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# Standard Specification for Installation and Integration of Propeller Systems[1]

This standard is issued under the fixed designation F3065/F3065M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification addresses the airworthiness requirements for the installation and integration of propeller systems.

1.2 This specification is applicable to aeroplanes as defined in F44 terminology standard.

1.3 The applicant for a design approval must seek the individual guidance to their respective CAA body concerning the use of this standard as part of a certification plan. For information on which CAA regulatory bodies have accepted this standard (in whole or in part) as a means of compliance to their Small Aircraft Airworthiness regulations (Hereinafter referred to as "the Rules"), refer to ASTM F44 webpage (www.ASTM.org/COMITTEE/F44.htm) which includes CAA website links.

1.4 *Units*—The values stated are SI units followed by Imperial units in square brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

F3060 Terminology for Aircraft

## 3. Terminology

3.1 See Terminology F3060.

## 4. Propeller Installation Aspects

4.1 *Propeller—General:*

4.1.1 Each propeller must:

4.1.1.1 Have a type certificate, or

4.1.1.2 Meet the requirements acceptable to the certifying aviation authority for inclusion in the approved aeroplane.

4.1.2 Engine power and propeller shaft rotational speed may not exceed the limits for which the propeller is certificated or approved.

4.2 *Feathering Propellers*—Each featherable propeller must have a means to un-feather in flight.

4.3 *Variable-Pitch Propellers*—The propeller blade pitch control system must meet the following requirements:

4.3.1 No single failure or malfunction in the propeller system will result in unintended travel of the propeller blades to a position below the in-flight low-pitch position. Failure of structural elements need not be considered if the occurrence of such a failure is shown to be extremely remote.

4.3.2 For propellers incorporating a method to select blade pitch below the in-flight low pitch position, provisions must be made to sense and indicate to the flight crew that the propeller blades are below that position by a defined amount. The method for sensing and indicating the propeller blade pitch position must be such that its failure does not affect the control of the propeller.

4.3.3 The propeller control system, operating in normal and alternative operating modes and in transition between operating modes, performs the defined functions throughout the declared operating conditions and flight envelope.

4.3.4 The propeller control system functionality is not adversely affected by the declared environmental conditions, including temperature, electromagnetic interference (EMI), high intensity radiated fields (HIRF) and lightning.

4.3.5 A method is provided to indicate that an operating mode change has occurred if flight crew action is required.

4.3.6 No single failure or malfunction of electrical or electronic components in the control system results in a hazardous propeller effect.

4.3.7 Failures or malfunctions directly affecting the propeller control system in a typical airplane, such as structural failures of attachments to the control, fire, or overheat, do not lead to a hazardous propeller effect.

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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.

4.3.8 The loss of normal propeller pitch control does not cause a hazardous propeller effect under the intended operating conditions.

4.3.9 The failure or corruption of data or signals shared across propellers does not cause a hazardous propeller effect.

4.3.10 Electronic propeller control system imbedded software must be designed and implemented by a method approved by the Civil Aviation Authority that is consistent with the criticality of the performed functions and that minimizes the existence of software errors.

4.3.11 The propeller control system must be designed and constructed so that the failure or corruption of airplane-supplied data does not result in hazardous propeller effects.

4.3.12 The propeller control system must be designed and constructed so that the loss, interruption or abnormal characteristic of airplane-supplied electrical power does not result in hazardous propeller effects.

4.3.13 Each propeller blade pitch control system component, including governors, pitch change assemblies, and feathering system components, can withstand cyclic operation that simulates the normal load and pitch change travel to which the component would be subjected during a minimum of 1000 h of typical operation in service.

4.3.14 Propeller components that contain hydraulic pressure and whose structural failure or leakage from a structural failure could cause a hazardous propeller effect demonstrate structural integrity by:

4.3.14.1 A proof pressure test to 1.5× the maximum operating pressure for one minute without permanent deformation or leakage that would prevent performance of the intended function, and

4.3.14.2 A burst pressure test to 2.0× the maximum operating pressure for one minute without failure. Leakage is permitted and seals may be excluded from the test.

4.4 *Pusher Propeller Installation:*

4.4.1 All engine cowling, access doors, and other removable items must be designed to have a remote probability of separation that could cause contact with the pusher propeller.

