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[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No.: FAA-2013-0142; Amdt. No. 25-141]

RIN 2120–AK12

Harmonization of Airworthiness Standards—Gust and Maneuver Load Requirements

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: This final rule amends certain airworthiness regulations for transport category airplanes, based on recommendations from the FAA-sponsored Aviation Rulemaking Advisory Committee (ARAC). This amendment eliminates regulatory differences between the airworthiness standards of the FAA and European Aviation Safety Agency (EASA). It does not add new requirements beyond what manufacturers currently meet for EASA certification and does not affect current industry design practices. This final rule revises the pitch maneuver design loads criteria; revises the gust and turbulence design loads criteria; revises the application of gust loads to engine mounts, high lift devices, and other control surfaces; adds a “round-the-clock” discrete gust criterion and a multi-axis discrete gust criterion for airplanes equipped with wing-mounted engines; revises the engine torque loads criteria; adds an engine failure dynamic load condition; revises the ground gust design loads criteria; revises the criteria used to establish the rough air design speed; and requires the establishment of a rough air Mach number.

DATES: Effective [INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: For information on where to obtain copies of rulemaking documents and other information related to this final rule, see "How To Obtain Additional Information" in the SUPPLEMENTARY INFORMATION section of this document.

FOR FURTHER INFORMATION CONTACT: For technical questions concerning this action, contact Todd Martin, Airframe and Cabin Safety Branch, ANM-115, Transport Airplane Directorate, Aircraft Certification Service, Federal Aviation Administration, 1601 Lind Avenue SW., Renton, WA 98057-3356; telephone (425) 227-1178; facsimile (425) 227-1232; e-mail Todd.Martin@faa.gov.

For legal questions concerning this action, contact Sean Howe, Office of the Regional Counsel, ANM-7, Federal Aviation Administration, 1601 Lind Avenue SW., Renton, Washington 98057-3356; telephone (425) 227-2591; facsimile (425) 227-1007; e-mail Sean.Howe@faa.gov.

SUPPLEMENTARY INFORMATION:

Authority for this Rulemaking

The FAA's authority to issue rules on aviation safety is found in Title 49 of the United States Code. Subtitle I, Section 106 describes the authority of the FAA Administrator. Subtitle VII, Aviation Programs, describes in more detail the scope of the agency's authority.

This rulemaking is promulgated under the authority described in Subtitle VII, Part A, Subpart III, Section 44701, "General Requirements." Under that section, the FAA is charged with promoting safe flight of civil aircraft in air commerce by prescribing regulations and minimum standards for the design and performance of aircraft that the Administrator finds necessary for safety in air commerce. This regulation is within the scope of that authority. It prescribes new safety standards for the design and operation of transport category airplanes.

I. Overview of Final Rule

The FAA is amending Title 14, Code of Federal Regulations (14 CFR) Part 25 as described below. This action harmonizes part 25 requirements with the corresponding requirements in Book 1 of the EASA Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes (CS-25). As such, this action—

1. Revises § 25.331, "Symmetric maneuvering conditions," to prescribe both positive and negative checked pitch maneuver loads that take into account the size of the airplane and any effects of the flight control system. The introductory paragraph, § 25.331(c), is revised by moving some criteria to § 25.331(c)(2) where those criteria apply.
2. Removes appendix G to part 25, "Continuous Gust Design Criteria," and § 25.341(b) now clearly sets forth the continuous turbulence requirement.
3. Revises § 25.341, "Gust and turbulence loads," to—
    - Remove the optional mission analysis method currently specified in appendix G in favor of the design envelope analysis method.
    - Update the turbulence intensity criteria in § 25.341(b) to take into account in-service measurements of derived gust intensities.
    - Update § 25.341(a) to require evaluation of discrete gust conditions at airplane speeds from design speed for maximum gust intensity, $V_{B,}$ to design cruising speed, $V_{C,}$ (previously required only at V_C) and to specify reference gust velocities up to 60,000 feet, rather than the previously specified 50,000 feet.

- Add a new paragraph § 25.341(c) that specifies a “round-the-clock” discrete gust criterion and a multi-axis discrete gust criterion for airplanes equipped with wing-mounted engines.

