Airworthiness Criteria: Special Class Airworthiness Criteria for the AgustaWestland Philadelphia Corporation Model AW609 Powered-Lift, Docket No. FAA-2022-1726

Final Airworthiness Criteria.

Pursuant to the authority delegated to me by the Administrator, the following airworthiness criteria are issued as part of the type certification basis for the Model AW609 Powered-Lift. The FAA finds these criteria to be appropriate for the aircraft and applicable to the specific type design and provide an equivalent level of safety to existing airworthiness standards.

SUBPART A – GENERAL.

TR.1 Applicability.

(a) This document prescribes airworthiness standards for the issuance of a type certificate, and changes to that type certificate, for the AgustaWestland Philadelphia Corporation Model AW609, a multi-turbine engine powered-lift, with a maximum of nine passengers, designated as a “special class” aircraft under § 21.17(b).

(b) Each application under 14 CFR part 21 for a change to this type certificate must show compliance with these requirements.

(c) Unless otherwise stated, these airworthiness standards are applicable to all flight modes and the entire operating range of the Model AW609.

(d) Any requirement in this certification basis for aircraft systems and installations operation under expected operating conditions will include all approved conversion angles.

(e) Subparts A through H of these airworthiness standards contain transport category performance criteria, including Category A performance. TR Appendix H Category B Performance contains performance criteria for operation of the AW609 as normal category (Category B) with nine or fewer passenger seats. The AW609 may be certificated as both Category A and Category B with appropriate and different operating limitations for each.

TR.10 Definitions.

For purposes of the Model AW609 certification basis, the following definitions apply:

(a) *Aircraft failure state* means the aircraft state when modified by one or more malfunctions in aircraft components, such as failure of a propulsion unit or a discrepancy between a selected configuration and an actual configuration.

(b) *Aircraft flight modes.*

(1) *Airplane mode* means a configuration with the nacelles on the down-stop and proprotor speed set to cruise r.p.m.

(2) *VTOL/Conversion mode* means all approved configurations (gated nacelle positions) and flight modes where the design operating proprotor speed is that used for hover operations.

(c) *Center Stick* means a flight deck control that affects aircraft pitch and roll changes.

(d) *Configurations.*

(1) *Takeoff configuration* means VTOL/Conversion mode at nacelle angles selected by applicant for the takeoff flight path segment.

(2) *Enroute configuration*. The two enroute configurations are One Engine Inoperative (OEI) in either VTOL/Conversion mode or airplane mode, and All Engines Operative (AEO) in airplane mode.

(e) *Conversion* means rotation or tilting of the proprotor/nacelle assembly.

(f) *Conversion angle* means nacelle position where zero degrees is the horizontal thrust line and ninety degrees is the vertical thrust line.

(g) *Flaperon* means a wing trailing-edge moveable aerodynamic surface that serves as a flap (symmetric deflection) to increase wing lift or reduce download on the wing, and as an aileron (asymmetric deflection) to generate an aircraft roll moment.

(h) *Flight phase* means the segment of the flight in which the work to be carried out by the crew is characterized by a general objective, such as takeoff, climb, transition, approach, and landing.

(i) *Flight reference* means a reference that provides a simple guide for the pilot to complete all necessary maneuvers while remaining within the authorized flight envelope. It is established using parameters or combinations of parameters (e.g., angle of attack or pitch attitude) and not by looking at speed alone to define limiting or operating conditions. It may be used in defining points or states (e.g., V_{TOSS}, LDP, V_{MO} and the limits of the authorized flight envelope).

(j) *Flight reference system* means a system that integrates multiple parameters to provide a simple guide for the pilot to accomplish necessary maneuvers while remaining within the normal flight envelope. Such a system ensures that the pilot is not required to keep a multidimensional envelope of flight parameters and aircraft state in mind during authorized maneuvers.

(k) *Power Lever* means a cockpit control that, in conjunction with the r.p.m. governor, affects changes in proprotor thrust and engine power.

(l) *Proprotor* means an aerodynamically designed rotor that serves as a primary lift device in VTOL/Conversion mode and as a propulsive thrust device in airplane mode.

(m) *Speed* means speed, airspeed, or flight reference. These terms are used interchangeably throughout this certification basis although within a section (or subject area) there may be only one parameter, such as calibrated airspeed, that is appropriate.

(n) *Transition* means the flight segment in which nacelle angle is converted from one gated position to another gated position.

(o) Terms used in the regulations that are incorporated by reference in this certification basis shall be interpreted as follows:

- “Rotorcraft,” “Category A rotorcraft” means “powered-lift.”

- "Airplane" means "powered-lift."
- "Aileron," "flap" means "flaperon."
- "Rudder" means "directional control."
- "Rotor," "propeller" means "proprotor."

TR.11 Abbreviations.

For purposes of the Model AW609 certification basis, the following abbreviations apply.

(a) "V_{CON}" means maximum authorized speed for any nacelle angle in the V_{TOL}/Conversion mode.

(b) "VD_{CON}" means design speed (structural) for any nacelle angle in the V_{TOL}/Conversion mode.

(c) "V_{MIN}" means the minimum authorized speed for the V_{TOL}/Conversion mode for each approved nacelle position.

(d) "V_{TOL}" means vertical takeoff and landing.

SUBPART B – FLIGHT.

General

TR.21 Proof of compliance.

(a) The controllability, stability, trim, and stalling characteristics of the aircraft must be shown for each altitude up to the maximum expected in operation.

(b) If compliance with the flight characteristic requirements is dependent upon a stability augmentation system or upon any other automatic or power–operated system, compliance must be shown with TR.671, § 29.672, and TR.672.

(c) The requirements of this subpart associated with icing conditions apply only if the applicant is seeking certification for flight in icing conditions.

(1) Each requirement of this subpart, except TR.67(a), TR.141(b)(1) and (b)(2), TR.201(c)(2), TR.207(c) and (d), and TR.251(b) through (e), must be met in icing conditions. Compliance must be shown using the ice accretions defined in Appendix C to part 25, and using those icing conditions in Appendix O to part 25 for which certification is sought, assuming normal operation of the aircraft and its ice protection system in accordance with the operating limitations and operating procedures established by the applicant and provided in the aircraft flight manual.

(2) No changes in the load distribution limits of § 25.23, the weight limits of § 29.25 (except where limited by performance requirements of this subpart), and the center of gravity limits of § 29.27, from those for non-icing conditions, are allowed for flight in icing conditions or with ice accretion.

§ 29.21 Proof of compliance.

(a) through (b) [Applicable to AW609]

§ 25.23 Load distribution limits.

(a) through (b) [Applicable to AW609]

§ 29.25 Weight limits.

(a)(1) through (a)(3) [Applicable to AW609]

(a)(4) [Not applicable to AW609]

(b) [Applicable to AW609]

(c) [Not applicable to AW609]

§ 29.27 Center of gravity limits.

(a) through (c) [Applicable to AW609]

§ 25.29 Empty weight and corresponding center of gravity.

(a) through (b) [Applicable to AW609]

§ 29.31 Removable ballast.

[Applicable to AW609]

TR.33 Powerplant-generated lift and thrust limits.

(a) The applicant must select the upper and lower operating limits of powerplant-generated lift or thrust for demonstrating compliance with subpart B without exceeding the limitations in §§ 25.393, 29.547, 25.675, 29.675, and 29.1521.

(b) The applicant must define the configuration and limits of operation of those parts of the power-generated lift system that change configuration during transition for demonstrating compliance with subpart B without exceeding the limitations in §§ 25.393, 29.547, 25.675, 29.675, and 29.1521.

(c) A means must be provided to preclude the pilot from inadvertently exceeding the limits required by paragraphs (a) and (b) of this section during any flight or ground operating conditions.

TR.34 Requirements for aircraft failure states.

The applicant shall determine, based on the most accurate available data, the probability of occurrence of each aircraft failure state per flight hour and the effect of that failure state on the flying qualities and performance within the authorized flight envelopes. The authorized flight envelopes shall be established by the applicant and will include safe operating configurations, weights, airspeeds, altitudes, and attitudes. When an aircraft failure state exists, a degradation in flying qualities is permitted only to the extent that the probability of encountering unsatisfactory characteristics is sufficiently remote. The specific failure is assumed to occur or be present at whichever point in the envelope being considered is most critical. Requirements on the effects of specific types of failures shall be met on the basis that the specific failure has occurred, unless the failure has been shown to be extremely improbable. After a failure, the procedures and limitations for all subsequent flight phases necessary to safely complete the flight must be determined.

(a) *Critical propulsion system failure*. The requirements of this section apply to loss of power from one or more engines or segments of a powered-lift system caused by any single failure, including the failure or malfunction of a powered or driven subsystem.

(1) *Critical propulsion system failure during takeoff and landing.*

(i) During all takeoffs and landings of the aircraft, it must be possible to maintain control without exceptional piloting skill following a sudden critical propulsion system failure. For rolling takeoffs and landings, it must be possible after critical propulsion system failure to achieve and maintain a straight path while on the ground without a deviation of more than 30 feet from the path originally intended.

(ii) Controls and automatic devices that normally operate in the event of the failure may be used in this analysis. For aborted takeoffs, the requirements of this section apply up to the maximum authorized V_{TOSS} speed and thereafter during deceleration to a full stop. For continued takeoffs, the requirements of this section apply at speeds up to the maximum authorized lift-off speed.

(2) *Critical propulsion system failure in flight.* The aircraft motions during and following a sudden critical propulsion system failure that is not shown to be extremely improbable must be such that the aircraft can be returned to the authorized flight envelope without exceptional piloting skill. It must be possible to establish a safe failure state and proceed to a landing.

(3) *Loss of all powerplants*. In all enroute flight phases and corresponding aircraft states, following loss of power from all engines, it must be possible to maintain control and to change the aircraft state or configuration as necessary for an emergency landing.

(b) *Time delays*. A realistic time delay between failure and initiation of pilot corrective action must be included when determining compliance with failure requirements. This time delay must include the interval between the occurrence of the failure and the occurrence of a cue such as acceleration, rate, displacement, sound, or other warning that will indicate to the pilot that a failure has occurred, plus an additional interval representing the time required for the pilot to evaluate the situation and initiate corrective action.

(c) *Warnings and indications of failures*. Immediate and easily interpreted indications must be provided to the flight crew whenever a failure occurs.

TR.37 Flight reference.

(a) A flight reference with a recommended range, a permitted range, and limits is required. The flight reference must use one or two parameters for each flight phase. This reference must provide a simple guide for the pilot to complete the flight phase while remaining within the authorized flight envelope.

(b) Where a flight reference system is used, it must clearly indicate to the pilot the necessary corrective action to be taken when approaching, reaching, and after exceeding a limit.

TR.38 Avoidance of hazardous flight conditions.

The aircraft design must include functions and features that meet the requirements of this section to avoid hazardous flight conditions.

(a) *Flight Envelope Protection (FEP)*.

(1) Onset characteristics of each envelope protection feature must be smooth, appropriate to the phase of flight and type of maneuver, and not conflict with the ability of the pilot to satisfactorily change aircraft flight path, speed, or attitude within the approved flight envelope.

(2) Limit values of protected flight parameters (and if applicable, associated warning thresholds) must be compatible with—

(i) Aircraft structural limits;

(ii) Required safe and controllable maneuvering of the aircraft; and

(iii) Margins to critical conditions. Dynamic maneuvering, airframe and system tolerances (both manufacturing and in-service), or non-steady atmospheric conditions—in any phase of flight—must not result in a flight parameter beyond the nominal design limit value that would cause unsafe flight characteristics.

(3) The aircraft must be responsive to pilot-commanded dynamic maneuvering within a suitable range of the parameter limits that define the approved flight envelope.

(4) When simultaneous envelope limiting is active, it must not result in adverse control coupling or priority.

(5) Following a failure in the envelope protection features of the Flight Control System, the aircraft must:

(i) Be capable of continued safe flight and landing;

(ii) Be capable of initial counteraction of malfunctions without requiring exceptional piloting skill or strength;

(iii) Be safely controllable following any FEP failure or malfunction occurring at any point within the approved flight envelope;

(iv) Be controllable and maneuverable when operated with a degraded flight control system, within a practical flight envelope described in the Aircraft Flight Manual;

(v) Be capable of prolonged instrument flight without requiring exceptional piloting skill; and

(vi) Meet the controllability and maneuverability requirements of subpart B of this certification basis throughout a practical flight envelope.

(6) Devices intended to prevent exceeding flight envelope limits must not cause nuisance warnings or limit normal operation within the approved flight envelope. Failure or inadvertent operation of these devices must not result in a hazardous condition.

(b) *Control Margin Awareness*. The flight control system design must provide a suitable means for the crew to determine flight control position for any flight condition that exists in which any flight control is coming so close to its limits that return to normal flight or continuation of safe flight requires a specific crew action.

(c) *Alerts, indications, and annunciation*.

(1) *Alerting.* Warning systems that indicate or prevent exceeding flight envelope limits must not be ambiguous to the pilot (e.g., the warning must cue the pilot to take proper corrective action). In addition, warning cues that prevent or indicate impending departure from the approved flight envelope must be readily apparent to the pilot. Functional failures of warning devices or systems must be indicated to the pilot.

(2) *Indications and annunciation.* Where the design of the flight control system has multiple modes of operation, a means must be provided to indicate to the crew any mode that significantly changes or degrades the normal handling or operational characteristics of the aircraft.

Performance.

TR.45 General.

(a) Unless otherwise prescribed, the aircraft must meet the applicable performance requirements of this subpart for ambient atmospheric conditions and still air.

(b) The performance, as affected by engine power or thrust, must be based on the following relative humidities:

(1) For turbine engine powered aircraft, a relative humidity of—

(i) 80 percent, at and below standard temperature; and

(ii) 34 percent, at and above standard temperature plus 50°F.

(2) Between these two temperatures, the relative humidity must vary linearly.

(c) The performance must correspond to the propulsive thrust available under the particular ambient atmospheric conditions, the particular flight condition, and the relative humidity specified in paragraph (b) of this section. The available propulsive thrust must correspond to engine power or thrust at nacelle angles appropriate for the configuration for takeoff, cruise, and landing, not exceeding the approved power or thrust less—

(1) Installation losses; and

(2) The power or equivalent thrust absorbed by the accessories and services appropriate to the particular ambient atmospheric conditions and the particular flight condition.

(d) Unless otherwise prescribed, the applicant must select the takeoff, enroute, approach, and landing configurations for the aircraft.

(e) The aircraft configurations may vary with weight, altitude, and temperature, to the extent they are compatible with the operating procedures required by paragraph (f) of this section.

(f) Unless otherwise prescribed, in determining the accelerate-stop distances, takeoff flight paths, takeoff distances, balked landing, and landing distances, changes in the aircraft's configuration, speed, power, and thrust, must be made in accordance with procedures established by the applicant for operation in service.

(g) The procedures established under paragraph (f) of this section must:

(1) Be able to be consistently executed in service by crews of average skill;

(2) Use methods or devices that are safe and reliable; and

(3) Include allowance for any time delays, in the execution of the procedures that may reasonably be expected in service.

(h) A means must be provided to permit the pilot to determine prior to takeoff that each engine is capable of developing the power necessary to achieve the applicable aircraft performance prescribed in this subpart.

TR.51 Takeoff: general.

(a) The takeoff data required by TR.53, TR.55, TR.59, TR.60, TR.61, TR.62, TR.63, and TR.67 must be determined—

(1) At each weight, altitude, and temperature selected by the applicant; and

(2) With the operating engines within approved operating limitations.

(b) Takeoff data must—

(1) Be determined on a smooth, dry, hard surface;

(2) Be in the selected configuration for takeoff; and

(3) Be corrected to assume a level takeoff surface.

(c) No takeoff made to determine the data required by this section may require exceptional piloting skill or alertness, or exceptionally favorable conditions.

TR.53 Takeoff.

(a) The takeoff performance must be determined so that, if one engine fails after the start of takeoff, the aircraft can—

(1) Return to, and stop safely on, the takeoff area; or

(2) Continue the takeoff and climbout, and attain a configuration and airspeed allowing compliance with TR.67.

(b) At no time during the transition from the takeoff configuration to the enroute configuration used in determining the takeoff path under TR.59 may the airspeed be less than V_{MIN} at normal pylon conversion rates.

TR.55 Takeoff Decision Point (TDP).

(a) The TDP is the first point from which a continued takeoff capability is assured under TR.59 and is the last point in the takeoff path from which a rejected takeoff is assured within the distance determined under TR.62.

(b) The TDP must be established in relation to the takeoff path using no more than two parameters (e.g., airspeed and height) to designate the TDP.

(c) Determination of the TDP must include a pilot recognition time interval of not less than one second following failure of the critical engine.

TR.59 Takeoff path: ground level heliport/runway.

(a) The takeoff path extends from the point of commencement of the takeoff procedure to a point at which the aircraft is 1,500 feet above the takeoff surface, or at which the transition from the takeoff configuration to the enroute configuration is completed and compliance with TR.67(c) is shown, whichever point is higher. In addition—

(1) The takeoff path must be based on the procedures prescribed in TR.45(f);

(2) The aircraft must be accelerated to the engine failure point; at which point, the critical engine must be made inoperative and remain inoperative for the rest of the takeoff;

(3) After the critical engine is made inoperative, the aircraft must continue to the TDP, and then attain V_{TOSS};

(4) Only primary controls may be used while attaining V_{TOSS} and while establishing a positive rate of climb. Secondary controls that are located on the primary controls may be used after a positive rate of climb and V_{TOSS} are established but in no case less than 3 seconds after the critical engine is made inoperative; and

(5) After attaining V_{TOSS} and a positive rate of climb, the landing gear may be retracted.

(b) During the takeoff path determination made in accordance with paragraph (a) of this section and after the landing gear is fully retracted, the climb must be continued at a speed as close as practicable to, but not less than, V_{TOSS} until the aircraft is 400 feet above the takeoff surface. During this interval, the climb performance must meet or exceed that required by TR.67(b).

(c) From 400 feet above the takeoff surface, the aircraft takeoff path must be level or positive until a height 1,500 feet above the takeoff surface is attained with not less than the gradient of climb required by TR.67(c). Any secondary or auxiliary control may be used after attaining 400 feet above the takeoff surface. At each point along the takeoff path, starting at the point in which the aircraft reaches 400 feet above the takeoff surface, the available gradient of climb may not be less than 1.2 percent.

(d) Takeoff distance will be determined in accordance with TR.61.

(e) During the continued takeoff, the aircraft must not descend below 15 feet above the takeoff surface when the takeoff decision point is above 35 feet.

(f) The takeoff path must be determined by a demonstrated continuous takeoff or by synthesis from segments. If the takeoff path is determined by the segmental method:

(1) The segments must be clearly defined and must be related to the distinct changes in the configuration, power or thrust, and speed;

(2) The weight of the aircraft, the configuration, and the power or thrust must be constant throughout each segment and must correspond to the most critical condition prevailing in the segment;

(3) The flight path must be based on the aircraft's performance without ground effect; and

(4) The takeoff path data must be checked by demonstrated continuous takeoffs up to the point at which the aircraft is out of ground effect and its speed is stabilized, to ensure that the path is conservative relative to the continuous path.

TR.60 Takeoff path: elevated heliport.

(a) The elevated heliport takeoff path extends from the point of commencement of the takeoff procedure to a point at which the aircraft is 1,500 feet above the takeoff surface, or at which the transition from the takeoff configuration to the enroute configuration is completed and compliance with TR.67(c) is shown, whichever is higher. In addition—

(1) The requirements of TR.59(a) must be met;

(2) While attaining V_{TOSS} and a positive rate of climb, the aircraft may descend below the level of the takeoff surface if, in so doing and when clearing the elevated heliport edge, every part of the aircraft clears all obstacles by at least 15 feet;

(3) The vertical magnitude of any descent below the takeoff surface must be determined; and

(4) After obtaining V_{TOSS} and a positive rate of climb, the landing gear may be retracted.

(b) The scheduled takeoff weight must be such that the climb requirements of TR.67(a) and (b) will be met.

(c) Takeoff distance will be determined in accordance with TR.61(b).

TR.61 Takeoff distance.

(a) The takeoff distance is the greater of—

(1) The horizontal distance along the takeoff path from the start of the takeoff to the point at which the aircraft attains and maintains an altitude of at least 35 feet above the takeoff surface, attains and maintains a speed of at least V_{TOSS}, and establishes a positive rate of climb, assuming the critical engine failure occurs at the engine failure point just prior to the takeoff decision point; or

(2) 115 percent of the horizontal distance along the takeoff path, with all engines operating, from the start of the takeoff to the point at which the aircraft is 35 feet above the takeoff surface, as determined by a procedure consistent with TR.59.

(b) For elevated landing pads, the takeoff distance is the horizontal distance along the takeoff path from the start of the takeoff to the point at which the aircraft attains and maintains a speed of at least V_{TOSS} and establishes a positive rate of climb, assuming the critical engine failure occurs at the engine failure point just prior to the takeoff decision point.

TR.62 Rejected takeoff.

The rejected takeoff distance and procedures for each condition where takeoff is approved will be established with—

(a) The takeoff path requirements of TR.59 and TR.60 being used up to the TDP where the critical engine failure is recognized and the aircraft is landed and brought to a complete stop on the takeoff surface;

(b) The remaining engines operating within approved limits;

(c) The landing gear remaining extended throughout the entire rejected takeoff; and

(d) The use of only the primary controls until the aircraft is on the ground. Secondary controls located on the primary control may not be used until the aircraft is on the ground. Means other than wheel brakes may be used to stop the aircraft if:

(1) The means are safe and reliable;

(2) Consistent results can be expected under normal operating conditions; and

(3) Exceptional piloting skill is not required to control the aircraft.

TR.63 Takeoff flight path.

(a) The takeoff flight path begins 35 feet above the takeoff surface at the end of the takeoff distance determined in accordance with TR.61(a) or (b).

(b) The net takeoff flight path data must be determined so that they represent the actual takeoff flight paths (determined in accordance with TR.59 and with paragraph (a) of this section) reduced at each point by a gradient of climb equal to 0.8 percent.

(c) The prescribed reduction in climb gradient may be applied as an equivalent reduction in acceleration along that part of the takeoff flight path at which the aircraft is accelerated in level flight.

TR.67 Climb: One engine inoperative.

(a) *Landing gear extended.* In the critical takeoff configuration existing along the flight path (between the points at which the aircraft reaches V_{TOSS} and at which the landing gear is fully retracted) and in the configuration used in TR.59 and TR.60 but without ground effect, the steady rate of climb without ground effect must be positive for each weight, altitude, and temperature for which the requirements of TR.59 and TR.60 are met with—

(1) The critical engine inoperative and the remaining engines within approved operating limitations, except that for aircraft for which the use of 30-second or 2-minute OEI power is requested, only the 2-minute OEI power may be used in showing compliance with this paragraph.

(2) [Reserved]

(b) *Landing gear retracted*. In the critical takeoff configuration existing along the flight path (between the points at which the landing gear is fully retracted and at which the aircraft is 400 feet above the takeoff surface) and in the configuration used in TR.59 and TR.60 but without ground effect, the steady gradient of climb must be at least 2.4 percent for each weight, altitude, and temperature for which takeoff requirements of TR.59 and TR.60 are met with —

(1) The critical engine inoperative and the remaining engines at a power selected by the applicant, provided that power setting, if time limited, must allow for the completion of the climb requirement of TR.67(b) within the allotted time limitation; and

(2) The most unfavorable center of gravity for climb following takeoff.

(c) *Final takeoff*. In the enroute configuration at the end of the takeoff path determined in accordance with TR.59 and TR.60, the steady gradient of climb may not be less than 1.2 percent for each weight, altitude, and temperature for which the takeoff requirements of TR.59 and TR.60 are met with—

(1) The critical engine inoperative and the remaining engines at maximum continuous power including OEI maximum continuous power, if approved, or at 30-minute power for aircraft for which certification for use of 30-minute power is requested; and

(2) A climb speed not less than:

(i) For airplane mode, 1.13 V_{SR1} and a speed that provides the maneuvering capability specified in TR.143(j).

(ii) For VTOL/Conversion mode, a speed selected by the applicant but not less than V_{MIN} and a speed that provides the maneuvering capability specified in TR.143(j).

TR.69 Enroute flight paths.

(a) *All engines operating*. The steady gradient and rate of climb must be determined at each weight, altitude, and ambient temperature within the operational limits established by the applicant with—

(1) Not more than maximum continuous power on each engine;

(2) The landing gear retracted;

(3) The flaperon retracted or in the autoflap position; and

(4) A climb speed of not less than $1.23V_{SR1}$.

(b) *One engine inoperative*. When the critical engine is inoperative, the steady gradient and rate of climb/descent must be determined at each weight, altitude, and ambient temperature within the operational limits established by the applicant with—

(1) The remaining engine at not more than maximum continuous power or 30-minute power;

(2) The landing gear retracted;

(3) The flaperon retracted or in the autoflap position; and

(4) A climb speed of not less than:

(i) For airplane mode, $1.13V_{SR1}$; and

(ii) For VTOL/Conversion mode, a speed selected by applicant but not less than V_{MIN}.

§ 23.75 Landing distance.

(a) through (d) [Not applicable to AW609]

(e) [Applicable to AW609]

(f) through (g) [Not applicable to AW609]

§ 29.75 Landing; General.

(a) through (b) [Applicable to AW609, except replace the reference to § 29.85 with TR.85]]

TR.77 Landing Decision Point (LDP).

(a) The LDP is the last point in the approach and landing path from which a balked landing can be accomplished in accordance with TR.85.

(b) Determination of the LDP must include the pilot recognition time interval following failure of the critical engine.

TR.79 Landing performance (OEI).

(a) The landing performance must be determined and scheduled so that if the critical engine fails at any point in the approach path, the aircraft can either land and stop safely or climb out and attain an aircraft configuration and speed allowing compliance with the climb requirements of TR.67.

(b) The approach and landing paths must be established with the critical engine inoperative so that the transition between each stage can be made smoothly and safely.

(c) The approach and landing speeds and configurations must be selected by the applicant and must be appropriate to the type of aircraft.

(d) It must be possible to make a safe landing on a prepared landing surface after complete power failure occurring during normal cruise.

TR.81 Landing distance (OEI).

The horizontal distance required to land and come to a complete stop (or to a speed of approximately 3 knots for water landings) from a point 50 feet above the landing surface must be determined from the approach and landing paths established in accordance with TR.79.

TR.85 Balked landing (OEI).

The balked landing path with the critical engine inoperative must be established so that—

(a) The transition from each stage of the maneuver to the next stage can be made smoothly and safely;

(b) From the LDP on the approach path selected by the applicant, a safe climbout can be made at speeds allowing compliance with the climb requirements of TR.67; and

(c) The aircraft does not descend below 15 feet above the landing surface. For elevated heliport operations, descent may be below the level of the landing surface provided the deck edge clearance of TR.60 is maintained and the descent (loss of height) below the landing surface is determined.

TR.103 Stall speed.

(a) The reference stall speed, V_{SR}, is a calibrated airspeed defined by the applicant. V_{SR} may not be less than a 1-g stall speed. V_{SR} is expressed as:

$$V_{SR} \geq \frac{V_{CL_{MAX}}}{\sqrt{n_{ZW}}}$$

where:

$V_{CL_{MAX}}$ = Calibrated airspeed obtained when the load factor corrected lift coefficient

$$\left(\frac{n_{ZW} \cdot W}{qS}\right)$$

is first a maximum during the maneuver described in paragraph (c) of this section, and where:

n_{zw} = Load factor normal to the flight path at V_{CLMAX};

W = Aircraft gross weight;

S = Aerodynamic reference wing area; and

q = Dynamic pressure.

(b) V_{CLMAX} is determined with:

(1) Power off.

(2) The aircraft in other respects (such as flaperons, landing gear, and ice accretions) in the condition existing in the test or performance standard in which V_{SR} is being used;

(3) The weight used when V_{SR} is being used as a factor to determine compliance with a required performance standard;

(4) The center of gravity position that results in the highest value of reference stall speed;

(5) The aircraft trimmed for straight flight at a speed selected by the applicant, but not less than $1.13V_{SR}$ and not greater than $1.3V_{SR}$; and

(6) Nacelles at zero or any other approved configuration for which stall considerations apply.

(c) Starting from the stabilized trim condition, apply the longitudinal control to decelerate the aircraft so that the speed reduction does not exceed one knot per second.

Flight Characteristics.

TR.141 General.

(a) Except as specifically required in the applicable section, the aircraft must meet the flight characteristics requirements of this subpart—

(1) At the approved operating altitudes and temperatures;

(2) Under any critical loading condition within the range of weights and centers of gravity for which certification is requested; and

(3) For power-on operations, under any condition of speed, power, and proprotor r.p.m. for which certification is requested.

(b) The aircraft must be able to maintain any required flight condition and make a smooth transition from any flight condition to any other flight condition without exceptional piloting skill, alertness, or strength, and without danger of exceeding the limit load factor under any operating condition probable for the type, including—

(1) Sudden failure of one engine; and

(2) Sudden, complete control system failures specified in § 29.695.

TR.143 Controllability and maneuverability.

(a) The aircraft must be safely controllable and maneuverable during steady flight and during any maneuver appropriate to the type, including—

(1) Takeoff;

(2) Conversion and re-conversion with power on and power off;

(3) Climb;

(4) Level flight;

(5) Descent; and

(6) Landing.

