**KURDISTAN REGIONAL GOVERNMENT**


# SULAYMANIYAH INTERNATIONAL AIRPORT

# MATS

## APPENDIX " O "

## SPEED CONTROL GUIDANCE

**( First Edition )**

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# APPENDIX " O "

# SPEED CONTROL GUIDANCE

## 1. Speed Terminology and Relationships

**1.1 Four main speeds are used within the ATC environment:**

**a. Ground Speed (GS) : The actual speed of the aircraft over the surface of the earth. This equals to TAS corrected for the effects of wind.**

**b. True Airspeed (TAS): The actual speed of the aircraft through the air and is shown on the flight plan and flight progress strips.**

**c. Indicated Airspeed (IAS): Often used by ATC for speed control and varies from the TAS dependant on altitude, air density and temperature.**

**d. Mach Number: TAS expressed as a fraction of the local speed of sound. The speed of sound (Mach 1) is a function of temperature – colder (i.e. higher) equaling slower. In international standard atmosphere (ISA) conditions, at sea level Mach 1 is a little over 661 kt TAS, but at FL360 it has decreased to 572 kt and remains at that figure to around FL600 - FL700 .**

**1.2 If an aircraft climbs from sea level to FL350 at a constant Mach number then the TAS will decrease. Similarly, a constant Mach number descent will result in increasing TAS.**

**1.3 Due to the low air density at high altitude, airspeed indicators read less than the actual speed of the aircraft, but at sea level there is virtually no difference between them. Therefore, an aircraft climbing at a constant IAS will have an increasing TAS. For example, under ISA conditions 250 kt IAS at sea level equals to 250 kt TAS, but at FL430 an IAS of 250 kt equals a TAS of 502 kt. Conversely, if a descent is carried out at a constant IAS the TAS will decrease as altitude is lost.**

**1.4 Looking at a typical climb/descent profile for an MD80 the following can be observed. The aircraft climbs at 290 kt IAS until it reaches Mach 0.76. It continues the climb maintaining 0.76 to cruise altitude, cruises at 0.76 and holds that Mach speed in descent until reaching 290 kt IAS again. As there is a speed limitation of 250 kt IAS below FL100 the initial climb will be at 250 kt IAS (289 kt TAS/Mach 0.45). The aircraft will then accelerate to 290 kt IAS (334 kt TAS/Mach 0.52 at 10,000 feet) and then climb at this constant indicated speed. During this climb both the TAS and Mach number will be increasing as follows:**

| | TAS | Mach |
|---|---|---|
| **15,000** | **359kt** | **0.57** |
| **20,000** | **387kt** | **0.63** |
| **25,000** | **418kt** | **0.69** |
| **29,000** | **445kt** | **0.75**** |
| **33,000** | **441kt** | **0.76 (268 kt IAS)** |
| **37,000** | **435kt** | **0.76 (245 kt IAS)** |

**** From this point on the pilot will fly at Mach 0.76 and no longer use IAS as a reference unless requested to do so by ATC.**

**If the crew had not changed from IAS to Mach number and tried to hold 290 kt IAS all the way to FL370, the speed at top of climb would be Mach 0.88 – far in excess of the permitted limit.**

**1.5 In the descent, the process is reversed. The pilot will fly at Mach 0.76 until the IAS reaches 290 kt, which should occur around FL290. During this part of the descent the aircraft will accelerate slightly from 245 to 290 kt IAS (435 to 445 kt TAS). In the descent from FL290 to FL100 the aircraft will be flown at a constant 290 kt IAS and the TAS will decrease from 445 to 334 kt. IAS will then be reduced to around 210 kt in preparation for configuring the aircraft for approach. Controllers should be aware of airspeed changes according to the stage of flight when applying speed control.**

**1.6 Turbulence narrows the allowable speed range of the aircraft as minimum speeds are increased to maintain control effectiveness and maximum speeds may be reduced to prevent damage from excessive 'G' loads encountered in rough air.**

# 2. Aircraft Performance and Handling

**2.1 Whilst TAS and ground speed are of interest to ATC and are factors in aircraft navigation, they are of very little significance to the pilot's task of handling the aircraft. Aircraft performance, handling qualities and limitations are dependent upon, and expressed in terms of, IAS and Mach number. IAS considerations predominate at lower altitudes and Mach number at higher ones.**

**2.2 Considering the aircraft in the clean configuration that applies throughout the flight, except for short periods during take-off and landing, the operational speed range is bounded by the stall at low speed and by the maximum operating speed at high speed ( This maximum operating speed is designated "Vmo" when defind as an Air Speed and "Mmo" when Mach Number is used. The stall speed is principally related to IAS and increases with increasing weight and, to some extent, with increasing altitude. Minimum operational speeds will allow a margin from the stall speed to permit a manoeuvre capability and protection from short term atmospheric effects without encountering the stall.**

**2.3 The high speed limits of Vmo/Mmo are set at a suitable margin below the ultimate design limits to provide protection for inadvertent speed increases due to atmospheric disturbances or other causes. The high speed design limits may be set by structural or handling considerations. While the pilot may fly at speeds up to Vmo/ Mmo, various performance considerations will generally preclude this except during the descent. At high altitude and high weight an aircraft may encounter high Mach buffet when manoeuvring at speeds below Mmo which will present an additional constraint on maximum speed. As these are also the considerations that lead to the highest values of low speed stall, it can be seen that the effective speed range available may be reduced markedly with altitude. Indeed, the minimum and maximum operational speeds due to low speed stall and high speed Mach buffet respectively, may become coincident at a particular weight/altitude combination that is below the absolute ceiling that the aircraft might utilise at lower weights.**

