'HOT AND HIGH' OPERATIONS

INTRODUCTION

Air density is a fundamental variable when considering aircraft performance. Air density is a function of temperature and pressure. There is no flight deck instrument indicating density, but temperature and pressure (from sea level pressure and altitude) are readily available. It is therefore more natural for the pilot to think of performance using these variables, hence the term 'hot and high'. Density altitude makes the concept easier to visualise.

To calculate the density altitude the rule of thumb is:

Density Altitude = Airfield Pressure Altitude + 1000ft per 8°C above ISA.

e.g. Johannesburg, elevation 5500ft amsl. With an OAT of 32°C (ISA + 28) and standard pressure the density altitude is 9000ft.

AWARENESS OF THE DENSITY ALTITUDE

'Hot and high' conditions can be anticipated and therefore covered in the approach briefing. Most of the problems arise because the TAS increases with increasing density altitude (refer to appendix). Therefore a comparison of IAS and TAS will give a good indication of the problems ahead.

HORIZONTAL PROFILE

The turning radius will increase as the TAS increases. It may be necessary to reduce speed by the increment in TAS (due to high density altitude) to achieve the horizontal profile. Using the Johannesburg example, an initial approach speed of 220 kt IAS at 3000ft aal will give a TAS of 260 kt. Modifying the FMC speed to 180 kt, for example, will produce a TAS of 215 kt and will restore the aircraft's turning radius to the sea level equivalent.

VERTICAL PROFILE

When flying a 3° profile the rule of thumb is:

Rate of descent = 5 × groundspeed.

Therefore if the TAS is higher it follows that the V/S will be higher by an equivalent amount. In the above example, 220 kt IAS gives 260 kt TAS and (in still air) a V/S of 1300ft/min. This should be anticipated, especially for a non precision approach.

ENERGY MANAGEMENT

An aircraft will glide equally well at sea level or at altitude, and thereforedensity altitude has no effect on the ability of the aircraft to follow a 3° profile. This is despite the increased vertical speed and therefore, perhaps, contrary to initial expectations. The descent profile will be achievable with normal configurations and thrust settings.

This is a potential trap, because everything appears normal it may be (incorrectly) assumed that slowing up will be equally straightforward. This will not be the case. Again the high TAS is the clue, and it has two effects.

- Acceleration (and deceleration) is a rate of change of speed. That is to say it takes a certain time to slow up. However, our approaches are normally based on 'gates' that are a fixed distance (or height, it amounts to the same thing) from touchdown. With a higher TAS this distance will be covered a lot more quickly, leaving less time to slow up. Using the Johannesburg example, 180 kt IAS equates to 215 kt TAS, which is 20% faster.

- Reducing speed from 180 kt IAS to 140 kt IAS appears to be a reduction of 40 kt. In our example this would equate to 215 kt TAS and 167 kt TAS respectively. In other words this is actually a reduction of 48 kt – again a 20% difference.

These factors are compounded, and the increase in distance required to slow down may be considerable. In the Johannesburg example 1.2 × 1.2 = 1.44, so it will take 44% longer to decelerate. Therefore the deceleration 'gate' must be moved to a more appropriate position earlier in the approach. Allowing a minimum of 50% extra distance would seem to be a good rule of thumb, however it could be more for very high density altitudes. This should be increased further if other factors (e.g. tailwind, non-normal configuration, high approach speeds due to weight, etc.) are also present.

BRAKING

The kinetic energy will be higher on touchdown and this has to be dissipated by the brakes. The use of reverse thrust and an appropriate runway turn-off will keep brake temperatures down.

SUMMARY

- 'Hot and high' conditions should be anticipated and briefed. Comparing IAS to TAS will give a good indication of likely problems.

- Turning radius will increase. A speed reduction may be necessary to achieve the horizontal profile.

- The ability of the aircraft to follow a descent profile is not necessarily an indication of how well it will slow down.

- It could take up to 50% further to decelerate (more if the density altitude is very high or if other factors are present). The 'gates' should be moved back to a more appropriate position to allow more time and distance to slow up.

- Touchdown speeds will be higher. Choose appropriate braking.