Hot and High

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Overview

My experience

Why this topic

Gas properties

Atmospheric effects

Inside the jet engine

Drag and power

My Background

Joined the Royal Australian Navy in 1997

Flew PC9/A Jet Trainer 1998-1999

AS350BA Squirrel Helicopter 1999-2001

S-70B-2 Seahawk Helicopter 2001-2004

KA350/B300 King Air Nav Trainer 2005-2007

Australian Helicopters/ Babcock Adelaide contract 2007-

- Bell 412

- BK117

- **EC130**

- **AS 350 BA**

Why am I giving this brief?

Air Properties

Gases act like a fluid, but can be compressed.

Gas particles are affected by temperature and gravity.

If atmospheric pressure is high, we have more air particles present.

As atmospheric temperature increases, air particles become more active and require more space. Therefore less air particles are present.

Air Pressure

Sea level air pressure is 1013mb(hPa), or 14psi.

At 18 000’ air pressure is ½ that of sea level.

Therefore as altitude increases, pressure decreases.

Pressure is the effect of air molecules on their surroundings,

Air Density

Pressure (P) ~ Density (ρ)

Density is the weight of air molecules.

As temperature increases, density decreases.

Humid air is less dense than dry air as H_2O < O_2 and N_2.

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How does this affect us?

Standard atmosphere at SL is 1013.25 hPa and 15°C.

Any variation of these EFFECTIVELY varies our operating altitude.

An altitude adjusted for pressure variations is called a Pressure Altitude.

- **-30’/hPa.**

An altitude adjusted for pressure and temperature variations is called a Density Altitude.

- **Pressure Altitude +120’/°C.**

DA calculation examples

1030hPa, 10º @ SL:

1030 – 1013 = 17 **17 x -30 = -510’** **10 – 15 = -5** **-5 x 120 = -600’**

PA = -510’ **DA = -1110’**

1000hPa, 40º @ 2000’:

1000 – 1013 = -13 **-13 x -30 = 390’** **40 – 15 = 25** **25 x 120 = 3000’**

PA = 2390’ **DA = 5390’**

Effects of Density

Rotor blades create lift through the reaction of pushing air down.

At a given power setting, the less dense the air is, the less effect is gained, so less lift is produced.

Therefore more power is needed to achieve the same resultant lift on a day when the air is less dense.

Or aircraft weight needs to be reduced, which lowers the lift required and therefore the power needed.

Inside the jet engine

The compressor section of the engine is also affected by air density. The less dense the air, less actual air enters the engine.

This means that the engine must work harder with less dense air in order to produce the same amount of power.

A higher air temperature also means that we may reach the maximum operating temperature of the engine before we reach our maximum power output.

As a result of both, our maximum power available has reduced.

But how does all this affect us?

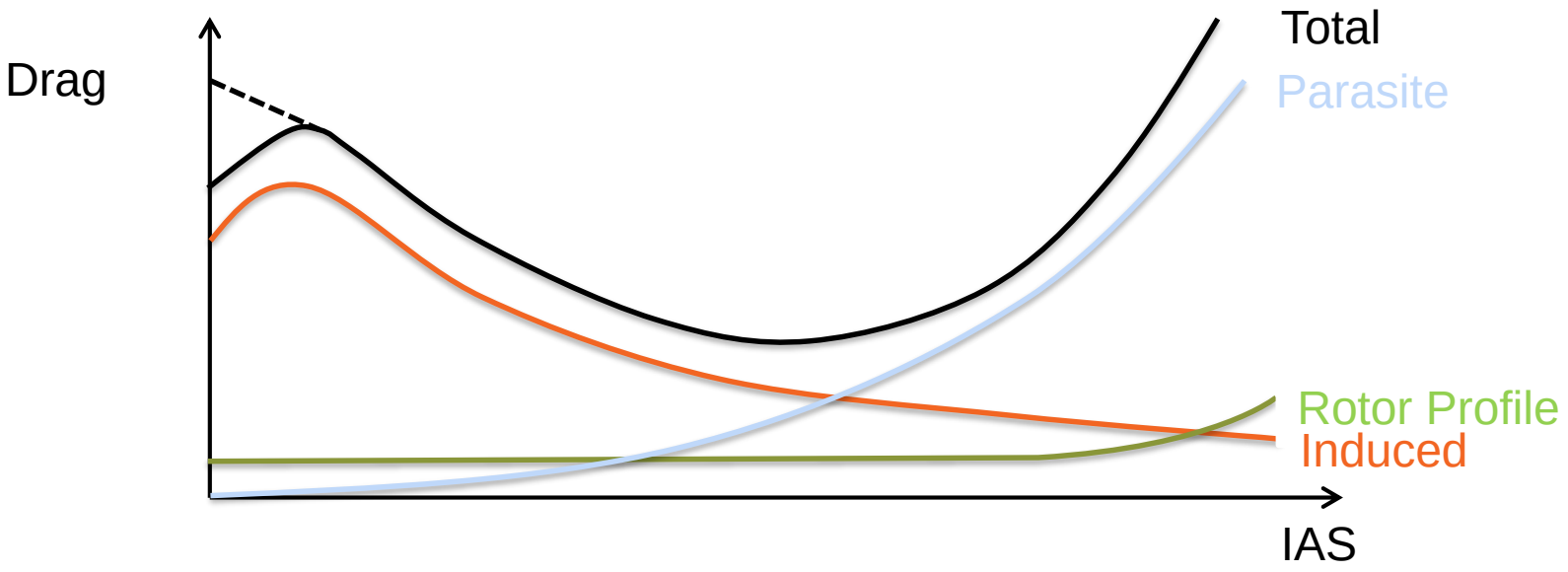
For every given aircraft weight at a certain density altitude, there will be a power requirement to hover IGE and OGE.

