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Section 5. Cooling

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SUBPART E - POWERPLANT

Section 5. Cooling

Section 25.1041 General.

a. **Rule Text.**

The powerplant and auxiliary power unit cooling provisions must be able to maintain the temperatures of powerplant components, engine fluids, and auxiliary power unit components and fluids within the temperature limits established for these components and fluids, under ground, water, and flight operating conditions, and after normal engine or auxiliary power unit shutdown, or both.

(Amdt. 25-38, 41 FR 55467, Dec. 20, 1976)

b. **Intent of Rule.** The intent of this rule is self-evident.

c. **Background.**

(1) Notice of Proposed Rulemaking 61-12, dated June 8, 1961, proposed to amend the cooling requirements of Civil Air Regulations (CAR) 4b to include turbine engines. The preamble to Amendment 4b-12 to the CAR discussed these changes as follows:

> Presently, [*CAR Sections*] 4b.450 through 4b.455 deal with the powerplant cooling capability and specify test to show that powerplant temperature limits can be maintained. With the exception of Section 4b.455, these sections apply to reciprocating engines. Sections 4b.450 through 4b.452 are being clarified by making them generally applicable to turbine engine installations as well as reciprocating engine installations, and by specifying test conditions in general terms that are based on the applicable performance requirements. This clarification makes sections 4b.453 and 4b.455 unnecessary.

(2) This section, which was originally contained in Part 4b of the Civil Air Regulations, was recodified into Part 25 as part of the Agency recodification program announced in Draft Release 61-25, and published in the Federal Register on November 15, 1961 (26 FR 10698).

(3) Notice of Proposed Rulemaking 65-43 (31 FR 93, January 5, 1966) proposed that § 25.1041 be amended to require that powerplant cooling provisions maintain safe temperatures after engine shutdown. Experience has shown that residual

powerplant heat can cause temperatures after shutdown higher than those experienced during engine operation, since normal powerplant cooling ceases upon shutdown.

(4) Amendment 25-11 (32 FR 6906, May 5, 1967) followed Notice 65-43 and amended § 25.1041 to require adequate cooling not only when the airplane is operating, but also "after engine shutdown." One commenter to the proposal stated that there may be abnormal engine shutdowns, such as an emergency shutdown from a high power setting, following which temperature limits may be exceeded. This commenter stated that the proposal should be narrowed to include only normal engine shutdowns. The FAA agreed.

(5) Notice of Proposed Rulemaking 75-10 (40 FR 10802, March 7, 1975) proposed to revise this section to include APU's. The explanation given was:

> The proposal would provide a general cooling requirement for auxiliary power units.

It should be noted that § 25.1041 contains only a general cooling requirement, while § 25.1043 and § 25.1045 are more specific with respect to the types of operating conditions to be considered during tests.

(6) Amendment 25-38 (41 FR 55467, December 20, 1976) followed Notice 75-10 and adopted the proposal.

d. **Policy/Compliance Methods**. No dedicated policy material on transport category airplanes is currently available. (See the following sections of this Mega AC, however, for guidance regarding testing.)

e. **References.**

(1) Notice of Proposed Rulemaking 61-12, June 8, 1961.

(2) Draft Release 61-25, 26 FR 10698, November 15, 1961.

(3) Notice of Proposed Rulemaking 65-43 (31 FR 93, January 5, 1966).

(4) Amendment 25-11 (32 FR 6906, May 5, 1967).

(5) Notice of Proposed Rulemaking 75-10 (40 FR 10802, March 7, 1975).

(6) Amendment 25-38 (41 FR 55467, December 20, 1976).

Section 25.1043 Cooling tests.

a. **Rule Text.**

(a) General. Compliance with § 25.1041 must be shown by tests, under critical ground, water, and flight operating conditions. For these tests, the following apply:

(1) If the tests are conducted under conditions deviating from the maximum ambient atmospheric temperature, the recorded powerplant temperatures must be corrected under paragraphs (c) and (d) of this section.

(2) No corrected temperatures determined under paragraph (a)(1) of this section may exceed established limits.

(3) For reciprocating engines, the fuel used during the cooling tests must be the minimum grade approved for the engines, and the mixture settings must be normally used in the flight stages for which the cooling tests are conducted. The test procedures must be as prescribed in § 25.1045.