(b) For operation in VTOL/Conversion mode, the yaw control must not overpower the pitch and roll control. Additionally, the margin of longitudinal, lateral, and directional control must allow satisfactory pitch, roll, and yaw control throughout the allowable speed range with—

(1) Critical weight;

(2) Critical center of gravity; and

(3) Critical proprotor r.p.m.

(c) For operation in airplane mode, it must be possible at any point between the trim speed prescribed in TR.103(b)(5) and stall speed identification as defined in TR.201(d) to pitch the nose downward with primary flight controls so that the acceleration to this selected trim speed is prompt with—

(1) The aircraft trimmed at the trim speed prescribed in TR.103(b)(5);

(2) The landing gear retracted;

(3) Flaperons (i) set to zero and (ii) automatically selected by flight controls; and

(4) Power (i) on and (ii) off.

(d) For operation in airplane mode, with landing gear retracted, no change in trim control, or exertion of more than 50 pounds control force (representative of the maximum short-term force that can be applied readily by one hand) may be required for the following maneuvers:

(1) With power off, flaperons retracted, and the aircraft trimmed at 1.3 V_{SR1}, extend the flaperons as rapidly as possible while maintaining the airspeed at approximately 30 percent above the reference stall speed existing at each instant throughout the maneuver.

(2) Repeat paragraph (d)(1) of this section, except initially extend the flaperons and then retract them as rapidly as possible.

(3) Repeat paragraph (d)(2) of this section, except at the go-around power.

(4) With power off, flaperons retracted, and the aircraft trimmed at 1.3 V_{SR1}, rapidly set go-around power while maintaining the same airspeed.

(5) Repeat paragraph (d)(4) of this section, except with flaperons extended.

(6) With power off, flaperons extended, and the aircraft trimmed at 1.3 V_{SR1}, obtain and maintain airspeeds between V_{SW} and either 1.6 V_{SR1} or V_{FE}, whichever is lower.

(e) For operation in VTOL/conversion mode:

(1) Wind velocities from zero to at least 20 knots, from all azimuths, must be established in which the aircraft can be operated without loss of control on or near the ground in any maneuver appropriate to the type (such as crosswind takeoffs, sideward flight, and rearward flight), with—

(i) Critical weight;

(ii) Critical center of gravity;

(iii) Critical proprotor r.p.m.; and

(iv) Altitude, from standard sea level conditions to the maximum takeoff and landing altitude capability of the aircraft.

(2) Wind velocities from zero to at least 20 knots, from all azimuths, must be established in which the aircraft can be operated without loss of control out-of-ground effect, with—

(i) Weight selected by the applicant;

(ii) Critical center of gravity;

(iii) Proprotor r.p.m. selected by the applicant; and

(iv) Altitude, from standard sea level conditions to the maximum takeoff and landing altitude capability of the aircraft.

(f) For the maneuvers in paragraph (a) of this section, the aircraft after failure of one engine must be safely controllable over the range of power, speeds, and altitudes for which certification is requested when such power failure occurs at critical power and weight. No corrective action time delay following the power failure may be less than normal pilot reaction time for takeoff and landing. For any other condition, three seconds or normal pilot reaction time (whichever is greater) is required.

(g) For operation in VTOL/Conversion mode for which a V_{CON} (power-off) is established under TR.1505, compliance must be demonstrated with the following requirements with critical weight, critical center of gravity, and critical proprotor r.p.m.:

(1) The aircraft in VTOL/Conversion mode must be able to safely transition from OEI power-on V_{CON} to power-off V_{CON} without exceptional piloting skill after the last operating engine is made inoperative at the OEI power-on V_{CON}.

(2) In VTOL/Conversion mode, there must be satisfactory pitch, roll, and directional control at a speed of $1.1V_{CON}$ (power-off).

(h) The control forces necessary to meet the requirements of this subpart must be determined by quantitative tests. In no case may the control forces of this section exceed—

(1) For temporary application: 60 pounds in pitch, 30 pounds in roll, and 150 pounds in yaw.

(2) For prolonged application: 10 pounds in pitch, 5 pounds in roll, and 20 pounds in yaw.

(i) When maneuvering at a constant airspeed or Mach number (up to V_{FC}/M_{FC}), the stick forces and the gradient of the stick force versus maneuvering load factor must lie within satisfactory limits. The stick forces must not be so great as to make excessive demands on the pilot's strength when maneuvering the aircraft, and must not be so low that the aircraft can easily be overstressed inadvertently. Changes of gradient that occur with changes of load factor must not cause undue difficulty in maintaining control of the aircraft, and local gradients must not be so low as to result in a danger of overcontrolling.

(j) The maneuvering capabilities on takeoff flight path at the speeds selected by the applicant shall allow the following single engine angle of bank coordinated turn free of stall warning or other characteristics that might interfere with normal maneuvering.

(1) 30 degrees in airplane mode.

(2) 20 degrees in VTOL/Conversion Mode.

TR.145 Longitudinal and lateral control.

(a) In steady turning flight at constant speed and in pull-ups, increased pull forces and aft displacement of the cockpit pitch control will be required to initiate increases in angle of attack, normal acceleration, and nose-up pitch rate throughout the range of angle of attack and load factor in the normal flight envelope. Increases in push forces and forward displacement of the cockpit pitch control will be required to initiate a reduction of angle of attack and normal acceleration.

(b) In VTOL/Conversion mode in steady turning flight at constant speed, and in pushovers and with the power lever fixed, the variation in pitch control force with steady-state normal acceleration or angle of attack will be approximately linear. The stick force change with normal acceleration must not be so low as to incur a likelihood of exceeding the limit load factor, nor so high as to impair ease of maneuvering. Changes of gradient that occur with changes of load factor must not cause undue difficulty in maintaining control of the aircraft, and local gradients must not be so low as to result in a danger of overcontrolling.

(c) There must be no excessive decrease in the gradient of the curve of stick force versus maneuvering load factor with increasing load factor.

(d) It must be possible, without exceptional piloting skill, alertness, or strength, to prevent loss of altitude when transitioning from one configuration to another during steady, straight, level flight throughout the approved operating envelope.

(e) In airplane mode, roll response must allow normal maneuvers (such as recovery from upsets produced by gusts and the initiation of evasive maneuvers). There must be enough excess lateral control in sideslips (up to sideslip angles that might be required in normal operation), to allow a limited amount of maneuvering and to correct for gusts. Lateral control must be enough at any speed up to V_{FC}/M_{FC} to provide a peak roll rate necessary for safety, without excessive control forces or travel.

TR.147 Closed loop handling qualities.

The applicant must demonstrate, through a combination of flight test and simulation, that the aircraft is safely controllable with no tendency for sustained oscillations resulting from efforts of the pilot to control the aircraft for any foreseeable operating condition or aircraft configuration.

TR.171 Stability: General.

The aircraft must be longitudinally, directionally, and laterally stable in accordance with the provisions of TR.173, TR.175, TR.177, TR.181, and TR.191. The aircraft must be able to be flown, without undue pilot fatigue or strain, in any normal maneuver for a period of time as long as that expected in normal operation. Suitable stability and control feel is required in any condition normally encountered in service, if flight tests show it is acceptable for safe operation.

TR.173 Static longitudinal stability.

Under the conditions specified in TR.175, the characteristics of the longitudinal control forces and positions must be as follows:

(a) A pull and aft control movement must be required to obtain and maintain speeds below the specified trim speed, and a push and forward control movement must be required to obtain and maintain speeds above the specified trim speed. In airplane mode, this must be shown at any speed that can be obtained except speeds lower than the minimum speed for steady, unstalled flight, or higher than the flaperons operating limit speeds or VFC/MFC, whichever is appropriate.

(b) The airspeed must return to within 10 percent of the original trim speed for the conditions specified in TR.175(a) through TR.175(g) when the control force is slowly released for each trim condition.

(c) In airplane mode, the average gradient of the stick force versus speed curve may not be less than one pound for each six knots.

(d) When showing compliance with paragraphs (a) and (b) of this section for VTOL/Conversion mode, in limited flight conditions or modes of operation determined by the Administrator to be acceptable, the slope of the control position versus speed curve may be neutral or negative if the aircraft possesses flight characteristics that allow the pilot to maintain airspeed within ±5 knots of the desired trim speed without exceptional piloting skill or alertness.

TR.175 Demonstration of static longitudinal stability

(a) *Climb in VTOL/Conversion mode*. Static longitudinal stability must be shown in the climb condition at speeds from 0.9 V_{MIN} or V_{MIN} - 10 knots, whichever is less, or if less than 30 knots, use 30 knots, to 1.1V_{CON} or V_{CON} + 10 knots, whichever is greater, with trim points selected by the applicant to demonstrate a speed range of ±20 knots from trim plus the resulting free return speed above and below trim with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Power required for limit climb rate (at least 1,000 fpm or maximum continuous power whichever is less);

(4) Flaperons in any approved configuration;

(5) The landing gear retracted; and

(6) The aircraft trimmed at the selected trim speeds.

(b) *Climb in airplane mode*. The stick force curve must have a stable slope at speeds between 85 and 115 percent of the speed at which the aircraft—

(1) Is trimmed with:

(i) Flaperons retracted and in any other approved flap configuration;

(ii) Landing gear retracted;

(iii) Maximum takeoff weight; and

(iv) The maximum power selected by the applicant as an operating limitation for use during climb; and

(2) Is trimmed at the speed for best rate of climb except that the speed need not be less than $1.3V_{SR1}$.

(c) *Cruise in VTOL/Conversion mode*. Static longitudinal stability must be shown in the cruise condition at speeds from 0.9 times the minimum approach speed to $1.1V_{CON}$ with trim points selected by the applicant to demonstrate a speed range of ±20 knots from trim plus the resulting free return speed above and below trim, with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Power for level flight at each selected trim speed;

(4) Flaperons in any approved configuration;

(5) The landing gear retracted, and

(6) The aircraft trimmed at the selected trim point.

(d) *Cruise in airplane mode*. Static longitudinal stability must be shown in the cruise condition as follows:

(1) With the landing gear retracted at high speed, the stick force curve must have a stable slope at all speeds within a range which is the greater of 15 percent of the trim speed plus the resulting free return speed range, or 50 knots plus the resulting free return speed range, above and below the trim speed (except that the speed range need not include speeds less than 1.3 V_{SR1}, nor speeds greater than VFC/MFC, nor speeds that require a stick force of more than 50 pounds), with—

(i) The flaperons retracted and in any other approved flaperon configuration;

(ii) The center of gravity in the most adverse position (see § 29.27);

(iii) The most critical weight;

(iv) The maximum continuous power selected by the applicant as an operating limitation, except that the power need not exceed that required at V_{MO}/M_{MO}; and

(v) The aircraft trimmed for level flight with the power required in paragraph (d)(1)(iv) of this section.

(2) With the landing gear retracted at low speed, the stick force curve must have a stable slope at all speeds within a range which is greater of 15 percent of the trim speed plus the resulting free return speed range, or 50 knots plus the resulting free return speed range, above and below the trim speed (except that the speed range need not include speeds less than 1.3 V_{SR1}, nor speeds greater than the minimum speed of the applicable speed range prescribed in paragraph (d)(1) of this section, nor speeds that require a stick force of more than 50 pounds), with—

(i) Flaperons, center of gravity position, and weight as specified in paragraph (d)(1) of this section;

(ii) Power required for level flight at a speed equal to (V_{MO} + 1.3 V_{SR})/2; and

(iii) The aircraft trimmed for level flight with the power required in paragraph (d)(2)(ii) of this section.

(e) *Descent in VTOL/Conversion mode.* Static longitudinal stability must be shown at speeds from 0.9 V_{MIN} or V_{MIN} - 10 knots, whichever is less, or if less than 30 knots, use 30 knots, to 1.1V_{CON} or V_{CON} + 10 knots, whichever is greater, with trim points selected by the applicant to demonstrate a speed range of ±20 knots from trim plus the resulting free return speed above and below with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Power required for 1,000 fpm descent at trim airspeed;

(4) Flaperons in any approved configuration; and

(5) Landing gear extended and retracted.

(f) *Approach in airplane mode*. The stick force curve must have a stable slope at speeds between 1.04 V_{SR1} and 1.7 V_{SR1}, with—

(1) Flaperons in the approach or any other approved configuration;

(2) Landing gear retracted;

(3) Maximum landing weight; and

(4) The aircraft trimmed at 1.3 V_{SR1} with power for level flight.

(g) *Approach and landing in VTOL/Conversion mode*. Static longitudinal stability must be shown from 0.7 times the minimum recommended approach speed to 20 knots above the maximum recommended approach speed with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Each nacelle angle approved for approach;

(4) Flaperons in any approved configuration;

(5) Landing gear extended and retracted; and

(6) Power required to maintain a 3-degree glide path and the steepest approach gradient for which approval is requested.

TR.177 Static lateral-directional stability.

(a) In airplane mode, the static directional stability (as shown by the tendency to recover from a skid with the yaw direction control free) must be positive for any landing gear and flaperon position and symmetric power condition, at speeds from 1.13 V_{SR1}, up to V_{FE}, V_{LE}, or VFC/MFC (as appropriate for the aircraft configuration).

(b) In airplane mode, the static lateral stability (as shown by the tendency to raise the low wing in a sideslip with the aileron controls free) for any landing gear and flap position and symmetric power condition, may not be negative at any airspeed (except that speeds higher than VFE need not be considered for flaperons extended configurations nor speeds higher than VLE for landing gear extended configurations) in the following airspeed ranges:

(1) From 1.13 VSR1 to V_{MO}/M_{MO}.

(2) From V_{MO}/M_{MO} to V_{FC}/ M_{FC}, unless the divergence is—

(i) Gradual;

(ii) Easily recognizable by the pilot; and

(iii) Easily controllable by the pilot.

(c) In airplane mode, the following requirement must be met for the configurations and speed specified in paragraph (a) of this section. In straight, steady sideslips over the range of sideslip angles appropriate to the operation of the aircraft, the aileron and yaw direction control movements and forces must be substantially proportional to the angle of sideslip in a stable sense. This factor of proportionality must lie between limits found necessary for safe operation. The range of sideslip angles evaluated must include those sideslip angles resulting from the lesser of:

(1) One-half of the available yaw direction control input; and

(2) A yaw direction control force of 180 pounds.

(d) In airplane mode, for sideslip angles greater than those prescribed by paragraph (c) of this section, up to the angle at which full yaw direction control is used or a yaw direction control force of 180 pounds is obtained, the yaw direction control forces may not reverse, and increased yaw direction control deflection must be needed for increased angles of sideslip. Compliance with this requirement must be shown using straight, steady sideslips, unless full lateral control input is achieved before reaching either full yaw direction control input or a yaw direction control force of 180 pounds; a straight, steady sideslip need not be maintained after achieving full lateral control input. This requirement must be met at all approved landing gear and flap positions for the range of operating speeds and power conditions appropriate to each landing gear and flap position with all engines operating.

(e) In VTOL/Conversion mode, the yaw direction control must operate in such a manner that the sense and direction of motion of the aircraft following yaw direction control displacement are in the direction of the pedal motion with throttle and collective controls held constant at the trim conditions specified in TR.175(a), (c), (e), and (g). In addition:

(1) Sideslip angles must increase with steadily increasing yaw direction control deflection for sideslip angles up to the lesser of—

(i) 25 degrees from trim at a speed of 15 knots less than the speed for minimum rate of descent varying linearly to 10 degrees from trim at V_{CON};

(ii) The steady-state sideslip angles established by TR.351;

(iii) A sideslip angle selected by the applicant, which corresponds to a sideforce of at least 0.1g; or

(iv) The sideslip angle attained by maximum yaw direction control input.

(2) Sufficient cues must accompany the sideslip to alert the pilot when approaching sideslip limits.

(3) Static directional stability must be positive throughout the approved ranges of airspeed, power, and vertical speed. In straight and steady sideslips up to 10 degrees from trim, yaw direction control position must increase without discontinuity with the angle of sideslip, except

for a small range of sideslip angles around trim. At greater angles up to the maximum sideslip angle appropriate to the type, increased yaw direction control position must produce an increased angle of sideslip. It must be possible to maintain balanced flight without exceptional piloting skill or alertness.

(4) During sideslips appropriate to the flight condition throughout the approved ranges of airspeed, power, and vertical speed, there must be no negative dihedral stability perceptible to the pilot through lateral control motion and force. Longitudinal control movement with sideslip must not be excessive.

TR.181 Dynamic stability.

(a) In airplane mode, any short period oscillation, not including combined lateral-directional oscillations, occurring between 1.13 V_{SR} and maximum allowable speed appropriate to the configuration of the aircraft must be heavily damped with the primary controls—

(1) Free; and

(2) In a fixed position.

(b) In airplane mode, any combined lateral-directional oscillation (“Dutch Roll”) occurring between 1.13 V_{SR} and maximum allowable speed appropriate to the configuration of the aircraft must be positively damped with controls free, and must be controllable with normal use of the primary controls without requiring exceptional piloting skill.

(c) In VTOL/Conversion mode:

(1) Any oscillation having a period of less than 5 seconds must damp to 1/2 amplitude in not more than one cycle.

(2) Any oscillation having a period of 5 or more seconds but less than 10 seconds must damp to 1/2 amplitude in not more than two cycles.

(3) Any oscillation having a period of 10 or more seconds but less than 20 seconds must be damped.

(4) Any oscillation having a period of 20 or more seconds may not achieve double amplitude in less than 20 seconds.

(5) Any aperiodic response may not achieve double amplitude in less than 9 seconds.

TR.191 Transition: General.

The transition requirements are applicable to the accelerating or decelerating transition maneuver itself and not to the maneuvering capability when operating in VTOL/Conversion or airplane mode while at a trim speed(s) defined by the applicant lying in the range between hover and V_{MO}. For operation around such fixed operating points, as defined by nacelle angle and airspeed, the requirements of TR.173 through TR.181 shall apply. Compliance shall be demonstrated when performing transition profiles as defined by the applicant. The transition maneuver requirements shall be met throughout the authorized flight envelope for all applicable aircraft states.

(a) *Acceleration-deceleration characteristics*. From an authorized fixed operating point at speeds below V_{MO}, with the aircraft trimmed at the operating point, it must be possible to transition safely to V_{MO} at approximately constant altitude and on any other approved flight path. From trimmed steady, level, unaccelerated flight at V_{MO}, it must be possible to transition safely, without exceptional piloting skill, alertness or strength and on any other approved flight path, to all fixed operating points at speeds below V_{MO}. It must be possible to decelerate safely, at approximately constant altitude and on any other approved flight path, to all fixed operating points at speeds below V_{MO}. It must be possible to execute these maneuvers without restriction due to factors such as pitch, roll, or yaw control power, loss of lift or buffeting, or thrust response characteristics.

(b) *Flexibility of operation*. At any time during a transition, it must be possible to safely stop the transition maneuver and reverse its direction.

(c) *Tolerance in transition program*. It must be possible to change from hover or minimum speed to conventional flight, and vice versa, safely and easily in winds up to the maximum allowable. There shall be no need for precise programming by the pilot of engine power, fuselage attitudes, wing or lift engine tilt, etc., in terms of speed or time, such as to demand excessive piloting skill and attention.

(d) *Control margin*. To allow for disturbances and for maneuvering, the margin of control power remaining at any stage in the transition shall be demonstrated to be adequate.

Control and force trim systems.

TR.195 Force Trim.

(a) *General*. It must be possible to trim the longitudinal, lateral, directional, and power lever forces to zero at all approved airspeeds, power settings, and configurations appropriate to the type.

(b) *Trim control.* The trim control may not introduce any undesirable discontinuities in control force gradients.

(c) *Lateral and directional trim*. In airplane mode, the aircraft must maintain lateral and directional trim with the most adverse lateral displacement of the center of gravity within the relevant operating limitations, during normally expected conditions of operation (including operation at any speed from 1.3 V_{SR} to V_{MO}/M_{MO}).

(d) *Longitudinal trim*. In airplane mode, the aircraft must maintain longitudinal trim during climb with maximum continuous power at a speed of 1.3 V_{SR} to V_{MO}, with the landing gear retracted, and the flaperons retracted or in autoflap position.

(e) *Longitudinal, directional, and lateral trim*. The aircraft must maintain longitudinal, directional, and lateral trim (with the angle of bank not exceeding five degrees) at 1.3 V_{SR1} during climbing flight with—

(1) The critical engine inoperative;

(2) The remaining engines at maximum continuous power; and

(3) The landing gear and flaperons retracted or in autoflap position.

Stalls.

TR.201 Stall demonstration.

(a) In airplane mode and in any other approved configuration in which wing stall considerations are applicable, stalls must be shown in straight flight and in 30 degree banked turns with—

(1) Power off; and

(2) The power necessary to maintain level flight at 1.5 V_{SR1} (where V_{SR1} corresponds to the stalling speed with flaperons in the autoflap position, the landing gear retracted, and at maximum landing weight).

(b) In each condition required by paragraph (a) of this section, it must be possible to meet the applicable requirements of TR.203 with—

(1) Flaperons, landing gear, and deceleration devices in any likely combination of positions approved for operation;

(2) Representative weights within the range for which certification is requested;

(3) The most adverse center of gravity for recovery; and

(4) The aircraft trimmed for straight flight at the speed prescribed in TR.103(b)(5).

(c) The following procedures must be used to show compliance with TR.203:

(1) Starting at a speed sufficiently above the stalling speed to ensure that a steady rate of speed reduction can be established, apply the longitudinal control so that the speed reduction does not exceed one knot per second until the aircraft is stalled.

(2) In addition, for turning flight stalls, apply the longitudinal control to achieve airspeed deceleration rates up to 3 knots per second.

(3) As soon as the aircraft is stalled, recover by normal recovery techniques.

(d) The aircraft is considered stalled when the behavior of the aircraft gives the pilot a clear and distinctive indication of an acceptable nature that the aircraft is stalled. Acceptable indications of a stall, occurring either individually or in combination, are—

(1) A nose-down pitch that cannot be readily arrested;

(2) Buffeting, of a magnitude and severity that is a strong and effective deterrent to further speed reduction; or

(3) The pitch control reaches the aft stop and no further increase in pitch attitude occurs when the control is held full aft for a short time before recovery is initiated. In this condition, the aircraft must have satisfactory roll and yaw control.

TR.203 Stall characteristics.

(a) It must be possible to produce and to correct roll and yaw by unreversed use of the flaperon and yaw controls, up to the time the aircraft is stalled. No abnormal nose-up pitching may occur. The longitudinal control force must be positive up to and throughout the stall. In addition, it must be possible to promptly prevent stalling and to recover from a stall by normal use of the controls.

(b) For level wing stalls, the roll occurring between the stall and the completion of the recovery may not exceed approximately 20 degrees.

(c) For turning flight stalls initiated with 30° of bank, the action of the aircraft after the stall may not be so violent or extreme as to make it difficult, with normal piloting skill, to effect a prompt recovery and to regain control of the aircraft. The maximum bank angle that occurs during the recovery may not exceed—

(1) Approximately 60 degrees in the original direction of the turn, or 30 degrees in the opposite direction, for deceleration rates up to 1 knot per second; and

(2) Approximately 90 degrees in the original direction of the turn, or 60 degrees in the opposite direction, for deceleration rates in excess of 1 knot per second.

TR.207 Stall warning.

(a) Stall warning with sufficient margin to prevent inadvertent stalling with the flaperons and landing gear in any normal position and nacelles in any approved position must be clear and distinctive to the pilot in straight and turning flight.

(b) The warning must be furnished either through the inherent aerodynamic qualities of the aircraft or by a device that will give clearly distinguishable indications under expected conditions of flight. A visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself. If a warning device is used, it must provide a warning in each of the aircraft configurations prescribed in paragraph (a) of this section at the speed prescribed in paragraphs (c) and (d) of this section. Except for the stall warning margin prescribed in paragraph (h)(3)(ii) of this section, the stall warning for flight in icing conditions must be provided by the same means as the stall warning for flight in non-icing conditions.

(c) When the speed is reduced at rates not exceeding one knot per second, stall warning must begin, in each normal configuration, at a speed, V_{SW}, exceeding the speed at which the stall is identified in accordance with TR.201(d) by not less than five knots or five percent CAS, whichever is greater. Once initiated, stall warning must continue until the angle of attack is reduced to approximately that at which stall warning began.

(d) In addition to the requirement of paragraph (c) of this section, when the speed is reduced at rates not exceeding one knot per second, in straight flight with engines idling and at the center-of-gravity position specified in TR.103(b)(4), V_{SW}, in each normal configuration, must exceed V_{SR} by not less than three knots or three percent CAS, whichever is greater.

(e) In icing conditions, the stall warning margin in straight and turning flight must be sufficient to allow the pilot to prevent stalling (as defined in TR.201(d)) when the pilot starts a recovery maneuver not less than three seconds after the onset of stall warning. When demonstrating compliance with this paragraph, the pilot must perform the recovery maneuver in the same way as for the aircraft in non-icing conditions. Compliance with this requirement must be demonstrated in flight with the speed reduced at rates not exceeding one knot per second, with—

(1) The more critical of the takeoff ice and final takeoff ice accretions defined in Appendix C to part 25 for each configuration used in the takeoff phase of flight;

(2) The enroute ice accretion defined in Appendix C to part 25 for the enroute configuration; and

(3) The holding ice accretion defined in Appendix C to part 25 for the holding configuration(s).

(f) The stall warning margin must be sufficient in both non-icing and icing conditions to allow the pilot to prevent stalling when the pilot starts a recovery maneuver not less than one second after the onset of stall warning in slow-down turns with at least 1.5 g load factor normal to the flight path and airspeed deceleration rates of at least 2 knots per second. When demonstrating compliance with this paragraph for icing conditions, the pilot must perform the recovery maneuver in the same way as for the aircraft in non-icing conditions. Compliance with this requirement must be demonstrated in flight with—

(1) The flaperons and landing gear in any normal position;

(2) The aircraft trimmed for straight flight at a speed of 1.3 V_{SR}; and

(3) The power or thrust necessary to maintain level flight at 1.3 V_{SR}.

(g) Stall warning must also be provided in each abnormal configuration of the high lift devices and nacelle positions that are likely to be used in flight following system failures (including all configurations covered by Aircraft Flight Manual procedures).

(h) For flight in icing conditions before the ice protection system has been activated and is performing its intended function, with the ice accretion defined in part II(e) of Appendix C to part 25, the stall warning margin in straight and turning flight must be sufficient to allow the pilot to prevent stalling without encountering any adverse flight characteristics when—

(1) The speed is reduced at rates not exceeding one knot per second;

(2) The pilot performs the recovery maneuver in the same way as for flight in non-icing conditions; and

(3) The recovery maneuver is started no earlier than:

(i) One second after the onset of stall warning if stall warning is provided by the same means as for flight in non-icing conditions; or

(ii) Three seconds after the onset of stall warning if stall warning is provided by a different means than for flight in non-icing conditions.

(i) In showing compliance with paragraph (h) of this section, if stall warning is provided by a different means in icing conditions than for non-icing conditions, compliance with TR.203 must be shown using the accretion defined in part II(e) of Appendix C of part 25. Compliance with this requirement must be shown using the demonstration prescribed by TR.201, except that the deceleration rates of TR.201(c)(2) need not be demonstrated.

(j) In VTOL/Conversion mode, the V_{MIN} warning may be used in lieu of the stall warning.

Ground Handling Characteristics.

TR.231 General.

The aircraft must have satisfactory ground handling characteristics, including freedom from uncontrollable tendencies in any condition expected in operation.

§ 29.235 Taxiing condition.

[Applicable to AW609]

§ 29.241 Ground resonance.

[Applicable to AW609]

Miscellaneous Flight Requirements.

TR.251 Vibration and buffeting.

(a) The aircraft must be demonstrated in flight to be free from any vibration and buffeting that would prevent continued safe flight in any likely operating condition.

(b) Each part of the aircraft must be shown in flight to be free from excessive vibration under any appropriate speed and power conditions up to the minimum value of V_{DF}. The maximum speeds shown must be used in establishing the operating limitations of the aircraft in accordance with TR.1505.

(c) Except as provided in paragraph (d) of this section, there may be no buffeting condition, in normal flight, including configuration changes during cruise, severe enough to interfere with the control of the aircraft, to cause excessive fatigue to the crew, or to cause structural damage. Stall warning buffeting within these limits is allowable.

(d) There may be no perceptible buffeting in any configuration approved for the enroute mode in straight flight at any speed up to V_{MO}/M_{MO}, except that stall warning buffeting is allowable.

(e) With the aircraft in any configuration approved for the enroute mode, the positive maneuvering load factors at which the onset of perceptible buffeting occurs must be determined for the ranges of airspeed, weight, and altitude for which the aircraft is to be certificated. The envelopes of load factor, speed, altitude, and weight must provide a sufficient range of speeds and load factors for normal operations. Probable inadvertent excursions beyond the boundaries of the buffet onset envelopes may not result in unsafe conditions.

TR.253 High-speed characteristics.

(a) *Speed increase and recovery characteristics.* The following speed increase and recovery characteristics must be met:

(1) Operating conditions and characteristics likely to cause inadvertent speed increases (including upsets in pitch and roll) must be simulated with the aircraft trimmed at any likely cruise speed up to V_{MO}/M_{MO}. These conditions and characteristics include gust upsets, inadvertent control movements, low stick force gradient in relation to control friction, passenger movement, leveling off from climb, and descent from Mach to airspeed limit altitudes.

