Presented by:

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Flex temperature, choice of takeoff configuration

AIRBUS

Contents

- Introduction
- Principle of takeoff optimization
- Flexible thrust
- Choice of takeoff configuration
- Conclusion

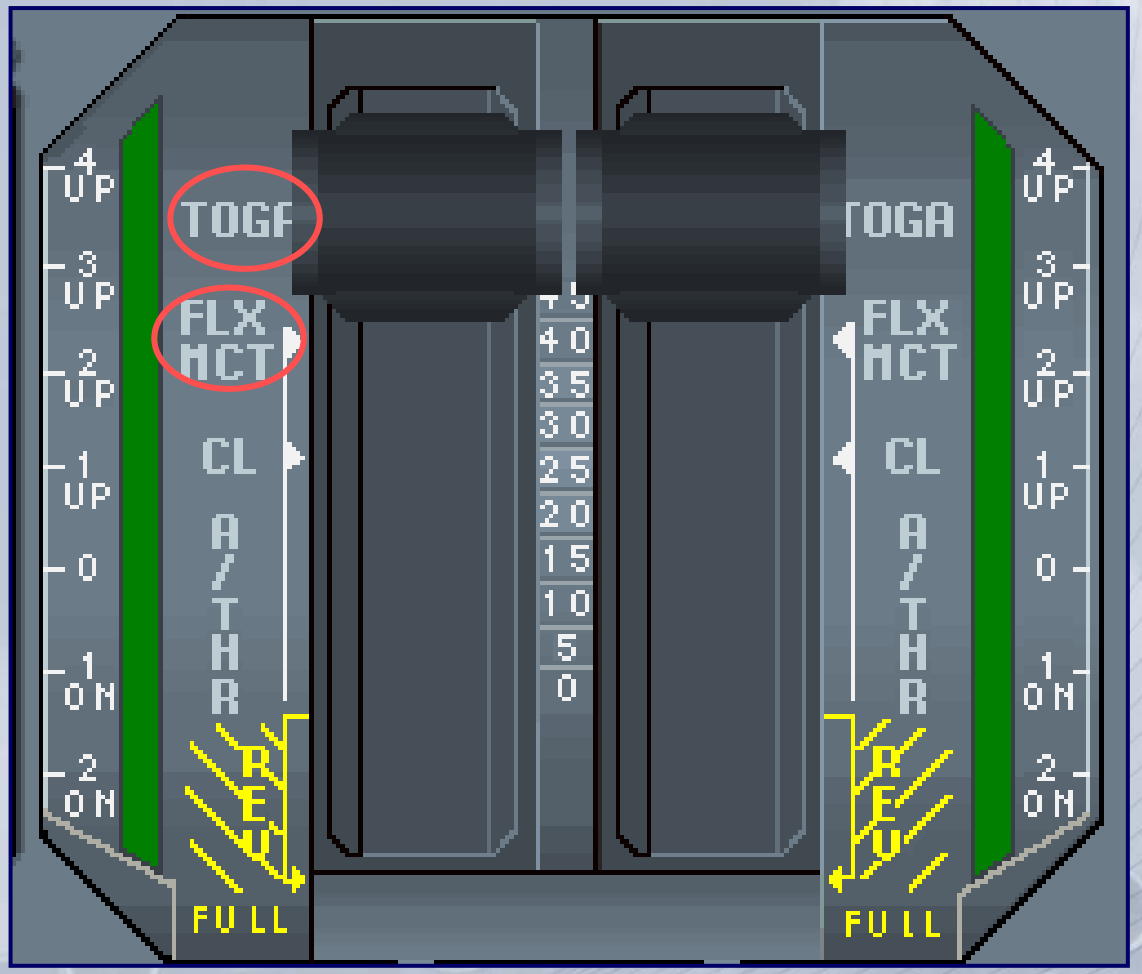
Introduction

When takeoff is not performance limited, the pilot must make a choice:

Introduction

TOGA ?

Or flex ?