4. Revises § 25.343, “Design fuel and oil loads,” § 25.345, “High lift devices,” § 25.371, “Gyroscopic loads,” § 25.373, “Speed control devices,” and § 25.391, “Control surface loads: General,” by adding to each of these regulations a requirement to evaluate the continuous turbulence loads criteria in § 25.341(b).
5. Revises § 25.361, “Engine and auxiliary power unit torque,” to—
   - Remove the requirement to assess engine torque loads due to engine structural failures (this requirement is re-established in the new § 25.362, outlined below).
   - Provide specific engine torque load criteria for auxiliary power unit installations.
   - Remove the requirements that apply to reciprocating engines.
   - Change the title of § 25.361 from “Engine torque” to “Engine and auxiliary power unit torque.”
6. Adds new § 25.362, “Engine failure loads,” to require engine mounts and supporting airframe structure be designed for 1g flight loads combined with the most critical transient dynamic loads and vibrations resulting from failure of a blade, shaft, bearing or bearing support, or bird strike event.
7. Revises § 25.391, “Control surface loads: General,” and § 25.395, “Control system,” to remove references to the ground gust requirements in § 25.415.
8. Revises § 25.415, “Ground gust conditions” to—
   - Reorganize and clarify the design conditions to be considered.

- Identify the components and parts of the control system to which each of the conditions apply.
- Make it stand alone in regard to the required multiplying factors and to provide an additional multiplying factor to account for dynamic amplification.

9. Revises § 25.1517, “Rough air speed, V_{RA}” to remove the reference to VB in the definition of rough air speed and to require that a rough air Mach number, MRA, be established in addition to rough air speed. Also, this action removes the reference to § 25.1585, “Operating procedures,” because it is no longer applicable since that regulation was modified.

II. Background

A. Statement of the Problem

Part 25 prescribes airworthiness standards for type certification of transport category airplanes for products certified in the United States. EASA CS-25 Book 1 prescribes the corresponding airworthiness standards for products certified in Europe. While part 25 and CS-25 Book 1 are similar, they differ in several respects.

The FAA tasked ARAC through the Loads and Dynamics Harmonization Working Group (LDHWG) to review existing structures regulations and recommend changes that would eliminate differences between the U.S. and European airworthiness standards. The LDHWG developed recommendations, which EASA has incorporated into CS-25 with some changes. The FAA agrees with the ARAC recommendations as adopted by EASA, and this final rule amends part 25 accordingly.

B. Summary of the NPRM

On May 6, 2013, the FAA issued a Notice of Proposed Rulemaking (NPRM), Notice No. 25-139[1], Docket No. FAA-2013-0142, to amend §§ 25.331, 25.341, 25.343, 25.345, 25.361, 25.371, 25.373, 25.391, 25.395, 25.415, and 25.1517; to add § 25.362; and to remove appendix G of 14 CFR part 25. That NPRM was published in the Federal Register on May 28, 2013 (78 FR 31851). In the NPRM, the FAA proposed to (1) revise the pitch maneuver design loads criteria; (2) revise the gust and turbulence design loads criteria; (3) revise the application of gust loads to engine mounts, high lift devices, and other control surfaces; (4) add a "round-the-clock" discrete gust criterion and a multi-axis discrete gust criterion for airplanes equipped with wing-mounted engines; (5) revise the engine torque loads criteria and add an engine failure dynamic load condition; (6) revise the ground gust design loads criteria; (7) revise the criteria used to establish the rough air design speed; and (8) require the establishment of a rough air Mach number.

The FAA proposed these changes to eliminate regulatory differences between the airworthiness standards of the FAA and EASA. The NPRM comment period closed on August 26, 2013.

On June 24, 2013, the Federal Register published a correction to the NPRM to correct three equations in the proposed amendments to § 25.341 (78 FR 37722). On July 16, 2013, the Federal Register published a second correction to one equation in the proposed amendments to § 25.341 (78 FR 42480). The equations in this final rule have not changed from those in the corrected NPRM.

[1] On April 16, 2014, the Federal Register published a correction (79 FR 21413) changing the Notice No. to "13-04" for the NPRM that published May 28, 2013 (78 FR 31851) and for subsequent NPRM corrections that published June 24, 2013 (78 FR 37722) and July 16, 2013 (78 FR 42480).

C. General Overview of Comments

The FAA received two comments. One commenter supported the NPRM and the ongoing international harmonization of certification requirements. The other comment addressed § 25.341 and is discussed below.

III. Discussion of Public Comments and Final Rule

A. Section 25.341, "Gust and turbulence loads"

Section 25.341(a)(6) uses the term Z_{mo}, which is the maximum operating altitude, in feet, specifically defined in § 25.1527. A commenter noted that the units for the term Z_{mo} are not provided in the current rule. While § 25.341(a)(6) was not being revised as part of this rulemaking, the commenter recommended that this paragraph be revised to include the appropriate units for Z_{mo} (feet) for ease of reference. We agree, and revise the rule as recommended.

