U.S. Department
of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Compliance with Requirements of § 121.321, Operations in Icing

Date: 08/04/11

Initiated By: ANM-100

AC No: 121.321-1

1. Purpose. This advisory circular (AC) describes an acceptable means for showing compliance with the requirements of Title 14, Code of Federal Regulations (14 CFR) 121.321, Operations in Icing. Part 121 contains the aircraft operating requirements applicable to domestic, flag, and supplemental operations. This AC provides guidance for:

a. Using visible moisture and temperature as a means for the flightcrew to know when the airframe ice protection system (IPS) must be activated.

b. Developing acceptable procedures for activating and deactivating the airframe IPS.

c. Installing a primary or advisory ice detection system.

2. Applicability.

a. General. This AC provides guidance to part 121 operators, airplane manufacturers, modifiers, foreign regulatory authorities, and Federal Aviation Administration (FAA) airplane type certification engineers, their designees, and inspectors. This guidance applies to the operation, in conditions conducive to inflight airframe icing, of part 23 (small) and part 25 (transport category) airplanes with a maximum certified takeoff weight less than 60,000 pounds that are used in part 121 operations.

b. Limitations. 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 FAA 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 pertinent 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. Disclaimer. This material does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements.

3. Definition of Terms. For purposes of this AC, the following definitions should be used. These definitions are intended for use only with respect to § 121.321.

a. Advisory ice detection system. A system that advises the flightcrew of the presence of ice accretion or icing conditions. Both primary ice detection systems and advisory ice detection systems can either direct the pilot to manually activate the IPS or provide a signal that automatically activates the IPS. However, because it has lower reliability than a primary system, an advisory ice detection system can only be used in conjunction with other means (most commonly, visual observation by the flightcrew) to determine the need for, or timing of, activating the anti-icing or deicing system. With an advisory ice detection system, the flightcrew is responsible for monitoring icing conditions or ice accretion as defined in the airplane flight manual (AFM), typically using total air temperature and visible moisture criteria or visible ice accretion. With an advisory ice detection system, the flightcrew is responsible for activating the anti-icing or deicing system(s).

b. Airframe icing. Ice accretion on the airplane, except for on the propulsion system.

c. Anti-icing. Prevention of ice accretions on a protected surface either by evaporating the impinging water, or allowing the impinging water to run back and off the protected surface or freeze on non-critical areas.

d. Automatic cycling mode. A mode of operation of the airframe de-icing system that provides repetitive cycles of the system without the need for the pilot to select each cycle. This is generally done with a timer, and there may be more than one timing mode.

e. Conditions conducive to airframe icing. Visible moisture at or below a static air temperature of 5 °C (41 °F) or total air temperature of 10 °C (50 °F), unless otherwise substantiated.

f. Deicing. The removal or the process of removal of an ice accretion after it has formed on a surface.

g. Ice protection system (IPS). A system that protects certain critical aircraft parts from ice accretion. To be an approved system, it must satisfy the requirements of § 23.1419 or § 25.1419 and other applicable requirements.

h. Primary ice detection system. A detection system used to determine when the IPS must be activated. This system announces the presence of ice accretion or icing conditions, and it may also provide information to other aircraft systems. A primary automatic system automatically activates the anti-icing or deicing IPS. A primary manual system requires the flightcrew to activate the anti-icing or deicing IPS upon indication from the primary ice detection system.

i. Reference surface. The observed surface used as a reference for the presence of ice on the monitored surface. The reference surface may be observed directly or indirectly. Ice must occur on the reference surface before—or at the same time as—it appears on the monitored surface. Examples of reference surfaces include windshield wiper blades or bolts, windshield

posts, ice evidence probes, the propeller spinner, and the surface of ice detectors. The reference surface may also be the monitored surface.

j. Static air temperature. The air temperature that would be measured by a temperature sensor that is not in motion in relation to that air. This temperature is also referred to in other documents as "outside air temperature," "true outside temperature," or "ambient temperature."

k. Total air temperature. The static air temperature plus the rise in temperature due to the air being brought to rest relative to the airplane.

l. Visual cues. Ice accretion on a reference surface that the flightcrew observes. The visual cue is used to detect the first sign of airframe ice accretion.

