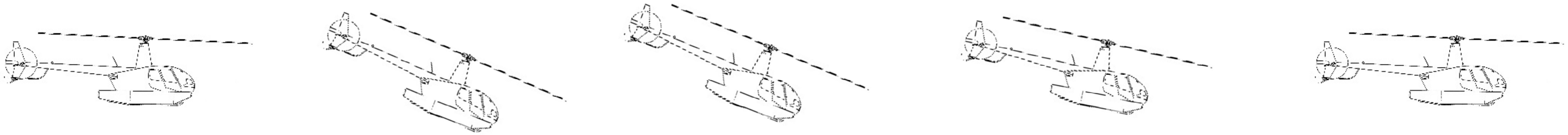
Exercise 5 Attitude & Power Changes

AIM: To learn how to change power and show the relationship between attitude and airspeed

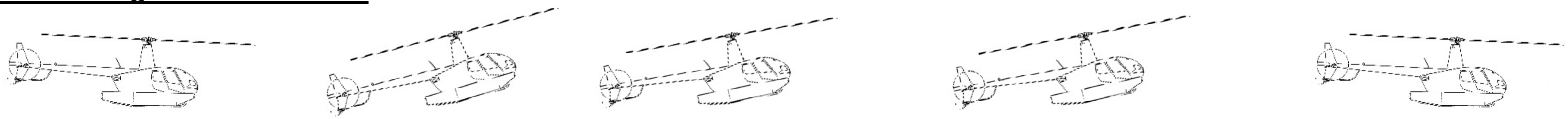
T.EM.: LOOKOUT, Clock code, Location & Landmarks, Engine Instruments, T's & P's, Effective Scan, Hand over of controls,

Speed Changes - Acceleration



Cruise Flight — Accelerative Attitude — Overcome FLAPBACK — Hold Attitude to obtain speed — Reselect Datum Attitude

Speed Changes - Deceleration



Cruise Flight — Decelerative Attitude — Overcome FLAP FORWARD — Hold Attitude to obtain speed — Reselect Datum Attitude

Accelerative Attitude ← - - - - → Accelerative Attitude

Datum Attitude ◆——◆ Datum Attitude

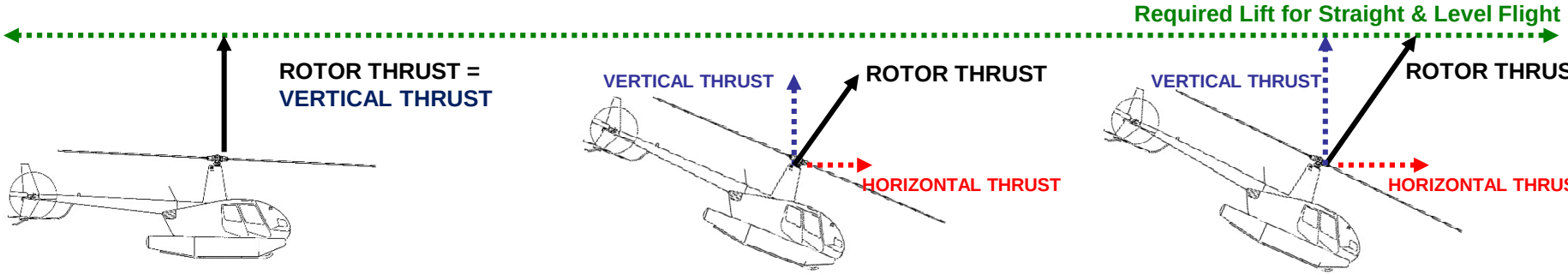
Decelerative Attitude ← - - - - → Decelerative Attitude