B. Section 25.415, "Ground Gust Conditions"

After further FAA review of what we proposed by NPRM, we now specify that control system gust locks are to be taken into account only when the airplane is so equipped. As proposed, § 25.415 would have required that the airplane be evaluated while taxiing with the controls locked and unlocked, and while parked with the controls locked. However, many transport category airplanes with powered flight controls do not have control system gust locks. As noted in the NPRM, these airplanes rely on their hydraulic actuators to provide protection from ground gusts. We, therefore, now revise § 25.415 to clarify that, for all airplanes, the ground gust conditions apply when the airplane is taxiing and while parked. For airplanes that include control system gust locks, the taxiing condition must be evaluated with the controls locked and unlocked, and the parked condition must be evaluated with the controls locked.

Airplanes not equipped with gust locks are to be evaluated in their normal configuration while taxiing and while parked. With these changes to § 25.415, the rule wording will no longer be exactly the same as CS 25.415; however, the intent of the two rules is the same in how airplanes with and without gust locks are evaluated.

C. Advisory Material

On May 31, 2013, the FAA published and solicited public comments on three proposed ACs that describe acceptable means for showing compliance with the NPRM's proposed regulations. The comment period for the proposed ACs closed on September 26, 2013. The FAA did not receive any comments on the proposed ACs. Concurrently with this final rule, the FAA is issuing the following final ACs to provide guidance material for the new regulations adopted by this amendment:

- AC 25.341-1, "Dynamic Gust Loads."
- AC 25.362-1, "Engine Failure Loads."
- AC 25.415-1, "Ground Gust Conditions."

IV. Regulatory Notices and Analyses

A. Regulatory Evaluation

Changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 and Executive Order 13563 direct that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 (Public Law 96-354) requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (Public Law 96-39) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S.

standards, the Trade Act requires agencies to consider international standards and, where appropriate, that they be the basis of U.S. standards. Fourth, the Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of $100 million or more annually (adjusted for inflation with base year of 1995). This portion of the preamble summarizes the FAA’s analysis of the economic impacts of this final rule.

Department of Transportation Order DOT 2100.5 prescribes policies and procedures for simplification, analysis, and review of regulations. If the expected cost impact is so minimal that a proposed or final rule does not warrant a full evaluation, this order permits that a statement to that effect and the basis for it be included in the preamble if a full regulatory evaluation of the cost and benefits is not prepared. Such a determination has been made for this final rule. The reasoning for this determination follows.

The FAA is amending certain airworthiness standards for transport category airplanes. Adopting this final rule will eliminate regulatory differences between the airworthiness standards of the FAA and EASA. This final rule does not add new requirements beyond what manufacturers currently meet for EASA certification and does not affect current industry design practices. Meeting two sets of certification requirements raises the cost of developing new transport category airplanes with little to no increase in safety. In the interest of fostering international trade, lowering the cost of manufacturing new transport category airplanes, and making the certification process more efficient, the FAA, EASA, and several industry working groups came together to create, to the maximum extent possible, a single set of certification requirements that would be accepted in both the United States and Europe. Therefore, as a result of these harmonization efforts, the FAA is amending the airworthiness regulations described in section I of this final rule, “Overview of Final Rule.” This action harmonizes part 25 requirements with the corresponding requirements in EASA CS-25 Book 1.

Currently, all manufacturers of transport category airplanes, certificated under part 25 are expected to continue their current practice of compliance with the EASA certification requirements in CS-25 Book 1. Since future certificated transport airplanes are expected to meet CS-25 Book 1, and this rule simply adopts EASA requirements, manufacturers will incur minimal or no additional cost resulting from this final rule. The FAA made this same determination in the NPRM and received no comments.

The FAA has, therefore, determined that this final rule is not a “significant regulatory action” as defined in section 3(f) of Executive Order 12866, and is not “significant” as defined in DOT’s Regulatory Policies and Procedures.

B. Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (Public Law 96-354) (RFA) establishes “as a principle of regulatory issuance that agencies shall endeavor, consistent with the objectives of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the businesses, organizations, and governmental jurisdictions subject to regulation. To achieve this principle, agencies are required to solicit and consider flexible regulatory proposals and to explain the rationale for their actions to assure that such proposals are given serious consideration.” The RFA covers a wide-range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a rule will have a significant economic impact on a substantial number of small entities. If the agency determines that it will, the agency must prepare a regulatory flexibility analysis as described in the RFA.

