U S Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject CERTIFICATION OF NORMAL CATEGORY ROTORCRAFT	Date: 9/30/98	Initiated by ASW-110	AC No 27-1A Change 1

1 PURPOSE This change revises existing material in one paragraph and adds new material for one appendix The change number and the date of the changed material are show" at the top of each changed page Vertical bars in the margin indicate the changed material Pages having no changes retain the same heading information

2 PRINCIPAL CHANGES

a Paragraph 531 is revised

b New Appendix 2, Advisory Material for Substantiation of Emergency Flotation System, is added to Chapter 3

Remove Panes	Dated	Insert Panes	Dated
XV	7-30-97	XV	7-30-97
XVI	7-30-97	XVI	9-30-98
693	7-30-97	693	9-30-98
694	7-30-97	694	7-30-97
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SECTION 46 OPERATING LIMITATIONS (continued)

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SECTION 41 MARKINGS AND PLACARDS

SECTION 42 ROTORCRAFT FLIGHT MANUAL

CHAPTER 3 - MISCELLANEOUS AIRWORTHINESS STANDARDS

Chapter 3 (continued)

SECTION 30 INDUCTION SYSTEM

531 § 27 1091 (Amendment 27-2) AIR INDUCTION

a Explanation

(1) The air induction system for each engine should be of a configuration to supply the air required under the operating conditions for which certification is required

(2) The intake system shall be designed such that if a backfire flame occurs, it will emerge outside the engine compartment cowling

(3) Where required in the induction system, drains must be provided which discharge clear of the rotorcraft and out of the path of exhaust flames

(4) For rotorcraft powered by a turbine, the inlets should be located or protected to minimize foreign object ingestion as defined in the regulation The inlets must be protected during takeoff, landing, and taxiing There must also be means to prevent leakage of hazardous amounts of flammable fluids from entenng the engine intake system

b Procedures

(1) For turbine-engine installation, the induction system should supply air of suitable quality to meet the installation requirements of the engine manufacturers The installation requirements should be met throughout the operating envelope of the rotorcraft In addition, the design and location of the air induction system should prevent accumulations of rain or hall, either external or internal to the induction system, that could adversely affect engine operation

(2) The inlet design should account for the prevention of hazardous fluids entering the engine Some designs will have inlet duds which are free from any fluid lines, however, other designs may route the engine inlet air through a compartment which has flammable fluid lines When the condition exists, test demonstrations of critical leakage during operations have been used to substantiate the installation The fluid leakage may not have an adverse effect on engine operation

(3) The air Induction system design should also account for and minimize the possibility of foreign matter ingestion during takeoff, landing, and taxiing

(4) For reciprocating engine installations, the induction system should supply air of suitable quality and quantity to the carburetor inlet of the engine The condition of the air at the entering face of the carburetor is extremely Important For proper operation, it is essential that the airflow be smooth, uniform, clean, and unrestricted throughout the very wide range of horsepower expected from the engine

531A § 27 1091 (Amendment 27-23) AIR INDUCTION

a Explanation Amendment 27-23 removed § 27 1091 (d) since the specific test defined by this paragraph was not critical for certain rotorcraft The turbine inlet foreign-object-ingestion protection provided by § 27 1091 (d) is adequately evaluated by existing requirements in § 27 1091 (e)(2)

b Procedures This rule change did not change the current suggested methods of compliance

532 § 27 1093 (Amendment 27-20) INDUCTION SYSTEM ICING PROTECTION

a Reciprocating Engines

(1) Explanation

(i) Atmospheric moisture, even in clean air and temperatures above freezing, can result in ice accumulations in induction systems to a degree which can easily cause engine failure

(A) Impact Ice This forms as supercooled water droplets impact on engine induction system components Particularly heavy accumulations must be expected where bends or turns in the Induction system force changes in the airflow direction thus centrifuging the droplets out of the air stream where they freeze on impact with induction system components A serious form of impact ice is the collection of ice on fuel metering elements of the carburetor, the alternate (preheat) valve, and any screens in the system

(B) Throttle Ice This type of ice forms at or near the throttle in a partly closed position (up to 30° F) due to cooling effect resulting from the increase in kinetic energy (Increased velocity) of the air in the restricted flow area

(C) Refrigeration Ice This forms as a result of the cooling effect of the fuel evaporating after the fuel is Introduced into the airstream For some float type carburetors, it is possible in rare Instances to accumulate serious ice during a closed throttle glide with ambient air temperatures as high as 93" F and relative humidity of 30 percent At low cruise power, ice can occur at outside air temperatures as high as 62" F and relative humidities as low as 60 percent Most of the heat necessary to evaporate fuel is supplied from the air as it drops in temperature Fuel evaporation ice can affect airflow by blocking the throat of the manifold riser, it can affect the fuel-air-ratio by Interfering with the fuel flow, and it can affect mixture distribution or quantity of mixture flowing to individual cylinders by upsetting the fuel flow distribution or quantity of mixture flowing to individual cylinders by upsetting the fuel flow distribution at the fuel nozzle or airflow distribution in the manifold throat This refrigeration phenomenon is the most serious of all factors causing carburetor ice