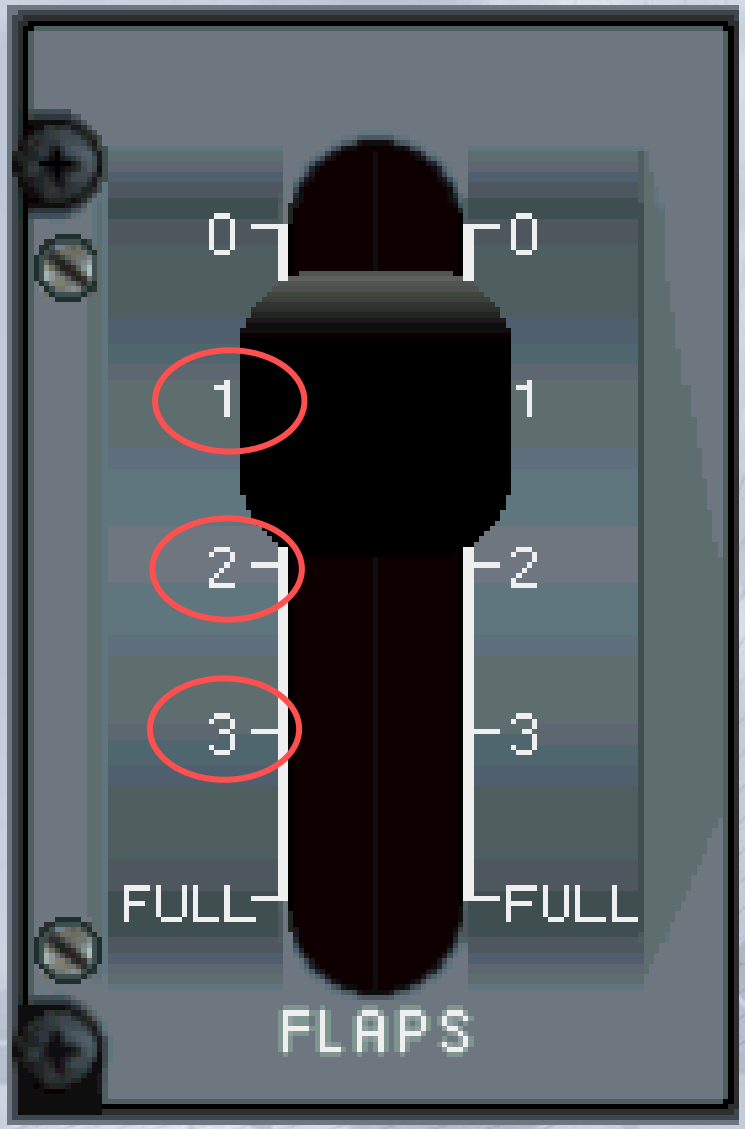


Introduction

CONF 1+F ?

or CONF 2 ?

or CONF 3 ?



Introduction

- In some cases, TOGA is mandatory, but choice of configuration remains

- Selection of a given takeoff configuration affects the level of necessary thrust

