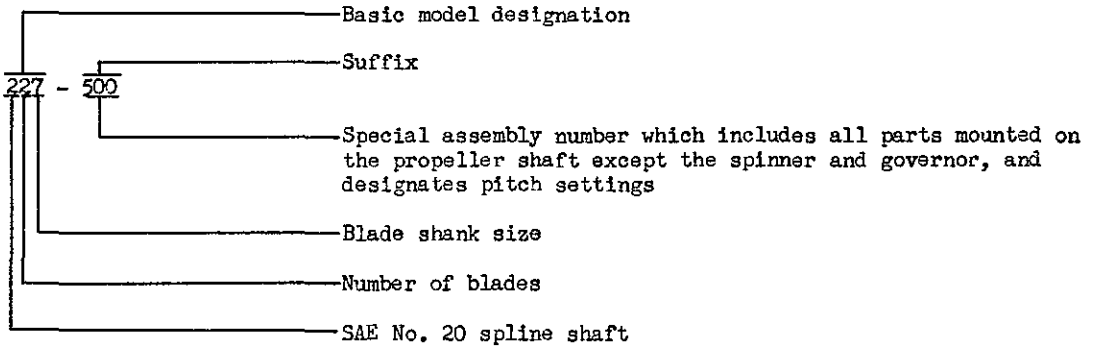
*Higher weight applies to design series -600.
**Higher weight applies to design series -700.

Certification basis	Type Certificate No. XXX
Production basis	Production Certificate No. XX

Figure 3. Sample Propeller Specification for Variable-Pitch Propellers.

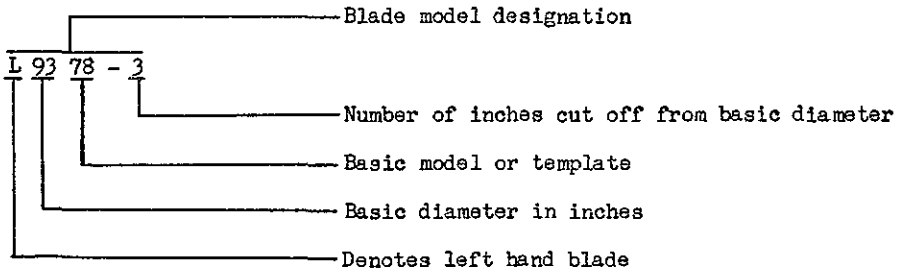
PROPELLER SPECIFICATION NO. XXX Excell 227 Page 2 of 3 pages P-XXX-6

NOTE 1. Propeller Model Designation. The model designation of a complete propeller assembly (which includes all parts mounted on the propeller shaft except the spinner and governor) consists of a number suffixed to the basic model designation. For example:



A change in the suffix number indicates a design series change which may affect eligibility.

NOTE 2. Blade Model Designation.



NOTE 3. Pitch Control. Eligible with Excell manual or constant speed control. Constant speed control includes the Excell governor Model A-1. Additional weight of governor is 3.75 lbs.

NOTE 4. (a) Feathering. Eligible with full feathering control installed in accordance with the propeller manufacturer's instructions.
(b) Reversing. The -500 and -600 models incorporate hydraulically controlled reversing.

NOTE 5. Left Hand Models. The left hand version of an approved model propeller is eligible at the same rating and diameter as listed for the right hand model. (See NOTE 2.)

NOTE 6. Interchangeable Blades. Only blades listed in the same group of the following listed groups are sufficiently similar aerodynamically and vibrationwise to permit interchangeability in the same diameter without a flight test. Blades with different model numbers should not be incorporated in the same propeller and reference should always be made to the ratings of the blades.
Group (a) 7425,7438.

NOTE 7. Accessories.
(a) Propeller spinners.
(1) Eligible with Excell spinners. Additional weight 3 lbs. The -700 model includes a spinner.
(b) Propeller de-icing.
(1) Aluminum alloy blades eligible with Goodfield 38053 fluid feed shoes, or Goodfield "Iceno" shoes, when applied in accordance with Goodfield instructions.
(2) Eligible with Excell de-icing slinger ring assemblies only.

Figure 3. Sample Propeller Specification for Variable-Pitch Propellers—Continued

PROPELLER SPECIFICATION NO. XXX Excell 227 Page 3 of 3 pages P-XXX-6

NOTE 8. Not applicable.

NOTE 9. Table of Propeller-Engine Combinations
Approved Vibrationwise for Use on Single-Engine Tractor Aircraft
The maximum and minimum propeller diameters that can be used from a vibration standpoint are shown below. No reduction below the minimum diameter listed is permissible, since this figure includes the diameter reduction allowable for repair purposes.

Blade Model	Engine Model	Max. Dia. (Inches)	Min. Dia. (Inches)	Placards
7425	Brown B-310	74	72	Never exceed 2750 rpm.
7652	Brown B-310	76	72	None.
8482	National F-960	84	82	None.
	National F-970	84	80	None.
	National F-980	84	82	None.
8848	Brown B-350	88	86	None.
	Brown B-370	88	86	None.
9378	National F-990	90	88	None.
	Brown B-370	93	91	Avoid cont. eng. operation between 1675 and 2160 rpm and between 2900 and 3200 rpm.

NOTE 10. Special Limits. The -600 and -700 hubs can be used only on installations with powerplant oil pressure of 50 psi or above.

....END....

Figure 3. Sample Propeller Specification for Variable-Pitch Propellers—Continued

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