APPENDIX 2
ADVISORY MATERIAL FOR SUBSTANTIATION OF EMERGENCY FLOTATION SYSTEM

1 REFERENCE FAR sections 27 521, 883(b), 751, 753(a)(l), (a)(2), 801(b),(d), 807(d)

2 EXPLANATION

a This section pertains to emergency flotation systems used to provide buoyancy for rotorcraft not specifically certificated for ditching but performing over-water operations According to Paragraph 338, AC 27-1A, ditching may be defined as an emergency landing on the water deliberately executed with the intent of abandoning the rotorcraft as soon as practical Currently, ditching certification is not required by FAR 27, however, certification requirements are prescribed for applicants requesting ditching certification approval If a rotorcraft operates over water during a Part 135 operation, the rotorcraft must comply with FAR 135 183, which may require floats

b There are no airworthiness rules specifying the minimum standards for emergency flotation systems on rotorcraft not certificated for ditching requirements Equipment presented for evaluation must perform its intended function and not create a hazard for the rotorcraft or occupants The objective in evaluating emergency flotation systems is safe flight and evacuation of the rotorcraft in emergency situations Adequate emergency flotation systems would aid in keeping rotorcraft sufficiently upright and in adequate trim to permit safe and orderly evacuation in an emergency water landing

3 PROCEDURES The following guidance criteria is based on past certification policy and experience for emergency flotation systems Demonstration of compliance to other criteria may produce acceptable results if adequately justified by rational analysis Model tests of the appropriate emergency water landing configuration may be conducted to demonstrate satisfactory flotation and trim characteristics where satisfactory correlation between model testing and flight testing has been established Model tests and other data from rotorcraft of similar configurations may be used to satisfy the water requirements where appropriate

a Flotation Systems

(1) Normally inflated The flotation systems which are normally Inflated and Intended for emergency use only, should be evaluated for

(i) Structural integrity when subjected to

(A) Air loads throughout the approved flight envelope with floats Installed,

(B) Water loads dunng water entry, and

(C) Waler loads after water entry at speeds likely to be experienced after water impact

(ii) Rotorcraft handling qualities throughout the approved flight envelope with floats Installed

(2) Normallv deflated Emergency flotation systems which are normally stowed in a deflated condition and inflated either in flight or after water contact dunng an emergency water landing should be evaluated for

(i) Inflation

(A) Proper Inflation The inflation system design should minimize the probability of the floats not inflating properly or inflating asymmetrically This may be accomplished by use of a single inflation agent container or multiple container system interconnected together Redundant Inflation activation systems will also normally be required If the pnmary actuation system is electrical, a mechanical backup actuation system will usually provide the necessary reliability A secondary electrical actuation system may also be acceptable if adequate electrical system independence and reliability can be documented

(B) Inadvertent actuation The inflation system should be safeguarded against spontaneous or inadvertent actuation for all flight conditions It should be demonstrated that float inflation at any flight condition within the approved operating envelope will not result in a hazardous condition unless the safeguarding system can be shown to be reliable Limitations to the approved envelope can be established so Inadvertent actuation does not impose a hazard at the new envelope

(C) Float actuation The float activation means may be fully automatic or manual with a means to verify pnmary actuation system prior to each flight If manually inflated, the float activation switch should be located on one of the primary flight controls These activation means should be safeguarded against spontaneous or inadvertent actuation for all flight conditions

(D) Flight Limitations Maximum airspeeds for intentional In-flight actuation of the float system and for flight with the floats inflated should be established as limitations in the Rotorcraft Flight Manual (RFM) unless in-flight actuation is prohibited by the RFM

(E) Inflation time For floats inflated automatically by water contact, inflation time from actuation to neutral buoyancy should be short enough to prevent the rotorcraft from becoming submerged to the point where egress is impeded

(F) Pressure checking A means should be provided for checking the pressure of the gas storage cylinders prior to each flight A table or device showing acceptable gas cylinder pressure variation with ambient temperature and altitude (if applicable) should be provided

(G) Over inflation A means should be provided to minimize the possibility of over inflation of float bags under any reasonably probable actuation conditions

(H) No puncture inflation The ability of the floats to inflate without puncture when subjected to actual water pressure should be substantiated A full scale rotorcraft immersion demonstration in a calm body of water is one acceptable method of substantiation Other methods of substantiation may be acceptable depending upon the particular design of the flotation system

(I) Flotation baa containment Float installations should be evaluated to ascertain that emergency exits are not blocked by the inflated floats when the float bags are inflated to their maximum inflation pressure or their most adverse inflation pressure for emergency exits and the rotorcraft at Its most critical weight and canter of gravity configuration

(ii) Structural Integrity The flotation bags should be evaluated for loads resulting from