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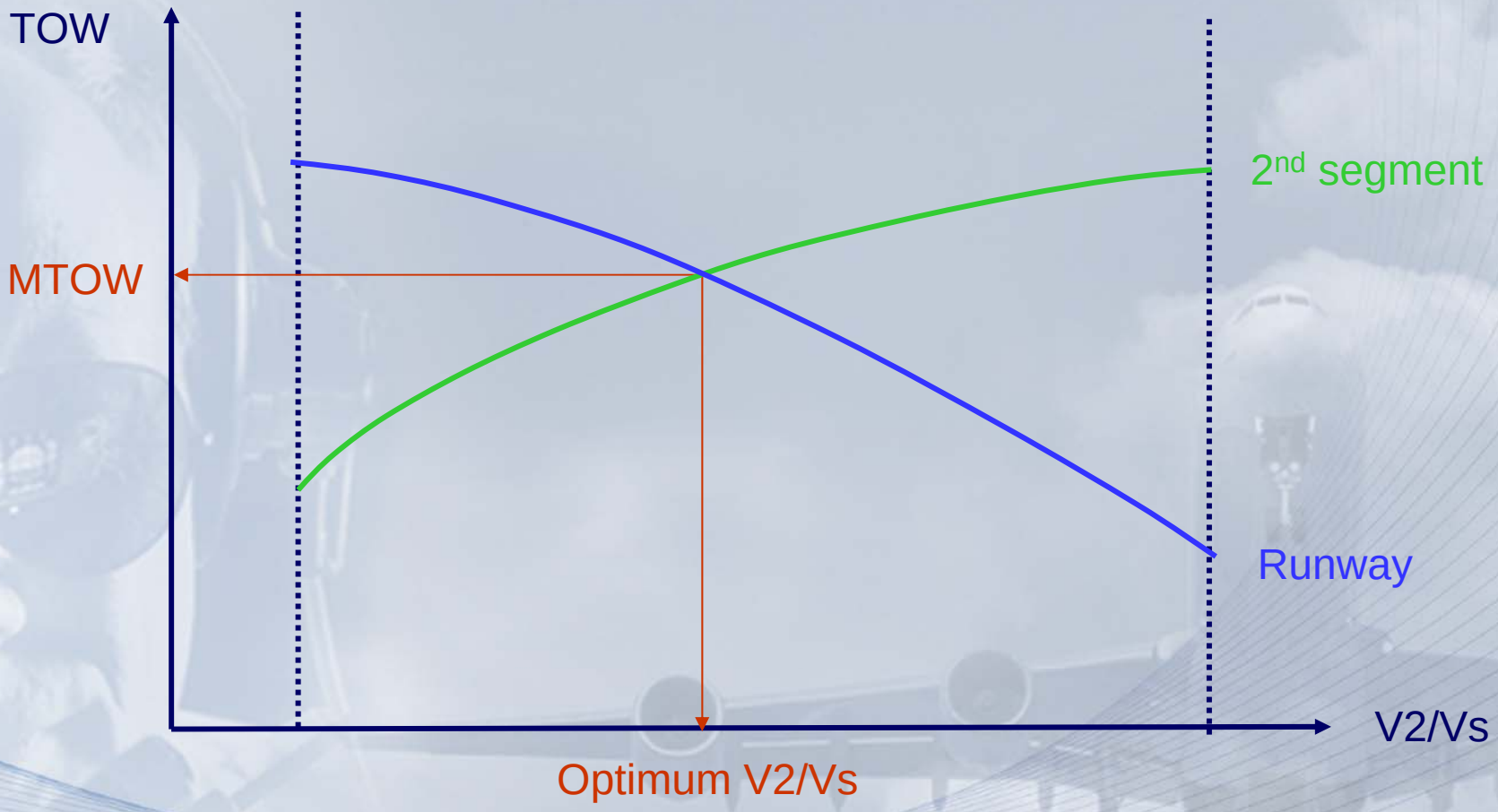
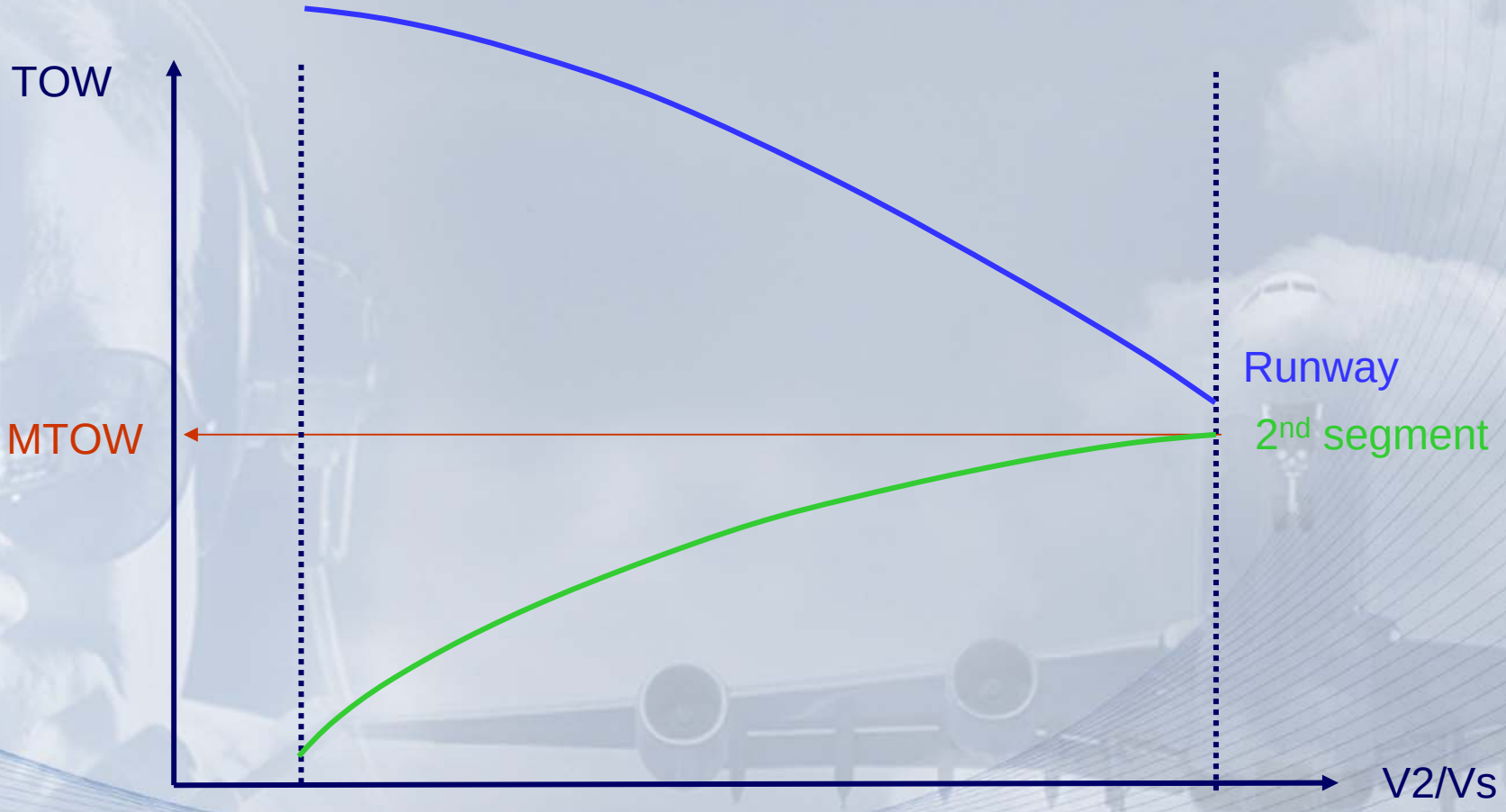
Principle of takeoff optimization