4.4.2 Each pusher propeller must be marked so that the disc is conspicuous under normal daylight ground conditions.

4.4.3 If the engine exhaust gases are discharged into the pusher propeller disc, it must be shown by tests, or analysis supported by tests, that the propeller is capable of continuous safe operation.

4.5 *Propeller Clearance:*

4.5.1 Propeller clearances in section 4.5 are the minimum allowable, unless otherwise substantiated, under the following conditions:

4.5.1.1 With the aeroplane at maximum weight,

4.5.1.2 With the most adverse center of gravity, and

4.5.1.3 With the propeller in the most adverse pitch position.

4.5.2 *Ground Clearance with Forward Mounted Propellers:*

4.5.2.1 *Normal Operation*—With landing gear statically deflected and the aeroplane in the level, normal takeoff, or taxiing attitude, whichever is most critical; there must be a clearance between each propeller and the ground of at least:

*(1)* 18 cm [7 in.] for each aeroplane with nose wheel landing gear, or

*(2)* 23 cm [9 in.] for each aeroplane with tail wheel landing gear.

4.5.2.2 *Deflated and Bottomed Struts*—For each aeroplane with conventional landing gear struts using fluid or mechanical means for absorbing landing shocks, there must be positive clearance between the propeller and the ground in the level takeoff attitude with the critical tire completely deflated and the corresponding landing gear strut bottomed.

4.5.2.3 *Leaf Spring Struts*—Positive clearance for aeroplanes using leaf spring struts is shown with a deflection corresponding to 1.5 g.

4.5.3 *Ground Clearance with Aft-Mounted Propellers*—In addition to the clearances specified in 4.5.2, an aeroplane with an aft mounted propeller must be designed such that the propeller will not contact the runway surface when the aeroplane is in the maximum pitch attitude attainable during normal takeoffs and landings.

4.5.4 *Water Clearance:*

4.5.4.1 There must be a clearance of at least 46 cm [18 in.] between each propeller and the water.

4.5.4.2 The clearance may be reduced if the spray does not dangerously obscure the vision of the pilots or damage the propellers or other parts of the seaplane or amphibian at any time during taxiing, takeoff, or landing.

4.5.5 *Structural Clearance*—There must be:

4.5.5.1 At least 25 mm [1 in.] radial clearance between the blade tips and the aeroplane structure, plus any additional radial clearance necessary to prevent harmful vibration;

4.5.5.2 At least 12.7 mm [½ in.] longitudinal clearance between the propeller blades or cuffs and stationary parts of the aeroplane; and

4.5.5.3 Positive clearance between other rotating parts of the propeller or spinner and stationary parts of the aeroplane.

4.5.6 *Clearance from Occupant(s)*—There must be adequate clearance or shielding between the occupant(s) and the propeller, such that it is not possible for the occupant(s), when seated and strapped in, to contact the propeller.

## 5. Structural Aspects

5.1 *Propeller Vibration and Fatigue:*

5.1.1 Section 5.1 does not apply to fixed-pitch wood propellers of conventional design.

5.1.2 The magnitude of the propeller vibration stresses or loads, including any stress peaks and resonant conditions, throughout the normal operational envelope of the aeroplane must be determined by either:

5.1.2.1 Measurement of stresses or loads through direct testing or analysis based on direct testing of the propeller on the aeroplane and engine installation for which approval is sought; or

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

5.1.3 A fatigue evaluation of the propeller hub, blades, and blade retention must be made to show that failure due to fatigue will be avoided throughout the operational life of the propeller.

5.1.3.1 The fatigue evaluation must use the structural data obtained in accordance with the propeller regulatory requirements or specifications and the vibration data obtained from 5.1.2.

5.1.3.2 The fatigue evaluation must include:

*(1)* The intended loading spectra including reasonably foreseeable propeller vibration and cyclic load patterns,

*(2)* Identified emergency conditions,

*(3)* Allowable over speeds and over torques,

*(4)* The effects of temperatures and humidity expected in service,

*(5)* The effects of aeroplane operating airworthiness limitations, and

*(6)* The effects of propeller operating airworthiness limitations.

5.1.3.3 The fatigue evaluation must consider any other propeller component whose failure due to fatigue could be catastrophic to the aeroplane.