SELECT - HOLD - ADJUST

Exercise 5 Power and Attitude Changes

Vector Diagram

Power Changes - Acceleration

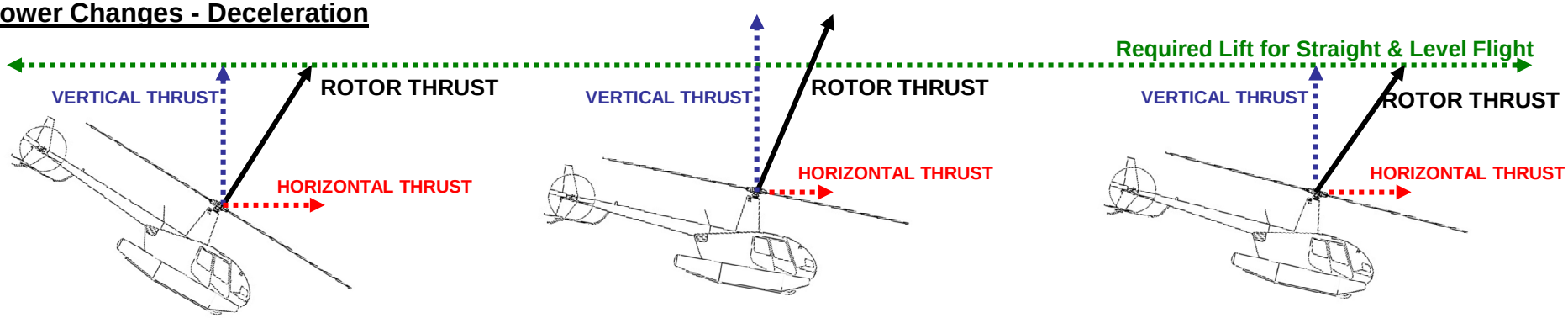


- Hover – Rotor Thrust
- Is Vertical only

- Cyclic Forward – Rotor Thrust
- Is broken down in 2 components.
- Vertical Thrust & Horizontal Thrust.
- There is no longer sufficient vertical thrust to maintain straight & level flight.
- With NO Collective lever movement, the aircraft will descend.