(2) Allowing for pilot reaction time after effective inherent or artificial speed warning occurs, it must be shown that the aircraft can be recovered to a normal attitude and its speed reduced to V_{MO}/M_{MO}, without—

(i) Exceptional piloting strength or skill;

(ii) Exceeding VD/MD, V_{DF}/M_{DF}, or the structural limitations; and

(iii) Buffeting that would impair the pilot's ability to read the instruments or control the aircraft for recovery.

(3) With the aircraft trimmed at any speed up to V_{MO}/M_{MO}, there must be no reversal of the response to control input about any axis at any speed up to V_{DF}/M_{DF}. Any tendency to pitch, roll, or yaw must be mild and readily controllable, using normal piloting techniques. When the aircraft is trimmed at V_{MO}/M_{MO}, the slope of the elevator control force versus speed curve need not be stable at speeds greater than V_{FC}/M_{FC}, but there must be a push force at all speeds up to V_{DF}/M_{DF} and there must be no sudden or excessive reduction of elevator control force as V_{DF}/M_{DF} is reached.

(4) Adequate roll capability to assure a prompt recovery from a lateral upset condition must be available at any speed up to V_{DF}/M_{DF}.

(b) *Maximum speed for stability characteristics, VFC/MFC.* VFC/MFC is the maximum speed at which the requirements of TR.143(i), TR.145(f), TR.175(d), TR.177(a) and (b), and TR.181(a) and (b) must be met with flaperons and landing gear retracted. It may not be less than a speed midway between V_{MO}/M_{MO} and V_{DF}/M_{DF}, except that for altitudes where Mach number is the limiting factor, MFC need not exceed the Mach number at which effective speed warning occurs.

TR.255 Out-of-trim characteristics.

(a) From an initial condition with the aircraft trimmed at cruise speeds up to V_{MO}/M_{MO}, the aircraft must have satisfactory maneuvering stability and controllability with the degree of out-of-trim in both the aircraft nose-up and nose-down directions, which results from the greater of—

(1) A three-second movement of the longitudinal trim system at its normal rate for the particular flight condition with no aerodynamic load (or an equivalent degree of trim for aircraft that do not have a power-operated trim system), except as limited by stops in the trim system; or

(2) The maximum mistrim that can be sustained by the autopilot while maintaining level flight in the high speed cruising condition.

(b) In the out-of-trim condition specified in paragraph (a) of this section, when the normal acceleration is varied from +1 g to the positive and negative values specified in paragraph (c) of this section—

(1) The stick force vs. “g” curve must have a positive slope at any speed up to and including V_{FC}/M_{FC}; and

(2) At speeds between V_{FC}/M_{FC} and V_{DF}/M_{DF} the direction of the primary longitudinal control force may not reverse.

(c) Except as provided in paragraphs (d) and (e) of this section, compliance with the provisions of paragraph (a) of this section must be demonstrated in flight over the acceleration range—

(1) -1 g to +2.5 g; or

(2) 0 g to 2.0 g, and extrapolating by an acceptable method to -1 g and +2.5 g.

(d) If the procedure set forth in paragraph (c)(2) of this section is used to demonstrate compliance and marginal conditions exist during flight test with regard to reversal of primary longitudinal control force, flight tests must be accomplished from the normal acceleration at which a marginal condition is found to exist to the applicable limit specified in paragraph (b)(1) of this section.

(e) During flight tests required by paragraph (a) of this section, the limit maneuvering load factors prescribed in TR.333 and TR.337, and the maneuvering load factors associated with probable inadvertent excursions beyond the boundaries of the buffet onset envelopes determined under TR.251(e), need not be exceeded. In addition, the entry speeds for flight test demonstrations at normal acceleration values less than 1 g must be limited to the extent necessary to accomplish a recovery without exceeding V_{DF}/M_{DF}.

(f) In the out-of-trim condition specified in paragraph (a) of this section, it must be possible from an overspeed condition at V_{DF}/M_{DF} to produce at least 1.5g for recovery by applying not more than 125 pounds of longitudinal control force using either the primary longitudinal control alone or the primary longitudinal control and the longitudinal trim system. If the longitudinal trim is used to assist in producing the required load factor, it must be shown at V_{DF}/M_{DF} that the longitudinal trim can be actuated in the aircraft nose-up direction with the primary surface loaded to correspond to the least of the following aircraft nose-up control forces:

(1) The maximum control forces expected in service as specified in §§ 29.301 and TR.397.

(2) The control force required to produce 1.5g.

(3) The control force corresponding to buffeting or other phenomena of such intensity that it is a strong deterrent to further application of primary longitudinal control force.

SUBPART C – STRUCTURE AND STRENGTH.

General.

§ 29.301 Loads.

(a) through (c) [Applicable to AW609]

TR.302 Interaction of systems and structure.

For aircraft equipped with systems which affect the aircraft's structural performance, either directly or as a result of failure or malfunction, the influence of these systems and their failure conditions must be taken into account when showing compliance with requirements of subparts

C and D of this certification basis. TR Appendix K must be used to evaluate the structural performance of aircraft equipped with these systems.

§ 25.303 Factor of safety.

[Applicable to AW609]

§ 25.305 Strength and deformation.

(a) through (c) [Applicable to AW609]

(d) [Reserved in § 25.305]

(e) through (f) [Applicable to AW609]

§ 25.307 Proof of structure.

(a) [Not Applicable to AW609]

(b) through (c) [Reserved in § 25.307]

(d) [Applicable to AW609]

§ 29.307 Proof of structure.

(a) through (b) [Applicable to AW609]

§ 29.309 Design limitations.

(a) through (g) [Applicable to AW609]

TR.309 Design limitations.

In addition to the values and limitations in § 29.309, the following values and limitations must be established to show compliance with the structural requirements of this subpart:

(a) Ranges of altitude for which certification is requested.

(b) Ranges of position of adjustable elements of lift and control devices.

(c) Design maximum cabin pressure differential.

Flight Loads.

§ 25.321 General.

(a) through (d) [Applicable to AW609]

TR.321 General.

(a) When sudden displacement of a control is specified, the assumed rate of displacement need not exceed the rate that could be applied by the pilot. The pilot force need not exceed the maximum value specified in TR.397. In lieu of rational analyses where checked maneuvers are called for, the maneuver may be assumed to be checked by using not more than one-half of the initial displacement of the control in the reverse direction. If a lower rate of displacement of the controls is critical for any component, the effect of this lower rate must be addressed.

(b) In determining control device angles and pressure distributions in maneuvers, the effect of corresponding angular aircraft velocities must be addressed.

TR.331 Symmetrical flight maneuvers.

(a) *Procedure*. The analysis of symmetrical flight must include the conditions specified in paragraphs (b) and (c) of this section within the range of design limitations specified in § 29.309 and TR.309. The distribution of external forces to the various propulsive lift and control surfaces must be conservatively or rationally determined to correspond to each flight mode.

(b) *Maneuvering balanced conditions (airplane mode).* Assuming the aircraft to be in equilibrium with zero pitching acceleration, pull-up, pushover, and steady turn maneuvers to the load factors prescribed in §§ 25.337 and TR.337 must be addressed.

(c) *Pitch maneuver conditions (airplane mode)*. The conditions specified in paragraphs (c)(1) and (2) of this section must be addressed. The movement of the pitch control surfaces may be adjusted to take into account limitations imposed by the maximum pilot effort specified by

TR.397, control system stops, and any indirect effect imposed by limitations in the output side of the control system (for example, stalling torque or maximum rate obtainable by a power control system).

(1) *Maximum pitching control displacement.* The aircraft must be designed for maximum pitching control displacement in airplane mode. The aircraft is assumed to be flying initially in steady level flight at any speed up to V_A, and the pitching control is suddenly moved to obtain extreme positive (nose up) pitching. Aircraft loads that occur subsequent to normal acceleration at the center of gravity exceeding the maximum positive limit maneuvering load factor "n" need not be considered. Less than maximum pitching control may be considered where it can be demonstrated that use of maximum displacement is inappropriate because of the inherent flight stability and response characteristics of the aircraft.

(2) *Checked maneuver between V_A and V_D.* Nose-up checked pitching maneuvers must be analyzed in which the positive limit load factor prescribed in § 25.337 is achieved. As a separate condition, nose-down checked pitching maneuvers must be analyzed in which a limit load factor of 0g is achieved. In defining the aircraft loads, the cockpit pitch control motions described in paragraphs (c)(2)(i) through (iv) of this section must be used:

(i) The aircraft is assumed to be flying in steady level flight at any speed between V_A and V_D and the cockpit pitch control is moved in accordance with the following formula:

$\delta(t) = \delta 1 \sin(\omega t)$ for $0 \leq \omega t \leq t_{max}$

Where –

δ1 = the maximum available displacement of the cockpit pitch control in the initial direction, as limited by the control system stops, control surface stops, or by pilot effort in accordance with TR.397;

$\delta(t)$ = the displacement of the cockpit pitch control as a function of time. In the initial direction, $\delta(t)$ is limited to $\delta 1$. In the reverse direction, $\delta(t)$ may be truncated at the maximum available displacement of the cockpit pitch control as limited by the control system stops, control surface stops, or by pilot effort in accordance with TR.397;

$t_{max} = 3\pi/2\omega$;

ω = the circular frequency (radians/second) of the control deflection taken equal to the undamped natural frequency of the short period rigid mode of the aircraft, with active control system effects included where appropriate; but not less than:

$\omega = \frac{\pi V}{2V_A}$ radians per second;

Where –

V = the speed of the aircraft at entry to the maneuver.

V_A = the design maneuvering speed prescribed in TR.335(c).

(ii) For nose-up pitching maneuvers the complete cockpit pitch control displacement history may be scaled down in amplitude to the extent just necessary to ensure that the positive limit load factor prescribed in § 25.337 is not exceeded. For nose-down pitching maneuvers, the complete cockpit control displacement history may be scaled down in amplitude to the extent just necessary to ensure that the normal acceleration at the center of gravity (c.g.) does not go below 0g.

(iii) In addition, for cases where the aircraft response to the specified cockpit pitch control motion does not achieve the prescribed limit load factors, then the following cockpit pitch control motion must be used:

$\delta(t) = \delta 1 \sin(\omega t)$ for $0 \leq t \leq t1$

$\delta(t) = \delta 1$ for $t1 \leq t \leq t2$

$\delta(t) = \delta 1 \sin(\omega[t + t1 - t2])$ for $t2 \leq t \leq t_{max}$

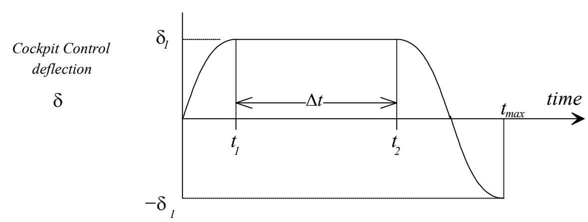
Where –

$t1 = \pi/2\omega$

$t2 = t1 + \Delta t$

$t_{max} = t2 + \pi/\omega$;

Δt = the minimum period of time necessary to allow the prescribed limit load factor to be achieved in the initial direction, but it need not exceed five seconds (see figure below).



(iv) In cases where the cockpit pitch control motion may be affected by inputs from systems (for example, by a stick pusher that can operate at high load factor as well as at 1g), then the effects of those systems shall be addressed.

(v) Aircraft loads that occur beyond the following times need not be considered:

(A) For the nose-up pitching maneuver, the time at which the normal acceleration at the c.g. goes below 0g;

(B) For the nose-down pitching maneuver, the time at which the normal acceleration at the c.g. goes above the positive limit load factor prescribed in § 25.337; and

(C) t_{max}.

(d) *Maneuvering conditions (VTOL/Conversion mode)*. The aircraft is assumed to be flying initially in 1g flight at any speed up to V_{DCON} in VTOL/Conversion mode. The pitching accelerations shall be those developed by a sudden linear displacement of the controls to that displacement which results in the specified load factor followed, after attainment of the specified load factor, by a linear return of the controls to the initial displacement. The load factors shall be the maximum positive (for pull-up maneuvers) and maximum negative (for pushover maneuvers) limit load factors described in §§ 25.337 and TR.337.

TR.333 Flight design envelope.

For each flight mode, the strength requirements must be met for symmetrical flight conditions at each combination of airspeed and flight load factor on and within the boundaries of the envelope of the prescribed maneuvering and gust load factors.

TR.335 Design airspeeds.

The selected design airspeeds are equivalent airspeeds.

(a) *Design cruising speed (V_C).* For V_C, the following apply:

(1) The minimum value of V_C must be sufficiently greater than V_B to provide for inadvertent speed increases likely to occur as a result of severe atmospheric turbulence.

(2) Except as provided in paragraph (d)(2) of this section, V_C may not be less than V_B + 1.32 U_{REF} (with U_{REF} as specified in § 25.341(a)(5)(i)). However, V_C need not exceed the maximum speed in level flight at maximum continuous power for the corresponding altitude.

(3) At altitudes where V_D is limited by Mach number, V_C may be limited to a selected Mach number.

(b) *Design dive speed (VD).* VD must be selected so that V_C/M_C is not greater than 0.8 VD/MD, or so that the minimum speed margin between V_C/M_C and V_D/M_D is the greater of the following values:

(1) From an initial condition of stabilized flight at V_C/M_C, the aircraft is upset, flown for 20 seconds along a flight path 7.5 degrees below the initial path, and then pulled up at a load factor of 1.5 g (0.5 g acceleration increment). The speed increase occurring in this maneuver may be

calculated if reliable or conservative aerodynamic data is used. Maximum cruise power selected by the applicant as an operating limitation, which need not exceed that required at V_{MO}/M_{MO}, is assumed until the pull-up is initiated, at which time power reduction and the use of pilot controlled drag devices may be assumed; or

(2) The minimum speed margin must be enough to provide for atmospheric variations (such as horizontal gusts, and penetration of jet streams and cold fronts) and for instrument errors and airframe production variations. These factors may be considered on a probability basis. The margin at altitude where M_C is limited by compressibility effects must not be less than 0.07M unless a lower margin is determined using a rational analysis that includes the effects of any automatic systems. In any case, the margin may not be reduced to less than 0.05M.

(c) *Design maneuvering speed (V_A)*. For V_A, the following apply:

(1) V_A may not be less than $V_{S1}\sqrt{n}$ where—

(i) *n* is the limit positive maneuvering load factor at V_C; and

(ii) V_{S1} is the 1-g stalling speed in the appropriate flaperon configuration.

(2) V_A and V_S must be evaluated at the design weight and altitude under consideration.

(3) V_A need not be more than V_C or the speed at which the positive C_{Nmax} curve intersects the positive maneuver load factor line, whichever is less.

(d) Design speed for maximum gust intensity (V_B).

(1) V_B may not be less than

$$V_{S1}\left[1+\frac{K_g U_{ref} V_c a}{498w}\right]^{1/2}$$

where—

VS1 = the 1-g stalling speed in the appropriate flaperon configuration at the particular weight under consideration;

VC = design cruise speed (knots equivalent airspeed);

UREF = the reference gust velocity (feet per second equivalent airspeed) from § 25.341(a)(5)(i);

w = average wing loading (pounds per square foot) at the particular weight under consideration.

$$K_g = \frac{.88\mu}{5.3 + \mu}$$

$$\mu = \frac{2w}{\rho cag}$$

ρ = density of air (slugs/ft^3);

c = mean geometric chord of the wing (feet);

g = acceleration due to gravity (ft/sec^2);

a = slope of the aircraft normal force coefficient curve, C_{NA} per radian;

(2) At altitudes where V_C is limited by Mach number—

(i) V_B may be chosen to provide an optimum margin between low and high speed buffet boundaries; and

(ii) V_B need not be greater than V_C.

(e) *Design speeds for propulsive lift and control devices and configuration conversion devices (V_{DCON}).* For V_{DCON} the following apply:

(1) The design speed for each device must be sufficiently greater than the operating speed recommended for the corresponding state of flight (including balked landings) to allow for probable variations in control of speed and for transition from one flight mode or configuration to another.

(2) If an automatic positioning or load limiting device is used, the speeds and corresponding positions programmed or allowed by the device may be used.

(f) *Flaperon design speeds (V_F)*. For V_F the following apply:

(1) The design flaperon speed for each flaperon position and mode must be sufficiently greater than the operating speed recommended for the corresponding stage of flight (including balked landings) to allow for probable variations in control of airspeed and for transition from one position to the other.

(2) If an automatic flaperon positioning or load limiting device is used, the speeds and corresponding flaperon position programmed or allowed by the device may be used.

§ 25.337 Limit maneuvering load factors.

(a) through (d) [Applicable to AW609]

TR.337 Limit maneuvering load factors in VTOL/Conversion mode.

(a) Except where limited by maximum (static) lift coefficients, the aircraft is assumed to be subjected to symmetrical maneuvers resulting in the limit maneuvering load factors prescribed in this section. Pitching velocities appropriate to the corresponding pull-up and steady turn maneuvers must be addressed.

(b) The positive limit maneuvering load factor "n" for any speed up to V_n may not be less than 2.1 + 24,000/ (W + 10,000) except that "n" may not be less than 2.0 and need not be greater than 3.5, where "W" is the design maximum takeoff weight.

(c) The negative limit maneuvering load factor may not be less than -0.5.

(d) Maneuvering load factors lower than those specified in this section may be used if the aircraft has design features that make it impossible to exceed these values in flight.

§ 25.341 Gust and turbulence loads.

(a) through (b) [Applicable to AW609 except in (a)(6) replace the reference to § 25.1527 with § 29.1527]

§ 29.341 Gust Loads.

[Applicable to AW609]

§ 25.343 Design fuel and oil loads.

(a) through (b) [Applicable to AW609 except replace the references to § 25.1001 with § 29.1001]

TR.349 Rolling maneuvers.

The aircraft must be designed for loads resulting from the maneuvers specified in paragraphs (a) through (d) of this section. In these maneuvers, the directional controls must be maintained in their initial position throughout the maneuver and, additionally, the directional controls must be assumed to be displaced as necessary to maintain zero sideslip. The longitudinal controls must be maintained in the initial position throughout the maneuver except that the resultant load factor need not exceed the initial load factor. The reaction to unbalanced aerodynamic moments about the center of gravity must be addressed in a rational or conservative manner.

(a) *Positive "g" rolls*. At any speed within the design limitations for the enroute flight mode, the aircraft is assumed to be in a coordinated steady turn at an angle of bank corresponding to a load factor of two-thirds of those specified in §§ 25.337 and TR.337. The following lateral control movements must be addressed, except as limited by the maximum pilot force of TR.397.

(1) At V_A, the lateral control must be suddenly displaced to the maximum lateral limit to perform a checked roll to an equal and opposite angle of bank.

(2) At V_C, the lateral control must be suddenly displaced the amount required to perform a checked roll to an equal and opposite angle of bank, achieving the same maximum roll acceleration or roll rate, whichever is critical, as in paragraph (a)(1) of this section.

(3) At V_D, the lateral control must be suddenly displaced the amount required to perform a checked roll to an equal and opposite angle of bank, achieving one-third of the maximum roll acceleration or roll rates, whichever is critical, as in paragraph (a)(1) of this section.

(b) *Minimum "g" rolls*. At any speed within the design limitations for the enroute flight mode, the aircraft is assumed to be in a minimum "g" pushover at zero bank angle and sideslip. The minimum load factor need not be less than that for which positive roll control is available but not less than zero "g" in any case. Sufficient roll control must be provided for all maneuvers in normal operation. The lateral control must be suddenly displaced to perform a checked roll to a bank angle of 60 degrees. The following lateral control displacement must be addressed, except as limited by the maximum pilot forces in TR.397.

(1) At V_A, the lateral control must be displaced to perform the checked roll achieving the maximum possible roll acceleration or roll rate whichever is critical.

(2) At V_C, the lateral control displacement must be that which will achieve the same roll acceleration or roll rate, whichever is critical, as in paragraph (b)(1) of this section.

(3) At V_D, the lateral control displacement must be that which will achieve one-third of the roll acceleration or roll rate, whichever is critical, as in paragraph (b)(1) of this section.

(c) *Rolls in takeoff, hover, landing, and transition modes*. In these modes, within the speed limitations of § 29.309(c), it is assumed that the lateral control is suddenly displaced to the maximum deflection as limited by control stops or by the maximum pilot force specified in

TR.397 or as required to achieve a checked roll to an angle of 30 degrees, whichever is least. All critical positive limit load factors between 1.5 and 0.5 shall be assumed.

(d) *Unsymmetrical gusts.* The aircraft is assumed to be subjected to unsymmetrical vertical gusts in level flight. The resulting limit loads must be determined from either the wing maximum airload derived directly from § 25.341(a), or the wing maximum airload derived indirectly from the vertical load factor calculated from § 25.341(a). It must be assumed that 100 percent of the wing air load acts on one side of the aircraft and 80 percent of the wing air load acts on the other side.

TR.351 Yawing maneuvers.

(a) *General*. The aircraft must be designed for loads resulting from the conditions specified in paragraphs (b) and (c) of this section. It may be assumed for all conditions that lateral control is applied as necessary to maintain a reasonable angle of bank. The reactions to unbalanced aerodynamic moments about the center of gravity must be addressed in a rational or conservative manner. In computing the tail loads the yawing velocity may be assumed to be zero.

(b) *Airplane mode yaws*.

(1) At all speeds from 1.13 V_{SR} up to V_D, with the aircraft in unaccelerated flight at zero yaw, it is assumed that the cockpit directional control is suddenly displaced to the maximum deflection, as limited by the control system stops.

(2) With the cockpit directional control deflected so as always to maintain the maximum deflection available within the limitations specified in paragraph (b)(1) of this section, it is assumed that the aircraft yaws to the overswing sideslip angle.

(3) With the aircraft yawed to the static equilibrium sideslip angle, it is assumed that the cockpit directional control is held so as to achieve the maximum deflection available within the

limitations specified in paragraph (b)(1) of this section until the aircraft yaws to the resulting static equilibrium sideslip angle.

(4) With the aircraft yawed to the static equilibrium sideslip angle of paragraph (b)(3) of this section, it is assumed that the cockpit directional control is suddenly returned to neutral.

(c) *VTOL/Conversion mode yaws.*

(1) To produce the load required in paragraph (a) of this section, in unaccelerated flight with zero yaw, at forward speeds from zero up to 0.6 V_{CON}—

(i) Displace the cockpit control suddenly to the maximum deflection limited by the control system stops;

(ii) Attain a resulting sideslip angle or 90 degrees, whichever is less; and

(iii) Return the directional control suddenly to neutral.

(2) To produce the load required in paragraph (a) of the section, in unaccelerated flight with zero yaw, at forward speeds from 0.6 V_{CON} up to V_{CON}—

(i) Displace the cockpit directional control suddenly to the maximum deflection limited by the control system stops;

(ii) Attain a resulting sideslip angle or 15 degrees, whichever is less, at V_{CON};

(iii) Vary the sideslip angles of paragraphs (c)(1)(ii) and (c)(2)(ii) of this section directly with speed; and

(iv) Return the directional control suddenly to neutral.

TR.353 Unsymmetrical and combined control device surface loads.

The control device surfaces and their supporting structure for the prescribed yawing and rolling maneuvers must be designed for asymmetrically distributed loads arising from the effects of—

(a) Slip stream;

(b) Dihedral; and

(c) Aerodynamic, elastic, and inertial interaction.

TR.361 Engine torque and gyroscopic forces.

(a) Each engine mount, drive train, and rotating component mount and their supporting structures must be designed for the effects of—

(1) A limit engine torque corresponding to takeoff power combined with 75 percent of the limit loads specified for the hover, takeoff, landing, and VTOL/Conversion mode flight conditions;

(2) A limit engine torque corresponding to the maximum continuous power (including OEI maximum continuous, where applicable), combined with the limit loads specified for airplane mode flight conditions; and

(3) A limit engine torque corresponding to takeoff power multiplied by a factor accounting for a power absorber control malfunction acting simultaneously with 1g level flight loads. In the absence of a rational analysis, a factor of 1.6 must be used.

(b) The engine mounts and supporting structure must be designed for the effects of—

(1) A limit engine torque load imposed by sudden engine stoppage due to malfunction or structural failure (such as compressor jamming); and

(2) A limit torque load imposed by the maximum acceleration of the engine.

(c) The structure supporting any engine or other rotating component must be designed for the gyroscopic and aerodynamic loads associated with all specified flight and ground conditions with the engines at the appropriate r.p.m.

(d) The limit engine torque addressed under paragraph (a) of this section must be obtained by multiplying the mean torque for each specified power condition by a factor of 1.25. In addition, the mean torque must be determined by distributing the power to the various power absorbers in a rational and conservative manner.

§ 25.363 Side load on engine and auxiliary power unit mounts.

(a)(1) [Applicable to AW609]

(a)(2) [Not applicable to AW609]

(b) [Applicable to AW609]

§ 25.365 Pressurized cabin loads.

(a) through (g) [Applicable to AW609]

Control Surface and System Loads.

§ 25.391 Control surface loads: general.

(a) [Applicable to AW609]

(b) through (c) [Not applicable to AW609]

(d) [Applicable to AW609]

(e) [Not applicable to AW609]

[Except replace references to § 25.331 with TR.331, § 25.349 with TR.349, § 25.351 with TR.351, and § 25.427 with TR.427.]

§ 25.393 Loads parallel to hinge line.

(a) through (b) [Applicable to AW609]

TR.395 Control system loads.

(a) Each component of the primary control system, including its supporting structure, must be designed to withstand the greater of the following loads:

(1) Loads corresponding to 125 percent of the computed aerodynamic hinge moments on the lift or control device in the conditions prescribed in TR.331, 25.341, 29.341, TR.349, and TR.351,

including the effects of any single power boost system failure, except the maximum loads considered need not include those which would assume pilot forces greater than the maximum pilot forces listed in TR.397;

(2) The loads produced by automatic devices operating the controls, including the effects of any single power boost system failure; or

(3) Loads resulting from application of the minimum pilot forces listed in TR.397, including considerations of § 25.399, assuming the lift or control device held fixed in the most critical position. The effects of elastic deflection may be considered.

(b) The pilot forces specified in TR.397 are assumed to act at the appropriate control grips or pads (in the manner simulating flight conditions) and the reaction to those loads must be provided by—

(1) The control stops only;

(2) The control locks only;

(3) The irreversible mechanism only (with the mechanism locked and the control devices in the critical positions for the effective parts of the system within its limit of motion); and

(4) The attachment of the control system to the first attachment point that is rigidly fixed to the lift or control device (with the control in the critical positions for the affected parts of the system within the limits of its motion).

(c) Where power boost or power-actuated control systems are used, except in proprotor collective and cyclic controls with triple redundant boost cylinders, the system between the boost or power unit and the control device must be designed for—

(1) The total boost output plus the required pilot force, but not less than the minimum pilot forces of TR.397 where the pilot force can supplement the boost output force; and

(2) The boost or power unit malfunction conditions of TR.671, with the remaining boost output plus the maximum pilot force of TR.397.

(d) For proprotor cyclic and collective controls using triple redundant boost cylinders, the system between the boost or power unit and the control device must be designed for the greater of 125 percent of the maximum computed aerodynamic hinge moment and the single-cylinder stall load of the boost or power unit.

(e) Each element of a configuration conversion control system that is not required to be continuously handled by the pilot during the flight and its supporting structure must be designed to withstand—

(1) Loads occurring in the prescribed flight and landing conditions when the device is in its appropriate position; and

(2) The combination of friction, inertia, torque, gyroscopic moments, and airloads, and pilot forces (specified in TR.397) if applicable, occurring during transition from one configuration to another, for all critical combinations of limitations and for the gust loads prescribed in §§ 25.341 and 29.341 in conjunction with power settings up to the maximum appropriate for each transition mode.

(f) Secondary control systems must be designed in accordance with the requirements specified in § 25.405.

(g) In the control surface flight loading condition, the air loads on movable surfaces and the corresponding deflections need not exceed those that would result in flight from the application of any pilot force within the ranges specified in TR.397. Two-thirds of the maximum values specified for the flaperon and elevator may be used if control surface hinge moments are based on reliable data. In applying this criterion, the effects of servo mechanisms, tabs, and automatic pilot systems must be considered.

TR.397 Limit pilot forces.

The limit pilot forces are as follows:

Control	**Maximum forces or torques**	**Minimum forces or torques**
Stick:		
Fore and Aft	250 lbs	100 lbs
Laterally	100 lbs	65 lbs
Wheel:		
Fore and Aft	300 lbs	100 lbs
Lateral Couple*	80D in-lbs	40D in-lbs**
Foot:	300 lbs	180 lbs
Lever ***:	150 lbs	83 lbs

* The critical parts of the control system associated with this motion must be designed for a single tangential force with the limit value equal to 1.25 times the couple force determined from these criteria.
** D = wheel diameter (inches)
*** Limited to configuration conversion controls. Actual limit pilot force may be computed as—

$$\frac{(1+R)}{3} \times 50$$

where-

R = radius in inches; applicable to any angle within 20° of plane of control.

§ 25.399 Dual control system.

(a) through (b) [Applicable to AW609 except replace the references to § 25.395 with TR.395 and the reference to § 25.397(c) with TR.397]

§ 25.405 Secondary control system.