5.1.4 The applicant must demonstrate by tests, analysis based on tests, or previous experience on similar designs that the propeller does not experience harmful effects of flutter throughout the normal operational envelope of the aeroplane.

5.1.5 Any other test method or service experience that proves the safety of the installation acceptable to the certifying aviation authority may be used in place of subsections 5.1.2, 5.1.3, and 5.1.4.

## 6. Propeller Control Limitations

6.1 *Propeller Speed and Pitch Limits:*

6.1.1 The propeller speed and pitch must be limited to values that will assure safe operation under normal operating conditions.

6.1.2 For each propeller whose pitch cannot be controlled in flight.

6.1.2.1 During takeoff and initial climb at the all engine(s) operating climb speed, the propeller must limit the engine r.p.m., at full throttle or at maximum allowable takeoff manifold pressure, to a speed not greater than the maximum allowable takeoff r.p.m.; and

6.1.2.2 During a closed throttle glide, at VNE, the propeller may not cause an engine speed above 110 % of maximum continuous speed.

6.1.3 Each propeller that can be controlled in flight, but that does not have constant speed controls, must have a means to limit the pitch range so that:

6.1.3.1 The lowest possible pitch allows compliance with section 6.1.2.1; and

6.1.3.2 The highest possible pitch allows compliance with section 6.1.2.2.

6.1.4 Each controllable pitch propeller with constant speed controls must have:

6.1.4.1 With the governor in operation, a means at the governor to limit the maximum engine speed to the maximum allowable takeoff r.p.m.; and

6.1.4.2 With the governor inoperative, there must be a means to limit the maximum engine speed to 103 % of the maximum allowable takeoff r.p.m. or maximum approved overspeed, with:

*(1)* The propeller blades at the lowest possible pitch,

*(2)* Takeoff power,

*(3)* The aeroplane stationary, and

*(4)* No wind.

6.2 *Propeller Reversing Systems:*

6.2.1 Each system must be designed so that no single failure, likely combination of failures or malfunction of the system will result in unwanted reverse thrust under any operating condition.

6.2.1.1 Failure of structural elements need not be considered if the probability of this type of failure is extremely remote.

6.2.1.2 Compliance must be shown by failure analysis, or testing, or both, for propeller systems that allow the propeller blades to move from the flight low-pitch position to a position that is substantially less than the normal flight, low-pitch position.

6.2.1.3 The analysis may include or be supported by the analysis from the propeller type certification. Credit will be given for pertinent analysis and testing completed by the engine and propeller manufacturers.

6.2.2 *For Turbopropeller-Powered, Level 4 Aircraft:*

6.2.2.1 Each system intended for in-flight use must be designed so that no unsafe condition will result during normal operation of the system, or from any failure, or likely combination of failures, of the reversing system, under any operating condition, including ground operation.

6.2.2.2 Failure of structural elements need not be considered if the probability of this type of failure is extremely remote.

6.2.2.3 Compliance must be shown by failure analysis, or testing, or both, for propeller systems that allow the propeller blades to move from the flight low-pitch position to a position that is substantially less than the normal flight, low-pitch position.

6.2.2.4 The analysis may include or be supported by the analysis from the propeller type certification and associated installation components.

## 7. Associated Propeller Systems

7.1 *Oil System—Propeller Feathering Systems:*

7.1.1 If the propeller feathering system uses engine oil and that oil supply can become depleted due to failure of any part of the oil system, a means must be incorporated to reserve enough oil to operate the feathering system.

7.1.2 The amount of reserved oil must be enough to accomplish feathering and must be available only to the feathering pump.

7.1.3 The ability of the system to accomplish feathering with the reserved oil must be shown.

7.1.4 Provision must be made to prevent sludge or other foreign matter from affecting the safe operation of the propeller feathering system.

7.2 *Turbopropeller-Drag Limiting Systems:*

7.2.1 As used in this section, drag limiting systems include manual or automatic devices that, when actuated after engine power loss, can move the propeller blades toward the feather position to reduce wind milling drag to a safe level.

7.2.2 Turbopropeller-powered aeroplane propeller-drag limiting systems must be designed so that no single failure or malfunction of any of the systems during normal or emergency operation results in propeller drag in excess of that for which the aeroplane was designed under the structural requirements of this part.

7.2.2.1 Failure of structural elements of the drag limiting systems need not be considered if the probability of this kind of failure is extremely remote.