- Collective Lever has been raised to Increase Vertical Thrust, which stops the Descent.

Power Changes - Deceleration



- Forward Flight, Cruise Straight & Level

- Cyclic Aft – deceleration.
- The Vertical Thrust is now greater than the required Vertical Thrust to maintain Level Flight.
- With NO Collective lever movement, the aircraft will climb.

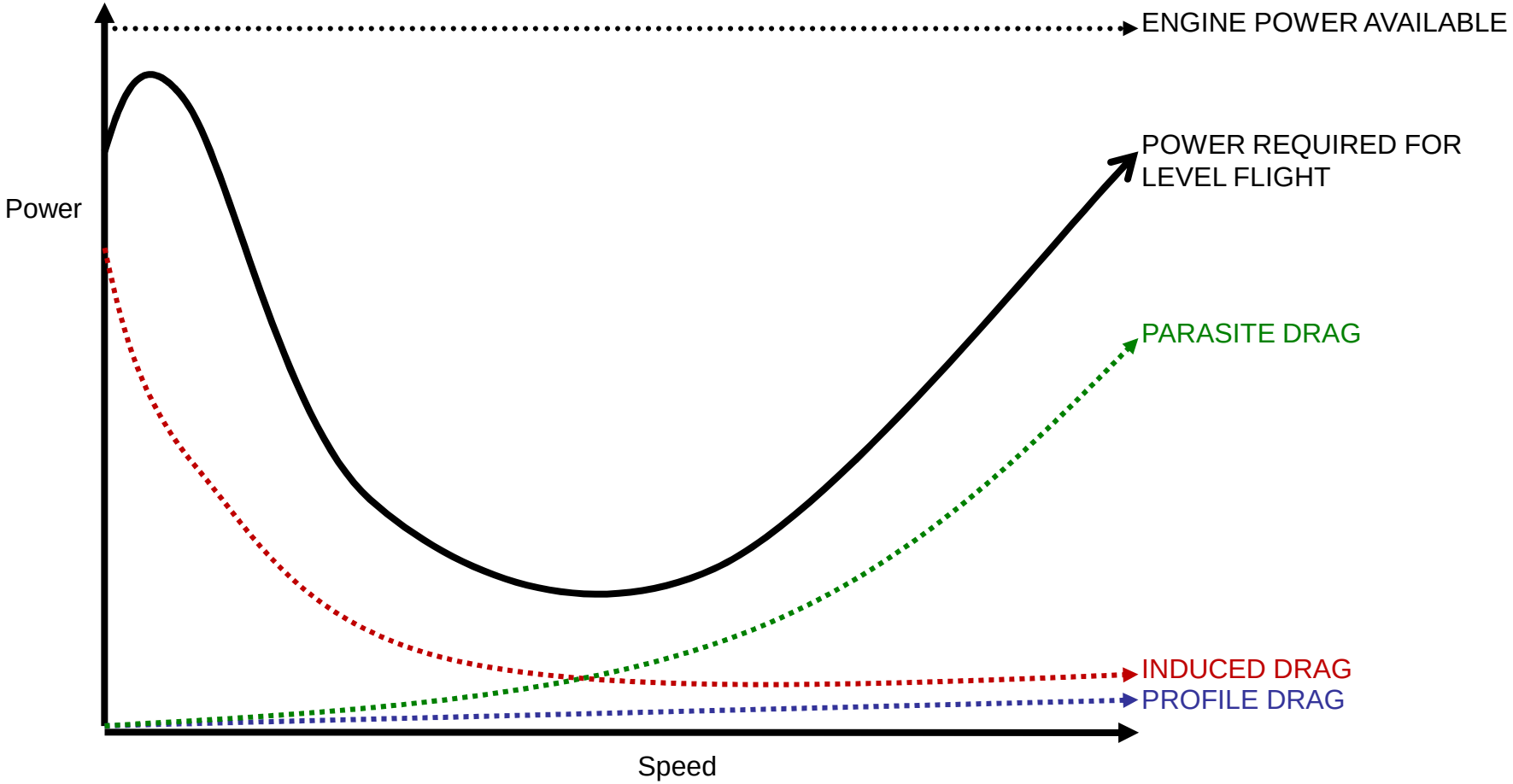
- Collective Lever has been lowered to Reduce Vertical Thrust which stops the climb.