- The takeoff optimization is based on speeds optimization



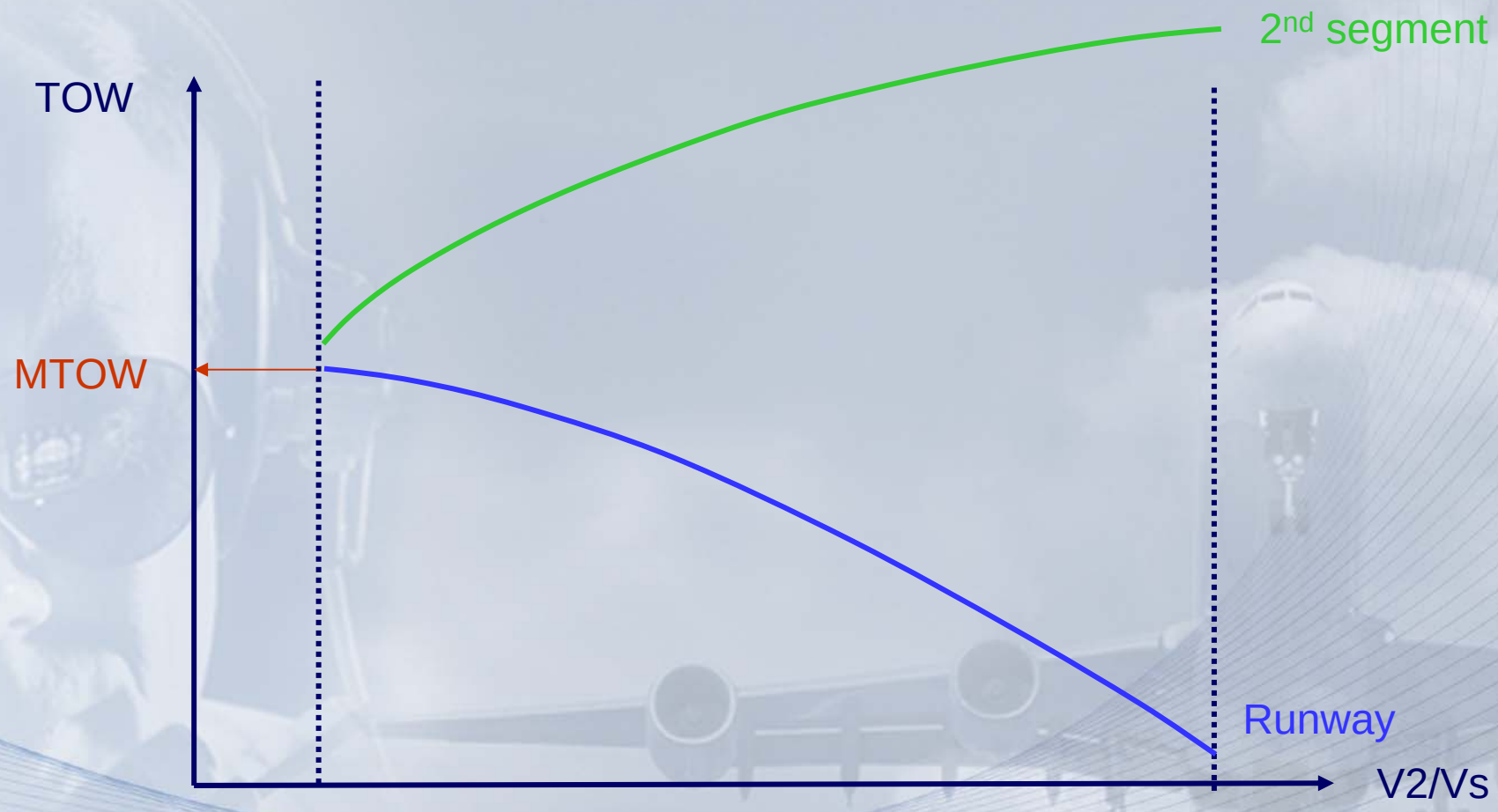
Principle of takeoff optimization

- In some cases, the limitations do not intersect, only one of them is limiting: 2nd segment,