An increase in weight will increase the power required.

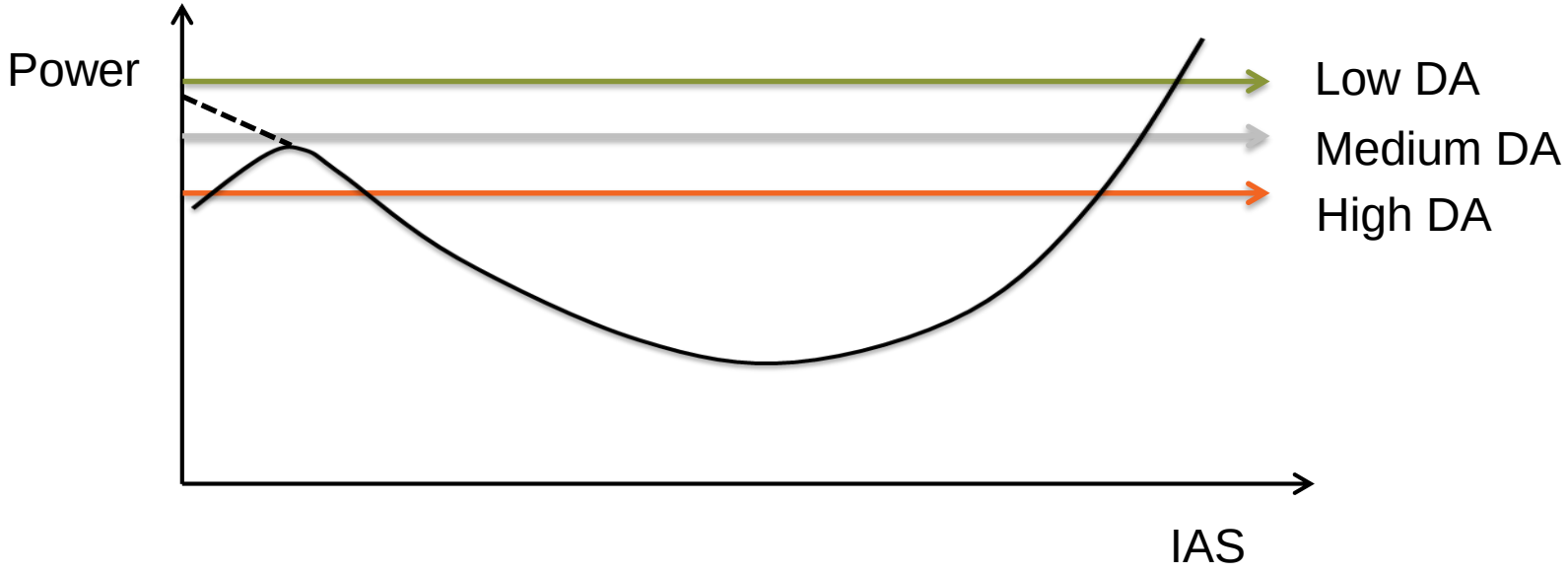
An increase in Density Altitude will increase the power required.

If power available is less than power required, we can't hover! We will need to reduce weight.