[Applicable to AW609]

§ 25.415 Ground gust conditions.

(a) through (b) [Applicable to AW609]

[except replace the reference to § 25.397(c) with TR.397]

TR.427 Unsymmetrical loads.

(a) In designing the aircraft for lateral gust, yaw maneuver and roll maneuver conditions, account must be taken of unsymmetrical loads on the empennage arising from effects such as slipstream and aerodynamic interference with the wing, vertical fin, and other aerodynamic surfaces.

(b) The horizontal tail must be assumed to be subjected to unsymmetrical loading conditions determined as follows:

(1) In VTOL/Conversion mode—

(i) 100 percent of the maximum loading from the symmetrical flight conditions acts on the surface on one side of the plane of symmetry, and no loading acts on the other side; and

(ii) 50 percent of the maximum loading from the symmetrical flight conditions acts on the surface on each side of the plane of symmetry, in opposite directions.

(2) In airplane mode—

(i) 100 percent of the maximum loading from the symmetrical maneuver conditions of TR.331 and the vertical gust conditions of § 25.341(a) acting separately on the surface on one side of the plane of symmetry; and

(ii) 80 percent of these loadings acting on the other side.

(c) For empennage arrangements where the horizontal tail surfaces have dihedral angles greater than plus or minus 10 degrees, or are supported by the vertical tail surfaces, the surfaces and the supporting structure must be designed for gust velocities specified in § 25.341(a) acting in any orientation at right angles to the flight path.

(d) Unsymmetrical loading on the empennage arising from buffet conditions of § 25.305(e) must be taken into account.

TR.457 Flaperons.

Flaperons, their operating mechanism, and their supporting structure must be designed for the limit loads resulting from the flight conditions in TR.331, 25.341(a), 29.341, TR.349, and TR.351, and the ground gust conditions in § 25.415, considering the effects of—

(a) Unsymmetrical loads prescribed in TR.353; and

(b) Transition from one flaperon position and airspeed to another.

§ 25.459 Special devices.

[Applicable to AW609]

Ground Loads.

§ 25.471 General.

(a) [Applicable to AW609]

(b) through (c) [Not applicable to AW609]

§ 29.471 General.

(a) [Not applicable to AW609]

(b) [Applicable to AW609]

§ 25.473 Landing load conditions and assumptions.

(a) through (b) [Not applicable to AW609]

(c) through (e) [Applicable to AW609, except replace the reference to § 25.723(a) with TR.723(a)]

§ 29.473 Ground loading conditions and assumptions.

(a) through (c) [Applicable to AW609, except replace the reference to § 29.725 with TR.725, and replace the reference to § 29.303 with § 25.303]

§ 29.475 Tires and shock absorbers.

[Applicable to AW609]

§ 29.477 Landing gear arrangement.

[Applicable to AW609]

§ 29.479 Level landing conditions.

(a) through (c) [Applicable to AW609]

§ 29.481 Tail-down landing conditions.

(a) through (b) [Applicable to AW609]

§ 29.483 One-wheel landing conditions.

(a) through (b) [Applicable to AW609]

§ 29.485 Lateral drift landing conditions.

(a) through (b) [Applicable to AW609]

§ 25.487 Rebound landing condition.

(a) through (b) [Applicable to AW609]

§ 25.489 Ground handling conditions.

[Applicable to AW609, except replace the reference to § 25.493 with § 29.493, and replace the reference to § 25. 495 with TR.495.]

§ 25.491 Taxi, takeoff and landing roll.

[Applicable to AW609]

§ 29.493 Braked roll conditions.

(a) through (b) [Applicable to AW609]

TR.495 Turning.

The aircraft is assumed to be in three-point static ground attitude and to execute a steady turn by nose gear steering, or by application of sufficient differential power, so that the limit load factors applied at the center of gravity are 1.0 vertically and n_y laterally. The side ground reaction of each wheel must be equal to n_y multiplied by the vertical reaction. The side load factor n_y shall be the lesser of 0.5 and the value that results in overturning, but not less than 0.4.

§ 25.499 Nose-wheel yaw and steering.

(a) through (e) [Applicable to AW609 except replace the reference to § 25.493(b) with § 29.493(b)]

§ 25.503 Pivoting.

(a) through (b) [Applicable to AW609]

§ 29.505 Ski landing conditions.

(a) through (c) [Applicable to AW609]

§ 25.507 Reversed braking.

(a) through (c) [Applicable to AW609]

§ 25.509 Towing loads.

(a) through (d) [Applicable to AW609]

§ 29.511 Ground load: unsymmetrical loads on multiple-wheel units.

(a) through (c) [Applicable to AW609]

TR.519 Jacking and tie-down provisions.

(a) *General*. The aircraft must be designed to withstand the limit load conditions resulting from the static ground load conditions of paragraph (b) of this section and, if applicable, paragraph (c) of this section at the most critical combinations of aircraft weight and center of gravity. The maximum allowable load at each jack pad must be specified.

(b) *Jacking*. The aircraft must have provisions for jacking and must withstand the following limit loads when the aircraft is supported on jacks—

(1) For jacking by the landing gear at the aircraft maximum defined jacking weight, the aircraft structure must be designed for a vertical load of 1.33 times the vertical static reaction at each jacking point acting singly and in combination with a horizontal load of 0.33 times the vertical static reaction applied in any direction; and

(2) For jacking by other aircraft structure at maximum approved jacking weight:

(i) The aircraft structure must be designed for a vertical load of 1.33 times the vertical reaction at each jacking point acting singly and in combination with a horizontal load of 0.33 times the vertical static reaction applied in any direction; and

(ii) The jacking pads and local structure must be designed for a vertical load of 2.0 times the vertical static reaction at each jacking point, acting singly and in combination with a horizontal load of 0.33 times the vertical static reaction applied in any direction.

(c) *Tie-down*. If tie-down points are provided, the main tie-down points and local structure must withstand the limit loads resulting from a 65-knot horizontal wind from any direction.

Main Component Loads.

§ 29.547 Main and tail rotor structure.

(a) through (b) [Applicable to AW609]

(c) [Applicable to AW609 except replace the reference to § 29.337 through § 29.341 and § 29.351 with § 25.337, TR.337, § 25.341, § 29.341, TR.349, and TR.351]

(d) [Applicable to AW609]

(e) [Applicable to AW609, except replace the reference to § 29.361 with TR.361]

§ 29.549 Fuselage and rotor pylon structures.

(a)(1) [Applicable to AW609, except replace the reference to §§ 29.337 through 29.341 and 29.351 with § 25.337, TR.337, § 25.341, § 29.341, TR.349, and TR.351]

(a)(2) [Applicable to AW609, except include in the reference to § 29.471 both §§ 25.471 and 29.471, include in the reference to § 29.473 both §§ 25.473 and 29.473, and remove the references to §§ 29.497 and 29.521]

(a)(3) [Applicable to AW609]

(b) through (c) [Applicable to AW609]

(d) [Reserved in § 29.549]

(e) [Applicable to AW609]

Emergency Landing Conditions.

§ 29.561 General.

(a) through (b) [Applicable to AW609]

(c) [Not applicable to AW609]

(d) [Applicable to AW609]

TR.561 General.

(a) The supporting structure must be designed to restrain under any ultimate inertial load factor up to those specified in this paragraph, any item of mass above and/or behind the crew and passenger compartment that could injure an occupant if it came loose in an emergency landing. Items of mass to be considered include, but are not limited to, any relevant section of top mounted wings with fuel tanks full of fuel, rotors, transmission, and engines. The items of mass must be restrained for the following ultimate inertial load factors:

(1) Upward—1.5g.

(2) Forward—12g.

(3) Sideward—6g.

(4) Downward—12g.

(5) Rearward—1.5g.

§ 29.562 Emergency landing dynamic conditions.

(a) through (d) [Applicable to AW609]

§ 29.563 Structural ditching provisions.

(a) through (b) [Applicable to AW609]

Fatigue Evaluation.

§ 29.571 Fatigue Tolerance Evaluation of Metallic Structure.

(a) through (i) [Applicable to AW609]

TR.571 Limit of Validity.

Based on the evaluations required by §§ 29.571, 29.573, TR.573, and this section, the applicant must establish a limit of validity of the engineering data that supports the structural maintenance program (hereafter referred to as LOV), stated as a number of total accumulated flight cycles or flight hours or both. The LOV must be included in the Airworthiness Limitations section of the Instructions for Continued Airworthiness.

(a) The applicant must demonstrate by full-scale fatigue test evidence, by analysis supported by full-scale fatigue test evidence, or by another method approved by the Administrator, that the cumulative effect of repeated loading or environment, as applicable, will not result in catastrophic failure throughout the operational life of the aircraft. Where the design is such that widespread fatigue damage (WFD) could occur, the evaluation must demonstrate that WFD will not occur in the aircraft structure up to the LOV. The residual strength of the structure must be shown, by test or analysis supported by test, to be able to withstand critical limit flight loads, considered as ultimate loads, with the extent of detectable damage consistent with the results of the damage tolerance evaluations. The following loads must be withstood:

(1) For the pressurized cabin:

(i) Critical limit flight loads with the combined effects of normal operating pressure and expected external aerodynamic pressures.

(ii) The expected external aerodynamic pressures in 1g flight combined with a cabin differential pressure equal to 1.15 times the normal operating differential pressure without any other load.

(2) The loads specified in paragraphs §§ 29.571 and 29.573 for the residual strength requirements.

(b) The applicant must demonstrate by analysis, supported by test evidence, that inspections or other procedures established as a result of the evaluations required by §§ 29.571, 29.573, TR.573, and this section, are capable of preventing catastrophic failure of aircraft structure up to the LOV.

(c) The Administrator may issue the type certificate prior to completion of full-scale fatigue testing, provided the Administrator has approved the applicant’s plan for completing the required tests. In that case, the Airworthiness Limitations section of the Instructions for Continued Airworthiness must prohibit the aircraft from operating beyond a number of cycles equal to 1/2 the number of cycles accumulated on the fatigue test article, until such testing is completed and the applicant has complied with paragraphs (a) and (b) of this section.

§ 29.573 Damage Tolerance and Fatigue Evaluation of Composite Rotorcraft Structures.

(a) through (e) [Applicable to AW609]

TR.573 Damage Tolerance and Fatigue Evaluation of Composite Structures.

The following requirements must be used jointly with requirements of § 29.573 of this certification basis for fatigue tolerance evaluation of composite structure. These requirements are in addition to the basic requirements of qualified bonding processes and rigorous quality controls for bonded structures. For composite structure that contains bonded joints, the failure of which would result in a fatality or loss of the aircraft, the limit load capacity must be substantiated by one of the following methods:

(a) The maximum disbonds of each bonded joint consistent with the capability to withstand the critical limit design loads must be determined by analysis supported by test evidence. Disbonds of each bonded joint greater than this must be prevented by design features;

(b) Proof testing must be conducted on each production article that will apply the critical limit design load to each critical bonded joint;

(c) Repeatable and reliable non-destructive inspection techniques must be established that ensure the strength of each joint; or

(d) Another method approved by the Administrator

TR.575 Damage tolerance and fatigue evaluation of elastomeric aircraft components.

(a) A damage tolerance evaluation of each elastomeric principal structural element (PSE) must be performed, and appropriate retirement lives and inspection intervals must be established to avoid catastrophic failure during the operational life of the aircraft. Elastomeric PSEs are structural elements that contribute significantly to the carrying of flight or ground loads; whose performance is critical to aircraft or system dynamics; and whose failure or reduction of critical performance attributes could result in catastrophic loss of the aircraft. Elastomeric components must be evaluated under the damage tolerance requirements of paragraph (b) of this section. Major metal components, which are the metallic fastening elements that connect the laminate to surrounding parts, must be evaluated under the requirements of § 29.571. Metallic shims that are part of the elastomeric laminate are not considered critical parts.

(b) Damage tolerance evaluation:

(1) Damage tolerance evaluations of elastomeric components must show that catastrophic failure due to aging, wear, contamination, environmental effects, static loads, or fatigue loads is avoided throughout the prescribed inspection intervals of the aircraft.

(2) The damage tolerance evaluation must include elastomeric PSEs of the airframe, prop rotor drive systems, blades and hubs, controls, fixed and movable control surfaces, engine and transmission mountings, landing gear, and any other detail design points whose failure or detachment could prevent continued safe flight and landing.

(3) Each damage tolerance evaluation must include:

(i) The identification of the component being evaluated;

(ii) A determination of the structural loads and motions for all critical conditions throughout the range of limits in § 29.309 (including altitude effects), supported by in-flight and ground measurements, except that maneuvering load factors need not exceed the maximum values expected in service;

(iii) The loading and motion spectra as severe as those expected in service based on data determined under paragraph (b)(3)(ii) of this section, including external load operations, if applicable, and other low and high frequency cycle operations, including pre-flight checks, Ground-Air-Ground and Start-Stop cycles;

(iv) A damage identification supported by test evidence, similarity and, if available, service experience for all components being evaluated that identifies the locations, types, and sizes of damage, considering fatigue, aging, wear, contamination, and environmental effects that may occur during operation;

(v) An assessment, supported by test evidence, and if available, service experience, of the residual strength, fatigue, and performance characteristics of all components being evaluated that supports the inspection intervals established under paragraph (b)(4) of this section;

(4) Based on the evaluations required by this section, inspections, or other procedures, must be established to require the replacement of damaged parts to prevent catastrophic failure. These inspections, or other procedures, must be included in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness required by § 29.1529.

(5) Inspection intervals must be determined by test, or by analysis supported by test, to show that any damage identified in paragraph (b)(3)(iv) of this section that may occur from fatigue or other in-service causes is revealed before it has grown to the extent that the component cannot sustain the required residual strength capability in-service, or loses its functionality, whichever comes first. In establishing these inspection intervals, the following items must be considered:

(i) Clearly detectable damage identified in paragraph (b)(3)(iv) of this section and established during fatigue testing, to be adopted as removal criteria;

(ii) Damage detectability in service by means of appropriate inspection technique;

(iii) The damage propagation duration under the loads and motions spectra expected in-service determined by tests;

(iv) Residual performance and residual ultimate load strength capability after complete growth of the damage identified in paragraph (b)(5)(i) of this section still ensuring (even if degraded) the part functions safely;

(v) A safety factor on the damage propagation duration defined in paragraph (b)(5)(iii) of this section.

(6) The functionality of the part (including stiffness and dynamic behavior) must be taken into account when substantiating the maximum assumed damage size and inspection interval.

SUBPART D – DESIGN AND CONSTRUCTION.

General.

§ 29.601 Design.

(a) through (b) [Applicable to AW609]

§ 29.602 Critical parts.

(a) through (b) [Applicable to AW609]

§ 29.603 Materials.

(a) through (c) [Applicable to AW609]

§ 29.605 Fabrication Methods.

(a) through (b) [Applicable to AW609]

§ 29.607 Fasteners.

(a) through (b) [Applicable to AW609]

§ 29.609 Protection of structure.

(a) through (b) [Applicable to AW609]

§ 29.610 Lightning and static electricity protection.

(a) through (d) [Applicable to AW609]

§ 29.611 Inspection provisions.

(a) through (c) [Applicable to AW609]

§ 29.613 Material strength properties and design values.

(a) through (e) [Applicable to AW609]

§ 29.619 Special factors.

(a) through (b) [Applicable to AW609 except replace the reference to § 29.303 with § 25.303]

§ 29.621 Casting Factors.

(a) through (d) [Applicable to AW609, except in (c)(2) replace the reference to § 29.305 with § 25.305]

§ 29.623 Bearing factors.

(a) through (b) [Applicable to AW609]

§ 29.625 Fitting factors.

(a) through (d) [Applicable to AW609]

§ 25.629 Aeroelastic stability requirements.

(a) through (e) [Applicable to AW609 except replace the references to §§ 25.335, 25.631, 25.671, 25.672, and 25.1309 with TR.335, TR.631, TR.671, 29.672 and TR.672, and TR.1309. Also replace § 25.571 with §§ 29.571, TR.571, and TR.575]

TR.629 Aeroelastic stability requirements.

(a) In showing compliance with § 25.629(b), the following configurations and design conditions must be additionally considered:

(1) Airspeeds up to 1.11 times the maximum permitted forward speed in helicopter or conversion modes.

(2) Main rotor speeds from 0.95 times the minimum permitted rotor r.p.m. up to 1.05 times the maximum permitted rotor r.p.m. in helicopter or conversion modes.

(3) The critical combinations of weight, c.g. position, load factor and altitude in helicopter or conversion modes.

(b) In showing compliance with § 25.629(d), the following failures, malfunctions, and adverse conditions must be additionally considered:

(1) Failure of any single element of the structure supporting the interconnect shaft; and

(2) Any likely control system stiffness reduction.

TR.631 Bird strike.

(a) The aircraft must be capable of continued safe flight and landing after—

(1) In airplane mode, impact with a 4-pound bird when the velocity of the aircraft (relative to the bird along the aircraft's flight path) is equal to V_C at sea level or 0.85 V_C at 8,000 feet, whichever is more critical; and

(2) In VTOL/Conversion Mode, impact with a 2.2-pound bird at V_{CON} or V_H (whichever is less) at altitudes up to 8,000 feet.

(b) Compliance must be shown by tests or by analysis based on tests carried out on sufficiently representative structures of similar design.

Control Devices.

§ 25.651 Proof of strength.

(a) through (b) [Applicable to AW609 except replace the reference to §§ 25.619 through 25.625 with §§ 29.619 through 29.625]

§ 29.653 Pressure venting and drainage of rotor blades.

(a) through (b) [Applicable to AW609]

§ 25.655 Installation.

(a) through (b) [Applicable to AW609 except replace the reference to § 25.161 with TR.195]

§ 25.657 Hinges.

(a) through (b) [Applicable to AW609]

§ 29.659 Mass balance.

(a) through (b) [Applicable to AW609]

§ 29.661 Rotor blade clearance.

[Applicable to AW609]

TR.661 Clearances.

(a) There must be sufficient clearance between any portion of the moveable nacelle and the alighting surface during all normal operating conditions.

(b) If a guard is required to show compliance with paragraph (a) of this section, suitable design loads must be established for and used to design the guard and its supporting structure.

§ 29.663 Ground resonance prevention means.

(a) through (b) [Applicable to AW609]

Control Systems.

TR.671 General.

(a) Each control and control system must operate with the ease, smoothness, and effectiveness appropriate to its function.

(b) Each element of each flight control system must be designed, or distinctively and permanently marked, to minimize the probability of incorrect assembly that could result in the malfunctioning of the system.

(c) The aircraft must be shown by analysis and tests to be capable of continued safe flight and landing after any of the following failures or jamming in the flight control system for any speed or altitude within the approved flight operating limitations, without requiring exceptional piloting skill or strength. Reasonably probable failures must have only minor effects.

(1) Any failure, excluding a jam as listed in paragraph (c)(3) of this section.

(2) Any combination of failures not shown to be extremely improbable, excluding a jam as listed in paragraph (c)(3) of this section.

(3) Any jam in a control position encountered during any flight condition, including transitions, within the approved operating limitations, unless the jam is shown to be extremely improbable or can be alleviated.

(d) The frequency response of each element to the forcing vibrations experienced must be accounted for.

(e) The aircraft must be designed so that it is controllable if all engines fail. Compliance with this requirement may be shown by analysis where that method has been shown to be reliable.

§ 29.672 Stability augmentation, automatic, and power-operated systems.

(a) through (b) [Applicable to AW609 except replace the reference to § 29.671 with TR.671]

(c) [Not applicable to AW609]

TR.672 Stability augmentation.

(a) If a stability augmentation system (SAS) is used, the reliability of the SAS must be related to the effects of its failure. Any SAS failure condition that would prevent continued safe flight and landing must be extremely improbable. It must be shown that, for the occurrence of any failure condition of the SAS that is not shown to be extremely improbable—

(1) The aircraft is safely controllable when the failure or malfunction occurs at any speed or altitude within the approved Instrument Flight Rules (IFR) operating limitations; and

(2) The overall flight characteristics of the aircraft allow for prolonged instrument flight without undue pilot effort. Additional unrelated probable failures affecting the control system must be addressed. In addition—

(i) The controllability and maneuverability requirements in subpart B of this certification basis must be met throughout a practical flight envelope;

(ii) The flight control, trim, and dynamic stability characteristics must not be impaired below a level needed to allow continued safe flight and landing;

(iii) The dynamic stability requirements of subpart B of this certification basis must also be met throughout a practical flight envelope; and

(iv) The static longitudinal and static directional stability requirements of subpart B of this certification basis must be met throughout a practical flight envelope.

(b) The SAS must be designed so that it cannot create a hazardous deviation in flight path or produce hazardous loads on the aircraft during normal operation or in the event of malfunction or failure, assuming corrective action begins within an appropriate period of time. Where multiple systems are installed, subsequent malfunction conditions must be considered in sequence unless their occurrence is shown to be remote.

TR.673 Primary and secondary controls.

(a) *Primary flight controls*

(1) Primary flight controls in VTOL/Conversion mode are those used by the pilot for immediate control of pitch, roll, yaw, vertical motion, and speed of the aircraft. These are the center stick, pedals, power lever, and conversion controller.

(2) Primary flight controls in airplane mode are those used by the pilot for immediate control of pitch, roll, and yaw. These are the center stick and pedals.

(b) *Secondary controls.* Secondary controls are those used by the pilot to operate flaperons (symmetric flaperon deflection), landing gear, and wheel brakes.

§ 29.674 Interconnected controls.

[Applicable to AW609]

§ 25.675 Stops.

(a) [Applicable to AW609]

(b) through (c) [Not applicable to AW609]

§ 29.675 Stops.

(a) through (d) [Applicable to AW609]

§ 29.679 Control system locks.

(a) through (b) [Applicable to AW609]

§ 29.681 Limit load static tests.

(a) through (b) [Applicable to AW609]

§ 25.683 Operation tests.

(a) through (c) [Applicable to AW609]

§ 29.685 Control system details.

(a) through (f) [Applicable to AW609]

§ 29.687 Spring devices.

(a) through (b) [Applicable to AW609]

§ 29.691 Autorotation control mechanism.

[Applicable to AW609]

TR.692 Propulsive lift and other configuration conversion devices.

(a) The control for each propulsive lift or configuration conversion device must be designed and located to prevent inadvertent operation, if such inadvertent operation would be unsafe.

(b) The control and operating mechanism for each propulsive lift or configuration conversion device must be designed so that the flight crew can place the device in any position appropriate to the desired mode of operation. The device must maintain these positions, except for movement produced by an automatic positioning or load limiting device, without further attention by the flight crew except during transition from one flight mode to another.

(c) The rate of motion of the propulsive lift or configuration conversion device, in response to the operation of the control and characteristics of the automatic positioning or load limiting device, must provide satisfactory flight and performance characteristics under steady or changing conditions of airspeed, engine power, and aircraft attitude.

(d) The control and the operating mechanism for each propulsive lift or configuration conversion device must be designed to operate the device throughout the complete range of positions appropriate to the flight and ground modes, considering any power setting up to the maximum appropriate to the respective mode and at any speed between design minimum and design maximum for appropriate flight modes.

(e) Each propulsive lift or configuration conversion device must comply with the requirements for an alternate system in § 29.695.

TR.693 Propulsive lift and other configuration conversion position indicator and warning device.

(a) There must be means to indicate the position of each configuration conversion device.

(b) The position indicated for each configuration conversion device must be clearly marked to identify the range or position appropriate to each mode of operation.

(c) If the control and operating mechanism for any propulsive lift or configuration conversion device is provided with a separately actuated system to mechanically lock the device in any position, there must be means to inform the pilot that the device is locked in the appropriate position or that it is unlocked. If sensor switches are used, they must be located and mechanically coupled to the device in a manner that prevents an erroneous indication of a locked or unlocked condition. The sensor switches may be located where they are operated by the actual locking latch or mechanism.

(d) In addition, on configuration conversion devices essential for safe flight and landing, an alternate means to determine the position must be provided, which will function automatically in the event of failure of the primary indicators.

TR.694 Interconnection.

(a) The operation of two or more propulsive lift or other configuration conversion devices that could produce unbalanced forces on the aircraft must be synchronized by a reliable interconnection unless the aircraft has safe flight and landing characteristics with the devices in their most adverse control position.

(b) If an interconnection is used, there must be means to prevent hazardous unsymmetrical operation of the conversion devices that may result in any of the failures listed in TR.671(c)(1) through (c)(3).

(c) The interconnection, if used, must be designed to account for the applicable unsymmetrical loads, including those resulting from flight with the engines on one side of the plan of symmetry inoperative and the remaining engines at takeoff power.

§ 29.695 Power boost and power-operated control system.

(a) through (c) [Applicable to AW609]

§ 25.697 Lift and drag devices, controls.

(a) through (d) [Applicable to AW609, except replace the reference to § 25.101(d) with TR.45(d)]

§ 25.699 Lift and drag device indicator.

(a) through (c) [Applicable to AW609]

§ 25.701 Flap and slat interconnection.

(a) through (d) [Applicable to AW609]

TR.703 Takeoff warning system.

A takeoff warning system must be installed and must meet the following requirements:

(a) The system must provide to the pilots an aural warning that is automatically activated during the initial portion of the takeoff if the aircraft configuration, proprotor speed, or engine control levers are in a position or setting that would not allow a safe takeoff.

(b) The warning required by paragraph (a) of this section must continue until—

(1) The configuration is changed to allow a safe takeoff;

(2) Action is taken by the pilot to terminate the takeoff;

(3) The aircraft is rotated for takeoff or other comparable point in the takeoff procedure; or

(4) The warning is manually deactivated by the pilot.

(c) The means used to activate the system must function properly throughout the ranges of takeoff weights, altitudes, and temperatures for which certification is requested.

Landing Gear.

TR.721 General.

The landing gear system must be designed so that if it fails due to overloads during takeoff and landing (assuming the overloads act in the upward and aft directions), the failure mode is not likely to puncture any part of the fuel system.

TR.723 Shock absorption tests.

(a) The analytical representation of the landing gear dynamic characteristics that is used in determining the landing loads must be validated by energy absorption tests. A range of tests, including at a minimum those required by TR.725 and § 29.727, must be conducted to ensure that the analytical representation is valid for the design conditions specified in §§ 25.473 and 29.473.

(b) In lieu of the tests prescribed in this section, changes in previously approved design weights and minor changes in design may be substantiated by analyses based on previous tests conducted on the same basic landing gear system that has similar energy absorption characteristics.

TR.725 Limit drop test.

The limit drop test must be conducted as follows:

(a) The drop height must be at least 8 inches.

(b) If considered, the proprotor lift specified in § 29.473(a) must be introduced into the drop test by appropriate energy absorbing devices or by the use of an effective mass.

(c) Each landing gear unit must be tested in the attitude simulating the landing condition that is most critical from the standpoint of the energy to be absorbed by it.

(d) When an effective mass is used in showing compliance with paragraph (b) of this section and structural dynamic response of the airframe is not significant, the following formulae may be used instead of more rational computations.

$$W_e = W \times \left[\frac{h + (1 - L) \cdot d}{(h + d)} \right]; \text{ and}$$

$$n = n_j \times \left(\frac{W_e}{W} \right) + L$$

where:

W_e = the effective weight to be used in the drop test (lbs.).

$W = W_M$ for main gear units (lbs.), equal to the static reaction on the particular unit with the aircraft in the most critical attitude. A rational method may be used in computing a main gear static reaction, taking into consideration the moment arm between the main wheel reaction and the aircraft center of gravity.

$W = W_N$ for nose gear units (lbs.), equal to the vertical component of the static reaction that would exist at the nose wheel, assuming that the mass of the aircraft acts at the center of gravity and exerts a force of 1.0g downward and 0.25g forward.

$W = W_T$ for tailwheel units (lbs.) equal to whichever of the following is critical—

(1) The static weight on the tailwheel with the aircraft resting on all wheels; or

(2) The vertical component of the ground reaction that would occur at the tailwheel assuming that the mass of the aircraft acts at the center of gravity and exerts a force of 1g downward with the aircraft in the maximum nose-up attitude considered in the nose-up landing conditions.

h = specified free drop height (inches).

L = ratio of assumed proprotor lift to the aircraft weight.

d = deflection under impact of the tire (at the proper inflation pressure) plus the vertical component of the axle travel (inches) relative to the drop mass.

n = limit inertia load factor.

n_j = the load factor developed, during impact, on the mass used in the drop test (i.e., the acceleration dv/dt in g's recorded in the drop test plus 1.0).

If structural dynamic response of the airframe is significant, an equivalent sprung mass system, which duplicates the energy absorbed, peak load, and maximum stroke of the landing gear unit under test resulting from identical landing conditions for the entire aircraft, shall be utilized.

§ 29.727 Reserve energy absorption drop test.

(a) through (c) [Applicable to AW609]

§ 25.729 Retracting mechanism.

(a) through (e) [Not applicable to AW609]

(f) [Applicable to AW609]

§ 29.729 Retracting mechanism.

(a) through (g) [Applicable to AW609 except replace the references to § 29.777 and § 29.779 with TR.777 and TR.779]

§ 25.731 Wheels.

(a) through (c) [Not applicable to AW609]

(d) [Applicable to AW609]

(e) [Not applicable to AW609]

§ 29.731 Wheels.

(a) through (c) [Applicable to AW609]

§ 29.733 Tires.