(b) Maximum ambient atmospheric temperature. A maximum ambient atmospheric temperature corresponding to sea level conditions of at least 100 degrees F must be established. The assumed temperature lapse rate is 3.6 degrees F per thousand feet of altitude above sea level until a temperature of -69.7 degrees F is reached, above which altitude the temperature is considered constant at -69.7 degrees F. However, for winterization installations, the applicant may select a maximum ambient atmospheric temperature corresponding to sea level conditions of less than 100 degrees F.

(c) Correction factor (except cylinder barrels). Unless a more rational correction applies, temperatures of engine fluids and powerplant components (except cylinder barrels) for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum component or fluid temperature recorded during the cooling test.

(d) Correction factor for cylinder barrel temperatures. Unless a more rational correction applies, cylinder barrel temperatures must be corrected by adding to them 0.7 times the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test.

(Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-42, 43 FR 2323, Jan. 16, 1978)

b. **<u>Intent of Rule</u>.** This section requires that certain ambient temperature correction factors be applied unless testing is accomplished at the maximum ambient atmospheric temperature prescribed.

c. **<u>Background.</u>**

(1) The regulatory history shows that this requirement originated from section 4b.45 of the Civil Air Regulations (CAR), December 31, 1953, per Amendment 4b-12 (27 FR 2986, March 30, 1962).

(2) This section was recodified into Part 25 as part of the Agency recodification program announced in Draft Release 61-25, and published in the Federal Register on November 15, 1961 (26 FR 10698). It was recodified from CAR 4b.484 without any substantive changes.

(3) Amendment 25-42 (43 FR 2323, January 16, 1978) contained a discussion in its preamble that introduced the requirement of a minimum temperature of 100° F. Justification given was that *"the 100 degrees F minimum is appropriate, since a lower temperature would be impractical and unrealistic considering summer operations in the United States. It should be noted that an exception to the minimum is provided for winterization installations."*

d. **<u>Policy/Compliance Methods</u>.** In general, the demonstration of compliance with this section requires testing and analysis. The applicant must identify all critical components (electronic components, actuators, etc.), including structure that have temperature limits. The limits are typically based on component qualification testing. Each limit may be expressed in terms of surface temperature, environmental temperature and may have associated time limits. Instrumentation should be installed to provide data needed to show that each component corrected temperature remains below the identified limit.

(1) For transport category airplanes, the cooling test consists of a ground and flight test. The following guidance was developed during a recent certification project due to specific questions from an Aircraft Certification Office.

(a) <u>Ground Cooling Test</u>: Ground testing should be conducted with the engine operated at idle power until all critical temperatures have stabilized, followed by operation of the engine at rated takeoff power for 5 minutes, and then idle power until all critical temperatures have stabilized. During the ground operation portion of the compliance demonstration, the definition of stabilized temperatures defined for the flight test (rate of change less than 2 degrees per minute) should not be used for determining maximum component temperatures, unless it can be shown that ground operation of the engine is limited to the conditions tested. The reason for utilizing a different definition of stabilized temperatures for ground operation is that during ground operations sustained operation at a particular condition, such as idle power for reasons such as utilizing the engines as a pneumatic source, may result in temperatures that gradually exceed the defined temperature limits.

To address this concern, some manufacturers have used engine operating limitations for ground operations that limit engine operation for discrete time periods. For example, engine operation at takeoff power may be limited to 2 minutes at ambient temperatures above 110°F, or engine operation at idle power is limited to 2 hours at ambient temperatures above 110°F.

(b) Flight Test: The flight test should be initiated with critical temperatures stabilized, followed by operation of the engine at rated takeoff power (either 5 or 10 minutes) and then operation at Maximum Continuous Thrust until temperatures stabilize. The airplane flight profile (climb gradient) should simulate that of a maximum gross weight airplane executing an engine out climb.

The compliance demonstration flight test should be conducted with ambient temperatures as close to hot day conditions as is practical. The test should not be conducted when a temperature inversion exists. During an inversion, where a layer of colder air is at ground level, component temperatures at the beginning of the cooling climb will be lower relative to the ambient air temperature encountered during the climb. For some components that are not significantly affected by ambient temperature (or require significant time to adjust to ambient temperature changes), the artificially low starting temperature may result in erroneous results. If cooling tests are conducted when an inversion exists the applicant should present a “more rational correction method” than a degree- for- degree or that defined in § 25.1043. The FAA has accepted a correction method that utilized the difference between the test day ambient and the hot day atmospheric temperature taken at the beginning of the flight being used as the correction factor for all flight data. Although conservative, this method accounts for the effects of an inversion.