Exercise 5 Power & Attitude Changes

POWER REQUIRED CURVE

There are 3 Drag forces that power needs to overcome. The resultant of the 3 Drag forces is the Power required curve. The 3 Drag forces are:

PROFILE: The shape, or profile, of the blades, stays relatively constant in relation to speed
INDUCED: The drag created due to creation of lift, as speed increase Induced Drag reduces
PARASITE: The drag created by the parts of the aircraft not creating lift, as speed increases so does Parasite drag (exponentially)



Exercise 5 Attitude & Power Changes

Power Changes – Constant RPM – Governor ON

INCREASE POWER 15” – 23”

Raise Lever MAP ↑ RPM —

CYCLIC **FWD** PEDAL ←

DECREASE POWER 23” – 15”

Carb. Heat OUT

Lower Lever MAP ↓ RPM —

CYCLIC **AFT** PEDAL →

Exercise 5 Power and Attitude Changes

Lift Equation

$LIFT = C_L \times \frac{1}{2} \rho \times V^2 \times S$

CL = Coefficient of Lift
½ ρ = "RHO", Air Density
V^2 = Velocity
S = Surface Area of Blade

Notes:

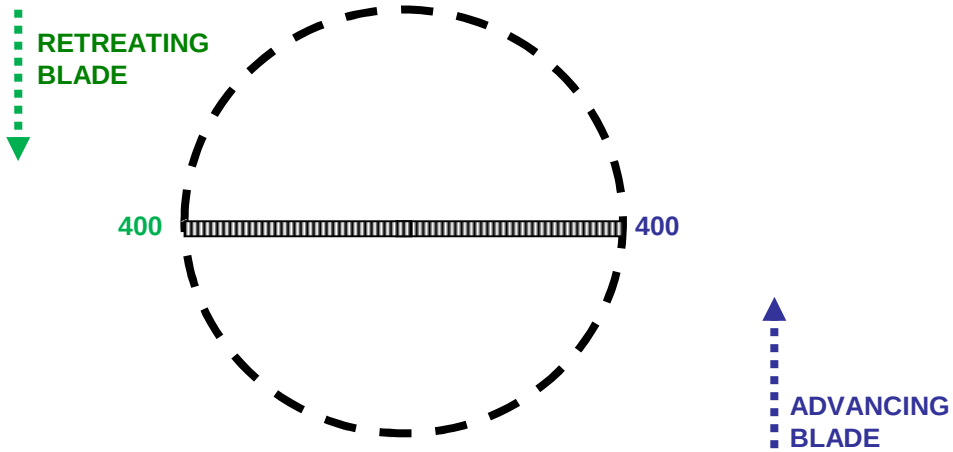
- As pilots we cannot change Air Density, although it is changed by Pressure, Temperature and Humidity.
- As pilots we cannot change the Surface Area of the Blade (S)
- We can change the Coefficient of Lift (CL), by altering the Angle of Attack
- We can change the Velocity (V^2)
- Velocity is squared, therefore if we increase Velocity by a factor of 10, Lift will be increased by a factor of 100

Maintaining Constant Lift

- To maintain a constant amount of Lift if:
- Velocity is increased then CL would need to be reduced
- Velocity is reduced the CL would need to be increased

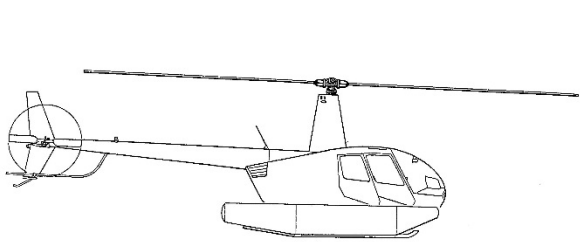
Exercise 5 Power & Attitude Changes

DIS-SYMMETRY OF LIFT & FLAPPING

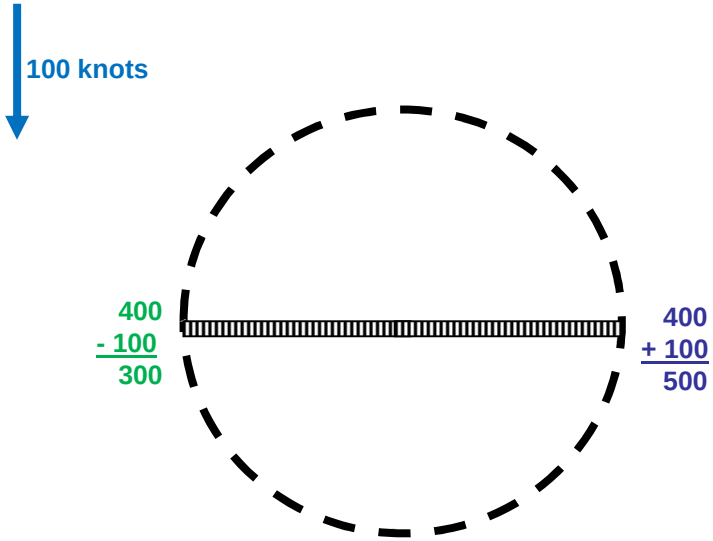


Zero Wind Hover

Both blades have equal velocity on the Advancing and Retreating Blades, therefore there is an equal amount of lift evenly distributed across the disc