(a) through (c) [Applicable to AW609]

§ 29.735 Brakes.

(a) through (c) [Applicable to AW609]

Personnel and Cargo Compartment.

§ 25.771 Pilot compartment.

(a) through (e) [Applicable to AW609 except replace the references to § 25.779 and § 25.1523 with TR.779 and § 29.1523]

§ 25.773 Pilot compartment view.

(a) through (d) [Applicable to AW609]

§ 25.775 Windshields and windows.

(a) through (e) [Applicable to AW609 except replace the references to § 25.335(a) and § 25.1523 with TR.335(a) and § 29.1523]

TR.777 Cockpit controls.

(a) Cockpit controls must be—

(1) Located to provide convenient operation and to prevent confusion and inadvertent operation; and

(2) Located and arranged with respect to the pilots' seats so that there is full and unrestricted movement of each control without interference from the cockpit structure or the pilot's clothing when pilots from 5'2" to 6'2" in height are seated with the seat belt and shoulder harness fastened.

(b) All primary flight control and trim systems must be integrated to keep the motion and effect of cockpit controls for pitch, yaw, roll, and flight path unaffected by aircraft configuration changes.

TR.779 Motion and effect of cockpit controls.

Where appropriate, cockpit controls must be designed so that they operate in accordance with the following movements and actuation:

(a) *Primary controls for control and lift devices.*

(1) For roll control, control motion shall be— Right (clockwise) for right wing down.

(2) For pitch control, control motion shall be— Rearward for nose up.

(3) For directional control, control motion shall be— Right pedal forward (or control clockwise for nose right).

(4) For lift control, control motion shall be— Up or forward to increase lift.

(5) For thrust vector control, control motion shall be — Forward for increasing speed and conversion to airplane mode, aft for decreasing speed and transition to VTOL/Conversion mode.

(b) *Secondary controls for control and lift devices*.

(1) For auxiliary lift devices, control motion shall be —rearward/down for increasing lift, forward/up for decreasing lift.

(2) For trim devices, control motion shall be — Rotate to produce similar rotation of the aircraft about an axis parallel to the axis of the control.

(c) *Power plant and auxiliary controls*.

(1) For powerplant throttle controls, control motion shall be — Forward or clockwise to increase power.

(2) For landing gear controls, control motion shall be — Down to extend.

§ 25.781 Cockpit control knob shape.

[Applicable to AW609]

§ 25.783 Fuselage doors.

(a)(1) through (5) [Applicable to AW609 except replace the reference to § 25.607 with § 29.607]

(a)(6) [Not applicable to AW609]

(b) through (h) [Applicable to AW609 except in (h)(5) in addition to § 25.629, the requirements of TR.629 and subpart C of this certification basis must be complied with]

TR.783 FUSELAGE DOORS.

Doors identified as passenger emergency exits must also meet the applicable requirements of §§ 29.809 through 29.813 for emergency exits.

§ 29.783 Doors.

(a) [Not applicable to AW609]

(b) through (d) [Applicable to AW609]

(e) through (h) [Not applicable to AW609]

§ 29.785 Seats, berths, litters, safety belts, and harnesses.

(a) through (k) [Applicable to AW609, except replace the reference to § 29.397 with TR.397]

§ 29.787 Cargo and baggage compartments.

(a) through (d) [Applicable to AW609]

§ 25.789 Retention of items of mass in passenger and crew compartments and galleys.

(a) through (b) [Applicable to AW609 except replace the reference to § 25.561 with § 29.561]

§ 25.791 Passenger information signs and placards.

(a) through (e) [Applicable to AW609]

§ 25.793 Floor Surfaces.

[Applicable to AW609]

Emergency Provisions.

§ 29.801 Ditching.

(a) through (e) [Applicable to AW609]

§ 29.803 Emergency evacuation.

(a) through (b) [Applicable to AW609]

(c) [Reserved in 29.803]

(d) through (e) [Applicable to AW609]

§ 29.805 Flight crew emergency exits.

(a) through (c) [Applicable to AW609]

§ 29.807 Passenger emergency exits.

(a) through (d) [Not applicable to AW609]

(e) through (f) [Applicable to AW609]

TR.807 Passenger emergency exits.

For the purpose of this certification basis, the type of passenger emergency exit is defined as follows. Openings with dimensions larger than those specified in this section may be used, regardless of shape, if the base of the opening has a flat surface of not less than the specified width.

(a) Type. A rectangular opening of not less than 19 inches wide by 22 inches high, with corner radii not greater than one third the width of the exit, in the side of the fuselage with a step-up inside the aircraft of not more than 29 inches.

(b) Passenger emergency exits; side-of-fuselage. Emergency exits must be accessible to the passengers and, except as provided in paragraph (d) of this section, two emergency exits must be provided in each side of the fuselage.

(c) Passenger emergency exits; other than side-of-fuselage. In addition to the requirements of paragraph (b) of this section:

(1) There must be enough openings in the top, bottom, or ends of the fuselage to allow evacuation with the aircraft on its side; or

(2) The probability of the aircraft coming to rest on its side in a crash landing must be extremely remote.

(d) Ditching emergency exits for passengers. If certification with ditching provisions is requested, ditching emergency exits must be provided in accordance with the following requirements. This exit configuration must be tested in accordance with the requirements of Appendix D of part 29 to demonstrate that the maximum seating capacity, including the crewmembers required by the operating rules, can be evacuated from the aircraft within 90 seconds.

(1) At least one exit above the waterline in each side of the aircraft, meeting at least the dimensions of paragraph (a) of this section, and at least one top exit meeting the requirement of paragraph (c)(1) of this section.

(2) Flotation devices, whether stowed or deployed, may not interfere with or obstruct the exits.

§ 29.809 Emergency exit arrangement.

(a) through (i) [Applicable to AW609]

TR.809 Emergency exits.

If an integral stair is installed in a passenger entry door that is qualified as a passenger emergency exit, the stair must be designed so that, under the following conditions, the effectiveness of passenger emergency egress will not be impaired:

(a) The door, integral stair, and operating mechanism have been subjected to the following inertia forces acting separately relative to the surrounding structure:

(1) Upward, 3.0g

(2) Forward, 9.0g

(3) Sideward, 3.0g

(4) Downward, 6.0g

(5) Rearward, 1.5g

(b) The aircraft is in the normal ground attitude and in each of the attitudes corresponding to collapse of one or more legs of the landing gear.

§ 29.811 Emergency exit marking.

(a) through (g) [Applicable to AW609]

§ 29.812 Emergency lighting.

(a) through (f) [Applicable to AW609]

§ 29.813 Emergency exit access.

(a) through (c) [Applicable to AW609, except replace Type I and II exits in (a), and Type III and IV exits in (c), with exit as defined in TR.807(a)]

§ 29.815 Main aisle width.

[Applicable to AW609]

§ 25.817 Maximum number of seats abreast.

[Applicable to AW609]

§ 25.820 Lavatory doors.

[Applicable to AW609]

§ 25.831 Ventilation.

(a) through (g) [Applicable to AW609]

§ 25.833 Combustion heating systems.

[Applicable to AW609]

§ 25.841 Pressurized cabins.

(a) through (b) [Applicable to AW609]

§ 25.843 Tests for pressurized cabins.

(a) through (b) [Applicable to AW609]

Fire Protection.

§ 29.851 Fire extinguishers.

(a) through (b) [Applicable to AW609]

§ 25.853 Compartment interiors.

(a) through (e) [Not applicable to AW609]

(f) through (g) [Applicable to AW609]

(h) [Not applicable to AW609]

§ 29.853 Compartment interiors.

(a)(1) [Applicable to AW609]

(a)(2) [Not applicable to AW609]

(a)(3) through (4) [Applicable to AW609]

(b) through (f) [Applicable to AW609]

TR.853 Compartment interiors.

For each compartment to be used by the crew or passengers, the materials (including finishes or decorative surfaces applied to the materials) must meet the following test criteria as applicable.

Floor covering, textiles (including draperies and upholstery), seat cushions, padding, decorative and non-decorative coated fabrics, leather, trays and galley furnishings, electrical conduit, air ducting, joint and edge covering, cargo compartment liners, insulation blankets, cargo cover and transparencies, molded and thermoformed parts, air ducting joints, and trim strips (decorative and chafing), that are constructed of materials not covered in paragraph (a)(3) of § 29.853, must be self-extinguishing when tested vertically in accordance with the applicable portion of Appendix F to part 25 or other approved equivalent means. The average burn length may not exceed 8 inches and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 5 seconds after falling.

§ 29.855 Cargo and baggage compartments.

(a) through (e) [Applicable to AW609 except replace the reference to § 29.853(a)(2) with TR.853, and replace the reference to § 29.1439(a) with § 25.1439(a)]

§ 25.856 Thermal/Acoustic insulation materials.

(a) [Applicable to AW609]

(b) [Not applicable to AW609]

§ 25.858 Cargo or baggage compartment smoke or fire detection systems.

(a) through (d) [Applicable to AW609]

§ 29.859 Combustion heater fire protection.

(a) through (i) [Applicable to AW609 except replace the references to §§ 29.1181 through 29.1191 and §§ 29.1195 through 29.1203 with §§ 25.1181 through 25.1191 and §§ 25.1195 through 25.1203; and replace the references to §§ 29.1121 and 29.1123 with §§ 25.1121 and 25.1123]

§ 29.861 Fire protection of structure, controls, and other parts.

(a) [Applicable to AW609]

(b) [Not applicable to AW609]

§ 29.863 Flammable fluid fire protection.

(a) through (d) [Applicable to AW609]

§ 25.867 Fire protection: other components.

(a) through (b) [Applicable to AW609]

§ 25.869 Fire protection: systems.

(a) through (c) [Applicable to AW609, except 25.869(a)(3) is not applicable to AW609, and replace the reference to § 25.863 with § 29.863]

Miscellaneous.

§ 29.871 Leveling marks.

[Applicable to AW609]

§ 29.873 Ballast provisions.

[Applicable to AW609]

TR.875 Reinforcement near Proprotors

(a) Each part of the aircraft near the proprotor tips must be strong and stiff enough to withstand the effects of the induced vibration, buffeting, and ice thrown from the proprotor and other rotating components.

(b) No window may be near the proprotor tips unless it can withstand the most severe ice impact likely to occur.

§ 25.899 Electrical bonding and protection against static electricity.

(a) through (b) [Applicable to AW609]

SUBPART E – POWERPLANT.

General.

§ 29.901 Installation.

(a) through (d) [Applicable to AW609]

§ 25.903 Engines.

(a) [Applicable to AW609]

(b) through (f) [Not applicable to AW609]

§ 29.903 Engines.

(a) through (e) [Applicable to AW609]

§ 29.907 Engine vibration.

(a) through (b) [Applicable to AW609]

§ 29.908 Cooling fans.

(a) [Applicable to AW609]

(b) [Not applicable to AW609]

(c) [Applicable to AW609]

Drive System.

§ 29.917 DESIGN.

(a) [Not applicable to AW609]

(b) [Applicable to AW609]

(c)(1) [Applicable to AW609]

(c)(2) [Not applicable to AW609]

(c)(3) through (4) [Applicable to AW609]

(c)(5) through (6) [Not applicable to AW609]

TR.917 Design.

(a) The rotor drive system includes any part necessary to transmit power from the engines to the rotor hubs. This includes gearboxes, shafting, universal joints, couplings, rotor brake assemblies, clutches, supporting bearings for shafting, any attendant accessory pads or drives, lubricating systems for drive system gearboxes, oil coolers, and any cooling fans that are part of, attached to, or mounted on the rotor drive system.

(b) The rotor drive system must be designed to ensure that, with any engine failed, operation and control of the aircraft will be maintained so that continued safe flight and landing can be accomplished in accordance with the requirements of TR.141.

(c) The rotor drive system must function throughout the intended operating range of speed, power, and thrust. The determined vibration stresses or temperatures may not exceed values that have been shown to be safe for continuous operation.

(d) The design of the system must incorporate means to prevent entrapment of fluids, including moisture.

TR.918 Thrust producing system clearances.

(a) There must be sufficient clearance between thrust producing system components and other structures to prevent interference or harmful vibrations during any normal or emergency operating condition.

(b) To prevent harmful vibrations or damage to the thrust producing system components, there must be sufficient clearance between thrust producing system components and the alighting surface during all normal and emergency operating conditions. Sufficient clearance must also be provided for wheeled landing gears, when the aircraft is in the most critical of level takeoff or taxiing attitude with the critical tire completely deflated and the corresponding landing gear strut bottomed.

TR.923 Proprotor drive system and control mechanism tests.

(a) *Endurance tests, general*. Each proprotor drive system and proprotor control mechanism must be tested, as prescribed in paragraphs (b) through (m) and (o) of this section, for at least 200 hours plus the time required to meet the requirements of paragraphs (b)(2), (b)(3), and (k) of this section. These tests must be conducted as follows:

(1) Ten-hour test cycles must be used, except that the test cycle must be extended to include the OEI test of paragraphs (b)(2), (b)(3), and (k) of this section if OEI ratings are requested.

(2) The tests must be conducted on the aircraft or on a partial aircraft using sufficient aircraft (airframe and drive system) components to provide actual drive system static and dynamic support structure and clearances. The test components must be those used for compliance with the remainder of this section.

(3) The test torque and rotational speed must be—

(i) Determined by the powerplant limitations; and

(ii) Absorbed by the rotors to be approved for the aircraft.

(b) *Endurance tests; takeoff run*. The takeoff run must be conducted as follows:

(1) Except as prescribed in paragraphs (b)(2) and (3) of this section, the takeoff torque run must consist of 1 hour of alternate runs of 5 minutes at takeoff torque and the maximum speed for use with takeoff torque, and 5 minutes at as low an engine idle speed as practicable. The engine must be declutched from the proprotor drive system, and the proprotor brake, if furnished and so intended, must be applied during the first minute of the idle run. During the remaining 4 minutes of the idle run, the clutch must be engaged so that the engine drives the rotors at the minimum

practical r.p.m. The engine and the proprotor drive system must be accelerated at the maximum rate. When declutching the engine, it must be decelerated rapidly enough to allow the operation of the overrunning clutch. Two of the six takeoff power/idle segments must be accomplished with the nacelles at 90 degrees. Two of the six takeoff power/idle segments must be accomplished with the nacelles converting from 90 to zero degree nacelle angles. The remaining two of the six takeoff power/idle segments must be accomplished with the nacelles at 0 degrees. During any nacelle conversion, the power/thrust test parameter shall change in accordance with a specific conversion schedule supplied by the applicant and approved by the Administrator. The nacelle conversion rate and associated control positions shall be determined by flight testing.

(2) If the use of a 2 1⁄2-minute OEI rating is requested, the takeoff run must be conducted as prescribed in paragraph (b)(1) of this section, except for the third and sixth runs for which the takeoff torque and the maximum speed for use with takeoff torque are prescribed in that paragraph. For these runs, the following apply:

(i) Each run must consist of at least one period of 2 1⁄2 minutes with takeoff torque and the maximum speed for use with takeoff torque on all engines.

(ii) Each run must consist of at least one period, for each engine in sequence, during which that engine simulates a power failure and the remaining engines are run at the 2 1⁄2-minute OEI torque and the maximum speed for use with 2 1⁄2-minute OEI torque for 2 1⁄2 minutes.

(3) If the use of 30-second/2-minute OEI power is requested, the takeoff run must be conducted as prescribed in paragraph (b)(1) of this section except for the following:

(i) Immediately following any one 5-minute power-on run required by paragraph (b)(1) of this section, simulate a failure for each power source in turn, and apply the maximum torque and the maximum speed for use with 30-second OEI power to the remaining affected drive system power inputs for not less than 30 seconds. Each application of 30-second OEI power must be followed by two applications of the maximum torque and the maximum speed for use with the 2 minute OEI power for not less than 2 minutes each; the second application must follow a period at stabilized continuous or 30 minute OEI power (whichever is requested by the applicant). At least one run sequence must be conducted from a simulated "flight idle" condition. When conducted on a bench test, the test sequence must be conducted following stabilization at takeoff power.

(ii) The nacelle position at which the 30-second OEI power is applied must be changed for each test cycle such that an equal number of test cycles conducted at nacelle angles of 90 degrees, during conversion, and at 0 degrees.

(iii) For the purpose of this paragraph, an affected power input includes all parts of the proprotor drive system which can be adversely affected by the application of higher or asymmetric torque and speed prescribed by the test.

(iv) This test may be conducted on a representative bench test facility when engine limitations either preclude repeated use of this power or would result in premature engine removals during the test. The loads, the vibration frequency, and the methods of application to the affected proprotor drive system components must be representative of aircraft conditions. Test components must be those used to show compliance with the remainder of this section.

(c) *Endurance tests; maximum continuous run*. Three hours of continuous operation at maximum continuous torque and the maximum speed for use with maximum continuous torque must be conducted as follows:

(1) The proprotor controls must be operated at a minimum of 15 times each hour through the proprotor control positions associated with maximum vertical thrust, maximum forward thrust component, maximum aft thrust component, maximum left thrust component, maximum right

thrust component, maximum left roll, maximum right roll, maximum left yaw, and maximum right yaw except that the control movements need not produce loads or blade flapping motion exceeding the maximum loads of motions encountered in-flight. The proprotor control positions that are executed shall be appropriate for the aircraft/nacelle configuration. Aircraft attitude control surfaces or devices not associated with the proprotors are not subject to this repetitive control operation requirement; however, such control surfaces or devices must be activated if directly connected to and influencing the proprotor control system.

(2) The nacelle position shall be varied as follows:

(i) The nacelle shall be positioned at 90 degrees for 50 percent of the time.

(ii) The nacelle shall be positioned at 75 degrees for 20 percent of the time. The nacelle angle of 50 degrees instead of 75 degrees may be selected based on the operational spectrum.

(iii) The nacelle shall be positioned at 95 degrees for 5 percent of the time.

(iv) The nacelle shall be positioned at 0 degrees for 25 percent of the time.

(v) The nacelle shall be converted through the extremes of 95 degrees to 0 degrees to 95 degrees twice during each hour.

(3) Each maximum control position must be held for at least 10 seconds, and the rate of change of control position must be at least as rapid as that for normal operation.

(d) *Endurance tests; 90 percent of maximum continuous run*. One hour of continuous operation at 90 percent of maximum continuous torque and the maximum speed for use with 90 percent of maximum continuous torque must be conducted with the nacelle position varied as follows:

(1) The nacelle shall be positioned at 90 degrees for 50 percent of the time.

(2) The nacelle shall be positioned at 75 degrees for 20 percent of the time. The nacelle angle of 50 degrees instead of 75 degrees may be selected based on the operational spectrum.

(3) The nacelle shall be positioned at 95 degrees for 5 percent of the time.

(4) The nacelle shall be positioned at 0 degrees for 25 percent of the time.

(5) The nacelle shall be converted through the extremes of 95 degrees to 0 degrees to 95 degrees twice during each hour.

(e) *Endurance tests; 80 percent of maximum continuous run*. One hour of continuous operation at 80 percent of maximum continuous torque and the maximum speed for use with 80 percent of maximum continuous torque must be conducted with the nacelle position varied as follows:

(1) The nacelle shall be positioned at 90 degrees for 50 percent of the time.

(2) The nacelle shall be positioned at 75 degrees for 20 percent of the time. The nacelle angle of 50 degrees instead of 75 degrees may be selected based on the operational spectrum.

(3) The nacelle shall be positioned at 95 degrees for 5 percent of the time.

(4) The nacelle shall be positioned at 0 degrees for 25 percent of the time.

(5) The nacelle shall be converted through the extremes of 95 degrees to 0 degrees to 95 degrees twice during each hour.

(f) *Endurance tests; 60 percent of maximum continuous run*. One hour of continuous operation at 60 percent of maximum continuous torque and the maximum speed for use with 60 percent of maximum continuous torque must be conducted with the nacelle position varied as follows:

(1) The nacelle shall be positioned at 90 degrees for 50 percent of the time.

(2) The nacelle shall be positioned at 75 degrees for 20 percent of the time. The nacelle angle of 50 degrees instead of 75 degrees may be selected based on the operational spectrum.

(3) The nacelle shall be positioned at 95 degrees for 5 percent of the time.

(4) The nacelle shall be positioned at 0 degrees for 25 percent of the time.

(5) The nacelle shall be converted through the extremes of 95 degrees to 0 degrees to 95 degrees twice during each hour.

(g) *Endurance tests; engine malfunctioning run*. It must be determined whether malfunctioning of components, such as the engine fuel or ignition systems, or whether unequal engine power can cause dynamic conditions detrimental to the drive system. If so, a suitable number of hours of operation must be accomplished under those conditions, one hour of which must be included in each cycle, and the remaining hours of which must be accomplished at the end of the 20 cycles. If no detrimental condition results, an additional hour of operation in compliance with paragraph (b) of this section must be conducted in accordance with the run schedule of paragraph (b)(1) of this section without consideration of paragraphs (b)(2) or (3) of this section.

(h) *Endurance tests; overspeed run*. One hour of continuous operation must be conducted at maximum continuous torque and the maximum power-on overspeed expected in service, assuming that speed and torque limiting devices, if any, function properly.

(i) *Endurance tests; proprotor control positions*. When the proprotor controls are not being cycled during the tie-down tests, the proprotors must be operated, using the procedures prescribed in paragraph (c) of this section, to produce each of the maximum thrust positions for the following percentages of test time (except that the control positions need not produce loads or blade flapping motion exceeding the maximum loads or motions encountered in flight):

(1) For full vertical thrust, 20 percent.

(2) For the forward thrust component, 50 percent.

(3) For the right thrust component, 10 percent.

(4) For the left thrust component, 10 percent.

(5) For the aft thrust component, 10 percent.

(j) *Endurance tests, clutch and brake engagements*. A total of at least 400 clutch and brake engagements, including the engagements of paragraph (b) of this section, must be made during the takeoff torque runs and, if necessary, at each change of torque and speed throughout the test. In each clutch engagement, the shaft on the driven side of the clutch must be accelerated from rest. The clutch engagements must be accomplished at the speed and by the method prescribed by the applicant. During deceleration after each clutch engagement, the engines must be stopped rapidly enough to allow the engines to be automatically disengaged from the proprotors and proprotor drives. If a proprotor brake is installed for stopping the proprotor, the clutch, during brake engagements, must be disengaged above 40 percent of maximum continuous proprotor speed and the proprotors allowed to decelerate to 40 percent of maximum continuous proprotor speed, at which time the proprotor brake must be applied. If the clutch design does not allow stopping the proprotors with the engine running, or if no clutch is provided, the engine must be stopped before each application of the proprotor brake, and then immediately be started after the proprotors stop.

(k) *Endurance tests; OEI power run*.

(1) *30-minute OEI power run.* For aircraft for which the use of 30-minute OEI power is requested, a run at 30-minute OEI torque and the maximum speed for use with 30-minute OEI torque must be conducted as follows: For each engine, in sequence, that engine must be inoperative and the remaining engines must be run for a 30-minute period.

(2) *Continuous OEI power run.* For aircraft for which the use of continuous OEI power is requested, a run at continuous OEI torque and the maximum speed for use with continuous OEI torque must be conducted as follows: For each engine, in sequence, that engine must be inoperative and the remaining engines must be run for a one hour.

(3) The number of periods prescribed in paragraph (k)(1) or (2) of this section may not be less than the number of engines, nor may it be less than two.

(4) For each power run specified in paragraphs (k)(1) and (2) of this section, the nacelle position shall be varied as follows:

(i) The nacelle shall be positioned at 90 degrees for 50 percent of the time.

(ii) The nacelle shall be positioned at 75 degrees for 20 percent of the time. The nacelle angle of 50 degrees instead of 75 degrees may be selected based on the operational spectrum.

(iii) The nacelle shall be positioned at 95 degrees for 5 percent of the time.

(iv) The nacelle shall be positioned at 0 degrees for 25 percent of the time.

(v) The nacelle shall be converted through the extremes of 95 degrees to 0 degrees to 95 degrees twice during each hour.

(l) Any components that are affected by maneuvering and gust loads must be investigated for the same flight conditions as are the proprotors, and their service lives must be determined by fatigue tests or by other acceptable methods. In addition, a level of safety equal to that of the proprotors must be provided for—

(1) Each component in the proprotor drive system whose failure would cause an uncontrolled landing;

(2) Each component essential to the phasing of proprotors, or that furnishes a driving link for the essential control of proprotors in autorotation; and

(3) Each component common to two or more engines on multiengine aircraft.

(m) *Special tests*. Each proprotor drive system designed to operate at two or more gear ratios must be subjected to special testing for durations necessary to substantiate the safety of the proprotor drive system.

(n) Each part tested as prescribed in this section must be in a serviceable condition at the end of the tests. No intervening disassembly which might affect test results may be conducted.

(o) *Endurance tests; operating lubricants*. To be approved for use in proprotor drive and control systems, lubricants must meet the specifications of lubricants used during the tests prescribed by this section. Additional or alternate lubricants may be qualified by equivalent testing or by comparative analysis of lubricant specifications and proprotor drive and control system characteristics. In addition—

(1) At least three 10-hour cycles required by this section must be conducted with transmission and gearbox lubricant temperatures, at the location prescribed for measurement, not lower than the maximum operating temperature for which approval is requested;

(2) For pressure lubricated systems, at least three 10-hour cycles required by this section must be conducted with the lubricant pressure, at the location prescribed for measurement, not higher than the minimum operating pressure for which approval is requested; and

(3) The test conditions of paragraphs (o)(1) and (o)(2) of this section must be applied simultaneously and must be extended to include operation at any one-engine-inoperative rating for which approval is requested.

TR.927 Additional tests.

(a) Any additional dynamic, endurance, and operational tests, and vibratory investigations necessary to determine that the proprotor drive mechanism is safe, must be performed.

(b) If turbine engine torque output to the transmission can exceed the highest engine or transmission torque limit, and that output is not directly controlled by the pilot under normal operating conditions (such as where the primary engine power control is accomplished through the flight control), the following test must be made:

(1) Under conditions associated with all engines operating, make 200 applications, for 10 seconds each, of torque that is at least equal to the lesser of—

(i) The maximum torque used in meeting TR.923 plus 10 percent; or

(ii) The maximum torque attainable under probable operating conditions, assuming that torque limiting devices, if any, function properly.

(2) For multiengine aircraft under conditions associated with each engine, in turn, becoming inoperative, apply to the remaining transmission torque inputs the maximum torque attainable under probable operating conditions, assuming that torque limiting devices, if any, function properly. Each transmission input must be tested at this maximum torque for at least fifteen minutes.

(c) *Lubrication system failure*. For lubrication systems required for proper operation of proprotor drive systems it must be shown by test that any failure which results in loss of lubricant in any normal use lubrication system will not prevent continued safe operation, although not necessarily without damage, under the conditions proposed by the applicant and approved by the Administrator, for at least 30 minutes after perception by the flight crew of the lubrication system failure or loss of lubricant.

(d) *Overspeed test*. The proprotor drive system must be subjected to 50 overspeed runs, each 30 ± 3 seconds in duration, at not less than either the higher of the rotational speed to be expected from an engine control device failure or 105 percent of the maximum rotational speed, including transients, to be expected in service. If speed and torque limiting devices are installed, are independent of the normal engine control, and are shown to be reliable, their rotational speed limits need not be exceeded. These runs must be conducted as follows:

(1) Overspeed runs must be alternated with stabilizing runs of from 1 to 5 minutes duration each at 60 to 80 percent of maximum continuous speed.

(2) Acceleration and deceleration must be accomplished in a period not longer than 10 seconds (except where maximum engine acceleration rate will require more than 10 seconds), and the time for changing speeds may not be deducted from the specified time for the overspeed runs.

(3) Overspeed runs must be made with the proprotors in the flattest pitch for smooth operation.

(e) The tests prescribed in paragraphs (b) and (d) of this section must be conducted on the aircraft and the torque must be absorbed by the proprotors to be installed, except that other ground or flight test facilities with other appropriate methods of torque absorption may be used if the conditions of support and vibration closely simulate the conditions that would exist during a test on the aircraft.

(f) Each test prescribed by this section must be conducted without intervening disassembly and, except for the lubrication system failure test required by paragraph (c) of this section, each part tested must be in a serviceable condition at the conclusion of the test.

§ 25.929 Propeller deicing.

(a) through (b) [Applicable to AW609 except replace the references to §§ 25.1181, 25.1182, 25.1183, 25.1185, and § 25.1189 with § 29.1181, TR.1182, § 29.1183, § 29.1185, and § 29.1189]

§ 29.931 Shafting critical speed.

(a) through (c) [Applicable to AW609]

§ 29.935 Shafting joints.

[Applicable to AW609]

§ 29.939 Turbine engine operating characteristics.

(a) through (c) [Applicable to AW609]

§ 25.943 Negative acceleration.

[Applicable to AW609, except replace the reference to § 25.333 with TR.333]

Fuel System.

§ 29.951 General.

(a) through (c) [Applicable to AW609]

§ 25.952 Fuel system analysis and test.

(a) through (b) [Applicable to AW609]

§ 29.952 Fuel system crash resistance.

(a) through (g) [Applicable to AW609]

§ 29.953 Fuel system independence.

(a) [Applicable to AW609]

(b) [Not applicable to AW609]

§ 29.954 Fuel system lightning protection.

(a) through (c) [Applicable to AW609]

§ 29.955 Fuel flow.