(2) The following extract from Advisory Circular AC 29-2A, “Certification of Transport Category Rotorcraft,” (paragraph 516, Section 29.1041), provides guidance for transport category rotorcraft, but may be used as a basis for establishing a methodology for transport category airplanes.

Cooling Tests.

b. Procedures.

(1) Seldom is testing actually accomplished at the maximum required ambient temperature of at least 100° F at sea level lapsed 3.6° F per 1,000 feet pressure altitude. Component and fluid temperatures must therefore be corrected to derive the item temperature that would have been reached if the test day had matched exactly the maximum ambient temperature day. The applicant may select a higher maximum ambient temperature for cooling certification than the 100° F sea level hot day prescribed. Provisions are also made for selecting a maximum ambient temperature less than the 100° F sea level hot day for winterization installations not intended to function at the hot day conditions.

(2) When cooling test ambient conditions are cooler than the selected or prescribed hot day conditions, the applicant may take advantage of cooling air or fluid flows that would exist at hot day conditions. For example, thermostatically controlled oil cooler flow could be set for hot day conditions provided the system has been shown to have adequate margin to maintain temperatures at this value during hot day conditions.

(3) The component and fluid temperature correction factor to be applied when test ambients do not correspond to the hot day conditions is commonly called the “degree-for-degree correction.” It may be possible to justify, and the regulation allows the application of a more rational, less conservative correction factor. A correction factor other than degree-for-degree should be based on engineering test data.

(4) No corrected temperatures may exceed established limits. In order to maintain temperatures within established limits, the applicant may be willing to accept lesser performance than the full capability of a device. For example, a starter/generator capable of cooling under test cell conditions to 200 amperes continuous load may be limited to a lesser value, perhaps to 150 amperes, when installed in the aircraft due to cooling considerations. This continuous load for cooling must be equal to or greater than the allowable continuous load designated on aircraft instruments.

c. Thermal Limit Correction.

(1) An important correction factor which is not discussed in the regulations, but is frequently necessary to show the cooling adequacy required by § 29.1041, is the thermal limit correction factor. This factor is sometimes required if, at test day conditions, the engine-measured temperature does not correspond to that which would have occurred on a minimum specification engine at hot day conditions.

(2) The correction factor would not apply to those components not affected by changes in measured gas temperature (MGT) at a constant power. Typical items expected to be affected by changes in the MGT at constant power would be engine oil temperature, thermocouple harnesses, or other fluid, component, or ambient temperatures in the vicinity of the engine hot-section or exhaust gases. Other items remote from the hot-section, perhaps the starter-generator or fuel control, would not be expected to be influenced by MGT variations; however, the items affected and the magnitude of the factor to be applied should be established by testing.

(3) There are several acceptable methods for establishing the appropriate thermal limit correction factor during development testing. The general idea is to establish a stabilized flight condition, typically ground-run or in- ground-effect (IGE) hover, and to vary the measured gas temperature at approximately fixed power and OAT conditions. This may be accomplished by utilizing engine anti-ice bleed air, customer bleed air, or by ingesting warmer than ambient air (either an external source or the engine bleed air) into the engine inlet. Care should be used when ingesting warmer than ambient air to assure that the warm air is diffused in order to avoid possible engine surge.

(i) If it is not possible to attain a suitable in MGT by these methods, an acceptable, but conservative thermal limit correction may be obtained by allowing both shaft horsepower and MGT to vary at stabilized flight condition and OAT.

(ii) The component temperature is plotted as a function MGT, and the thermal limit correction from any test day MGT for any flight condition, to the MGT that would have existed with minimum specification engines on a hot day, is then applied to derive the final measured component temperature.

(4) In certain rare instances, it may not be required that the correction factor be applied to the full thermal limit capability of the engine. Consider the following example for the hot day hover IGE cooling test point at sea level.