4. Compliance with § 121.321: Determining Static Air Temperature and Total Air Temperature.

a. Regulation compliance. In the absence of more specific guidance provided by the manufacturer and approved by the FAA, § 121.321 allows use of visible moisture and either a total air temperature at or below 10 °C (50 °F), or a static air temperature at or below 5 °C (41 °F), for determining conditions conducive to airframe icing. If this provision is used, the flightcrew should be able to easily determine total air temperature or static air temperature. If the engine and airframe IPS are both activated based on visible moisture and temperature, a common conservative temperature for operation of both systems should be used. This will ease flightcrew workload and increase the probability of procedural compliance.

b. The FAA anticipates that most types of airplanes to which § 121.321 applies already incorporate a display of total and/or static air temperature available to the pilot. Existing displays that have been previously certificated need not be re-certificated. If the display is a new installation, the responsible aircraft certification office must approve the modification through an amended type certificate or supplemental type certificate (STC). Some aircraft, however, may display temperature information that is not appropriately calibrated to reflect either static or total temperature. If that is the case, a placard should be provided showing the relationship of whatever temperature information is available and the current true air speed, or altitude and other displayed airspeed if not true, to total and/or static air temperature. Temperatures should be shown to the nearest degree Centigrade in the region of interest (for example, around 0 degrees).

c. Hand-held charts and calculators. Requiring pilots to access hand-held charts or calculators instead of a placard should not be used for compliance with § 121.321 because of the increased flightcrew workload that would result.

5. Compliance with § 121.321(a). This section of the rule requires compliance with paragraph (a)(1), (a)(2), or (a)(3) of § 121.321(a). Each option provides the flightcrew with a means to know when the airframe ice protection must be activated; requires activation based on that means; and requires adherence to other AFM operational procedures for flight in icing when the airframe IPS is activated. Section 121.321 defines conditions conducive to airframe icing as visible moisture at or below a static air temperature of 5 °C (41 °F), or a total air temperature of 10 °C (50 °F), unless the approved AFM provides another definition.

a. Section 121.321(a)(1). This option requires a primary airframe ice detection system. One of the following provides an acceptable means of compliance with § 121.321(a)(1):

(1) A primary manual ice detection system that provides an alert that the airframe IPS must be activated.

(2) A primary automatic ice detection system.

b. Section 121.321(a)(2). This option requires both an advisory ice detection system and visual cues to the flightcrew of the first sign of ice formation anywhere on the aircraft. The rule requires the flightcrew to activate the airframe IPS when any of the visual cues are observed or the advisory ice detection system indicates activation is necessary, whichever occurs first.

c. Ice Detection Systems and Amended Type Certificates/STCs. An amended type certificate or STC is necessary for installation of an ice detection system. The applicant should present an ice detection system certification plan to the responsible aircraft certification office. The requirements in § 121.321(a)(1) and (a)(2) for ice detection and visual cues are identical to the requirements of § 25.1419(e)(1) and (e)(2), respectively. Guidance for complying with § 25.1419(e)(1) and (e)(2) is provided in AC 25.1419-2, *Compliance with the Ice Protection Requirements of § 25.1419(e), (f), (g), and (h)*. That AC should also be consulted for compliance with § 121.321(a)(1) and (a)(2). The guidance in that AC is equally applicable to part 23 and part 25 airplanes with the exceptions identified in paragraphs 5c(1) and (2) of this AC. Additional guidance on certification of ice detectors and visual cues is located in AC 23.1419-2D, *Certification of Part 23 Airplanes for Flight in Icing Conditions*, and AC 20-73A, *Aircraft Ice Protection*.

(1) Part 25 airplanes should comply with §§ 25.1301, 25.1309, and 25.1419.

(2) Part 23 airplanes should comply with §§ 23.1301, 23.1309, and 23.1419.

d. Section 121.321(a)(3). This option requires the flightcrew to operate the airframe IPS when the airplane is in conditions conducive to airframe icing (in other words, visible moisture and applicable temperature), during certain phases of flight, and at the first sign of ice formation anywhere on the aircraft during other phases of flight. It is not acceptable to use crew assessment of ice depth as the first sign of ice formation. The intent is to permit current certified manual systems to be used in such a way that they replicate the effectiveness of an automatic system without depending on the crew to establish ice depths.

6. Fluid Ice Protection Systems. Certain IPS use fluids that lower the freezing point of water. Unlike other IPS, fluid systems have a limited duration of ice protection that is related to the capacity of fluid that the airplane can carry. Therefore, these systems need additional evaluation. When considering compliance with § 121.321, for airplanes equipped with fluid IPS, two issues should be addressed:

a. System design. Older fluid systems may have been certificated based on an assumption of activation at the first sign of ice accretion or after certain accumulations of ice, not activation upon entering conditions of visible moisture and temperature in accordance with § 121.321(a)(3).

Therefore, the system design should be re-evaluated and shown to have adequate fluid capacity to ensure that the airplane/flightcrew can comply with § 121.321(a)(3), if that option is elected.

b. AFM dispatch instructions.

(1) The minimum dispatch quantity of IPS fluid in the AFM Limitations section should be re-evaluated and shown to be adequate to ensure that the airplane/flightcrew can comply with § 121.321(a)(3), if that option is elected.

(2) The AFM Limitations section should contain pre-flight procedures to verify adequate fluid quantity, both at the tank itself and on the cockpit display, and contain procedures for the system to be operationally checked before flight.