Helicopter Drag



Power Required

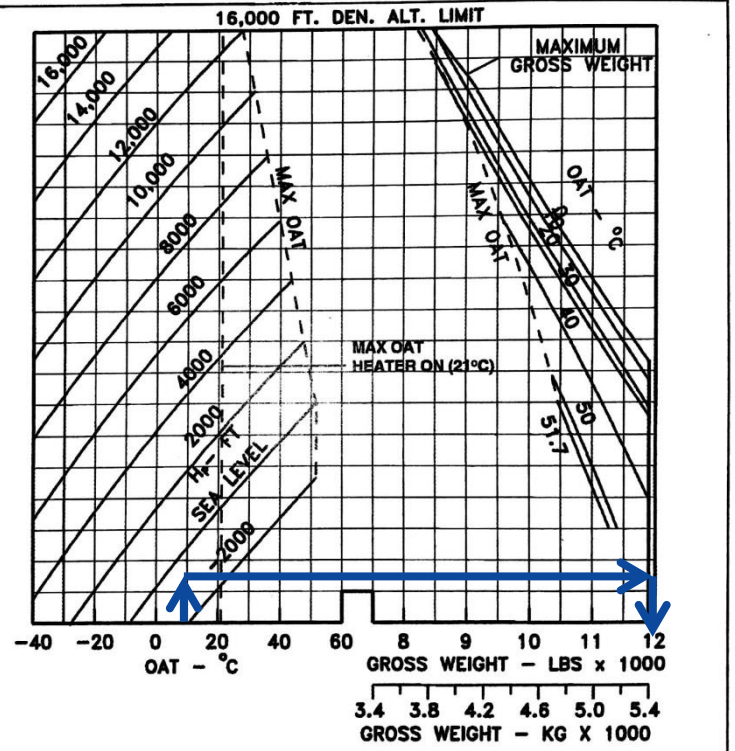


HOVER CEILING OUT OF GROUND EFFECT

TAKEOFF POWER
ENGINE RPM 100%
GENERATOR 150 AMPS(EA.)

SKID HEIGHT 60 FEET
HEATER ON OR OFF
0 TO 52°C

NOTE: THESE DATA VALID FOR ZERO WIND OUTSIDE OF THE CRITICAL WIND AZIMUTH AREA (REFER TO FIGURE 4-5)



FAA APPROVED BHT-412-FMS-35.3 AND 35.4

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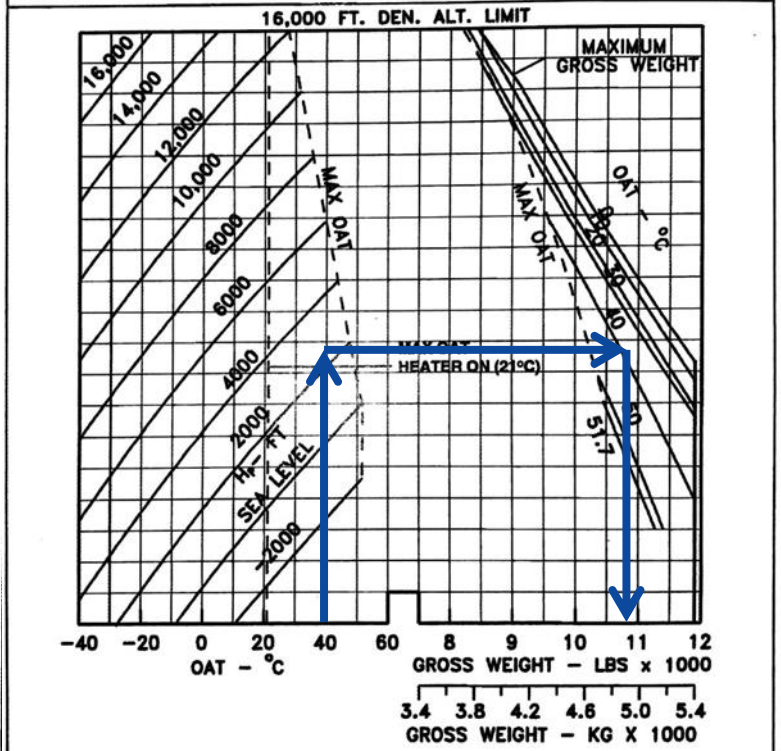

Conclusion

Increase in air pressure, increase in air density.

Increase in air temperature, decrease in air density.

Increase in air density, lower Density Altitude.

Decrease in air density, decrease in rotor lift.

Decrease in air density, decrease in engine power.

Decrease in aircraft weight, decrease in power required.

The End

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