	Corresponding	
	Power (SHP)	**MGT (°C)**
Drive System Limit	900	--
Twin Engine Hot Day Power Available	1,050	750
Hot Day Power Required at Maximum G.W	850	650
Engine Maximum Allowable MGT (Instrument Marking)	--	765
Test Day (90° F OAT) Parameters	850	600

(i) Notice that the installed hot day power available from the engine performance program, is 15° C cooler than the limit MGT (750° vs. 765° C). Thus, the engine has 15° C "field margin," which would allow the engine temperature to gradually increase 15°C to maintain given power as engine life is utilized. Secondly, measured gas temperature corresponding to hot day power required at maximum gross weight, is less than that corresponding to either the drive system limit or twin engine hot day power available. Thus, the thermal limit correction could be applied from the test day MGT, 600° C, to the power required MGT plus the field margin, 650° C plus 15° C, rather than applying the correction factor to the full thermal capability of the engine, 765° C.

(ii) Care should be used in applying this relieving method because as the hover altitude changes, the maximum gross weight and power required (and the associated MGT) will vary. The data must be corrected to at least the maximum MGT for a minimum specification engine that can occur in service at the flight condition under investigation.

e. **References.**

(1) Civil Air Regulations (CAR) 4b, December 31, 1953.

(2) Amendment 4b-12 (27 FR 2986, March 30, 1962).

(3) Amendment 25-42 (43 FR 2323, January 16, 1978).

(4) Advisory Circular 29-2B, “Certification of Transport Category Rotorcraft,” July 30, 1997.

Section 25.1045 Cooling test procedures.

a. **Rule Text.**

(a) Compliance with § 25.1041 must be shown for the takeoff, climb, en route, and landing stages of flight that correspond to the applicable performance requirements. The cooling tests must be conducted with the airplane in the configuration, and operating under the conditions, that are critical relative to cooling during each stage of flight. For the cooling tests, a temperature is ''stabilized'' when its rate of change is less than two degrees F. per minute.

(b) Temperatures must be stabilized under the conditions from which entry is made into each stage of flight being investigated, unless the entry condition normally is not one during which component and the engine fluid temperatures would stabilize (in which case, operation through the full entry condition must be conducted before entry into the stage of flight being investigated in order to allow temperatures to reach their natural levels at the time of entry). The takeoff cooling test must be preceded by a period during which the powerplant component and engine fluid temperatures are stabilized with the engines at ground idle.

(c) Cooling tests for each stage of flight must be continued until --

(1) The component and engine fluid temperatures stabilize;

(2) The stage of flight is completed; or

(3) An operating limitation is reached.

(d) For reciprocating engine powered airplanes, it may be assumed, for cooling test purposes, that the takeoff stage of flight is complete when the airplane reaches an altitude of 1,500 feet above the takeoff surface or reaches a point in the takeoff where the transition from the takeoff to the en route configuration is completed and a speed is reached at which compliance with § 25.121(c) is shown, whichever point is at a higher altitude. The airplane must be in the following configuration:

(1) Landing gear retracted.

(2) Wing flaps in the most favorable position.

(3) Cowl flaps (or other means of controlling the engine cooling supply) in the position that provides adequate cooling in the hot-day condition.

(4) Critical engine inoperative and its propeller stopped.

(5) Remaining engines at the maximum continuous power available for the altitude.

(e) For hull seaplanes and amphibians, cooling must be shown during taxing downwind for 10 minutes, at five knots above step speed.

(Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-57, 49 FR 6848, Feb. 23, 1984)

b. **Intent of Rule.** The intent of this rule is to verify, for transport category aircraft, that cooling provisions are adequate for a one-engine-inoperative (OEI) climb or descent initiated from a multiengine cruise at the critical altitude with stabilized component temperatures. Cooling tests are conducted to determine the ability of the powerplant cooling provisions to maintain the temperatures of powerplant components and engine fluids within the temperature limits for which they have been certificated. These limits will normally be specified on the type certificate data sheet.

c. **Background.**

(1) The regulatory history shows that this requirement originated from section 4b.452 of the Civil Air Regulations (CAR) 4b, December 31, 1953, per Amendment 4b-12 (27 FR 2986, March 30, 1962). Amendment 25-AD was published in the Federal Register on December 24, 1964 (29 FR 18289), which added Part 25 [New] to the Federal Aviation Regulations and replaced Part 4b of the Civil Air Regulations. It was part of the Agency recodification program announced in Draft Release 61-25, published in the Federal Register on November 15, 1961 (26 FR 10698). Part 25 [New] was published as a notice of proposed rule making in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. This rule was recodified from CAR 4b.452 without any substantive changes.