However, if an agency determines that a rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the RFA provides that the head of the agency may so certify, and a regulatory flexibility analysis is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear.

In the NPRM, the FAA determined that this rule would not impose more than minimal cost.

The FAA believes that this final rule does not have a significant economic impact on a substantial number of small entities for the following reasons. We did not receive any comments from small entities. All United States transport category airplane manufacturers exceed the Small Business Administration small-entity criteria of 1,500 employees. Therefore, as provided in section 605(b), the head of the FAA certifies that this rulemaking will not result in a significant economic impact on a substantial number of small entities.

C. International Trade Impact Assessment

The Trade Agreements Act of 1979 (Public Law 96-39), as amended by the Uruguay Round Agreements Act (Public Law 103-465), prohibits Federal agencies from establishing standards or engaging in related activities that create unnecessary obstacles to the foreign commerce of the United States. Pursuant to these Acts, the establishment of standards is not considered an unnecessary obstacle to the foreign commerce of the United States, so long as the standard has a legitimate domestic objective, such the protection of safety, and does not operate in a manner that excludes imports that meet this objective. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards. The FAA has assessed the potential effect of this final rule and determined that it is in accord with the Trade Agreements Act as the rule furthers the legitimate domestic objectives of safety, creates no unnecessary obstacles to foreign commerce, does not exclude imports, and uses European standards as the basis for United States regulation.

D. Unfunded Mandates Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in an expenditure of $100 million or more (in 1995 dollars) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a “significant regulatory action.” The FAA currently uses an inflation-adjusted value of $151 million in lieu of $100 million. This final rule does not contain such a mandate; therefore, the requirements of Title II of the Act do not apply.

E. Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. The FAA has determined that there is no new requirement for information collection associated with this final rule.

F. International Compatibility and Cooperation

(1) In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to conform to International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA has

reviewed the corresponding ICAO Standards and Recommended Practices and has identified no differences with these regulations.

(2) Executive Order (EO) 13609, Promoting International Regulatory Cooperation, (77 FR 26413, May 4, 2012) promotes international regulatory cooperation to meet shared challenges involving health, safety, labor, security, environmental, and other issues and reduce, eliminate, or prevent unnecessary differences in regulatory requirements. The FAA has analyzed this action under the policy and agency responsibilities of Executive Order 13609, Promoting International Regulatory Cooperation. The agency has determined that this action would eliminate differences between U.S. aviation standards and those of other civil aviation authorities by creating a single set of certification requirements for transport category airplanes that would be acceptable in both the United States and Europe.

G. Environmental Analysis

FAA Order 1050.1E identifies FAA actions that are categorically excluded from preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act in the absence of extraordinary circumstances. The FAA has determined this rulemaking action qualifies for the categorical exclusion identified in paragraph 312f of Order 1050.1E and involves no extraordinary circumstances.

V. Executive Order Determinations

A. Executive Order 13132, Federalism

The FAA has analyzed this final rule under the principles and criteria of Executive Order 13132, Federalism. The agency determined that this action will not have a substantial direct effect on the States, or the relationship between the Federal Government and the States, or on the distribution of power and responsibilities among the various levels of government, and, therefore, does not have Federalism implications.

B. Executive Order 13211, Regulations that Significantly Affect Energy Supply, Distribution, or Use

The FAA analyzed this final rule under Executive Order 13211, Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use (May 18, 2001). The agency has determined that it is not a "significant energy action" under the executive order and it is not likely to have a significant adverse effect on the supply, distribution, or use of energy.

VI. How To Obtain Additional Information

A. Rulemaking Documents

An electronic copy of a rulemaking document may be obtained by using the Internet—

1. Search the Federal eRulemaking Portal (http://www.regulations.gov),
2. Visit the FAA's Regulations and Policies Web page at http://www.faa.gov/regulations_policies/, or
3. Access the Government Printing Office's Web page at http://www.gpo.gov/fdsys/.

Copies may also be obtained by sending a request (identified by notice, amendment, or docket number of this rulemaking) to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue SW., Washington, DC 20591; or by calling (202) 267-9680.

B. Comments Submitted to the Docket

Comments received may be viewed by going to http://www.regulations.gov and following the online instructions to search the docket number for this action. Anyone is able to search the electronic form of all comments received into any of the FAA's dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.).

