NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Aviation Engineering Division
Washington, DC 20594

March 11, 2004

ADDENDUM NUMBER 22 TO THE STRUCTURES GROUP CHAIRMAN'S FACTUAL REPORT

DCA02MA001

A. ACCIDENT

Location:	Belle Harbor, NY
Date:	November 12, 2001
Time:	09:16:14 EST
Aircraft:	American Airlines Flight 587, Airbus Model A300-605R, N14053 Manufactures Serial Number (MSN) 420

B. STRUCTURES GROUP

Chairman:	Brian K Murphy National Transportation Safety Board Washington, DC

C. RUSSIAN REQUIREMENTS

1. Part 25, 25.351 "Yawing Conditions"

[redacted]

МЕЖГОСУДАРСТВЕННЫЙ АВИАЦИОННЫЙ КОМИТЕТ

von : [redacted]

АВИАЦИОННЫЕ ПРАВИЛА

ЧАСТЬ 25

НОРМЫ ЛЕТНОЙ ГОДНОСТИ САМОЛЕТОВ ТРАНСПОРТНОЙ КАТЕГОРИИ

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these conditions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts within the range determined by -

(1) Maneuvering to a positive limit load factor as prescribed in § 25.337 (b); and

(2) Positive and negative derived gusts as prescribed in § 25.341 acting normal to the flight path in level flight.

(d) The airplane must be designed for landing at the maximum takeoff weight with a maneuvering load factor of 1.5 and the flaps and similar high lift devices in the landing configuration.

§ 25.349 Rolling conditions.

The airplane must be designed for rolling loads resulting from the conditions specified in paragraphs (a) and (b) of this section. Unbalanced aerodynamic moments about the center of gravity must be reacted in a rational or conservative manner, considering the principal masses furnishing the reacting inertia forces.

(a) **Maneuvering**. The following conditions, speeds, and aileron deflections (except as the deflections may be limited by pilot effort *or booster effort*) must be considered in combination with an airplane load factor of zero and of two-thirds of the positive *maximum maneuvering limit load factor* used in design. In determining the required aileron deflections, the torsional flexibility of the wing must be considered in accordance with § 25.301(b):

(1) Conditions corresponding to steady rolling velocities must be investigated. In addition, conditions corresponding to maximum angular acceleration must be investigated for airplanes with engines or other weight concentrations outboard of the fuselage. For the angular acceleration conditions, zero rolling velocity may be assumed in the absence of a rational time history investigation of the maneuver, *but pitching acceleration greater than 3.0 rad/s² need not to be considered.*

(2) At V_A, a sudden deflection of the aileron to the stop is assumed.

(3) At V_C, the aileron deflection must be that required to produce a rate of roll not less than that obtained in paragraph (a)(2) of this section.

(4) At V_D, the aileron deflection must be that required to produce a rate of roll not less than one-third of that in paragraph (a)(2) of this section.

(b) **Unsymmetrical gusts**. The condition of unsymmetrical gusts must be considered by modifying the symmetrical flight conditions *B'* or *C'* (in § 25.333(c)) whichever produces the critical load. It is assumed that 100 percent of the wing air load acts on one side of the airplane and 80 percent acts on the other side.

Such a combination of air loads is considered if the airplane design is conducted for loads of discrete gust dynamic response conditions of Appendix G.

(A) Maneuver with high lift devices extended. Consideration must be given to the sudden aileron deflection to an angle limited by a structural stops, maximum booster power or maximum pilot effort at V_F speed in combination with load factor of $n = 1.5$. Conditions of steady and unsteady rolling must be considered according to paragraph (a)(1) of this section.

§ 25.351 Yawing conditions.

The airplane must be designed for loads resulting from the conditions specified in paragraphs (a) and (b) of this section. Unbalanced aerodynamic moments about the center of gravity must be reacted in a rational or conservative manner considering the principal masses furnishing the reacting inertia forces:

(a) **Maneuvering**. At speeds from V_{MC} to V_D the following maneuvers must be considered.

