ATTACHMENT M

Flight Operations Technical Informational Bulletin

(2 pages)

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February 2002 Number 2002-02

Jet Transport Aircraft Flight Controls

Introduction

On February 8, 2002, the National Transportation Safety Board released recommendations to the FAA identifying industry wide issues addressing certification standards for the structural limits of vertical stabilizers and rudders, as well as how those criteria affect the operation of aircraft. The NTSB was careful to note that there was no implication of a relationship between these issues and the NTSB's determination of probable cause of the AA 587 accident. It is not unusual for an NTSB to make recommendations early in an investigation based on information revealed during the inquiry. The following information is provided for your review and consideration.

Ailerons / Spoilers

Ailerons and their associated wing spoilers are designed to provide roll control throughout the normal flight envelope. The amount of control input to achieve a desired roll rate will vary based on speed, however, even at low airspeeds, adequate ailerons / spoiler control is available to provide satisfactory roll control.

During rolling maneuvers, roll control spoilers minimize adverse yaw. This effect, combined with the yaw damper or other turn coordination system (an aileron-rudder interconnect for example) normally provides rudder input during turning / rolling maneuvers so that pilot rudder inputs are not necessary to achieve turn coordination.

Rudders

Rudder design requirements for handling quality characteristics vary with aircraft category. Vertical stabilizers and their rudders are usually sized to meet the directional control requirements for that type of aircraft. However, while there are other criteria that influence the design, each aircraft is designed to meet the overall requirements for that category of certification. From a handling quality prospective, single engine and centerline-thrust airplanes have relatively low powered rudders that are sized to provide directional control to compensate for propeller torque, crosswind takeoff / landing, adverse yaw in turns, aerobatic maneuvers, etc.

By contrast, transport category jet aircraft, especially those with wing-mounted engines, have large and powerful rudders to provide sufficient directional control to counter asymmetric thrust after an engine failure at V1, as well as provide crosswind landing and takeoff capability. Therefore, transport category aircraft have far more rudder power available than is required for normal maneuvers.

Rudder Limiters

A rudder limiter is designed into the directional control system to reduce the available rudder throw as airspeed increases to avoid excessive structural loads on the vertical stabilizer. Manufacturers use different methods to achieve this goal. In some designs, rudder pedal movement is limited along with rudder movement.

Additionally for some rudder control system designs, force feedback is provided through a relatively simple spring system. In the cases where rudder pedal deflection is also limited as airspeed increases, the associated force feedback will be light when compared to the force experienced during unrestricted full throw flight control ground checks. Detailed descriptions of rudder limiter systems are being requested from each aircraft manufacturer and will be incorporated into the appropriate Operating Manuals.

Rudder Reversals

For the purposes of this discussion, a "rudder reversal" or "rudder doublet" is defined as a large rudder deflection input in one direction followed immediately by a rudder deflection input in the opposite direction. Needless to say, the timing and magnitude of these two inputs can vary, but generally, reference to a "rudder reversal" or "doublet" is rapid inputs with very little time between events. The concern when performing a rudder reversal is that with large rapid input, the resultant loads due to dynamic overshoot, can exceed the structural limit of the aircraft design. Though rudder limiter systems are designed to prevent exceeding structural limits with a single large input, they do not necessarily provide protection from a large, rapid input rudder reversal. Even at airspeeds below maneuvering speed, a rudder reversal may result in excessive structural loads above the aircraft certification limit.

Sideslip Angle

If the ailerons are held neutral in level flight and a large rudder displacement is input and held, the aircraft enters a sideslip with one wing moving forward and the other aft. On a swept wing aircraft, this causes the forward positioned wing to generate more lift than the aft wing resulting in a rolling moment. Because of the large mass inertia, sideslip angle develops slowly, which in turn causes this roll to develop slowly making it difficult to predict or control.

If a large rudder displacement and a large aileron displacement are simultaneously input in the same direction, the resultant roll rate is the *cumulative* effect of ailerons, spoilers and sideslip induced roll. This roll rate can become extremely rapid and difficult to control.

It is important to use the rudder carefully to avoid developing unintentional large sideslip angles and high roll rates. Normally, rudder movement used in a turn or rolling maneuver should be limited to the amount of rudder needed to maintain coordinated flight. Excessive rudder may aggravate the flight condition or may result in loss of control and / or high structural loads.

Vertical Stabilizer Loading

The primary side forces that are generated on a vertical stabilizer come from sideslip angle and rudder deflection. There are other contributors to side force, but generally they are lesser in magnitude, such as yaw rate. The sum of the forces applied across the vertical stabilizer determine the load on the tail.

During the design phase of aircraft manufacturing, a maximum side force bending moment (limit load) is computed for the vertical stabilizer. From that point, certification requires that the vertical stabilizer structure be designed and tested to withstand at least 150% of the design limit load.

Summary

Notwithstanding the need for potentially large rudder inputs in the event of engine failure or for crosswind takeoff and landings, the following cautions apply to rudder inputs:

- Large "rudder reversals" or "rudder doublets" must be avoided on Transport Category Aircraft. These inputs can result in loss of control or structural failure of the aircraft.
- Defensive maneuvering tactics in confronting terrorist activity should be restricted to inputs in the pitch axis only and should be performed only as a last resort in accordance with Flight Manual Part I.
- At all angles of attack and airspeeds, the primary roll control is provided by the ailerons / spoilers. *If rudder is used, it should normally be limited to the amount of rudder required to maintain coordinated flight.* Excessive use of the rudder may aggravate a flight condition or may result in loss of control and / or high structural loads.
- Depending on the design of the rudder limiter, it may be possible under certain conditions to apply full available rudder displacement with small rudder pedal inputs.

The Flight Department is working closely with the aircraft manufacturers to acquire better information regarding flight control limitations which will be incorporated in the Operating Manuals as appropriate.

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