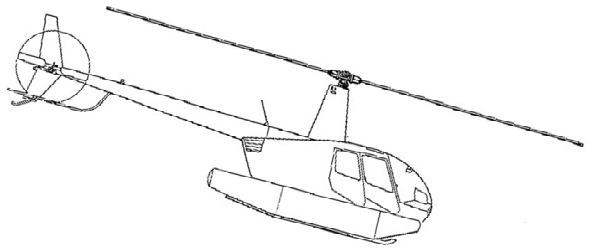


HOVER



100 knots Forward Speed

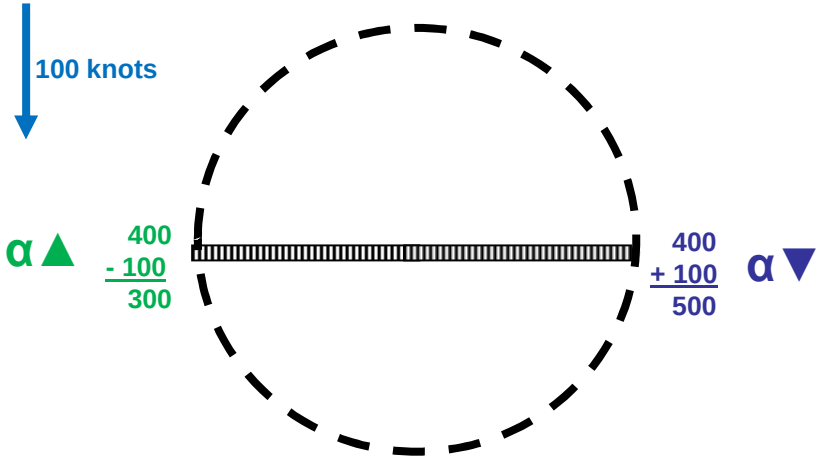
Lift on the Advancing blade is much greater due to the increased velocity. Lift on the Retreating blade is less due to the reduced velocity. In this state the helicopter would roll towards the retreating blade side



NORMAL FORWARD CRUISE

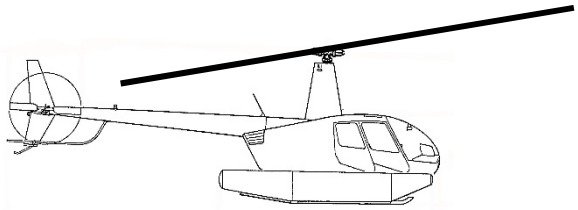
Exercise 5 Power & Attitude Changes

FLAPBACK & FLAP FORWARD

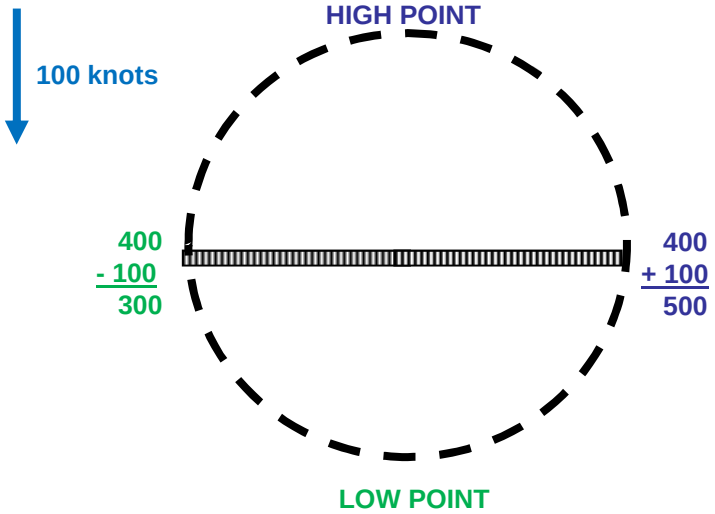


100 knots Forward Speed

To combat the unequal lift on the Advancing and Retreating Blade and restore equal and uniform lift the Angle of Attack (α) must be altered on both sides of the disc. On the Advancing Blade the Angle of Attack is reduced, whilst on the Retreating Blade the Angle of Attack is Increased

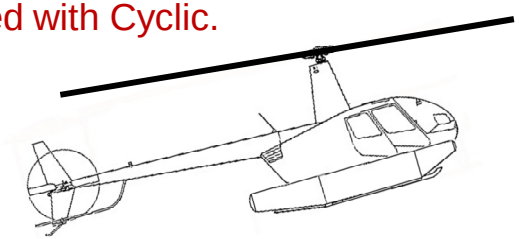


FLAPBACK OCCURING
FLAPPING OCCURS DUE TO THE TEETERING HEAD IN THE R44



Flapping to Equality

The Angle of Attack is changed naturally by the blade movement, this is called **FLAPPING**. On the Advancing Side the Blade moves UP to reduce the Angle of Attack, on the Retreating Side the Blade moves DOWN to increase the Angle if Attack. This creates a Disc HIGH POINT at the front of the Disc, and a Disc LOW POINT at the rear of the Disc. This is corrected with Cyclic.