(a) through (c) [Applicable to AW609 except replace the reference to § 29.927 with TR.927 and the reference to § 29.1305(a)(17) with § 29.1305(a)(18)]

§ 29.957 Flow between interconnected tanks.

(a) and (b) [Applicable to AW609]

§ 29.959 Unusable fuel supply.

[Applicable to AW609]

§ 29.961 Fuel system hot weather operation.

[Applicable to AW609 except replace the reference to § 29.927 (b)(1) and (2) with TR.927 (b)(1) and (2)]

§ 25.963 Fuel tanks: General.

(a) through (d) [Not applicable to AW609]

(e) [Applicable to AW609]

(f) [Not applicable to AW609]

§ 29.963 Fuel tanks: General.

(a) through (e) [Applicable to AW609]

TR.963 Fuel tanks: General.

In addition to § 29.963(b), if it can be shown by test or analysis that a structure or component in the fuel tank zone would not result in a puncture hazard under potentially survivable impact conditions, the bladder may be tested with the surrounding structure to meet a minimum puncture force of 370 pounds.

§ 29.965 Fuel tank tests.

(a) through (d) [Applicable to AW609]

§ 25.967 Fuel tank installation.

(a) through (d) [Not applicable to AW609]

(e) [Applicable to AW609]

§ 29.967 Fuel tank installation.

(a) through (d) [Applicable to AW609]

§ 29.969 Fuel tank expansion space.

[Applicable to AW609]

§ 25.971 Fuel tank sump.

(a) through (c) [Applicable to AW609]

§ 25.973 Fuel tank filler connection.

(a) [Reserved in § 25.973]

(b) through (c) [Not applicable to AW609]

(d) [Applicable to AW609]

§ 29.973 Fuel tank filler connection.

(a) through (b) [Applicable to AW609]

§ 29.975 Fuel tank vents and carburetor vapor vents.

(a) through (b) [Applicable to AW609]

TR.975 Fuel tank vents and carburetor vapor vents.

The fuel vent system design must have flame propagation arresting capability for a minimum period of 90 seconds. This must be demonstrated by test.

§ 29.977 Fuel tank outlet.

(a) through (d) [Applicable to AW609]

§ 25.979 Pressure fueling system.

(a) through (e) [Applicable to AW609]

Fuel System Components.

§ 29.991 Fuel pumps.

(a) through (b) [Applicable to AW609]

§ 29.993 Fuel system lines and fittings.

(a) through (e) [Applicable to AW609]

§ 29.995 Fuel valves.

(a) [Reserved in § 29.995]

(b) [Applicable to AW609]

§ 29.997 Fuel strainer or filter.

(a) through (d) [Applicable to AW609]

§ 29.999 Fuel system drains.

(a) through (b) [Applicable to AW609 except replace the reference to § 29.971 with § 25.971]

§ 29.1001 Fuel jettisoning.

(a) through (f) [Applicable to AW609]

Oil System.

§ 29.1011 Engines: general.

(a) through (d) [Applicable to AW609 except replace the references to § 29.1049 with TR.1049 and replace the references to § 29.1045 and § 29.1047 with TR.1045 and TR.1047

§ 29.1013 Oil tanks.

(a) through (f) [Applicable to AW609]

TR.1013 Oil tanks.

In addition to the requirements in § 29.1013(a), each oil tank installation must meet the requirements of § 25.967(e).

§ 29.1015 Oil tank tests.

(a) through (b) [Applicable to AW609]

§ 29.1017 Oil lines and fittings.

(a) through (b) [Applicable to AW609]

§ 29.1019 Oil strainer or filter.

(a) through (b) [Applicable to AW609]

§ 29.1021 Oil system drains.

(a) through (b) [Applicable to AW609]

§ 29.1023 Oil radiators.

(a) through (b) [Applicable to AW609]

§ 29.1025 Oil valves.

(a) through (c) [Applicable to AW609]

§ 29.1027 Transmission and gearboxes: General.

(a) through (c) [Applicable to AW609]

Cooling.

§ 29.1041 General.

(a) through (c) [Applicable to AW609]

§ 29.1043 Cooling tests.

(a) through (d) [Applicable to AW609 except replace the references to § 29.1045 and § 29.1047 with TR.1045 and TR.1047, and replace the reference to § 29.1049 with both § 29.1049 and TR.1049]

TR.1045 Climb cooling test procedures.

(a) The climb cooling tests must be conducted with the critical engine inoperative and the nacelle at an angle that produces the most adverse cooling conditions for the remaining engine and powerplant components.

(b) Each operating engine must—

(1) For aircraft for which the use of 30-minute OEI power is requested, be at 30-minute OEI power for 30 minutes, and then at maximum continuous power (or at full throttle when above the critical altitude);

(2) For aircraft for which the use of continuous OEI power is requested, be at continuous OEI power (or at full throttle when above the critical altitude); and

(3) For other aircraft, be at maximum continuous power (or at full throttle when above the critical altitude).

(c) After temperatures have stabilized in flight, the climb must be—

(1) Begun from an altitude not greater than the lower of—

(i) 1,000 feet below the engine critical altitude; and

(ii) 1,000 feet below the maximum altitude at which the rate of climb is 150 fpm; and

(2) Continued for at least five minutes after the occurrence of the highest temperature recorded, or until the aircraft reaches the maximum altitude for which certification is requested.

(d) The climb must be conducted at an airspeed representing a normal operational practice for the configuration being tested. However, if the cooling provisions are sensitive to aircraft speed, the most critical airspeed must be used, but need not exceed the speeds established under TR.67(b) or TR.69(b). The climb cooling test may be conducted in conjunction with the takeoff cooling test of TR.1047.

TR.1047 Takeoff cooling test procedures.

Cooling must be shown during takeoff and subsequent climb as follows:

(a) Each temperature must be stabilized while hovering in ground effect with—

(1) The power necessary for hovering;

(2) The appropriate cowl flap, nacelle angle, and shutter settings; and

(3) The maximum weight.

(b) After the temperatures have stabilized, a climb must be started at the lowest practicable altitude and must be conducted with OEI.

(c) The operating engines must be at the greatest power for which approval is sought (or at full throttle when above the critical altitude) for the same period as this power is used in determining the takeoff climbout path under TR.59.

(d) At the end of the time interval used in determining takeoff flight path under TR.63, the power must be changed to that used in meeting TR.67(b) and the climb must be continued for—

(1) Thirty minutes, if 30-minute OEI power is used; or

(2) At least 5 minutes after the occurrence of the highest temperature recorded, if continuous OEI power or maximum continuous power is used.

(e) The speeds and nacelle angle must be those used in determining the takeoff flight path under TR.59.

(f) The cooling test must be conducted at an airspeed and nacelle angle corresponding to normal operating practice for the configuration being tested. However, if the cooling provisions are sensitive to aircraft speed and nacelle angle, the most critical airspeed and nacelle angle must be used, but need not exceed the speed for best rate of climb with maximum continuous power.

§ 29.1049 Hovering cooling test procedures.

(a) through (b) [Applicable to AW609]

TR.1049 Hovering cooling test procedures.

For use of a 30-minute AEO power rating, the hovering cooling provisions at the 30-minute AEO power rating must be shown:

(a) At maximum weight or at the greatest weight at which the aircraft can hover (if less), at sea level, with the power required to hover but not more than the 30-minute power, in the ground effect in still air, until at least 5 minutes after the occurrence of the highest temperature recorded, or until the continuous time limit of the 30-minute AEO power rating if the highest temperature recorded is not stabilized before.

(b) At maximum weight and at the altitude resulting in zero rate of climb for this configuration, until at least 5 minutes after the occurrence of the highest temperature recorded, or until the continuous time limit of the 30-minute AEO power rating if the highest temperature recorded is not stabilized before.

Induction System.

§ 25.1091 Air induction.

(a) through (d) [Not applicable to AW609]

(e) [Applicable to AW609]

§ 29.1091 Air induction.

(a) through (c) [Applicable to AW609]

(d) [Not applicable to AW609]

(e) through (f) [Applicable to AW609]

TR.1093 Induction System Icing Protection.

(a) It must be shown that each turbine engine and its air inlet system can operate throughout the flight power range of the engine (including idling) —

(1) Without accumulating ice on the engine or inlet system components that would adversely affect engine operation or cause serious loss of power when operating in VTOL/conversion mode under the icing conditions specified in Appendix C of part 29;

(2) Without accumulating ice on the engine or inlet system components that would adversely affect engine operation or cause serious loss of power when operating in airplane mode under the icing conditions specified in Appendix C of part 25; and

(3) In snow, both falling and blowing, without adverse effect on engine operation, within the limitations established for the aircraft when operating in VTOL/conversion mode, airplane mode, or transition.

(b) Each turbine engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15° and 30°F (between -9° and -1°C) and has a liquid water content not less than 0.3 grams per cubic meter in the form of drops having a mean effective diameter not less than 20 microns, followed by momentary operation at takeoff power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Administrator.

(c) Aircraft not certificated for flight into icing conditions must meet the following requirements.

(1) The aircraft must have a means to detect encounters into the icing conditions defined in Appendix C and Appendix O to part 25.

(2) The Aircraft Flight Manual must include operating limitations to prevent inadvertent encounters into icing conditions and procedures for exiting those icing conditions.

(3) The aircraft's engine air inlet system must also address Appendix D, to part 33.

(d) Aircraft certificated for flight into icing conditions must meet the following requirements.

(1) Each turbine engine must be able to idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect or serious loss of power while exposed to the atmospheric conditions in paragraphs (d)(1)(i) and (ii) of this

section, followed by a momentary operation at takeoff power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Administrator.

(i) The atmosphere is at a total air temperature between 0º and 15 ºF (-18º to -9 ºC) and has a liquid water concentration of not less than 0.3 grams per cubic meter in the form of particles having a mean effective diameter of not less than 20 microns.

(ii) For aircraft certificated for flight into icing conditions defined in appendix O of part 25, the atmosphere is at a total air temperature between 15º and 30 ºF (-9º to -1 ºC) and has a liquid water concentration of not less than 0.3 grams per cubic meter in the form of particles having a mean effective diameter of not less than 100 microns.

(2) In flight, the air inlet system must be able to operate throughout the flight power range of the engine (including idling) without accumulating ice on the engine or inlet system that would adversely affect engine operation or cause serious loss of power in VTOL/conversion mode, airplane mode, or in transition while—

(i) Encountering the icing conditions in Appendix C to part 25; and

(ii) Encountering the icing conditions in Appendix O to part 25, if certification for flight under those conditions is sought.

(iii) Encountering the icing conditions in Appendix D, to part 33.

(3) For those icing conditions in Appendix O to part 25 for which certification is not sought, the aircraft must have a means to detect encounters into those icing conditions, and the Aircraft Flight Manual must include operating limitations to prevent inadvertent encounters into those icing conditions and procedures for exiting those icing conditions.

§ 25.1103 Induction system ducts and air duct systems.

(a) through (c) [Not applicable to AW609]

(d) [Applicable to AW609]

(e) through (f) [Not applicable to AW609]

§ 29.1103 Induction systems ducts and air duct systems.

(a) through (f) [Applicable to AW609]

§ 29.1105 Induction system screens.

(a) through (d) [Applicable to AW609]

Exhaust System.

§ 29.1121 General.

(a) through (h) [Applicable to AW609]

TR.1121 General.

In addition to the requirements in § 29.1121 for powerplant and auxiliary power unit installations, the following apply:

(a) Each exhaust system must ensure safe discharge of exhaust gases from the engine, auxiliary power units, or thrust producing device to which it is connected under the operating conditions and maneuvers and engine operating environment for which certification is requested.

(b) Each exhaust system must permit the discharge of exhaust gases when the aircraft is in close proximity to the ground without inducing harmful loads, vibrations, or temperatures in any engine or in any other part of the aircraft.

§ 29.1123 Exhaust piping.

(a) through (c) [Applicable to AW609]

Powerplant System Controls and Accessories.

§ 25.1141 Powerplant controls: general.

(a) through (d) [Not applicable to AW609]

(e) through (f) [Applicable to AW609, except replace the reference to § 25.1555 with TR.1555]

§ 29.1141 Powerplant controls: general.

(a) through (f) [Applicable to AW609 except replace the reference to § 29.777 with TR.777, and replace the reference to § 29.1555 with both § 29.1555 and TR.1555, as applicable]

§ 29.1142 Auxiliary power unit controls.

[Applicable to AW609]

§ 29.1143 Engine controls.

(a) through (f) [Applicable to AW609]

TR.1143 Engine controls.

(a) Simultaneous control must be provided for all engines having a common thrust indication. Engines with common thrust control must have automatic torque/thrust balancing within approved tolerances.

(b) Control of engines, thrust producing devices, and conversion devices which may affect or are intended for aircraft stability and control must regulate the magnitude and rate of control power as required for compliance with § 29.21(b) and TR.141 and must comply with the requirements specified in TR.671, §29.672, TR.672, TR.673, §29.674, § 25.675, §29.675, § 29.679, §29.681, §25.683, §29.685, §29.687, §29.691, TR.692, TR.693, TR.694, §29.695, §25.697, §25.699, §25.701, and TR.703 as applicable.

§ 29.1145 Ignition switches.

(a) through (c) [Applicable to AW609]

§ 29.1163 Powerplant accessories.

(a) through (d) [Applicable to AW609]

§ 25.1165 Engine ignition systems.

(a) through (g) [Not applicable to AW609]

(h) [Applicable to AW609]

§ 29.1165 Engine ignition systems.

(a) through (g) [Applicable to AW609]

Propulsion System Fire Protection.

§ 29.1181 Designated fire zones: regions included.

(a) through (b) [Applicable to AW609 except replace the references to §§ 29.1189, 29.1195, 29.1197, 29.1199, and 29.1203 with §§ 25.1189, 25.1195, 25.1197, TR.1199, and TR.1203]

TR.1182 Nacelle areas adjacent to designated fire zones.

Structural items, components, lines, fittings, and electrical components located behind the engine-compartment firewall must be constructed of materials and located at distances from the firewall such that they will not suffer damage sufficient to endanger the aircraft such that the temperature behind the firewall will not reach auto-ignition point of the fluids in the area, if a portion of the engine side of the firewall is subjected to a flame temperature of not less than 2,000° F for 15 minutes.

§ 25.1183 Flammable fluid-carrying components.

(a) through (b) [Not applicable to AW609]

(c) [Applicable to AW609]

§ 29.1183 Lines, fittings, and components.

(a) through (b) [Applicable to AW609]

§ 29.1185 Flammable fluids.

(a) through (d) [Applicable to AW609]

§ 29.1187 Drainage and ventilation of fire zones.

(a) through (e) [Applicable to AW609]

§ 25.1189 Shutoff means.

(a) through (f) [Not applicable to AW609]

(g) through (h) [Applicable to AW609]

§ 29.1189 Shutoff means.

(a)(1) through (2) [Applicable to AW609]

(a)(3) [Not applicable to AW609]

(b) through (f) [Applicable to AW609]

§ 29.1191 Firewalls.

(a) through (f) [Applicable to AW609]

§ 29.1193 Cowling and engine compartment covering.

(a) through (f) [Applicable to AW609]

§ 29.1194 Other surfaces.

[Applicable to AW609]

§ 25.1195 Fire extinguishing systems.

(a) through (b) [Not applicable to AW609]

(c) [Applicable to AW609]

§ 29.1195 Fire extinguishing systems.

(a) through (b) [Applicable to AW609]

(c) [Not applicable to AW609]

(d) [Applicable to AW609]

§ 25.1197 Fire extinguishing agents.

(a) through (b) [Applicable to AW609]

§ 25.1199 Extinguishing agent containers.

(a) through (e) [Applicable to AW609]

TR.1199 Extinguishing agent containers.

Each extinguishing agent container must provide an adequate discharge of the agent in any attitude.

§ 29.1201 Fire extinguishing system materials.

(a) through (b) [Applicable to AW609]

§ 25.1203 Fire detector system.

(a) through (g) [Applicable to AW609]

(h) [Not Applicable to AW609]

SUBPART F – EQUIPMENT.

General.

§ 29.1301 Function and installation.

(a) through (d) [Applicable to AW609]

§ 25.1303 Flight and navigation instruments.

(a) through (b) [Applicable to AW609, except § 25.1303 (a)(3) not applicable to AW609]

(c) [Not applicable to AW609]

TR.1303 Flight and navigation instruments.

(a) The following flight and navigation instruments are required as prescribed in this paragraph:

(1) A speed warning device is required as follows, unless the aircraft exhibits inherent speed warning characteristics:

(i) For airplane mode, where V_{MO}/M_{MO} is greater than 0.8 VD/MD or 0.8 VDF/MDF, the speed warning device must give effective aural warning (differing distinctively from aural warnings used for other purposes) to the pilots, whenever the speed exceeds V_{MO} plus 6 knots or M_{MO} plus 0.01. The upper limit of the production tolerance for the warning device may not exceed the prescribed warning speed.

(ii) For VTOL/Conversion mode, where V_{CON} is greater than 0.9 VDCON, the speed warning device must give effective aural warning (differing distinctively from aural warnings used for other purposes) to the pilots, whenever the speed exceeds V_{CON} plus 3 knots. The upper limit of the production tolerance for the warning device may not exceed the prescribed warning speed.

(2) For aircraft with compressibility limitations not otherwise indicated to the pilot by the airspeed indicating system required under § 25.1303 (b)(1):

(i) A machmeter at each pilot station; and

(ii) The airspeed indicator required under § 25.1303 (b)(1) must also show the variation of V_{MO} compressibility limitations where applicable.

(b) The following flight and navigation instruments must be installed so that the instrument is visible from each pilot station:

(1) A means to indicate to pylon angles and flaperon positions.

(2) A means to indicate to the pilots the position of any drag device which is movable in flight.

(3) A direction indicator (gyroscopically stabilized, magnetic or nonmagnetic) in addition to that required under 25.1303(b)(6).

(c) Instrument systems and other systems essential for continued safe flight that could be adversely affected by icing must be provided with adequate ice protection regardless of whether the aircraft is certificated for operation in icing conditions.

§ 25.1305 Powerplant instruments.

(a)(1) through (6) [Not applicable to AW609]

(a)(7) [Applicable to AW609]

(a)(8) [Not applicable to AW609]

(b) [Not applicable to AW609]

(c)(1) [Not applicable to AW609]

(c)(2) [Applicable to AW609]

(c)(3) through (8) [Not applicable to AW609]

(d) through (f) [Not applicable to AW609]

§ 29.1305 Powerplant instruments.

(a)(1) through (2) [Not applicable to AW609]

(a)(3) through (4) [Applicable to AW609]

(a)(5) [Not applicable to AW609]

(a)(6) through (10) [Applicable to AW609]

(a)(11) through (12) [Not applicable to AW609]

(a)(13) through (26) [Applicable to AW609]

(b)(1) through (3) [Applicable to AW609]

(c) [Not applicable to AW609]

TR.1305 Powerplant instruments and displays.

(a) In addition to the powerplant instruments required by §§ 25.1305(a)(7), 25.1305(c)(2), 29.1305(a)(3), 29.1305(a)(4), 29.1305(a)(6) through (10), 29.1305(a)(13) through (26), and 29.1305(b)(1) through (3), the following powerplant instruments are required:

(1) A position indicating means to indicate to the flight crew that the propulsive devices are in the position selected and warning devices(s) to warn the flight crew if any propulsive device fails to attain and retain the position selected.

(2) A means, for each engine, to indicate gas temperature for that engine.

(3) A means, for each engine, to indicate gas producer rotor speed, for that engine.

(4) For aircraft for which OEI Training Mode is requested, a means to indicate to the pilot –

(i) Simulation of the engine failure;

(ii) Annunciation of OEI Training Mode; and

(iii) Representation of the actual power being provided.

(5) For aircraft for which the use of a 30-minute AEO power rating is requested, a means to alert the pilot when the engine is at the 30-minute power level, when the event begins, when the time interval expires, and when the cumulative time in one flight is reached.

(b) If the continuous display of required engine and aircraft systems information is compressed or temporarily not displayed, adequate design features must be provided to allow the pilots to monitor the health and performance of the engine and aircraft systems at a level equivalent to continuous display of the information.

§ 25.1307 Miscellaneous equipment.

(a) [Reserved in § 25.1307]

(b) through (e) [Applicable to AW609]

§ 29.1307 Miscellaneous equipment.

(a) [Applicable to AW609]

(b) [Not applicable to AW609]

(c) through (d) [Applicable to AW609]

(e) [Not applicable to AW609]

TR.1309 Equipment, systems, and installations.

Equipment, systems, and installations.

(a) The equipment, systems, and installations whose functioning is required by this certification basis must be designed and installed to ensure that they perform their intended functions under any foreseeable operating condition.

(b) The aircraft systems and associated components, considered separately and in relation to other systems, must be designed so that—

(1) The occurrence of any failure condition which would prevent the continued safe flight and landing of the aircraft is extremely improbable; and

(2) The occurrence of any other failure conditions which would reduce the capability of the aircraft or the ability of the crew to cope with adverse operating conditions is improbable.

(c) Warning information must be provided to alert the crew to unsafe system operating conditions and to enable them to take appropriate corrective action. Systems, controls, and associated monitoring and warning means must be designed to minimize crew errors which could create additional hazards.

(d) Compliance with the requirements of paragraph (b)(2) of this section must be shown by analysis and, where necessary, by appropriate ground, flight, or simulator tests. The analysis must consider-—

(1) Possible modes of failure, including malfunctions and damage from external sources;

(2) The probability of multiple failures and undetected failures;

(3) The resulting effects on the aircraft and occupants, considering the stage of flight and operating conditions; and

(4) The crew warning cues, corrective action required, and the capability of detecting faults.

(e) For each installation whose functioning is required by this certification basis and which requires a power supply is an "essential load" on the power supply. The power sources and the system must be able to supply the following power loads in probable operating combinations and for probable durations:

(1) Loads connected to the system with the system functioning normally.

(2) Essential loads, after failure of any one prime mover, power converter, or energy storage device.

(3) Essential loads, after failure of—

(i) Any one engine, on aircraft with two engines; and

(ii) Any two engines, on aircraft with three or more engines.

(f) In determining compliance with paragraphs (e)(2) and (3) of this section, the power loads may be assumed to be reduced under a monitoring procedure consistent with safety in the kinds of operations authorized. Loads not required for controlled flight need not be considered for the two-engine-inoperative condition on aircraft with three or more engines.

(g) In showing compliance with paragraphs (a) and (b) of this section with regard to the electrical system and to equipment design and installation, critical environmental conditions must be considered. For electrical generation, distribution, and utilization equipment required by or used in complying with this certification basis, except equipment covered by Technical Standard

Orders containing environmental test procedures, the ability to provide continuous, safe service under foreseeable environmental conditions may be shown by environmental tests, design analysis, or reference to previous comparable service experience on other aircraft.

§ 29.1316 Electrical and electronic system lightning protection.

(a) through (b) [Applicable to AW609]

§ 29.1317 High-intensity Radiated Fields (HIRF) Protection.

(a) through (d) [Applicable to AW609]

Instruments Installation.

§ 29.1321 Arrangement and visibility.

(a) through (g) [Applicable to AW609]

TR.1322 Flightcrew alerting.

(a) Flightcrew alerts must:

(1) Provide the flightcrew with the information needed to:

(i) Identify non-normal operation or aircraft system conditions, and

(ii) Determine the appropriate actions, if any.

(2) Be readily and easily detectable and intelligible by the flightcrew under all foreseeable operating conditions, including conditions where multiple alerts are provided.

(3) Be removed when the alerting condition no longer exists.

(b) Alerts must conform to the following prioritization hierarchy based on the urgency of flightcrew awareness and response.

(1) Warning: For conditions that require immediate flightcrew awareness and immediate flightcrew response.

(2) Caution: For conditions that require immediate flightcrew awareness and subsequent flightcrew response.

(3) Advisory: For conditions that require flightcrew awareness and may require subsequent flightcrew response.

(c) Warning and caution alerts must:

(1) Be prioritized within each category, when necessary.

(2) Provide timely attention-getting cues through at least two different senses by a combination of aural, visual, or tactile indications.

(3) Permit each occurrence of the attention-getting cues required by paragraph (c)(2) of this section to be acknowledged and suppressed, unless they are required to be continuous.

(d) The alert function must be designed to minimize the effects of false and nuisance alerts. In particular, it must be designed to:

(1) Prevent the presentation of an alert that is inappropriate or unnecessary.

(2) Provide a means to suppress an attention-getting component of an alert caused by a failure of the alerting function that interferes with the flightcrew's ability to safely operate the aircraft. This means must not be readily available to the flightcrew so that it could be operated inadvertently or by habitual reflexive action. When an alert is suppressed, there must be a clear and unmistakable annunciation to the flightcrew that the alert has been suppressed.

(e) Visual alert indications must:

(1) Conform to the following color convention:

(i) Red for warning alert indications.

(ii) Amber or yellow for caution alert indications.

(iii) Any color except red, green, yellow, or amber for advisory alert indications.

(2) Use visual coding techniques, together with other alerting function elements on the flight deck, to distinguish between warning, caution, and advisory alert indications, if they are presented on monochromatic displays that are not capable of conforming to the color convention in paragraph (e)(1) of this section.

(f) Use of the colors red, amber, and yellow on the flight deck for functions other than flightcrew alerting must be limited and must not adversely affect flightcrew alerting.

§ 25.1323 Airspeed indicating system.

(a) through (c) [Not applicable to AW609]

(d) through (e) [Applicable to AW609]

(f) through (i) [Not applicable to AW609]

(j) [Applicable to AW609]

§ 29.1323 Airspeed indicating system.

(a) [Applicable to AW609]

(b) [Not applicable to AW609]

(c) [Applicable to AW609]

(d) [Not applicable to AW609]

(e) [Applicable to AW609]

(f) [Not applicable to AW609]

TR.1323 Airspeed indicating system.

For each airspeed indicating system, the following apply:

(a) Each system must be calibrated to determine system error excluding airspeed instrument error. This calibration must be determined—

(1) In level flight at speeds of 20 knots and greater, and over an appropriate range of speeds for flight conditions of climb and autorotation; and

(2) During takeoff and landing, with repeatable and readable indications that ensure—

(i) Consistent realization of the field lengths specified in the Aircraft Flight Manual; and

(ii) Avoidance of the critical areas during takeoff and landings as established under TR.53 and 29.75.

(b) If certification for IFR is requested, each airspeed indicating system must have a heated pitot tube or an equivalent means of preventing malfunction in:

(1) The heavy rain conditions defined in Table 1 of this section.

(2) The icing conditions described in Appendix C to part 25.

(3) For aircraft with MMO>0.6 and a maximum certified altitude above 25,000 ft, the mixed phase and ice crystal conditions in Appendix D to part 33.

Table 1 – Heavy Rain Conditions

Altitude range		**Liquid Water content**	**Horizontal extent**		**Droplet MVD**
(ft)	**(m)**	**(g/m^3)**	**(km)**	**(nmiles)**	**(µm)**
0 to 10,000	0 to 3,000	1	100	50	1,000
		6	5	3	2,000
		15	1	0.5	2,000

TR.1324 Angle of attack system.

If certification for IFR is requested, each angle of attack system must be heated or have an equivalent means of preventing malfunction in:

(1) The heavy rain conditions defined in Table 1 of this section,

(2) The icing conditions described in Appendix C to part 25

Table 1 – Heavy Rain Conditions

Altitude range		**Liquid Water content**	**Horizontal extent**		**Droplet MVD**
(ft)	**(m)**	**(g/m^3)**	**(km)**	**(nmiles)**	**(µm)**
0 to 10,000	0 to 3,000	1	100	50	1,000
		6	5	3	2,000
		15	1	0.5	2,000

§ 25.1325 Static pressure and pressure altimeter systems.

(a) [Applicable to AW609]

(b) [Not applicable to AW609]

(c) through (d) [Applicable to AW609]

(e) [Not applicable to AW609]

(f) through (h) [Applicable to AW609]

TR.1325 Static pressure systems.

(a) Each system must be designed and installed so that the error in indicated pressure altitude, at sea level, with a standard atmosphere, excluding instrument calibration error, does not result in an error of more than ±30 feet per 100 knots speed for each appropriate configuration. However, the error need not be less than ±30 feet.

(b) Each static port must be designed and located so that:

(1) The static pressure system performance is least affected by airflow variation, or by moisture or other foreign matter; and

(2) If certification for IFR is requested, the correlation between air pressure in the static pressure system and true ambient atmospheric static pressure is not changed when the airplane is exposed to the icing conditions defined in Appendix C to part 25.

§ 25.1326 Pitot heat indication systems.

(a) through (b) [Applicable to AW609]

§ 29.1327 Magnetic direction indicator.

(a) through (b) [Applicable to AW609]

§ 25.1329 Flight guidance system.

(a) through (j) [Applicable to AW609 except replace the reference to § 25.1309 with TR.1309]

(k) [Not applicable to AW609]

(l) [Applicable to AW609]

(m) [Not applicable to AW609]

(n) [Applicable to AW609 except replace the reference to § 25.143(c) with TR.143(d) and (h)]

TR.1329 Flight guidance system.

(a) A means to quickly disengage all axes of the flight guidance system from the automatic flight control system must be located on each pilot's center stick.