(2) Amendment 25-57 (49 FR 6832, February 23, 1984) corrected references in § 25.1045(d) to performance requirements that had become obsolete. The preamble to that amendment addressed one commenter's suggestion to delete the cooling test configuration center of gravity requirement as irrelevant; and another commenter's suggestion to include the following rewording: *". . . the most unfavorable center of gravity position at which the airplane can be flown safely."* The FAA noted that reference to the most unfavorable center of gravity was carried over from deleted § 25.67 ("Climb: One engine inoperative"), which governed demonstrations of one engine inoperative climb; § 25.121(c) is the new reference, and it has no requirement for center of gravity position. In any case, the airplane must be flown within the airplane limitations. The FAA agreed that, for this cooling test, the effect of center of gravity position was negligible and does not affect the outcome. The proposed amendment was revised and adopted.

d. **Policy/Compliance Methods**. No dedicated policy material on transport category airplanes is currently available. However, the following excerpts from advisory material for other types of aircraft may provide insight into the establishment of basis for a compliance methodology for transport category airplanes.

(1) Advisory Circular AC 29-2A C2, “Certification of Transport Category Rotorcraft,” paragraph 518, Section 29.1045, contains the following relevant information:

b. **Explanation**.

(1) This regulation specifies climb or descent cooling with OEI for Category A rotorcraft and for Category B rotorcraft with Category A powerplant isolation and fireproof or isolated structure, controls, etc., which are essential for controlled flight and landing. For the Category B machine described, the testing should be accomplished at the steady rate of climb or descent established under § 29.67(b), i.e., at the best OEI rate of climb (or descent) and the remaining engine at maximum continuous power or 30-minute power, whichever is applicable.

(2) The engine whose shutdown has the most adverse effect on the cooling conditions for the remaining engine(s) and powerplant components should be inoperative.

(3) The regulation provides that the climb cooling test may be conducted in conjunction with the takeoff cooling test of § 29.1047. This possible combining of tests applies only to § 29.1047(a), since § 29.1047(b) is a multiengine climb and not related to the OEI climb procedures of § 29.1045.

c. **Procedures**.

(1) The OEI climb cooling test point begins from a multiengine cruise, with stabilized fluid and component temperatures, 1,000 feet below either the all-engine-critical altitude or the maximum altitude at which the rate of climb is 150 f.p.m., whichever is the lowest altitude. If the minimum altitude derived is less than sea level, the climb should begin from a twin engine cruise with stabilized fluid and component temperatures at the minimum practical altitude.

(i) The all-engine-critical altitude is the maximum altitude at which, for the ambient conditions prescribed, it is possible to maintain the multiengine specified power. For example, if for multiengine operations, the transmission maximum continuous torque can be maintained on the hot day to a maximum altitude of 10,000 feet above which power would have to be reduced because of gas temperature or other limitations, then 10,000 feet is the all-engine-critical altitude.

(ii) The 150 f.p.m. climb criteria should be based on multiengine operation at maximum continuous power available at hot day conditions at maximum gross weight.

(iii) Fluid and component temperatures are considered stabilized when the rate of change is less than 2^{o} F per minute.

(2) The OEI climb power to be utilized is 30-minute OEI hot day power available (if approval of 30-minute power on the aircraft is requested), followed by maximum continuous hot day power available. If 30-minute

OEI power approval is not requested, the power to be utilized would be maximum continuous hot day power available.

(i) Rotorcraft for which approval of a continuous OEI power rating is requested would use the power available on a hot day at the maximum continuous OEI rating following the 30-minute OEI climb phase (or for the entire climb if approval of 30-minute OEI power is not requested).

(ii) If the maximum continuous OEI approval is not requested, then the highest hot day power available approved for continuous usage from the remaining engine(s) under OEI conditions would be used following the 30-minute OEI climb phase (or for the entire climb if approval of 30-minute OEI power is not requested).

(3) In order to achieve representative test results, the helicopter climb rate and airspeed should approximate those that would occur on a hot day. This is accomplished by adjusting helicopter gross weight as required to produce the desired climb rate based on published or predicted climb performance data. The possible effects of climb fuselage attitude on cooling air duct entrances should be considered in the selection of center-of-gravity of the test aircraft.

(4) The OEI climb should be continued for at least 5 minutes after the occurrence of the highest temperature recorded or until the maximum certification altitude is reached. Generally, temperatures would be expected to peak a short time after the climb begins since component and fluid temperatures are stabilized prior to entry to the climb phase.