7. Airplane Flight Manual or Manual Required by § 121.133.

a. Section 121.321(a)(1) or (a)(2) compliance. For airplanes that comply with § 121.321(a)(1) or (a)(2), § 121.321(c) requires that procedures for safe operation of the airframe IPS be established and documented in the AFM. For airplanes certified without § 25.1419 at amendment 25-129 in their certification basis, these procedures will be established as part of the STC process for adding equipment. For airplanes certified with § 25.1419 at amendment 25-129 or later, these procedures will be established in the AFM as part of the type certification process.

b. Section 121.321(a)(3) compliance. For airplanes that comply with § 121.321(a)(3), procedures for safe operation of the airframe IPS must be included in either the AFM or in the manual required by § 121.133. The location of these procedures will likely depend upon the certification basis of the airplane. For airplanes that were certified without § 25.1419 at amendment 25-129 in its certification basis, the procedures for operation of airframe IPS could be documented in the manual required by § 121.133. For airplanes certified with § 25.1419 at amendment 25-129, these procedures must be established during type certification and, therefore, must be documented in the AFM. They may also be documented in the manual required by § 121.133.

c. Section 121.321(d) compliance. Section 121.321(d) requires specific procedures for safe operation that must be included in the AFM, or in the manual required by § 121.133. Refer to Appendix A of this AC for acceptable AFM procedures for operation of the airframe IPS for compliance with § 121.321(a)(2). Refer to Appendix B for acceptable AFM procedures for operation of the airframe IPS for compliance with § 121.321(a)(3).

8. Flightcrew Training. Training in the use of and procedures for the equipment required by § 121.321 should be included in the air carrier's initial and recurrent approved training program for pilots.

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Appendix A

1. Acceptable Airplane Flight Manual (AFM) Procedures for Compliance with § 121.321(a)(2). Paragraphs 2 and 3 of this appendix provide acceptable AFM procedures for airframe ice protection system (IPS) operation in airplanes that comply with § 121.321(a)(2).

2. The Airframe IPS Must be Turned ON—At the first sign of ice formation anywhere on the aircraft, or upon annunciation from an ice detector system, whichever occurs first.

a. For anti-icing systems. The system must be operated continuously.

b. For deicing systems.

(1) If there is an automatic cycling mode with more than one rate of cycling available, the system must be operated continuously at the cycle rate appropriate to minimize ice accretions. If there is any uncertainty, the fastest cycling rate should be used.

(2) If an automatic cycling mode is not available, the system must be operated at short intervals (not to exceed three minutes) to minimize ice accretions. In addition, the system must be operated for at least one complete cycle immediately:

(a) Before decreasing airspeed for holding or for maneuvering for approach and landing.

(b) Before beginning the turn intended to intercept the final approach course inbound, including the procedure turn.

(c) Before selecting or changing any flap configuration.

(d) After gear and flap retraction on a go-around climb.

3. The Airframe IPS May be Turned OFF.

a. For anti-icing systems. Five minutes after:

(1) The visual cues and the advisory ice detection system no longer indicate ice formation or accretion (accumulation), or

(2) Leaving conditions conducive to airframe icing.

b. For deicing systems. Following completion of three deicing cycles after the substantiated visual cues and the advisory ice detection system no longer indicate ice accretion.

Appendix B

1. Acceptable Airplane Flight Manual (AFM) Procedures for Compliance with § 121.321(a)(3). Paragraphs 2 and 3 of this appendix provide acceptable AFM procedures for airframe ice protection system (IPS) operation in airplanes that comply with § 121.321(a)(3). These procedures may also be used in the manual required by § 121.133.

2. The Airframe IPS Must be Turned ON—When operating in visible moisture at or below a static air temperature of 5 °C (41 °F) or a total air temperature of 10 °C (50 °F) during:

- Takeoff climb after second segment, en route climb, and go-around climb,
- Holding,
- Maneuvering for approach and landing, and
- Any other operation at approach or holding speeds.

During any other phase of flight the IPS must be activated and operated at the first sign of ice formation anywhere on the aircraft except where the AFM specifies that the ice protection should not be used.

a. For anti-icing systems. The system must be operated continuously.

b. For deicing systems.

(1) If there is an automatic cycling mode with more than one rate of cycling available, the system must be operated continuously at the cycle rate appropriate to minimize ice accretions. If there is any uncertainty, the fastest cycling rate should be used.

(2) If an automatic cycling mode is not available, the system must be operated at short intervals (not to exceed three minutes) to minimize ice accretions. In addition, the system must be operated for at least one complete cycle immediately:

(a) Before decreasing airspeed for holding or for maneuvering for approach and landing.

(b) Before beginning the turn intended to intercept the final approach course inbound, including the procedure turn.

(c) Before selecting or changing any flap configuration.

(d) After gear and flap retraction on a go-around climb.

3. The Airframe IPS May be Turned OFF.

a. For anti-icing systems. Five minutes after leaving conditions conducive to airframe icing.

b. For deicing systems. Following completion of three deicing cycles after leaving conditions conducive to airframe icing.