(b) Secondary controls used to change aircraft attitude or altitude through the flight guidance system must operate in the plane and sense of motion specified in TR.777(c) and TR.779(a) for cockpit controls. The direction of motion must be plainly indicated on, or adjacent to, each control.

(c) The flight guidance system, when engaged, must be designed so that it can be sufficiently overpowered by one pilot to allow control of the aircraft.

§ 25.1331 Instruments using a power supply.

(a) through (b) [Applicable to AW609]

§ 29.1331 Instruments using a power supply.

(a) [Not applicable to AW609]

(b) [Applicable to AW609]

§ 25.1333 Instrument systems.

(a) through (b) [Not Applicable to AW609]

(c) [Applicable to AW609]

TR.1333 Instrument systems.

The equipment, systems, and installations must be designed so that one display of the information essential to the safety of flight which is provided by the instruments remains available to the pilots, without additional crewmember action, after any single failure or combination of failures that are not shown to be extremely improbable.

§ 29.1335 Flight director systems.

[Applicable to AW609]

§ 29.1337 Powerplant instruments.

(a) through (e) [Applicable to AW609 except replace the reference to § 29.1305(a)(22) with § 29.1305(a)(23)]

Electrical and Electronic Systems and Equipment.

§ 29.1351 General.

(a) through (d) [Applicable to AW609 except replace the reference to § 29.1309 with TR.1309]

§29.1353 **Energy Storage Systems (Amendment Level 29-59)**

(a) through (e) [Applicable to AW609]

§ 29.1355 Distribution system.

(a) through (b) [Applicable to AW609]

§ 29.1357 Circuit protective devices.

(a) through (g) [Applicable to AW609]

§ 29.1359 Electrical System Fire & Smoke Protection.

(a) through (c) [Applicable to AW609 except replace the reference to § 29.831 with § 25.831]

§ 29.1363 Electrical system tests.

(a) through (b) [Applicable to AW609]

Lights.

§ 25.1381 Instrument lights.

(a) through (b) [Applicable to AW609]

TR.1381 Instrument lights.

In addition to the instrument light requirements in § 25.1381(a), thunderstorm lights that provide high intensity white flood lighting to the basic flight instruments must be installed in accordance with § 25.1381(b).

§ 29.1383 Landing lights.

(a) through (c) [Applicable to AW609]

TR.1385 Position light system installation.

(a) ***General.*** Each part of each position light system must meet the applicable requirements of this section and each system as a whole must meet the requirements of TR.1387, TR.1389, TR.1391, TR.1393, TR.1395 and §29.1397.

(b) ***Forward position lights.*** Forward position lights must consist of red and green lights spaced laterally as far apart as practicable and installed as forward as practicable on the aircraft so that, with the aircraft in the normal flying position, the red lights are on the left side, and the green lights are on the right side. Each light must be approved.

(c) ***Rear position light.*** The rear position light must be a white light mounted as far aft as practicable, and must be approved.

(d) ***Circuit.*** The forward position lights and the rear position light must make a single circuit.

(e) ***Light covers and color filters.*** Each light cover or color filter must be at least flame resistant and may not change color or shape or lose any appreciable light transmission during normal use.

TR.1387 Position light system dihedral angles.

(a) Except as provided in paragraph (e) of this section, each forward position light group and rear position light must, as installed, show unbroken light within the dihedral angles described in this section.

(b) Dihedral angle *L* (left) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the aircraft, and the other at 110 degrees to the left of the first, as viewed when looking forward along the longitudinal axis.

(c) Dihedral angle *R* (right) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the aircraft, and the other at 110 degrees to the right of the first, as viewed when looking forward along the longitudinal axis.

(d) Dihedral angle *A* (aft) is formed by two intersecting vertical planes making angles of 70 degrees to the right and to the left, respectively, to a vertical plane passing through the longitudinal axis, as viewed when looking aft along the longitudinal axis.

(e) If the rear position light, when mounted as far aft as practicable in accordance with TR.1385(c), cannot show unbroken light within dihedral angle A (as defined in paragraph (d) of this section), a solid angle or angles of obstructed visibility totaling not more than 0.04 steradians is allowable within that dihedral angle, if such solid angle is within a cone whose apex is at the rear position light and whose elements make an angle of 30° with a vertical line passing through the rear position light.

TR.1389 Position light distribution and intensities.

(a) General. The intensities prescribed in this section must be provided by new equipment with light covers and color filters in place. Intensities must be determined with the light source operating at a steady value equal to the average luminous output of the source at the normal operating voltage of the aircraft. The light distribution and intensity of each position light group must meet the requirements of paragraph (b) of this section.

(b) Forward and rear position lights. The light distribution and intensities of forward and rear position lights must be expressed in terms of minimum intensities in the horizontal plane, minimum intensities in any vertical plane, and maximum intensities in overlapping beams, within dihedral angles, L, R, and A, and must meet the following requirements:

(1) Intensities in the horizontal plane. Each intensity in the horizontal plane (the plane containing the longitudinal axis of the aircraft and perpendicular to the plane of symmetry of the aircraft), must equal or exceed the values in TR.1391.

(2) Intensities in any vertical plane. Each intensity in any vertical plane (the plane perpendicular to the horizontal plane) must equal or exceed the appropriate value in TR.1393 where I is the minimum intensity prescribed in TR.1391 for the corresponding angles in the horizontal plane.

(3) Intensities in overlaps between adjacent signals. No intensity in any overlap between adjacent signals may exceed the values in TR.1395, except that higher intensities in overlaps may be used with the use of main beam intensities substantially greater than the minima specified in TR.1391 and TR.1393 if the overlap intensities in relation to the main beam intensities do not adversely affect signal clarity.

TR.1391 Minimum intensities in the horizontal plane of forward and rear position lights.

Each color group position light intensity must equal or exceed the applicable values in the following table:

Dihedral angle (light included)	Angle from right or left or longitudinal axis, measured from dead ahead	Intensity (candles)
L and R (forward red and green).	0° to 10° degrees	40
	10° to 20°............................	30
	20° to 110°	5
A (rear white)	110° to 180°	20

TR.1393 Minimum intensities in any vertical plane of forward and rear position lights.

Each color group position light intensity must equal or exceed the applicable values in the following table:

Angle above or below the horizontal plane	Intensity (candles)
0°	1.00
0° to 5°	.90
5° to 10°	.80
10° to 15°	.70
15° to 20°	.50

Angle above or below the horizontal plane	Intensity (candles)
20° to 30°	.30
30° to 40°	.10
40° to 90°	.05

TR.1395 Maximum intensities in overlapping beams of forward and rear position lights.

No color group position light intensity may exceed the applicable values in the following table, except as provided in TR.1389(b)(3).

Overlaps	Maximum intensity	
	Area A (candles)	Area B (candles)
Green in dihedral angle L........	10	1
Red in dihedral angle R...........	10	1
Green in dihedral angle A........	5	1
Red in dihedral angle A...........	5	1
Rear white in dihedral angle L .	5	1
Rear white in dihedral angle R	5	1

Where—
(a) Area A includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 10 degrees but less than 20 degrees; and

(b) Area B includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 20 degrees.

§ 29.1397 Color specifications.

(a) through (c) [Applicable to AW609]

§ 25.1401 Anticollision light system.

(a) [Applicable to AW609 except replace the reference to § 25.1401(b) with TR.1401]

(b) [Not applicable to AW609]

(c) through (f) [Applicable to AW609 except replace the reference to § 25.1397 with § 29.1397]

TR.1401 Anticollision light system.

Field of coverage. The system must consist of enough lights to illuminate the vital areas around the aircraft, considering the physical configuration and flight characteristics of the aircraft. The field of coverage must extend in each direction within at least 75 degrees above and 75 degrees below the horizontal plane of the aircraft, except that there may be a solid angle of obstructed visibility totaling not more than 0.5 steradians.

§ 25.1403 Wing icing detection lights.

[Applicable to AW609]

Safety Equipment.

§ 29.1411 General.

(a) through (f) [Applicable to AW609]

§ 29.1413 Safety belts: passenger warning device.

(a) through (b) [Applicable to AW609]

§ 29.1415 Ditching equipment.

(a) through (d) [Applicable to AW609]

TR.1416 Pneumatic deicer boot system.

If certification with ice protection provisions is requested and a pneumatic deicer boot system is installed—

(a) The system must meet the requirements in § 25.1419;

(b) The system and its components must be designed to perform their intended function under any normal system operating temperature or pressure; and

(c) A means must be provided to indicate to the flight crew that the pneumatic deicer boot system is receiving adequate pressure and is functioning normally.

(a) through (c) [Applicable to AW609 if obtaining certification for flight into icing conditions]

§ 25.1419 Ice protection.

(a) through (h) [Applicable to AW609 if obtaining certification for flight into icing conditions]

Miscellaneous equipment.

§ 25.1431 Electronic equipment.

(a) through (d) [Applicable to AW609 except replace the reference to § 25.1309 with TR.1309, and replace the reference to § 25.1355(c) with § 29.1355(b)]

§ 25.1433 Vacuum systems.

[Applicable to AW609]

§ 25.1435 Hydraulic systems.

(a) through (c) [Applicable to AW609 except replace the reference to §§ 25.863, 25.1185, and 25.1541 with §§ 29.863, 29.1185, and 29.1541; the reference to § 25.1183 with § 29.1183(a) and (b) and 25.1183(c); and the reference to § 25.1189 with the applicable paragraphs of §§ 25.1189 and 29.1189]

§ 25.1438 Pressurization and pneumatic systems.

(a) through (c) [Applicable to AW609]

§ 25.1439 Protective breathing equipment.

(a) through (b) [Applicable to AW609]

§ 25.1441 Oxygen equipment and supply.

(a) through (d) [Applicable to AW609]

§ 25.1443 Minimum mass flow of supplemental oxygen.

(a) through (e) [Applicable to AW609]

§ 25.1445 EQUIPMENT STANDARDS FOR THE OXYGEN DISTRIBUTING SYSTEM.

(a) through (b) [Applicable to AW609]

§ 25.1447 Equipment standards for oxygen dispensing units.

(a) through (c) [Applicable to AW609]

§ 25.1449 Means for determining use of oxygen.

[Applicable to AW609]

§ 25.1450 Chemical oxygen generators.

(a) through (c) [Applicable to AW609]

§ 25.1453 Protection of oxygen equipment from rupture.

(a) through (b) [Applicable to AW609]

§ 25.1455 Draining of fluids subject to freezing.

[Applicable to AW609]

§ 25.1457 Cockpit voice recorders.

(a) through (g) [Applicable to AW609]

§ 25.1459 Flight recorders.

(a) through (e) [Applicable to AW609 except replace the reference to § 25.1323 with §§ 25.1323, 29.1323, and TR.1323; replace the reference to §25.1325 with §§ 25.1325 and TR.1325 as applicable; and replace the reference to §25.1327 with §29.1327]

§ 29.1461 Equipment containing high energy rotors.

(a) through (d) [Applicable to AW609]

SUBPART G—OPERATING LIMITATIONS AND INFORMATION.

General.

TR.1501 General.

(a) Each operating limitation specified in § 29.1503, TR.1505, § 25.1507, TR.1509, §§ 25.1511, 25.1515, TR.1516, §§ 25.1517, 29.1519, 29.1521, 29.1523, 29.1525, and Appendix D to part 25 and other limitations and information necessary for safe operation must be established.

(b) The operating limitations and other information necessary for safe operation must be made available to the crewmembers as prescribed in §§ 29.1541, 29.1543, TR.1545, TR.1549, §§ 29.1551, 29.1553, 29.1555, 29.1557, 29.1559, 29.1561, 25.1563, TR.1565, TR.1581, TR.1583, TR.1585, TR.1587, and § 29.1589.

Operating Limitations.

§ 29.1503 Airspeed limitations: General.

(a) through (b) [Applicable to AW609]

TR.1505 Maximum operating airspeeds.

(a) For the aircraft in airplane mode, the maximum operating limit airspeed (V_{MO}/M_{MO} airspeed or Mach number, whichever is critical at a particular altitude) is a speed that may not be deliberately exceeded in any regime of flight (climb, cruise, or descent) unless a higher speed is authorized for flight test or pilot training operations. V_{MO}/M_{MO} must be established so that it is not greater than the design cruising speed V_C and so that it is sufficiently below VD/MD or VDF/MDF to make it highly improbable that the latter speeds will be inadvertently exceeded in operation. The speed margin between V_{MO}/M_{MO} and VD/MD or VDF/MDF must be less than that determined under TR.335(a) and (b) or found necessary during the flight tests conducted under TR.253.

(b) [Reserved]

(c) Maximum authorized speed for VTOL/Conversion mode (V_{CON}) may not exceed the lesser of—

(1) Nine-tenths of the maximum design speed selected under § 29.309(c), or the maximum design speed selected under § 29.309(c) less 10 knots; or

(2) Nine-tenths of the maximum flight speed demonstrated in the particular configuration, or maximum flight speed demonstrated in the particular configuration less 10 knots.

(d) V_{CON}, as scheduled with conversion angle, may vary with altitude, r.p.m., temperature, and weight, if—

(1) No more than two of these variables (or no more than two instruments integrating more than one of these variables) are used at one time; and

(2) The ranges of these variables (or of the indications on instruments integrating more than one of these variables) are large enough to allow an operationally practical and safe variation of V_{CON}.

(e) A stabilized power-off V_{CON} denoted as V_{CON} (power off) may be established at a speed greater than V_{CON}. These speeds are for all-engines inoperative emergency landings.

§ 25.1507 Maneuvering speed.

[Applicable to AW609 except replace the reference to § 25.335 with TR.335]

TR.1509 Proprotor speeds.

(a) *Maximum power-off (autorotation).* The maximum power-off proprotor speed must be established so that it does not exceed 95 percent of the lesser of—

(1) The maximum design r.p.m. determined under § 29.309(b); and

(2) The maximum r.p.m. shown during the type tests.

(b) *Minimum power-off.* The minimum power-off proprotor speed must be established so that it is not less than 105 percent of the greater of—

(1) The minimum shown during the type tests; and

(2) The minimum determined by design substantiation.

(c) *Minimum power-on.* The minimum power-on proprotor speed must be established so that it is—

(1) Not less than the greater of—

(i) The minimum shown during the type tests; and

(ii) The minimum determined by design substantiation; and

(2) Not more than a value determined under TR.33(a) and TR.33(b).

(d) *Maximum power on.* The maximum power-on proprotor speed must be established so that it—

(1) Is consistent with associated propulsion system limitations established under § 29.1521;

(2) Provides adequate margin to accommodate the variations in proprotor speed occurring in any appropriate maneuver; and

(3) Does not exceed 95 percent of the maximum determined by design substantiation or satisfactorily demonstrated in the critical operating regime during the type tests, whichever is less.

§ 25.1511 Flap extended speed.

[Applicable to AW609 except replace the reference to § 25.335 with TR.335; and replace the reference to § 25.345 with TR.457]

§ 25.1515 Landing gear speeds.

(a) through (b) [Applicable to AW609]

TR.1516 Other speed limitations.

The minimum authorized speed in VTOL/Conversion mode, V_{MIN}, must be established for each applicable nacelle angle such that the speed margins required by TR.175(a), (c), (e), (f), and TR.207(d) are satisfied.

§ 25.1517 Rough air speed, V_{RA} (Amendment Level 25-86)

[Applicable to AW609 except replace the reference to § 25.1585(a)(8) with TR.1585(a)(3)]

§ 29.1519 Weight and center of gravity.

[Applicable to AW609]

§ 29.1521 Powerplant limitations.

[(a) through (j) Applicable to the AW609 except replace the reference in 29.1521(c)(2) to 29.1509(c) with TR.1509(c).]

TR.1521 Powerplant limitations.

Thirty-minute AEO power operation. Unless otherwise authorized, the use of 30-minute AEO power must be limited to not longer than 30 minutes per use. The use of 30-minute AEO power must also be limited by—

(a) The maximum rotational speed, which may not be greater than—

(1) The maximum value determined by the rotor design; or

(2) The maximum value demonstrated during the type tests;

(b) The maximum allowable turbine inlet or turbine outlet gas temperature (for turbine engines);

(c)The maximum allowable power or torque for each engine, considering the power input limitations of the transmission with all engines operating;

(d) The maximum allowable power or torque for each engine considering the power input limitations of the transmission with OEI;

(e) The time limit for the use of the power corresponding to the limitations established in paragraphs (a) through (d) of this section; and

(f) The maximum allowable engine and transmission oil temperatures, if the time limit established in paragraph (e) of this section exceeds 2 minutes.

§ 29.1523 Minimum flight crew.

(a) through (c) [Applicable to AW609]

§ 29.1525 Kinds of operations.

[Applicable to AW609]

§ 29.1527 Maximum operating altitude.

[Applicable to AW609]

§ 25.1529 Instructions for Continued Airworthiness.

[Applicable to AW609]

§ 29.1529 Instructions for Continued Airworthiness.

[Applicable to AW609]

§ 25.1531 Maneuvering flight load factors.

[Applicable to AW609 except replace the reference to the maneuvering diagram in § 25.333(b) with TR.333]

Markings and Placards.

§ 29.1541 General.

(a) through (b) [Applicable to AW609 except replace the references to §§ 29.1545, 29.1549, and 29.1565 with TR.1545, TR.1549, and TR.1565; and replace the reference to § 29.1555 with §§ 29.1555, TR.1555, and § 25.1563]

§ 29.1543 Instrument markings: General.

(a) through (b) [Applicable to AW609]

TR.1545 Airspeed limitation information.

The airspeed limitations required by TR.1583(a) must be easily read and understood by the flight crew.

§ 29.1547 Magnetic direction indicator.

(a) through (d) [Applicable to AW609]

TR.1549 Powerplant instruments.

For each required powerplant instrument, as appropriate to the type of instruments—

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red line;

(b) Each normal operating range must be marked as a green or unmarked range;

(c) Each takeoff and precautionary range must be marked with a yellow range or yellow line;

(d) Each engine or propeller range that is restricted because of excessive vibration stresses must be marked with red ranges or red lines; and

(e) Each OEI limit or approved operating range must be marked to be clearly differentiated from the markings of paragraphs (a) through (d) of this section except that no marking is normally required for the 30-second OEI limit.

§ 29.1551 Oil quantity indicator.

[Applicable to AW609]

§ 29.1553 Fuel quantity indicator.

[Applicable to AW609]

§ 29.1555 Control markings.

(a) through (b) [Applicable to AW609]

(c) [Not Applicable to AW609]

(d) through (e) [Applicable to AW609]

TR.1555 Control markings.

The usable fuel capacity of the system must be indicated at the fuel quantity indicator unless it is—

(a) Provided by another system or equipment readily accessible to the pilot; and

(b) Contained in the limitations section of the aircraft flight manual.

§ 29.1557 Miscellaneous markings and placards.

(a) through (d) [Applicable to AW609 except replace the reference to § 29.811(h)(2) with § 29.811(f)(2)]

§ 29.1559 Limitations placard.

[Applicable to AW609]

§ 29.1561 Safety equipment.

(a) through (e) [Applicable to AW609]

§ 25.1563 Airspeed placard.

[Applicable to AW609]

TR.1565 Proprotors and rotating devices.

Each proprotor and unshrouded rotating device that may constitute a hazard to persons on the ground must be marked so that its disc is conspicuous under normal daylight ground conditions.

Aircraft Flight Manual.

TR.1581 General.

(a) *Furnishing information*. An Aircraft Flight Manual must be furnished with each aircraft, and it must contain the following:

(1) Information required by TR.1583 through TR.1587 and § 29.1589.

(2) Other information that is necessary for safe operation because of design, operating, or handling characteristics.

(b) *Approved information*. Each part of the manual listed in TR.1583 through TR.1587 and § 29.1589 that is appropriate to the aircraft must be furnished, verified, and approved, and must be segregated, identified, and clearly distinguished from each unapproved part of that manual.

(c) *Table of contents*. Each Aircraft Flight Manual must include a table of contents if the complexity of the manual indicates a need for it.

TR.1583 Operating limitations.

The Aircraft Flight Manual must contain the following operating limitations and information:

(a) *Airspeed limitations.*

(1) The significance of the airspeed limits and color-coded marking on the indicator as required in TR.1545.

(2) The maximum operating limit speed V_{MO}/M_{MO}, V_{CON}, and minimum operating speed limit V_{MIN}, and a statement that these speed limits may not be deliberately exceeded in any regime of flight (climb, cruise, or descent).

(3) If an airspeed limitation is based upon compressibility effects, a statement to this effect and information as to any symptoms, the probable behavior of the aircraft, and the recommended recovery procedures.

(4) The maneuvering speed V_A and a statement, as applicable to the particular design, explaining that:

(i) Full application of pitch, roll, or yaw controls should be confined to speeds below the maneuvering speed; and

(ii) Rapid and large alternating control inputs, especially in combination with large changes in pitch, roll, or yaw, and full control inputs in more than one axis at the same time, should be avoided as they may result in structural failures at any speed, including below the maneuvering speed.

(5) The flaperon extended speed V_{FE} and the pertinent flaperon positions and engine powers.

(6) The landing gear operating speed or speeds, and a statement explaining the speeds as defined in § 25.1515(a).

(7) The landing gear extended speed V_{LE}, if greater than V_{LO}, and a statement that this is the maximum speed at which the aircraft can be safely flown with the landing gear extended.

(b) *Powerplant limitations.*

(1) Limitations required by § 29.1521.

(2) Explanation of the limitations, when appropriate.

(3) Information necessary for marking the instruments required by TR.1549, 29.1551, and 29.1553.

(c) *Weight.*

(1) The maximum weight;

(2) The maximum takeoff weight at which—

(i) Compliance is shown with the climb requirements of TR.67;

(ii) The rejected takeoff distance determined under TR.62, accounting for runway gradients, is equal to the available heliport/runway length plus the length of any stopway, if utilized; and

(iii) The takeoff distance determined under TR.61, accounting for runway gradients, is equal to the available runway length plus the length of any clearway, if utilized;

(3) The maximum landing weight at which—

(i) Compliance is shown with the climb requirements of TR.67; and

(ii) The landing distance determined under TR.81, accounting for runway gradients, is equal to the available heliport/runway length; and

(4) The maximum zero wing fuel weight, where relevant, as established in accordance with § 25.343.

(d) *Center of gravity*. The established center of gravity limits.

(e) *Maneuvers*. The authorized maneuvers, appropriate airspeed limitations, and unauthorized maneuvers. Maneuvers are limited to any maneuver incident to normal flying, stalls, (except whip stalls) and steep turns in which the angle of bank is not more than 60 degrees.

(f) *Maneuver load factor*. The positive limit load factors in g's.

(g) *Minimum flight crew*. The number and functions of the minimum flight crew determined under § 29.1523 and Appendix D to part 25.

(h) *Kinds of operation*. A list of the kinds of operation to which the aircraft is limited or from which it is prohibited under § 29.1525, and a list of installed equipment that affects any operating limitation and identification as to the equipment's required operational status for the kinds of operation for which approval has been given.

(i) *Maximum allowable wind*. The maximum allowable wind for safe operation near the ground.

(j) *Maximum operating altitude*. The maximum altitude established under § 29.1527.

(k) *Maximum passenger seating configuration*. The maximum passenger seating configuration.

(l) *Allowable lateral fuel loading.* The maximum allowable lateral fuel loading differential, if less than the maximum possible.

(m) *Baggage and cargo loading*. For each baggage and cargo compartment or zone—

(1) The maximum allowable load; and

(2) The maximum intensity of loading.

(n) *Systems*. Any limitations on the use of aircraft systems and equipment.

(o) *Ambient temperatures*. Where appropriate, maximum and minimum ambient air temperatures for operation.

(p) *Smoking*. Any restrictions on smoking in the aircraft.

(q) *Types of surface*. A statement of the types of surface on which operations may be conducted.

TR.1585 Operating procedures.

(a) Information concerning normal, abnormal (if applicable), and emergency procedures and other pertinent information necessary for safe operation and the achievement of the scheduled performance must be furnished in the parts of the manual containing operating procedures, including—

(1) An explanation of significant or unusual flight or ground handling characteristics;

(2) The maximum demonstrated values of crosswind for takeoff and landing, and procedures and information pertinent to operations in crosswinds;

(3) A recommended speed for flight in rough air. This speed must be chosen to protect against the occurrence, as a result of gusts, of structural damage to the aircraft and loss of control (for example, stalling);

(4) Procedures for restarting any turbine engine in flight, including the effects of altitude;

(5) Procedures, speeds, and configurations for making a normal approach and landing in accordance with §§ 23.75, 29.75 and TR.77, and for making a transition to the balked landing condition under TR.85;

(6) Ditching;

(7) Procedures, speeds, and configuration(s) for making an approach and landing with OEI in accordance with TR.79;

(8) Procedures, speeds, and configuration(s) for making a balked landing with OEI and the conditions under which a balked landing can be performed safely;

(9) Procedures, speeds, and configuration(s) for making a normal takeoff;

(10) Procedures and speeds for carrying out rejected takeoff in accordance with TR.62; and

(11) Procedures and speeds for continuing a takeoff following engine failure in accordance with TR.53 and for following the flight path determined under TR.59 and TR.60.

(b) Information on the total quantity of usable fuel for each fuel tank, and the effect on the usable fuel quantity as a result of a failure of any pump, must be furnished.

(c) Procedures for the safe operation of the aircraft's systems and equipment, both in normal use and in the event of malfunction, must be furnished.

(d) The buffet onset envelopes determined under TR.251 must be furnished. The buffet onset envelopes presented may reflect the center of gravity at which the aircraft is normally loaded during cruise if corrections for the effect of different center of gravity locations are furnished.

TR.1587 Performance information.

Unless otherwise prescribed, performance information must be provided over the altitude and temperature ranges required by TR.45(a). The following information must be furnished:

(a) The reference stalling speeds determined in accordance with TR.103 with the landing gear and flaperons retracted and the effect on these stalling speeds of angles of bank up to 60 degrees;

(b) The steady rate and gradient of climb with all engines operating;

(c) The landing distance determined under TR.81 and TR.85, and the type of surface for which it is valid;

(d) The effect on landing distances of runway slope;

(e) The rejected takeoff distance determined under TR.62 with—

(1) The type of surface for which it is valid; and

(2) The effect of runway slope;

(f) The takeoff distance determined under TR.61 with—

(1) The type of surface for which it is valid; and

(2) The effect of runway slope;

(g) The net takeoff flight path determined under TR.63;

(h) The enroute gradient of climb/descent with OEI, determined under TR.69;

(i) The effect, on the net takeoff flight path and on the enroute gradient of climb/descent with OEI;

(j) The relationship between IAS and CAS determined in accordance with § 29.1323(b) and (c) and § 25.1323(d) and (e); and

(k) The altimeter system calibration required by § 29.1325(e).

§ 29.1589 Loading information

[Applicable to AW609]

Appendix A to Part 25.

[Applicable to AW609]

Appendix A to Part 29.

[Applicable to AW609]

Appendix B to Part 29.

Part I through Part VIII(b)(3) [Not applicable to AW609]

Part VIII(b)(4) [Applicable to AW609]

Part VIII(b)(5) through Part IX [Not applicable to AW609]

Appendix C to Part 25.

[Applicable to AW609, only as specified elsewhere in these airworthiness criteria (TR.1323 for example). Replace the references to § 25.21(g) with TR.21(c); § 25.207(h) with TR.207(h); and § 25.207(i) with TR.207(i)]

Appendix C to Part 29.

[Applicable to AW609, only as specified elsewhere in these airworthiness criteria (TR.1093 for example)]

Appendix D to Part 25.

[Applicable to AW609 except replace the reference to § 25.1523 with § 29.1523]

Appendix D to Part 29.

[Applicable to AW609]

Appendix D to Part 33.

[Applicable to AW609, only as specified elsewhere in these airworthiness criteria (TR.1323 for example)]

Appendix E to Part 29.

[Applicable to AW609]

Appendix F to Part 25.

Part I through Part VI [Applicable to AW609 except replace the reference to § 25.855 with § 29.855, and there is no requirement to comply with § 25.857]

Part VII [Not applicable to AW609]

Appendix G to Part 25.

[Applicable to AW609]

Appendix H to Part 25 - Instructions for Continued Airworthiness.

H25.1 through H.25.3

[Not applicable to AW609].

H25.4 Airworthiness Limitations section

(a) through (b) [Applicable to AW609 except replace the reference to § 25.571 with §§ 29.571, TR.571, § 29.573, and TR.573; and H25.4(a)(3) is not applicable to AW609]

TR APPENDIX H – CATEGORY B PERFORMANCE.

SUBPART A – GENERAL.

Transport category performance criteria, including Category A performance, are incorporated in the main AW609 certification basis. This appendix contains Category B performance criteria for operation of the AW609 with nine or fewer passenger seats. The AW609 may be type certificated as both Category A and Category B with appropriate and different operating limitations for each category.

SUBPART B – FLIGHT.

HTR.25 Weight limits.

The following requirement may be used in lieu of § 29.25(a)(3) to determine maximum weight for normal category performance:

The maximum weight (the highest weight at which compliance with each applicable requirement of this appendix is shown) or, at the option of the applicant, the highest weight for each altitude and for each practicably separable operating condition, such as takeoff, enroute operation, and landing, must be established so that it is not more than the maximum weight, altitude, and temperature at which the aircraft can safely operate near the ground with the maximum wind velocity determined under TR.143(e) and may include other demonstrated wind velocities and azimuths. The operating envelopes must be stated in the Limitations section of the Aircraft Flight Manual.