NOSE UP DUE TO UN-CORRECTED FLAPPING

Exercise 5 Power & Attitude Changes

Aircraft Limitations

Vne

- Velocity Never Exceed
- You must not fly faster than these speed when you are in certain flight regimes
- They are found in the flight manual for each particular R44 type and can differ. They are also found on a placard in each Helicopter:

R44 P.O.H. Section 2, 2-1 - R44 Raven & R44 Raven II

- Up to 3000ft density altitude
- 2200lb TOGW & Below 130 KIAS
- Over 2200lb TOGW 120 KIAS
- Autorotation 100 KIAS
- Above 3000 feet density altitude, see placard

ADDITIONAL AIRSPEED LIMITS:

- Do not exceed 100 KIAS when operating at power above MCP
- Do not exceed 100 KIAS with any door(s) removed
- Do not exceed 110 KIAS in wind conditions

R44 P.O.H. Section 9, 9-5.1 - Fixed Utility Floats

- Up to 3000ft density altitude
- 2200lb TOGW & Below 120 KIAS
- Over 2200lb TOGW 110 KIAS
- Autorotation 100 KIAS
- Above 3000 feet density altitude, see placard

P.O.H. Section 9, 9-10.1 - Pop-Out Floats

- Do not inflate floats above 80 KIAS
- Do not exceed 80KIAS with floats inflated

1. Red Line – Indicates Operating Limits. Pointer should NOT enter red during normal operations.

2. **Red / White Cross Hatch** – Indicates Power OFF Vne

3. **Green** – Normal Operating Range

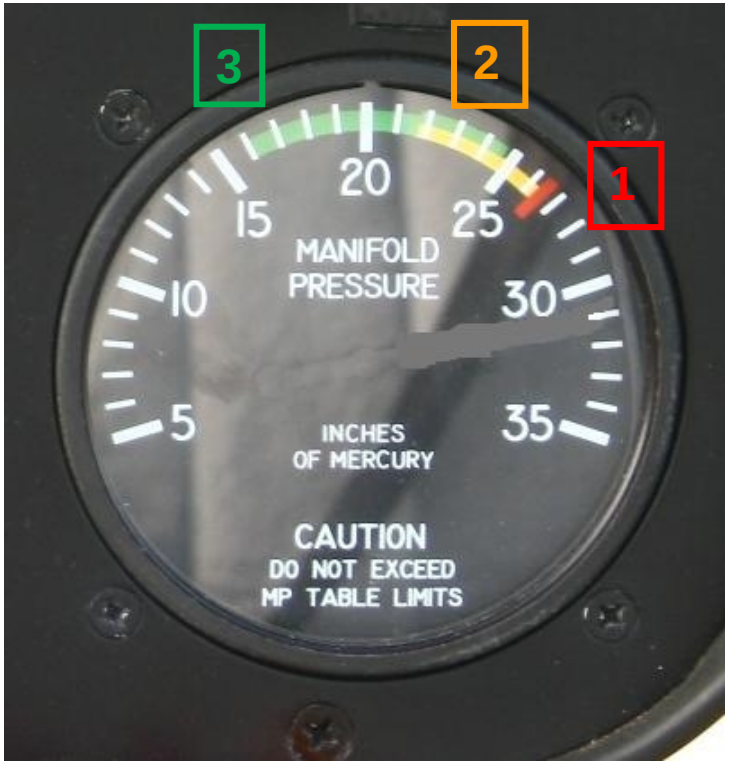
Yellow Arc added in 2016 above 110 kts as a caution area when operating in wind

Exercise 5 Power & Attitude Changes

Aircraft Limitations

ENGINE LIMITATIONS

- Found in the P.O.H. in each particular helicopter and type. They are also on a placard in the helicopter.
- M.A.P. Limits are determined by OAT and Pressure Altitude



1. **Red Line** – Indicates Operating Limits. Pointer should NOT enter red during normal operations.