(5) For Category B rotorcraft, defined in § 29.1045(a)(2) without a positive OEI rate of climb, the descent should begin from a hot day maximum continuous power multiengine cruise, with stabilized fluid and component temperatures, at the all-engine-critical altitude.

(6) The descent should conclude at either the maximum altitude at which level flight can be maintained with one engine inoperative or at the minimum practical altitude, whichever is higher.

(7) The OEI powers available to be utilized during the descent would be the same as those prescribed previously for OEI for climb cooling. OEI operation should continue until component and fluid temperatures stabilize.

(8) The airspeeds utilized in the climb and descents should be representative of normal speeds unless cooling provisions are sensitive to rotorcraft airspeed, in which case the airspeeds most critical for cooling should be used. In no case, however, should it be required that the selected airspeeds exceed the speeds established under §§ 29.67(a)(2) and 29.67(b).

(2) Advisory Circular AC 23-8A C1, "Flight Test Guide for Certification of Part 23 Airplanes," paragraph 247, Section 23.1045, contains the following relevant information:

Cooling Test Procedures for Turbine Engine-Powered Airplanes.

c. *Test Procedures for Single-Engine, Turbine-Powered Airplanes*.

(1) A normal engine start should be made and all checked out. The engine should be run at ground idle temperatures and other pertinent data should be recorded.

(2) Taxi airplane for approximately 1 mile to simulate normal taxi operations. Record cooling data at 1-minute intervals.

(3) For hull-type seaplanes operating on water, taxi tests should be conducted such that spray characteristics do not bias the cooling characteristics. Engine cooling during water taxiing should be checked by taxiing downwind at a speed approximately 5 knots above the step speed for a minimum of 10 minutes continuous. Record cooling data at 1-minute intervals.

(4) Establish a pre-takeoff holding condition on the ramp (crosswind) for 20 minutes minimum or until temperatures stabilize. Record cooling data at 5-minute intervals.

(5) On the runway, set takeoff power and record cooling data.

(6) Takeoff as prescribed in § 23.51 and climb to altitude. Record cooling data upon reaching pattern altitude or at 1-minute intervals if it takes more than 1 minute to reach pattern altitude.

(7) Retract flaps and continue climb with maximum power at the speed selected to meet the requirements of § 23.65(c). Climb to the maximum approved altitude, recording cooling data at 1-minute intervals.

(8) Cruise at maximum continuous power (or V_{MO}/M_{MO}, limiting) at maximum operating altitude until stabilize. Record cooling data at 1-minute intervals. For many components, this will be the critical temperature operating condition.

(9) Conduct a normal descent at V_{MO}/M_{MO} to holding and hold until temperatures stabilize. Record cooling data at 1-minute intervals.

(10) Conduct a normal approach to landing. Record cooling data at 1-minute intervals.

(11) From not less than 200 feet above the ground, perform a balked landing go-around in accordance with § 23.77. Record cooling data at 1-minute intervals during a traffic pattern circuit.

(12) Climb to pattern altitude, perform a normal approach and landing in accordance with the applicable portion of § 23.75. Record cooling data at 1-minute intervals.

(13) Taxi back to ramp. Shut down engines. Allow engine heat-soak. Record temperature data at 1-minute intervals until 5 minutes after temperatures peak.

d. *Test Procedures for Multiengine, Turbine-Powered Airplanes.* A multi-engine airplane should conduct the same profile as the single-engine airplane, in an all-engine configuration. On completion of the all-engine profile, conduct the applicable one-engine-inoperative cooling climb test recording data at 1-minute intervals. Shut down critical engine and with its propeller (if applicable) in the minimum drag position, the remaining engine(s) at not more than maximum continuous power, or thrust, landing gear retracted, and wing flaps in the most favorable position, climb at the speed used to show compliance with § 23.67. Continue until 5 minutes after temperatures peak.

e. **References.**

(1) Civil Air Regulations (CAR) 4b, December 31, 1953.

(2) Amendment 25-AD (29 FR 18289, December 24, 1964).

(3) Amendment 4b-12 (27 FR 2986, March 30, 1962).

(4) Amendment 25-57 (49 FR 6832 February 23, 1984).

(5) Advisory Circular AC 29-2A C2, “Certification of Transport Category Rotorcraft,” July 30, 1997.

(6) Advisory Circular AC 23-8A C1, “Flight Test Guide for Certification of Part 23 Airplanes,” August 30, 1993.