HTR.45 General.

(a) Performance prescribed in this subpart must be determined without requiring exceptional piloting skill, alertness, or strength.

(b) Compliance with the performance requirements of this subpart must be shown—

(1) For sea level standard conditions in still air; and

(2) For the approved range of operational variables.

(c) The performance, as affected by engine power or thrust, must be based on a relative humidity of—

(1) 80 percent, at and below standard temperature; and

(2) 34 percent, at standard temperature plus 50°F and above.

(3) Between these temperature ranges, the relative humidity must vary linearly.

(d) The performance must correspond to the available (or applicant selected lesser) thrust or power under the particular ambient atmospheric conditions, the particular flight conditions, and the relative humidity specified in paragraph (c) of this section. The available propulsive thrust and lift derived from the operating powerplants must correspond to powerplant power or thrust at nacelle angles appropriate for the configuration for takeoff, cruise, and landing, not exceeding the approved ratings less—

(1) Installation losses; and

(2) The power or thrust absorbed by the accessories and services at the values for which certification is requested.

(e) Unless otherwise prescribed, the applicant must select the authorized flight envelope for each practicably separable operating condition.

(f) The aircraft configurations for takeoff, climb, enroute, approach, missed approach, balked landing, and landing must be established by the applicant and may vary with weight, altitude, and temperature to the extent that they are compatible with procedures required by paragraph (g) of this section.

(g) Unless otherwise prescribed, in determining the aircraft performance, changes in the aircraft's speed and configuration including power and thrust must be made in accordance with procedures established by the applicant for operation in service. These procedures must include allowance for any time delays in the execution of the procedures that may reasonably be expected in service.

(h) The applicant shall supply the required procedures for establishing each configuration as defined in paragraph (f) of this section and for transitioning from one configuration to another to support the performance requirements of this appendix.

(i) A means must be provided to permit the pilot to determine prior to takeoff that each engine is capable of developing the power necessary to achieve the applicable aircraft performance prescribed in this subpart.

HTR.49 Performance at minimum operating speed.

(a) The hovering performance must be determined over the ranges of weight, altitude, and temperature for which certification is requested, with—

(1) Takeoff power;

(2) The landing gear extended; and

(3) The aircraft in ground effect at a height consistent with normal takeoff procedures.

(b) For each aircraft utilizing operation in VTOL/Conversion mode, the out-of-ground effect hovering performance must be determined over the ranges of weight, altitude, and temperature for which certification is requested with takeoff power.

HTR.51 Takeoff data: General.

(a) The takeoff data required by HTR.63 must be determined—

(1) At each weight, altitude, and temperature selected by the applicant;

(2) With the operating engines within approved operating limitations; and

(3) With the takeoff configuration selected by the applicant.

(b) Takeoff data must—

(1) Be determined on a smooth, dry, hard surface; and

(2) Be corrected to assume a level takeoff surface.

(c) No takeoff made to determine the data required by this section may require exceptional piloting skill or alertness, or exceptionally favorable conditions.

(d) At no time during the transition from the takeoff configuration to the enroute configuration may the airspeed be less than V_{MIN} at normal pylon conversion rates.

HTR.63 Takeoff flight path

The horizontal distance required to take off and climb over a 50-foot obstacle must be established with the most unfavorable center of gravity. Using the takeoff configuration and procedures established by the applicant, the following applies:

(a) The takeoff surface must be defined;

(b) Safeguards are maintained to ensure proper center of gravity and control positions; and

(c) A landing can be made safely at any point along the flight path following an engine failure.

HTR.64 Climb: General.

(a) Compliance with the requirements of HTR.65, HTR.67, HTR.69, and HTR.77 must be shown—

(1) With the aircraft out of ground effect; and

(2) At speeds not less than those at which compliance with the powerplant cooling requirements of § 29.1041, HTR.1045, and HTR.1047 has been demonstrated; and

(3) With the most unfavorable center of gravity for each configuration; and

(4) Unless otherwise specified, with OEI.

(b) Compliance must be shown at weights as a function of altitude and ambient temperature, within the operational limits established for takeoff and landing, respectively—

(1) With HTR.65(a) and HTR.67(b)(1); and

(2) Where appropriate, for takeoff.

HTR.65 Climb: all engines operating.

Each aircraft must have a steady gradient of climb after takeoff of at least 4 percent—

(a) With takeoff power on each engine;

(b) With the aircraft in the takeoff configuration(s);

(c) With the landing gear extended, except that if the landing gear can be retracted in not more than seven seconds, the test may be conducted with the gear retracted;

(d) With the flaperons in the takeoff position(s) or autoflap position; and

(e) At a climb speed selected by the applicant.

HTR.67 Climb: OEI.

(a) In the takeoff configuration, at nacelle angle(s) selected by the applicant, the steady rate of climb (or descent) must be determined at each weight, altitude, and ambient temperature at which the aircraft is expected to operate: —

(1) With the critical engine inoperative;

(2) With the remaining engine at a power selected by the applicant;

(3) With the landing gear retracted;

(4) With the flaperons in the autoflap position; and

(5) At speeds selected by the applicant but no less than V_{MIN}.

(b) In airplane mode, the steady gradient of climb, at an altitude of 1,500 feet above the takeoff or landing surface, as appropriate, must be not less than 0.75 percent—

(1) With the critical engine inoperative;

(2) With the remaining engine at not more than 30-minute power;

(3) With the landing gear retracted;

(4) With the flaperons in the autoflap position; and

(5) An airspeed not less than $1.13V_{SR1}$.

(c) For transition from the takeoff configuration to airplane mode at normal pylon conversion rate, the total altitude loss must be determined for the weight, altitude and ambient temperature where level flight cannot be maintained:—

(1) With the critical engine inoperative;

(2) With the remaining engine at a power selected by the applicant; however, that power setting, if time limited, must allow conversion from the takeoff nacelle configuration to airplane mode within the allotted time limitation;

(3) With the landing gear retracted;

(4) With the flaperons in the autoflap position.

HTR.69 Enroute climb/descent.

(a) *All engines operating*. The steady gradient and rate of climb must be determined at each weight, altitude, and ambient temperature within the operational limits established by the applicant with—

(1) Not more than maximum continuous power on each engine;

(2) The landing gear retracted;

(3) The flaperons in the autoflap position; and

(4) A climb speed selected by the applicant.

(b) *One engine inoperative*. The steady gradient and rate of climb/descent must be determined at each weight, altitude, and ambient temperature within the operational limits established by the applicant with—

(1) The critical engine inoperative;

(2) The remaining engine at not more than maximum continuous and 30-minute power;

(3) The landing gear retracted;

(4) The flaperons in the autoflap position; and

(5) A climb speed not less than:

i. For airplane mode, $1.13V_{SR1}$.

ii. For V_{TOL}/Conversion mode, a speed selected by the applicant but not less than V_{MIN}.

HTR.77 Balked landing (all engines operating).

Following a balked landing with all engines operating, each aircraft must be able to maintain a steady gradient of climb of at least 2.5 percent with—

(a) Not more than the power that is available on each engine eight seconds after initiation of movement of the power controls from minimum required to maintain glide slope;

(b) The landing gear extended;

(c) The flaperons in the autoflap position; and

(d) A climb speed equal to that used in HTR.65(e).

HTR.77 Balked landing (all engines operating).

Following a balked landing with all engines operating, each aircraft must be able to maintain a steady gradient of climb of at least 2.5 percent with—

(a) Not more than the power that is available on each engine eight seconds after initiation of movement of the power controls from minimum required to maintain glide slope;

(b) The landing gear extended;

(c) The flaperons in the landing position; and

(d) A climb speed equal to that used in HTR.69(a)(4).

HTR.83 Landing (all engines operating)

(a) The horizontal distance required to land and come to a complete stop (or to a speed of approximately 3 knots for water landings) from a point 50 feet above the landing surface must be determined with—

(1) Speeds chosen by the applicant to avoid the critical areas of the height-velocity envelope established under HTR.87;

(2) The approach and landing made with power on and within approved limits; and

(3) Changes in configuration, power, and speed made in accordance with the established procedures for service operation.

(b) It must be possible to make a safe landing on a prepared landing surface if complete engine power failure occurs during normal cruise.

HTR.87 Height-velocity envelope (operation in VTOL/Conversion mode).

If there is any combination of height and forward velocity under which a safe landing cannot be made after failure of the critical engine under any approved takeoff and landing configuration or procedures, except short takeoff and landing (STOL) operations in which a rolling takeoff can be completed and the requirements of HTR.67 can be met, and with the remaining engines (where applicable) operating within approved limits, a height-velocity envelope must be established for—

(a) All combinations of pressure altitude and ambient temperature for which takeoff and landing are approved; and

(b) Weight from the maximum weight (at sea level) to the highest weight approved for takeoff and landing at each altitude. This weight need not exceed the highest weight allowing hovering out-of-ground effect at each altitude above sea level.

SUBPART C – STRUCTURE AND STRENGTH.

[Unchanged from Subpart C of main certification basis]

SUBPART D – DESIGN AND CONSTRUCTION.

[Unchanged from Subpart D of main certification basis]

SUBPART E – POWERPLANT.

Cooling.

HTR.1045 Climb and descent cooling test procedures.

(a) The climb and descent cooling tests must be conducted with the critical engine inoperative and the nacelle angle that produces the most adverse cooling conditions for the remaining engine and powerplant components.

(b) Each operating engine must—

(1) For aircraft for which the use of 30-minute OEI power is requested, be at 30-minute power for 30 minutes, and then at maximum continuous power (or at full throttle when above the critical altitude);

(2) For aircraft for which the use of continuous OEI power is requested, be at continuous OEI power (or at full throttle when above the critical altitude); and

(3) For other aircraft, be at maximum continuous power (or at full throttle when above the critical altitude).

(c) After temperatures have stabilized in flight, the climb must be—

(1) Begun from an altitude not greater than the lower of—

(i) 1,000 feet below the engine critical altitude; and

(ii) 1,000 feet below the maximum altitude at which the rate of climb meets the requirements of HTR.67(a)(2).

(2) Continued for at least five minutes after the occurrence of the highest temperature recorded, or until the aircraft reaches the maximum altitude for which certification is requested.

(d) After temperatures have stabilized in flight, the descent must be—

(1) Begun at the all-engine-critical altitude and end at the higher of—

(i) The maximum altitude at which level flight can be maintained with one engine operative; or

(ii) Sea level; and

(2) Continued for at least five minutes after the occurrence highest temperature recorded.

(e) The climb or descent must be conducted at an airspeed representing a normal operational practice for the configuration being tested. However, if the cooling provisions are sensitive to aircraft speed, the most critical airspeed must be used, but need not exceed the speeds established under HTR.67(a)(1) or HTR.69(b).

HTR.1047 Takeoff cooling test procedures.

Cooling must be shown during takeoff and subsequent climb as follows:

(a) Each temperature must be stabilized while hovering in ground effect with—

(1) The power necessary for hovering;

(2) The appropriate cowl flap, nacelle angle, and shutter settings; and

(3) The maximum weight.

(b) After the temperatures have stabilized, a climb must be started at the lowest practicable altitude with takeoff power.

(c) Takeoff power must be used for the same time interval as takeoff power is used in determining the takeoff flight path under HTR.63.

(d) At the end of the time interval prescribed in HTR.1047(a)(3), the power must be reduced to maximum continuous power and the climb must be continued for at least five minutes after the occurrence of the highest temperature recorded.

(e) The cooling test must be conducted at an airspeed and nacelle angle corresponding to normal operating practice for the configuration being tested. However, if the cooling provisions are sensitive to aircraft speed and nacelle angle, the most critical airspeed and nacelle angle must be used, but need not exceed the speed for best rate of climb with maximum continuous power.

TR APP. H SUBPART F – EQUIPMENT.

[Unchanged from Subpart F of main certification basis]

SUBPART G – OPERATING LIMITATIONS AND INFORMATION.

Aircraft Flight Manual.

HTR.1581 General.

If the AW609 is type certificated as Category B under this Appendix, the Aircraft Flight Manual required by TR.1581 must include the following:

(a) Information required by HTR.1583 through HTR.1587.

(b) Other information that is necessary for safe operation of Category B aircraft because of design, operating, or handling characteristics.

HTR.1583 Operating limitations.

The Aircraft Flight Manual must include the following operating limitations and information for Category B operations:

(a) *Airspeed limitations*.

(1) The significance of the airspeed limits and color-coded marking on the indicator as required in TR.1545.

(2) The maximum operating limit speed V_{MO}/M_{MO}, V_{CON}, and minimum operating speed limit V_{MIN}, and a statement that these speed limits may not be deliberately exceeded in any regime of flight (climb, cruise, or descent).

(3) If an airspeed limitation is based upon compressibility effects, a statement to this effect and information as to any symptoms, the probable behavior of the aircraft, and the recommended recovery procedures.

(4) The maneuvering speed V_A and a statement, as applicable to the particular design, explaining that:

(i) Full application of pitch, roll, or yaw controls should be confined to speeds below the maneuvering speed; and

(ii) Rapid and large alternating control inputs, especially in combination with large changes in pitch, roll, or yaw, and full control inputs in more than one axis at the same time, should be avoided as they may result in structural failures at any speed, including below the maneuvering speed.

(5) The flaperon extended speed V_{FE} and the pertinent flaperon positions and engine powers.

(6) The landing gear operating speed or speeds, and a statement explaining the speeds as defined in § 25.1515(a).

(7) The landing gear extended speed V_{LE}, if greater than V_{LO}, and a statement that this is the maximum speed at which the aircraft can be safely flown with the landing gear extended.

(b) *Powerplant limitations*.

(1) Limitations required by § 29.1521.

(2) Explanation of the limitations, when appropriate.

(3) Information necessary for marking the instruments required by TR.1549, § 29.1551, and § 29.1553.

(c) *Weight*.

(1) The maximum weight;

(2) The maximum landing weight for each takeoff altitude and ambient temperature within the range selected by the applicant at which the aircraft complies with the climb requirements of HTR.77;

(3) The maximum takeoff weight for each takeoff altitude and ambient temperature within the range selected by the applicant at which the aircraft complies with the climb requirements of HTR.65;

(4) The maximum weight for transition from the takeoff configuration to the airplane mode configuration for each takeoff altitude and ambient temperature within the range selected by the applicant at which the aircraft complies with the climb requirements of HTR.67(b);

(5) The maximum zero wing fuel weight, where relevant, as established in accordance with § 25.343.

(d) *Center of gravity*. The established center of gravity limits.

(e) *Maneuver load factor*. The positive limit load factors in g's, and the negative limit load factor for acrobatic category aircraft.

(f) *Minimum flight crew*. The number and functions of the minimum flight crew determined under § 29.1523 and Appendix D to part 25.

(g) *Kinds of operation*. A list of the kinds of operation to which the aircraft is limited or from which it is prohibited under § 29.1525, and also a list of installed equipment that affects any operating limitation and identification as to the equipment's required operational status for the kinds of operation for which approval has been given.

(h) *Maximum operating altitude*. The maximum altitude established under § 29.1527.

(i) *Maximum passenger seating configuration*. The maximum passenger seating configuration.

(j) *Allowable lateral fuel loading*. The maximum allowable lateral fuel loading differential, if less than the maximum possible.

(k) *Baggage and cargo loading*. For each baggage and cargo compartment or zone—

(1) The maximum allowable load; and

(2) The maximum intensity of loading.

(l) *Systems*. Any limitations on the use of aircraft systems and equipment.

(m) *Ambient temperatures*. Where appropriate, maximum and minimum ambient air temperatures for operation.

HTR.1585 Operating procedures.

The Aircraft Flight Manual must include the following operating procedures and information for Category B operations.

(a) Information concerning normal, abnormal (if applicable), and emergency procedures and other pertinent information necessary for safe operation and the achievement of the scheduled performance must be furnished, including—

(1) An explanation of significant or unusual flight or ground handling characteristics;

(2) The maximum demonstrated values of crosswind for takeoff and landing, and procedures and information pertinent to operations in crosswinds;

(3) A recommended speed for flight in rough air. This speed must be chosen to protect against the occurrence, as a result of gusts, of structural damage to the aircraft and loss of control (for example, stalling);

(4) Procedures for restarting any turbine engine in flight, including the effects of altitude;

(5) Procedures, speeds, and configuration(s) for making a normal approach and landing in accordance with HTR.83, and for making a transition to the balked landing configuration defined by HTR.77;

(6) Procedures, speeds, and configuration(s) for making an approach and landing with OEI;

(7) Procedures, speeds, and configuration(s) for making a balked landing with OEI and the conditions under which a balked landing can be performed safely or a warning against attempting a balked landing; and

(8) Procedures, speeds, and configuration(s) for making a normal takeoff.

(b) Information on the total quantity of usable fuel for each fuel tank, and the effect on the usable fuel quantity as a result of a failure of any pump, must be furnished.

(c) Procedures for the safe operation of the aircraft's systems and equipment, both in normal use and in the event of malfunction, must be furnished.

(d) The buffet onset envelopes determined under TR.251 must be furnished. The buffet onset envelopes presented may reflect the center of gravity at which the aircraft is normally loaded during cruise if corrections for the effect of different center of gravity locations are furnished.

HTR.1587 Performance information.

Unless otherwise prescribed, performance information must be provided over the altitude and temperature ranges required by HTR.45(b). For Category B operations, the following information must be furnished:

(a) The reference stalling speeds determined in accordance with TR.103 with the landing gear and flaperons retracted and the effect on these stalling speeds of angles of bank up to 60 degrees;

(b) The steady rate and gradient of climb with all engines operating, determined under HTR.69(a);

(c) The landing distance, determined under HTR.83 for each appropriate airspeed and type of landing surface, together with all pertinent information that might affect this distance, including the effects of weight, altitude, and temperature;

(d) The takeoff distance determined under HTR.63;

(e) With OEI:

(1) The steady rate of climb/descent during takeoff as determined under HTR.67(a);

(2) The total altitude loss determined under HTR.67(c); and

(3) The enroute gradient of climb/descent, determined under HTR.69 (b).

(f) The relationship between IAS and CAS determined in accordance with § 29.1323(b) and (c) and § 25.1323(d) and (e);

(g) The altimeter system calibration required by TR.1325(a);

(h) For operation in VTOL/Conversation mode:

(1) The maximum safe wind for operation near the ground;

(2) The height-speed envelope; and

(3) Out-of-ground effect hover performance determined under HTR.49 and the maximum safe wind demonstrated under the ambient conditions for data presented; and

(i) Any additional performance data necessary for the application of any operating rule in Title 14, Code of Federal Regulations, Chapter 1.

TR APPENDIX K – INTERACTION OF SYSTEMS AND STRUCTURES.

General

The following criteria must be used for showing compliance for aircraft equipped with flight control systems, autopilots, stability augmentation systems, load alleviation systems, flutter control systems, fuel management systems, or other systems that either directly or as a result of a failure or malfunction affect structural performance. If this appendix is used for other systems, it may be necessary to adapt the criteria to the specific system.

(a) These criteria address only direct structural consequences of system responses and performances. They cannot be considered in isolation but must be included in the overall safety evaluation of the aircraft. They may in some instances duplicate standards already established for this evaluation. These criteria are only applicable to structure whose failure could prevent continued safe flight and landing. Specific criteria defining acceptable limits on handling characteristics or stability requirements when operating in the system degraded or inoperative mode are not provided in this appendix.

(b) Depending on the specific characteristics of the aircraft, additional studies may be required that go beyond these criteria in order to demonstrate the capability of the aircraft to meet other realistic conditions such as alternative gust conditions or maneuvers for an aircraft equipped with a load alleviation system.

(c) The following definitions are applicable to this appendix:

(1) *Structural performance:* Capability of the aircraft to meet the structural requirements of this certification basis.

(2) *Flight limitations:* Limitations that can be applied to the aircraft flight conditions following an in-flight failure and that are included in the flight manual (speed limitations or avoidance of severe weather conditions, for example).

(3) *Operational limitations:* Limitations, including flight limitations, that can be applied to the aircraft operating conditions before dispatch (fuel, payload, and master minimum equipment list limitations, for example).

(4) *Probabilistic terms*: Terms (extremely improbable, extremely remote, remote) used in this appendix that are the same as those probabilistic terms used in TR.1309.

(5) *Failure condition:* Term that is the same as that used in TR.1309; however, as used in this appendix, "failure condition" applies only to system failure conditions that affect structural performance of the aircraft. Examples are system failure conditions that induce loads, change the response of the aircraft to inputs such as gusts or pilot actions, or lower flutter margins.

Note: Although failure annunciation system reliability must be included in probability calculations for paragraph (c) of TR.1309, there is no specific reliability requirement for the annunciation system required in paragraph (d) of TR.1309.

Effects of System on Structure

(a) *General*. The following criteria will be used in determining the influence of a system and its failure conditions on the aircraft structure.

(b) *System fully operative*. With the system fully operative, the following apply:

(1) Limit loads must be derived in all normal operating configurations of the system from all the limit conditions specified in Subpart C of the certification basis, taking into account any special behavior of such a system or associated functions or any effect on the structural performance of the aircraft that may occur up to the limit loads. In particular, any significant degree of

nonlinearity in rate of displacement of control surface or thresholds, or any other system nonlinearities, must be accounted for in a realistic or conservative way when deriving limit loads from limit conditions.

(2) The aircraft must meet the strength requirements of the certification basis for static strength and residual strength, using the specified factors to derive ultimate loads from the limit loads described in paragraph (b)(1) of this section. The effect of nonlinearities must be investigated beyond limit conditions to ensure the behavior of the system presents no anomaly compared to the behavior below limit conditions. However, conditions beyond limit conditions need not be considered if the applicant demonstrates that the aircraft has design features that will not allow it to exceed those limit conditions.

(3) The aircraft must meet the aeroelastic stability requirements of § 25.629 and TR.629.

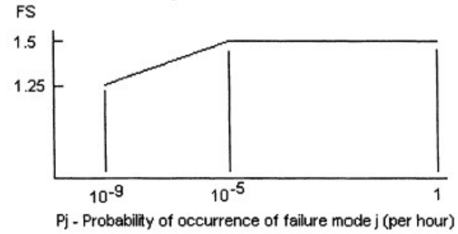
(c) *System in the failure condition*. For any system failure condition not shown to be extremely improbable, the following apply:

(1) Establishing loads at the time the failure occurs. A realistic scenario, including pilot corrective actions, must be established to determine loads occurring at the time of failure and immediately after failure. The initial conditions must address Airplane Mode 1-g level flight, VTOL/Conversion Mode hovering, conversion, and re-conversion.

(i) For static strength substantiation, these loads, multiplied by an appropriate factor of safety related to the probability of occurrence of the failure, are ultimate loads to be addressed for design. The factor of safety is defined in Figure 1.

Figure 1

Factor of safety at the time of occurrence



(ii) For residual strength substantiation, the aircraft must be able to withstand two thirds of the ultimate loads defined in paragraph (c)(1)(i) of this section. For pressurized cabin conditions, any associated loads must be combined with the normal operating differential pressure.

(iii) Freedom from aeroelastic instability must be shown up to the speeds defined in § 25.629(b)(2). For failure conditions that result in speeds beyond design cruise speed or design cruise Mach number (V_C/M_C), freedom from aeroelastic instability must be shown to increased speeds, so that the margins intended by § 25.629(b)(2) are maintained.

(iv) Failures of the system that result in forced structural vibrations (oscillatory failures) must not produce loads that could result in detrimental deformation of primary structure.

(2) Establishing loads in the system failed state part or the continuation of the flight. For the continuation of flight of the aircraft in the system failed state, and considering any appropriate reconfiguration and flight limitations, the following apply.

(i) Loads derived from the following conditions at speeds up to V_C/M_C, or the speed limitation prescribed for the remainder of the flight, must be determined:

(A) The limit symmetrical maneuvering conditions specified in TR.331.

(B) The limit gust and turbulence conditions specified in §§ 25.341 and 29.341.

(C) The limit rolling conditions specified in TR.349 and the limit unsymmetrical conditions for the empennage specified in TR.427(b) and (c).

(D) The limit yaw maneuvering conditions specified in TR.351.

(E) The limit ground loading conditions specified in §§ 25.473, 29.473 and 25.491.

(ii) For static strength substantiation, each part of the structure must be able to withstand the loads in paragraph (c)(2)(i) of this section multiplied by a factor of safety depending on the probability of being in this failure state. The factor of safety is defined in Figure 2.

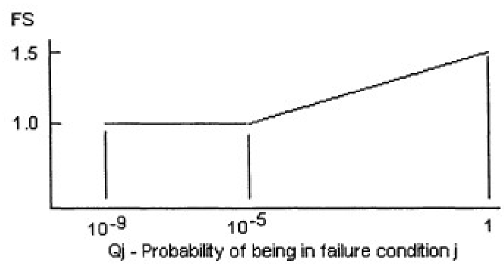


Figure 2 - Factor of Safety For Continuation of Flight

Qj=(Tj)(Pj)

Where:

Tj=Average time spent in failure condition j (in hours)

Pj=Probability of occurrence of failure mode j (per hour)

Note: If Pj is greater than 10^{-3} per flight hour, then a 1.5 factor of safety must be applied to all limit load conditions specified in Subpart C of the certification basis.

(iii) For residual strength substantiation, the aircraft must be able to withstand two thirds of the ultimate loads defined in paragraph (c)(2)(ii) of this section. For pressurized cabins conditions, any associated loads must be combined with the normal operating differential pressure.

(iv) If the loads induced by the failure condition have a significant effect on fatigue or damage tolerance then the effects of these loads must be taken into account.

(v) Freedom from aeroelastic instability must be shown up to a speed determined from Figure 3. Flutter clearance speeds V" and V' may be based on the speed limitation specified for the remainder of the flight using the margins defined by § 25.629(b).

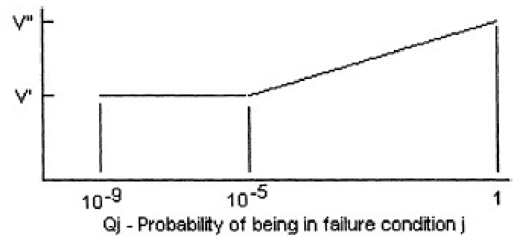


Figure 3 - Clearance Speed

V'=Clearance speed as defined by § 25.629(b)(2)

V"=Clearance speed as defined by § 25.629(b)(1)

Qj=(Tj)(Pj)

Where:

Tj=Average time spent in failure condition j (in hours)

Pj=Probability of occurrence of failure mode j (per hour)

Note: If Pj is greater than 10^{-3} per flight hour, then the flutter clearance speed must not be less than V".

(vi) Freedom from aeroelastic instability must also be shown up to V' in Figure 3 for any probable system failure condition combined with any damage required or selected for investigation by § 29.571, TR.571, § 29.573, and TR.573.

(3) Consideration of certain failure conditions may be required by other sections of this certification basis regardless of calculated system reliability. Where analysis shows the probability of these failure conditions to be less than 10^{-9}, criteria other than those specified in

this paragraph may be used for structural substantiation to show continued safe flight and landing.

(e) *Failure indications*. For system failure detection and indication, the following apply.

(1) The system must be checked for failure conditions, not extremely improbable, that degrade the structural capability of the aircraft below the level required by the certification basis or that significantly reduce the reliability of the remaining system. As far as reasonably practicable, the flightcrew must be made aware of these failures before flight. Certain elements of the control system, such as mechanical and hydraulic components, may use special periodic inspections, and electronic components may use daily checks, instead of detection and indication systems to achieve the objective of this requirement. Such certification maintenance inspections or daily checks must be limited to components on which faults are not readily detectable by normal detection and indication systems and where service history shows that inspections will provide an adequate level of safety.

(2) The existence of any failure condition, not extremely improbable, during flight that could significantly affect the structural capability of the aircraft and for which the associated reduction in airworthiness can be minimized by suitable flight limitations, must be signaled to the flightcrew. For example, failure conditions that result in a factor of safety between the aircraft strength and the loads of Subpart C of this certification basis below 1.25, or flutter margins below V", must be signaled to the crew during flight.

(f) *Dispatch with known failure conditions*. If the aircraft is to be dispatched in a known system failure condition that affects structural performance, or that affects the reliability of the remaining system to maintain structural performance, then the provisions of this appendix must be met, including the provisions of paragraph (c) of this section for the dispatched condition, and paragraph (d) of this section for subsequent failures. Expected operational limitations may be taken into account in establishing Pj as the probability of failure occurrence for determining the safety margin in Figure 1. Flight limitations and expected operational limitations may be taken into account in establishing Qj as the combined probability of being in the dispatched failure condition and the subsequent failure condition for the safety margins in Figures 2 and 3. These limitations must be such that the probability of being in this combined failure state condition and then subsequently encountering limit load conditions is extremely improbable. No reduction in these safety margins is allowed if the subsequent system failure rate is greater than 10^{-3} per hour.

APPENDIX O TO PART 25 – SUPERCOOLED LARGE DROP ICING CONDITIONS.

[Applicable to AW609 if obtaining certification for flight into icing conditions]

PART 36 – NOISE STANDARDS: AIRCRAFT TYPE AND AIRWORTHINESS CERTIFICATION.

14 CFR Part 36 amendments 36-1 through 36-31 [Applicable to AW609]