**2.4 Optimum climb and descent profiles are determined by various performance characteristics and speeds close to Vmo/Mmo may frequently be flown in the descent. In the climb, optimum speed, especially for large aircraft at high weight, can be severely limited to give protection against the stall. This speed may also be close to, if not above, the 250 kt ATC speed limit below 10,000 feet.**

**2.5 The methods at a pilot's disposal to increase descent capability are reduction of thrust, increase of airspeed and use of airbrakes. However, pilots are reluctant to use airbrakes, unless absolutely necessary, due to passenger discomfort and increased fuel burn considerations. Thus the optimum descent profile is one which permits the aircraft to maintain cruising altitude to that point from which a gliding descent to intercept the final approach can be made with throttles closed but with airbrakes retracted. Speed will normally be kept high initially, often at or close to Vmo/Mmo. The pilot may have significant flexibility over the speed at which he can safely and legally fly, but at the risk of deviating from the optimum descent profile. Subsequent corrections to the flight path may require the use of airbrakes or an indirect routing to final approach.**

**2.6 The available speed range is altered very considerably once flaps are extended. The use of flaps is normally restricted to lower altitudes. Once the flaps are extended the maximum permitted airspeed is significantly reduced. However, extending flaps does delay the onset of the stall and permits lower minimum speeds to be used. However, this again imposes fuel efficiency penalties and pilots normally prefer to maintain a holding speed that is not less than that at which they can safely maintain the clean (flaps retracted) configuration.**

**2.7 When an aircraft is heavily loaded and at a high level, its ability to change speed may, in cases, be very limited. In the event of engine failure or other systems failures, additional speed constraints are likely to apply. Quite apart from a reduced performance capability, these may involve an increased minimum speed, a reduced maximum speed, or both, at which the aircraft can be flown safely.**

# 3. Speed Control Technique and Practical Application

**3.1 When using speed control to maintain spacing between two aircraft, it is the aircrafts' Ground Speed that ATC are trying to match. However it is not practical to use this speed as a reference because it is dependant on the local wind. It is easier to manage the ground speed of two aircraft by reference to their IAS or Mach number. When controlling aircraft at the same level, assigning the same IAS or Mach number will produce the same TAS and the same Ground Speed.**

**3.2 At high levels (FL280 and above), speed control instructions should be passed by reference to Mach number. As a general rule of thumb, at these levels, 0.01 Mach equals 6 kt TAS. If a controller is trying to match speeds of aircraft at different levels, the same Mach number will mean that the higher aircraft will be a little slower. An allowance of 0.01 Mach for each 2 - 3000 feet level difference will achieve a closer match in ground speed.**

**3.3 Unlike Mach number control, the results of allocating IAS restrictions to aircraft vary substantially with altitude. An aircraft maintaining 280 kt IAS at FL330 will have a TAS of 459 kt while an aircraft with the same IAS at FL270 will produce a TAS of 417 kt. For aircraft operating at the same IAS, a rule of thumb is 7 kt for each 1000 feet level difference. Above FL240 each 10 kt of IAS equals approximately 15 kt of TAS.**

**3.4 The result of these differences is that when two aircraft are assigned the same Mach number, an aircraft at a higher level will be slower but when they are assigned the same IAS an aircraft at a higher level will be faster.**

**3.5 The variation in wind strength and/or direction with height is a factor to be considered before applying any speed control. A large variation in either element can cause any separation to be eroded very quickly.**

**3.6 It is important to give crews adequate notice of any speed restrictions they can expect particularly if other descent restrictions have been applied, e.g. to be at a level at a specified point. Aircrew plan descents at a given speed and rate so high descent rates and low airspeeds are not normally compatible. Short notice speed restrictions issued while descent to a target level is in progress, may cause problems for the crew.**

**3.7 The lack of aerodynamic drag and the presence of significant idle thrust of Turbine engined aircraft, particularly in icing conditions, make rapid descents with speed reduction generally impracticable. Whilst piston engined aircraft do have this performance capability by virtue of rapid engine response, propeller and airframe drag and less inertia, pilots may not be able to exploit this advantage as reduction in engine power while descending quickly can result in 'shock cooling' to the engine resulting in an expensive overhaul.**

**3.8 Significant speed reductions may require the pilot to level off to lose speed Before returning to the descent. Advance planning is even more important with heavy jets. At the bottom of a high speed descent their inertia will be great and both time and distance will be needed to reduce speed for ATC purposes.**

**3.9 'Minimum clean speed' signifies the minimum speed at which an aircraft can be flown in a clean configuration, i.e. without deployment of lift-augmentation devices, speed brakes or landing gear. The use of the phrase 'minimum clean speed' can achieve a reduction in aircraft speed in a very short space of time and is useful in appropriate circumstances. However, the actual speed flown will vary depending on type, and compliance may be affected by other factors such as local turbulence. This instruction to fly at minimum clean speed should be given early to enable aircrew to plan and achieve descent profiles.**

**3.10 A speed reduction instruction issued to a climbing aircraft may result in a temporary increase in climb rate. The pilot is likely to raise the nose of the aircraft to allow the airspeed to reduce and so the vertical speed will increase.**

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