(1) With the airplane in unaccelerated flight at zero yaw, it is assumed that the rudder control is suddenly displaced to the maximum deflection, as limited by the control surface stops, or *by maximum available booster effort or by 136 kg total rudder pedal load at speeds from V_{MC} to V_A and 91 kg from V_C/M_C to V_D/M_D with linear variation of effort between V_A and V_C/M_C.*

(2) With the rudder deflected as specified in paragraph (a)(1) of this section, it is assumed that the airplane yaws to the *maximum sideslip angle.*

(3) With airplane yawed to the maximum sideslip angle, specified in paragraph (a)(2) of this section, it is assumed that the rudder pedal is suddenly returned to neutral.

(b) **Lateral gusts**. The airplane is assumed to encounter derived gusts normal to the plane of symmetry while in unaccelerated flight. The derived gusts and airplane speeds corresponding to conditions *B'* through *J'* (in § 25.333(c)) (as determined by §§ 25.341 and 25.345(a)(2) or 25.345(c)(2)) must be investigated. The shape of the gust must be as specified in § 25.341. In the absence of a rational investigation of the airplane's response to a gust, the gust loading on the vertical tail surfaces must be computed as follows:

$$P_{vt} = \pm\, 0.05\, \eta_\beta\, C^{\beta}_{z\,vt}\, V\, U_{de}\, S_{vt}\,, \quad kg$$

Here

P_{vt} = *Vertical tail surface load, kg;*

V = *Airplane equivalent speed, m/s;*

U_{de} = *Derived gust velocity, m/s;*

S_{vt} = *Area of vertical surface, m².*

Coefficient η_β is determined by the formula:

$$\eta_\beta = 1 + e^{\frac{\pi a}{b}},$$

where

$$a = \frac{m_y^{\bar{\omega}_y}}{2\,\bar{r}_y^{\,2}}\ ; \qquad b = \sqrt{\frac{-\mu\, m_y^{\beta}}{\bar{r}_y^{\,2}} - a^2}\ ;$$

$$\mu = \frac{2m}{\rho_H\, S\, l}\ ; \qquad \bar{r}_y^{\,2} = \frac{J_y}{m\,(l/2)^2}\ ;$$

$$\bar{\omega}_y = \frac{\omega_y\, l}{2\, V_{true}}\ .$$

Here

S = *Wing area, m²;*

V_{true}	=	*True airspeed, m/s;*
ρ_H	=	*Air density at the flight altitude, kgs^2/m^4;*
m	=	*Airplane mass, kg s^2/m;*
l	=	*Wing span, m;*
J_y	=	*Airplane mass moment of inertia about axis Y, kg m s^2;*
m^{β}_y	=	*Derivative of the alrplane yawing moment with respect to a sideslip angle (per radian);*
ω_y	=	*Angle yawing speed, rad/s;*
$m_y^{\bar{\omega}_y}$	=	*Derivative of the airplane yawing moment with respect to a dimensioned yawing velocity $\bar{\omega}_y$. If there is a linear yaw damper in yaw control, that reacts only to ω_y, then the value of $m_y^{\bar{\omega}_y}$ must be taken with increment from yaw damper;*
$C^{\beta}_{z\,vt}$	=	*Lift curve slope of vertical tail, it must be determined based on the wind tunnel results for rigid models of the complete airplane and the airplane without the vertical surfaces, at the Mach number corresponding to the flight speed under consideration.*

SUPPLEMENTARY CONDITIONS

§ *25.361 Engine and auxiliary power unit (APU) torque.*

(a) Each engine *and APU* mount, and their supporting structure must be designed for the effects of -

(1) A limit engine *and APU* torque corresponding to takeoff power and propeller speed acting simultaneously with 75 percent of the limit loads from flight *condition I* in § 25.333(b);

(2) A limit torque corresponding to the maximum continuous power and propeller speed, acting simultaneously with the limit loads from flight condition *I in § 25.333(b);* and

(3) For turbopropeller installations, in addition to the conditions specified in paragraphs (a)(1) and (2) 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 1 g level flight loads. In the absence of a rational analysis, a factor of 1.6 must be used.

(b) For turbine engine *and APU* installations, the mounts and local supporting structure must be designed to withstand each of the following:

(1) The limit engine torque load imposed by;

(i) Sudden engine or APU stoppage due to a malfunction which could result in a temporary loss of power or thrust capability, and could cause a shut down due to vibrations, and

(ii) the maximum acceleration of the engine or APU.

(2) The maximum torque load, considered as ultimate, imposed by sudden