C. Small Business Regulatory Enforcement Fairness Act

The Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 requires the FAA to comply with small entity requests for information or advice about compliance with statutes and regulations within its jurisdiction. A small entity with questions regarding this document, may contact its local FAA official, or the person listed under the "FOR FURTHER INFORMATION CONTACT" heading at the beginning of the preamble. To find out more about SBREFA on the Internet, visit http://www.faa.gov/regulations_policies/rulemaking/sbre_act/.

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

The Amendment

In consideration of the foregoing, the Federal Aviation Administration amends part 25 of title 14, Code of Federal Regulations as follows:

PART 25—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

1. The authority citation for part 25 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, and 44704.

2. Amend § 25.331 by revising paragraph (c) introductory text and paragraph (c)(2) to read as follows:

§ 25.331 Symmetric maneuvering conditions.

* * * * *

(c) *Maneuvering pitching conditions.* The following conditions must be investigated:

* * * * *

(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 airplane loads, the flight deck pitch control motions described in paragraphs (c)(2)(i) through (iv) of this section must be used:

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

$\delta(t) = \delta_1 \sin(\omega t) \qquad \text{for} \qquad 0 \le t \le t_{max}$

where—

δ_1 = the maximum available displacement of the flight deck pitch control in the initial direction, as limited by the control system stops, control surface stops, or by pilot effort in accordance with § 25.397(b);

$\delta(t)$ = the displacement of the flight deck pitch control as a function of time. In the initial direction, $\delta(t)$ is limited to δ_1. In the reverse direction, $\delta(t)$ may be truncated at the maximum available displacement of the flight deck pitch control as limited by the control system stops, control surface stops, or by pilot effort in accordance with 25.397(b);

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

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 airplane, with active control system effects included where appropriate; but not less than:

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

where—

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

V_A = the design maneuvering speed prescribed in § 25.335(c).

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

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

$\delta(t) = \delta_1 \sin(\omega t)$ for $0 \leq t \leq t_1$

$\delta(t) = \delta_1$ for $t_1 \leq t \leq t_2$

$\delta(t) = \delta_1 \sin(\omega[t + t_1 - t_2])$ for $t_2 \leq t \leq t_{max}$

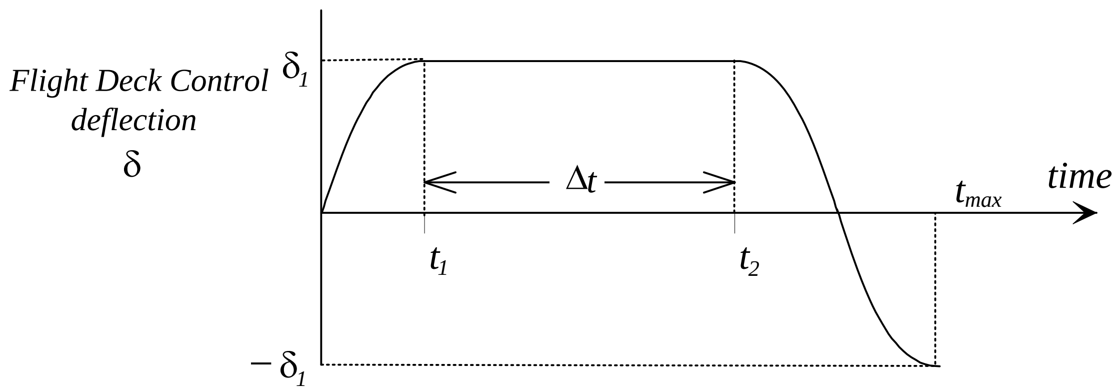
where—

$t_1 = \pi/2\omega$

$t_2 = t_1 + \Delta t$

$t_{max} = t_2 + \pi/\omega$;

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 flight deck 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 taken into account.

(v) Airplane 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 center of gravity goes below 0g;

(B) For the nose-down pitching maneuver, the time at which the normal acceleration at the center of gravity goes above the positive limit load factor prescribed in § 25.337;

(C) $t_{max.}$.

3. Amend § 25.341 by revising paragraphs (a)(5)(i), (a)(6), and (b), and by adding paragraph (c) to read as follows:

§ 25.341 Gust and turbulence loads.

(a) * * *

* * * * *

(5) * * *

(i) At airplane speeds between V_B and V_C: Positive and negative gusts with reference gust velocities of 56.0 ft/sec EAS must be considered at sea level. The reference gust velocity may be reduced linearly from 56.0 ft/sec EAS at sea level to 44.0 ft/sec EAS at 15,000 feet. The reference gust velocity may be further reduced linearly from 44.0 ft/sec EAS at 15,000 feet to 20.86 ft/sec EAS at 60,000 feet.

