Federal Aviation Agency

ADVISORY CIRCULAR

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	AIR CARRIER AND COMMERCIAL OPERATIONS
EFFECTIVE:	8/26/63

SUBJECT: HIGH ALTITUDE OPERATIONS IN AREAS OF TURBULENCE

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1. PURPOSE. This circular describes recommended procedures for use by jet pilots when penetrating areas of severe turbulence.

2. GENERAL. Most of the information contained in this circular has been said many times, in many different ways, by many people and should be well known to the jet pilot. However, the subject is of such importance to those who fly jet aircraft that it bears repeating.

   a. Maneuvering margins for today's jet transports are quite narrow when operating at high altitudes. These margins are normally bounded by the airplane's weight, thrust and M_{mo}. As altitude increases, thrust decreases as does indicated airspeed. To maintain lift at the lower indicated airspeeds higher angles of attack are required. The spread between true airspeed and indicated airspeed continues to increase with increasing altitude. True airspeed at high altitudes is normally expressed in terms of Mach number. Higher angles of attack accelerate the velocity of the air over the wing to Mach 1.0 in local areas and shock waves are developed. This manifests itself to the pilot in the form of airplane buffet quite similar to the feeling experienced at the onset of low speed buffet. Most pilots accustomed to flying at high altitudes are acquainted with this phenomenon which is associated with the area where either or both a low speed stall or Mach buffet can occur.

   b. So far, this discussion has been confined to what would be termed as unaccelerated flight. When turning or maneuvering about the pitch axis, acceleration forces can increase at a constant speed. As "G" forces increase, both the aerodynamic weight and angle of attack increase. The margin over low speed stall buffet decreases, as well as the margin below Mach buffet, due to the increased velocity of the air over the wing resulting from the higher angle of attack.

This in effect could lower the aerodynamic ceiling for a given gross weight. Increased "Gs" can also occur in non-maneuvering flight due to atmospheric turbulence. Pilots flying at high altitudes in areas where turbulence may be expected must consider margins to accommodate sudden and unexpected vertical accelerations.

3. RECOMMENDED PROCEDURE FOR TURBULENT AIR PENETRATION.

Flight through thunderstorm activity or known severe turbulence should be avoided, if possible. When flight through severe turbulence is anticipated and/or unavoidable, the following is recommended:

a. Airspeed/Mach. Use recommended turbulence target speed. Avoid overaction of thrust levers. Severe gusts may cause large and rapid variations in indicated airspeed. DO NOT CHASE AIRSPEED.

b. Altitude. The penetration altitude should be an altitude which provides adequate maneuvering margins when severe turbulence is encountered.

c. Autopilot. If severe turbulence is penetrated with the autopilot on, the altitude hold mode should be off. With autopilot off yaw damper should be engaged. Remember, controllability of aircraft in turbulence becomes more difficult with yaw damper off. Rudder should be centered before engaging yaw damper.

d. Fly Attitude. KEEP WINGS LEVEL and maintain desired pitch attitude. Use moderate control movements to resist changes in attitude. If large attitude changes occur, avoid sudden large control inputs. Avoid, as much as possible, the use of stabilizer trim in controlling pitch attitudes. DO NOT CHASE ALTITUDE.

e. Use of Speed Brakes. When excessive airspeed buildup occurs, pilots should have no reservations about using speed brakes. CAUTION: Use of aerodynamic speed brakes, when they are part of the lateral control system, may change roll rate any time there is a lateral control input.

For detailed information concerning specific turbojet aircraft refer to the Approved Airplane Flight Manual.

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