(A) Airloads during inflation and fully Inflated during the most critical flight conditions and water loads with fully inflated floats during water impact for the rotorcraft desiring float deployment before water entry, or

(B) Water loads during inflation after water entry

(iii) Handling qualities Rotorcraft handling qualities should be verified by tests or analysis to comply with the applicable regulations throughout the approved operating envelopes for

(A) Deflated and stowed condition,

(B) In-flight inflation condition

(C) Fully inflated condition, and

(D) Partially inflated condition, assuming the most critical float compartment fails to inflate b The float system attachment hardware should be shown to be structurally adequate to mthstand critical air loads and water loads during water entry when both deflated and stowed and fully inflated (unless in-flight inflation is prohibited) The appropriate vertical loads and drag loads determined from water entry conditions (or as limited by flight manual procedures) should be addressed The effects of the vertical loads and the drag loads may be considered separately for the analysis

c Flotation and Trim should be investigated for a range of sea states from zero to the maximum selected by the applicant and should be satisfactory in waves having height/length ratios of 1 12 5 for multi engine rotorcraft with Category A engine isolation and 1 10 for all other rotorcraft

(1) Demonstrated to be satisfactory to at least sea state 4 water conditions

(2) Flotation tests should be Investigated at the most critical rotorcrafl loading condition

(3) Flotation time and trim requirements should be evaluated with a simulated, ruptured deflation of the most critical float compartment Flotation characteristics should be satisfactory in this degraded mode to at least sea state 2 water conditions

(4) Probable rotorcraft door/window open or closed configurations and probable damage to the airframe/hull (i e , failure of doors, windows, skin, etc) should be considered when demonstrating compliance with the flotation and trim requirements

d Float Svstem Reliability Reliability should be considered in the basic design to ensure approximately equal inflation of the floats to preclude excessive yaw, roll, or pitch in flight or in the water

(1) Maintenance procedures should not degrade the flotation system (such as introducing contaminants which could affect normal operation, etc)

(2) The flotation system design should preclude Inadvertent damage due to normal personnel traffic flow and excessive wear and tear Protection covers should be evaluated for function and reliability

e Buoyancy requirements for emergency flotation systems should be a minimum of 25 percent excess buoyancy at maximum Internal gross weight The weight of fresh water (density 62 42 lb/ft^3) displaced by fully submerged float or floats should be a minimum of 25 percent greater than the maximum certificated gross weight of the rotorcraft Analysis may be used for buoyancy verification

f Sufficient watertight compartments should provide an acceptable margin of positive stability with any single main float compartment flooded or deflated The location of the floats, the most critical compartment, the rotorcraft weight, mass moment of inertia, and center of gravity location are also Important considerations for stability Analyses, tests, or a combination thereof may be used to substantiate a positive margin of stability with the most critical compartment flooded or deflated

g The Inflatable bag type floats should be designed for the maximum pressure differential developed at the maximum design altitude That is, the resulting pressure difference between an operational altitude and a takeoff site elevation should be established and substantiated This resulting pressure differential may become an operating limitation

h The float landing load factors may be determined from the drop test of the float landing gear or the loads may be derived from landing gear drop test or loads may be determined from model or full scale water entry tests The vertical loads are distributed over three fourths of the bags projected area Sag floats are not subject to the side loads Rigid floats are to be designed for vertical, horizontal, and side loads distributed along the length of the float

i Design and/or support of the forward part of bag type floats should be evaluated for maximum design speeds to prevent collapse or significant distortion of the bag while in flight

j Resistance to puncture and abrasion at attach/wear points is an Important design consideration Girt or attachment design loads should be sufficient to withstand the maximum imposed design loads

k Occupant Egress and Survival Each practicable design measure should be taken to minimize the probability that the behavior of the rotorcraft would cause immediate Injury to the occupants or prevent evacuation of the rotorcraft after an emergency landing on water Emergency exits should be located such that they are above the waterline and will not be blocked by the inflated or partially inflated floats, impeding evacuation of the rotorcraft The flotation time and trim of the rotorcraft should allow the occupants to evacuate the rotorcraft i e , the rotorcraft should remain sufficiently upright and in adequate trim to permit safe and orderly evacuation of all personnel For configurations which are considered to have critical occupant egress capabilities due to float proximity, an actual demonstration of egress may be required When a demonstration is required, it may be conducted on a full-scale rotorcraft actually Immersed in a calm body of water or using any other rig/ground test facility shown to be representative The demonstration should show that floats do not impede a satisfactory evacuation

l Rotorcraft Flight Manual The Rotorcraft Flight Manual should contain the information pertaining to the emergency flotation system This material should Include

(1) The information pertinent to the limitations applicable to the emergency float system and operating limitations for the emergency float system,

(2) Procedures and limitations for flotation device inflation,

(3) Procedures for use of emergency flotation equipment, and

(4) Procedures for emergency water landing occupant evacuation