* * * * *

(6) * * *

Z_{mo} = Maximum operating altitude defined in § 25.1527 (feet).

* * * * *

(b) *Continuous turbulence design criteria.* The dynamic response of the airplane to vertical and lateral continuous turbulence must be taken into account. The dynamic analysis must take into account unsteady aerodynamic characteristics and all significant structural degrees of freedom including rigid body motions. The limit loads must be determined for all critical altitudes, weights, and weight distributions as specified in § 25.321(b), and all critical speeds within the ranges indicated in § 25.341(b)(3).

(1) Except as provided in paragraphs (b)(4) and (5) of this section, the following equation must be used:

$$P_L = P_{L-1g} \pm U_\sigma \overline{A}$$

where—

P_L = limit load;

P_{L-1g} = steady 1g load for the condition;

$\overline{A}$ = ratio of root-mean-square incremental load for the condition to root-mean-square turbulence velocity; and

U_σ = limit turbulence intensity in true airspeed, specified in paragraph (b)(3) of this section.

(2) Values of $\overline{A}$ must be determined according to the following formula:

$$\overline{A} = \sqrt{\int_0^\infty \left|H(\Omega)\right|^2 \Phi(\Omega)\, d\Omega}$$

where—

$H(\Omega)$ = the frequency response function, determined by dynamic analysis, that relates the loads in the aircraft structure to the atmospheric turbulence; and

$\Phi(\Omega)$ = normalized power spectral density of atmospheric turbulence given by——

$$\Phi(\Omega) = \frac{L}{\pi} \frac{1 + \frac{8}{3}(1.339\Omega L)^2}{\left[1 + (1.339\Omega L)^2\right]^{11/6}}$$

where—

Ω = reduced frequency, radians per foot; and

L = scale of turbulence = 2,500 ft.

(3) The limit turbulence intensities, U_σ, in feet per second true airspeed required for compliance with this paragraph are—

(i) At airplane speeds between V_B and V_C: $U_\sigma = U_{\sigma ref} F_g$

where—

$U_{\sigma ref}$ is the reference turbulence intensity that varies linearly with altitude from 90 fps (TAS) at sea level to 79 fps (TAS) at 24,000 feet and is then constant at 79 fps (TAS) up to the altitude of 60,000 feet.

F_g is the flight profile alleviation factor defined in paragraph (a)(6) of this section;

(ii) At speed V_D: U_σ is equal to 1/2 the values obtained under paragraph (b)(3)(i) of this section.

(iii) At speeds between V_C and V_D: U_σ is equal to a value obtained by linear interpolation.

(iv) At all speeds, both positive and negative incremental loads due to continuous turbulence must be considered.

(4) When an automatic system affecting the dynamic response of the airplane is included in the analysis, the effects of system non-linearities on loads at the limit load level must be taken into account in a realistic or conservative manner.

(5) If necessary for the assessment of loads on airplanes with significant non-linearities, it must be assumed that the turbulence field has a root-mean-square velocity equal to 40 percent of the U_σ values specified in paragraph (b)(3) of this section. The value of limit load is that load with the same probability of exceedance in the turbulence field as $\bar{A}\,U_\sigma$ of the same load quantity in a linear approximated model.

(c) *Supplementary gust conditions for wing-mounted engines.* For airplanes equipped with wing-mounted engines, the engine mounts, pylons, and wing supporting structure must be designed for the maximum response at the nacelle center of gravity derived from the following dynamic gust conditions applied to the airplane:

(1) A discrete gust determined in accordance with § 25.341(a) at each angle normal to the flight path, and separately,

(2) A pair of discrete gusts, one vertical and one lateral. The length of each of these gusts must be independently tuned to the maximum response in accordance with § 25.341(a). The penetration of the airplane in the combined gust field and the phasing of the vertical and lateral component gusts must be established to develop the maximum response to the gust pair. In the

absence of a more rational analysis, the following formula must be used for each of the maximum engine loads in all six degrees of freedom:

$$P_L = P_{L-1g} \pm 0.85\sqrt{L_V^2 + L_L^2}$$

where—

P_L = limit load;

P_{L-1g} = steady 1g load for the condition;

L_V = peak incremental response load due to a vertical gust according to § 25.341(a); and

L_L = peak incremental response load due to a lateral gust according to § 25.341(a).