2. **Yellow** – Precautionary or special operating procedure range

3. **Green** – Normal Operating Range

ROTOR SPEED LIMITATIONS

Found in the R44 P.O.H., Section 2, 2-2

Power On

Maximum:	102%	RPM 408
Minimum:	101%*	RPM 404

* - transient operation below 101% permitted for emergency procedures training

Power Off

Maximum:	108%	RPM 432
Minimum:	90%	RPM 360
Low RPM Horn & Light:	97%	

Exercise 5 Power & Attitude Changes

Aircraft Limitations

ROBINSON
HELICOPTER COMPANY
2901 Airport Drive, Torrance, California 90505 Phone (310) 539-0508 Fax (310) 539-5198

R22 & R44 SAFETY ALERT

Issued: 20 December 2004

EXCEEDING POWER LIMITS CAN BE FATAL

Some pilots continue to exceed engine manifold pressure limits. The engine is significantly derated from full-throttle power to provide a margin for altitude performance and for momentary emergencies. Pilots must monitor manifold pressure to avoid exceeding limits. Exceeding power limits has caused several rotor blade and drive system failures.

At standard sea level conditions, the maximum continuous manifold pressure limit is 22.4 inches for the R22 Beta II and 22.7 inches for the R44 Raven II. The manifold pressure limits are even less at higher altitude or lower temperature. Operation above these limits may produce fatigue damage in rotor blades or drive system components which can result in a catastrophic inflight failure.

WARNING

1. NEVER EXCEED LIMIT TAKEOFF POWER.
2. NEVER EXCEED MAX CONTINUOUS POWER IN FORWARD FLIGHT.
3. NEVER EXCEED MAX GROSS WEIGHT LIMIT.

Reread Safety Notice SN-37.

R22 Beta II Limit Manifold Pressure Chart.

LIMIT MANIFOLD PRESSURE - IN. HG

MAXIMUM CONTINUOUS POWER							
PRESS ALT-FT	OAT - °C						
	-20	-10	0	10	20	30	40
SL	21.5	21.8	22.1	22.3	22.6	22.9	23.2
2000	21.1	21.4	21.6	21.9	22.2	22.5	22.8
4000	20.7	21.0	21.2	21.5	21.8	22.0	22.3
6000	20.3	20.6	20.8	21.1	21.3	21.6	21.9
8000	19.9	20.2	20.4	20.7	20.9	FULL THROTTLE	
FOR MAX TAKEOFF POWER (5 MIN), ADD 0.9 IN. HG							

Safety Notice SN-37

Issued: Dec 01

EXCEEDING APPROVED LIMITATIONS CAN BE FATAL

Many pilots do not understand metal fatigue. Each time a metal component is loaded to a stress level above its fatigue limit, hidden damage occurs within the metal. There is no inspection method which can detect this invisible fatigue damage. The first indication will be a tiny microscopic crack in the metal, often hidden from view. The crack will grow with each repetition of the critical stress until the part suddenly breaks. Crack growth will occur quite rapidly in drive system parts from the high frequency torsional loads. It will also occur rapidly in rotor system components due to the high centrifugal force on the blades and hub. Damaging fatigue cycles occur with every revolution of an overload drive shaft or rotor blade.

If a pilot exceeds the power or airspeed limits on a few occasions without failure, he may be misled into believing he can safely operate at those high loads. Not true. Every second the limitations are exceeded, more stress cycles occur and additional fatigue damage can accumulate within the metal. Eventually, a fatigue crack will begin and grow until a sudden failure occurs. If the pilot is lucky, the part will have reached its approved service life and be replaced before failure. If not, there will likely be a serious or fatal accident.

WARNING

1) Always operate the aircraft well below its approved Vne (never exceed speed), especially in turbulent wind conditions.

2) Do not operate the engine above its placarded manifold pressure limits.

3) Do not load the aircraft above its approved gross weight limit.

4) The most damaging conditions occur when flying or maneuvering at high airspeeds combined with high power settings.

Power & Attitude Changes – Common Errors

- Looking inside too much
- Not using Horizon to maintain speed(s)
- Over controlling