Code of Federal Regulations

Sec. 25.571

Part 25 AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES	
Subpart C--Structure	Fatigue Evaluation

Sec. 25.571

Damage-tolerance and fatigue evaluation of structure.

(a) *General.* An evaluation of the strength, detail design, and fabrication must show that catastrophic failure due to fatigue, corrosion, or accidental damage, will be avoided throughout the operational life of the airplane. This evaluation must be conducted in accordance with the provisions of paragraphs (b) and (e) of this section, except as specified in paragraph (c) of this section, for each part of the structure which could contribute to a catastrophic failure (such as wing, empennage, control surfaces and their systems, the fuselage, engine mounting, landing gear, and their related primary attachments). Advisory Circular AC No. 25.571-1 contains guidance information relating to the requirements of this section (copies of the Advisory Circular may be obtained from--U.S. Department of Transportation, Publications Section M443.1, Washington, D.C. 20590). For turbojet powered airplanes, those parts which could contribute to a catastrophic failure must also be evaluated under paragraph (d) of this sections. In addition, the following apply:
(1) Each evaluation required by this section must include--
(i) The typical loading spectra, temperatures, and humidities expected in services;
(ii) The identification of principal structural elements and detail design points, the failure of which could cause catastrophic failure of the airplane; and
(iii) An analysis, supported by test evidence, of the principal structural elements and detail design points identified in paragraph (a)(1)(ii) of this section.
(2) The service history of airplanes of similar structural design, taking due account of differences in operating conditions and procedures, may be used in the evaluations required by this section.
(3) Based on the evaluations required by this section, inspections or other procedures must be established as necessary to prevent catastrophic failure, and must be included in the
[Airworthiness Limitations section of the Instructions for Continued Airworthiness**]** required by Sec. 25.1529.
(b) *Damage-tolerance (fail-safe) evaluation.* The evaluation must include a determination of the probable locations and modes of damage due to fatigue, corrosion, or accidental damage. The determination must be by analysis supported by test evidence and (if available) service experience. Damage at multiple sites due to prior fatigue exposure must be included where the design is such that this type of damage can be expected to occur. The evaluation must incorporate repeated load and static analyses supported by

test evidence. The extent of damage for residual strength evaluation at any time within the operational life must be consistent with the initial detectability and subsequent growth under repeated loads. The residual strength evaluation must show that the remaining structure is able to withstand loads (considered as static ultimate loads) corresponding to the following conditions:
(1) The limit symmetrical maneuvering conditions specified in Sec. 25.337 at V_C and in Sec. 25.345.
(2) The limit gust conditions specified in Secs. 25.341 and 25.351(b) at the specified speeds up to V_C and in Sec. 25.345.
(3) The limit rolling conditions specified in Sec. 25.349 and the limit unsymmetrical conditions specified in Secs. 25.367 and 25.427, at speeds up to V_C;
(4) The limit yaw maneuvering conditions specified in Sec. 25.351(a) at the specified speeds up to V_C.
(5) For pressurized cabins, the following conditions:
(i) The normal operating differential pressure combined with the expected external aerodynamic pressures applied simultaneously with the flight loading conditions specified in paragraphs (b)(1) through (4) of this section, if they have a significant effect.
(ii) The expected external aerodynamic pressures in l*g* flight combined with a cabin differential pressure equal to 1.1 times the normal operating differential pressure without any other load.
(6) For landing gear and directly-affected airframe structure, the limit ground loading conditions specified in Secs. 25.473, 25.491, and 25.493.

If significant changes in structural stiffness or geometry, or both, follow from a structural failure, or partial failure, the effect on damage tolerance must be further investigated.

(c) *Fatigue (safe-life) evaluation.* Compliance with the damage-tolerance requirements of paragraph (b) of this section is not required if the applicant establishes that their application for particular structure is impractical. This structure must be shown by analysis, supported by test evidence, to be able to withstand the repeated loads of variable magnitude expected during its service life without detectable cracks. Appropriate safe-life scatter factors must be applied.
(d) *Sonic fatigue strength.* It must be shown by analysis, supported by test evidence, or by the service history of airplanes of similar structural design and sonic excitation environment, that--
(1) Sonic fatigue cracks are not probable in any part of the flight structure to sonic excitation; or
(2) Catastrophic failure caused by sonic cracks is not probable assuming that the loads prescribed in paragraph (b) of this section are applied to al areas affected by those cracks.
(e) *Damage-tolerance (discrete source) evaluation.* The airplane must be capable of successfully completing a flight during which likely structural damage occurs as a result of--
(1) Impact with a 4-pound bird at likely operational speeds at altitudes up to 8,000 feet;
(2) Propeller and uncontained fan blade impact;
(3) Uncontained engine failure; or
(4) Uncontained high energy rotating machinery failure.

The damaged structure must be able to withstand the static loads (considered as ultimate loads) which are reasonably expected to occur on the flight. Dynamic effects on these static loads need not be considered. Corrective action to be taken by the pilot following the incident, such as limiting maneuvers, avoiding turbulence, and reducing speed, must be considered. If significant changes in structural stiffness or geometry, or both, follow from a structural failure or partial failure, the effect on damage tolerance must be further investigated.

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