4. Amend § 25.343 by revising paragraph (b)(1)(ii) to read as follows:

§ 25.343 Design fuel and oil loads.

* * * * *

(b) * * *

(1) * * *

(ii) The gust and turbulence conditions of § 25.341(a) and (b), but assuming 85% of the gust velocities prescribed in § 25.341(a)(4) and 85% of the turbulence intensities prescribed in § 25.341(b)(3).

* * * * *

5. Amend § 25.345 by revising paragraph (c)(2) to read as follows:

§ 25.345 High lift devices.

* * * * *

(c) * * *

(2) The vertical gust and turbulence conditions prescribed in § 25.341(a) and (b).

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6. Revise § 25.361 to read as follows:

§ 25.361 Engine and auxiliary power unit torque.

(a) For engine installations—

(1) Each engine mount, pylon, and adjacent supporting airframe structures must be designed for the effects of—

(i) A limit engine torque corresponding to takeoff power/thrust and, if applicable, corresponding propeller speed, acting simultaneously with 75% of the limit loads from flight condition A of § 25.333(b);

(ii) A limit engine torque corresponding to the maximum continuous power/thrust and, if applicable, corresponding propeller speed, acting simultaneously with the limit loads from flight condition A of § 25.333(b); and

(iii) For turbopropeller installations only, in addition to the conditions specified in paragraphs (a)(1)(i) and (ii) of this section, a limit engine torque corresponding to takeoff power and propeller speed, multiplied by a factor accounting for propeller control system malfunction, including quick feathering, acting simultaneously with 1g level flight loads. In the absence of a rational analysis, a factor of 1.6 must be used.

(2) The limit engine torque to be considered under paragraph (a)(1) of this section must be obtained by—

(i) For turbopropeller installations, multiplying mean engine torque for the specified power/thrust and speed by a factor of 1.25;

(ii) For other turbine engines, the limit engine torque must be equal to the maximum accelerating torque for the case considered.

(3) The engine mounts, pylons, and adjacent supporting airframe structure must be designed to withstand 1g level flight loads acting simultaneously with the limit engine torque loads imposed by each of the following conditions to be considered separately:

(i) Sudden maximum engine deceleration due to malfunction or abnormal condition; and

(ii) The maximum acceleration of engine.

(b) For auxiliary power unit installations, the power unit mounts and adjacent supporting airframe structure must be designed to withstand 1g level flight loads acting simultaneously with the limit torque loads imposed by each of the following conditions to be considered separately:

(1) Sudden maximum auxiliary power unit deceleration due to malfunction, abnormal condition, or structural failure; and

(2) The maximum acceleration of the auxiliary power unit.

7. Add § 25.362 to read as follows:

§ 25.362 Engine failure loads.

(a) For engine mounts, pylons, and adjacent supporting airframe structure, an ultimate loading condition must be considered that combines 1g flight loads with the most critical transient dynamic loads and vibrations, as determined by dynamic analysis, resulting from failure of a blade, shaft, bearing or bearing support, or bird strike event. Any permanent deformation from these ultimate load conditions must not prevent continued safe flight and landing.

(b) The ultimate loads developed from the conditions specified in paragraph (a) of this section are to be—

(1) Multiplied by a factor of 1.0 when applied to engine mounts and pylons; and

(2) Multiplied by a factor of 1.25 when applied to adjacent supporting airframe structure.

8. Revise § 25.371 to read as follows:

§ 25.371 Gyroscopic loads.

The structure supporting any engine or auxiliary power unit must be designed for the loads, including gyroscopic loads, arising from the conditions specified in §§ 25.331, 25.341, 25.349, 25.351, 25.473, 25.479, and 25.481, with the engine or auxiliary power unit at the maximum rotating speed appropriate to the condition. For the purposes of compliance with this paragraph, the pitch maneuver in § 25.331(c)(1) must be carried out until the positive limit maneuvering load factor (point A_2 in § 25.333(b)) is reached.

9. Amend § 25.373 by revising paragraph (a) to read as follows:

§ 25.373 Speed control devices.

* * * * *

(a) The airplane must be designed for the symmetrical maneuvers prescribed in §§ 25.333 and 25.337, the yawing maneuvers in § 25.351, and the vertical and lateral gust and turbulence conditions prescribed in § 25.341(a) and (b) at each setting and the maximum speed associated with that setting; and

* * * * *

10. Amend § 25.391 by revising the introductory text to read as follows:

§ 25.391 Control surface loads: General.

The control surfaces must be designed for the limit loads resulting from the flight conditions in §§ 25.331, 25.341(a) and (b), 25.349, and 25.351, considering the requirements for—

* * * * *

11. Amend § 25.395 by revising paragraph (b) to read as follows:

§ 25.395 Control system.

* * * * *

(b) The system limit loads of paragraph (a) of this section need not exceed the loads that can be produced by the pilot (or pilots) and by automatic or power devices operating the controls.

* * * * *

12. Revise § 25.415 to read as follows:

§ 25.415 Ground gust conditions.

(a) The flight control systems and surfaces must be designed for the limit loads generated when the airplane is subjected to a horizontal 65-knot ground gust from any direction while taxiing and while parked. For airplanes equipped with control system gust locks, the taxiing condition must be evaluated with the controls locked and unlocked, and the parked condition must be evaluated with the controls locked.

(b) The control system and surface loads due to ground gust may be assumed to be static loads, and the hinge moments H must be computed from the formula:

$$H = K (1/2) \rho_o V^2 c S$$

where—

K = hinge moment factor for ground gusts derived in paragraph (c) of this section;

ρ_o = density of air at sea level;

V = 65 knots relative to the aircraft;

S = area of the control surface aft of the hinge line;

c = mean aerodynamic chord of the control surface aft of the hinge line.

(c) The hinge moment factor K for ground gusts must be taken from the following table:

Surface	K	Position of controls
(1) Aileron	0.75	Control column locked or lashed in mid-position.
(2) Aileron	*±0.50	Ailerons at full throw.
(3) Elevator	*±0.75	Elevator full down.
(4) Elevator	*±0.75	Elevator full up.
(5) Rudder	0.75	Rudder in neutral.
(6) Rudder	0.75	Rudder at full throw.

* A positive value of K indicates a moment tending to depress the surface, while a negative value of K indicates a moment tending to raise the surface.

(d) The computed hinge moment of paragraph (b) of this section must be used to determine the limit loads due to ground gust conditions for the control surface. A 1.25 factor on the computed hinge moments must be used in calculating limit control system loads.

(e) Where control system flexibility is such that the rate of load application in the ground gust conditions might produce transient stresses appreciably higher than those corresponding to static loads, in the absence of a rational analysis substantiating a different dynamic factor, an additional factor of 1.6 must be applied to the control system loads of paragraph (d) of this section to obtain limit loads. If a rational analysis is used, the additional factor must not be less than 1.2.

(f) For the condition of the control locks engaged, the control surfaces, the control system locks, and the parts of any control systems between the surfaces and the locks must be designed to the resultant limit loads. Where control locks are not provided, then the control surfaces, the control system stops nearest the surfaces, and the parts of any control systems between the surfaces and the stops must be designed to the resultant limit loads. If the control system design is such as to allow any part of the control system to impact with the stops due to flexibility, then the resultant impact loads must be taken into account in deriving the limit loads due to ground gust.

(g) For the condition of taxiing with the control locks disengaged, or where control locks are not provided, the following apply:

(1) The control surfaces, the control system stops nearest the surfaces, and the parts of any control systems between the surfaces and the stops must be designed to the resultant limit loads.

(2) The parts of the control systems between the stops nearest the surfaces and the flight deck controls must be designed to the resultant limit loads, except that the parts of the control system where loads are eventually reacted by the pilot need not exceed:

(i) The loads corresponding to the maximum pilot loads in § 25.397(c) for each pilot alone; or

(ii) 0.75 times these maximum loads for each pilot when the pilot forces are applied in the same direction.

13. Revise 25.1517 to read as follows:

§ 25.1517 Rough air speed, V_{RA}

(a) A rough air speed, $V_{RA,}$ for use as the recommended turbulence penetration airspeed, and a rough air Mach number, M_{RA}, for use as the recommended turbulence penetration Mach number, must be established. V_{RA}/M_{RA} must be sufficiently less than V_{MO}/M_{MO} to ensure that likely speed variation during rough air encounters will not cause the overspeed warning to operate too frequently.

(b) At altitudes where V_{MO} is not limited by Mach number, in the absence of a rational investigation substantiating the use of other values, V_{RA} must be less than V_{MO} - 35 KTAS.

(c) At altitudes where V_{MO} is limited by Mach number, M_{RA} may be chosen to provide an optimum margin between low and high speed buffet boundaries.

Appendix G to Part 25 [Removed and Reserved]

14. Remove and reserve appendix G to part 25.

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Michael P. Huerta,
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