Principle of takeoff optimization

- In some cases, the limitations do not intersect, only one of them is limiting: 2nd segment, or runway



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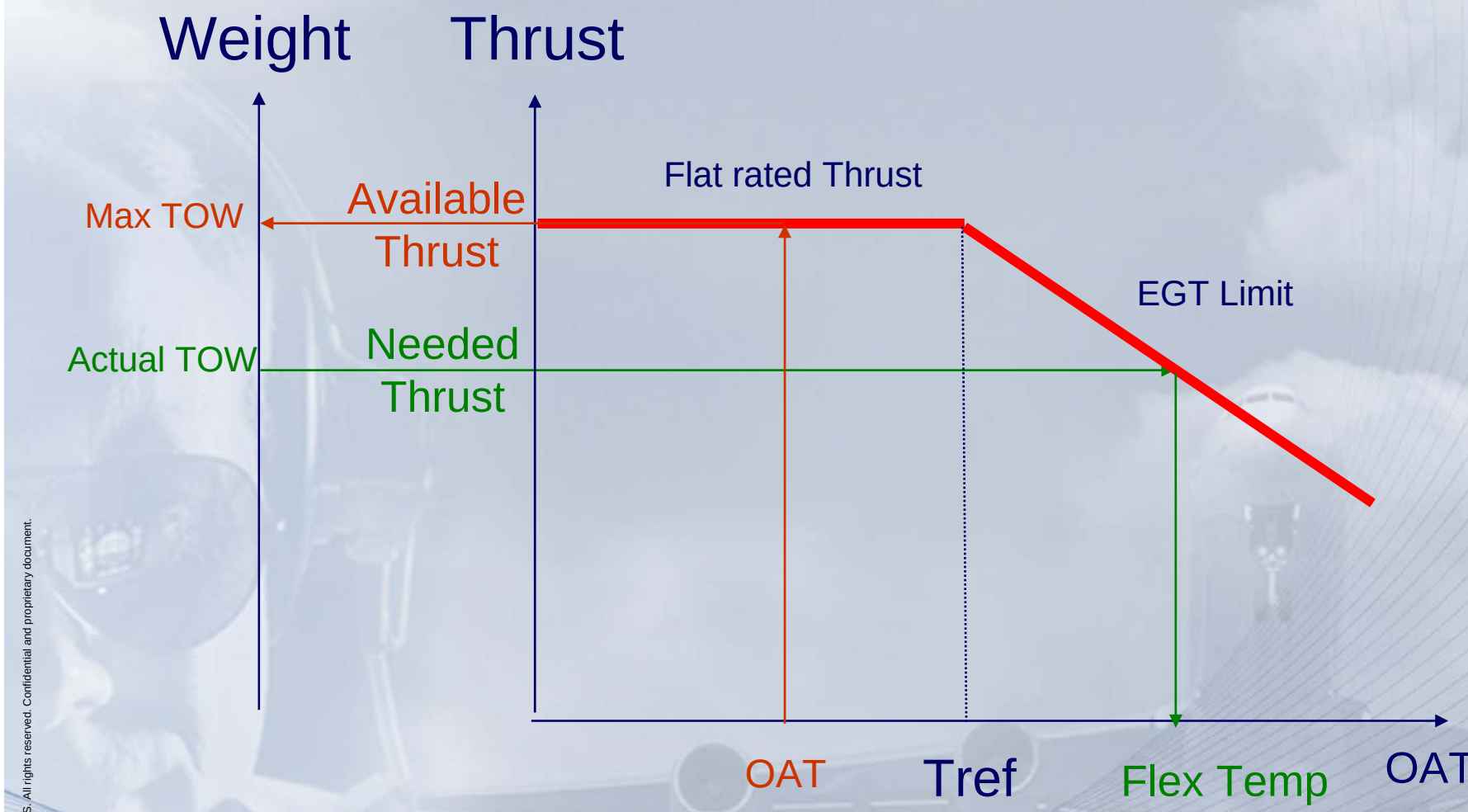
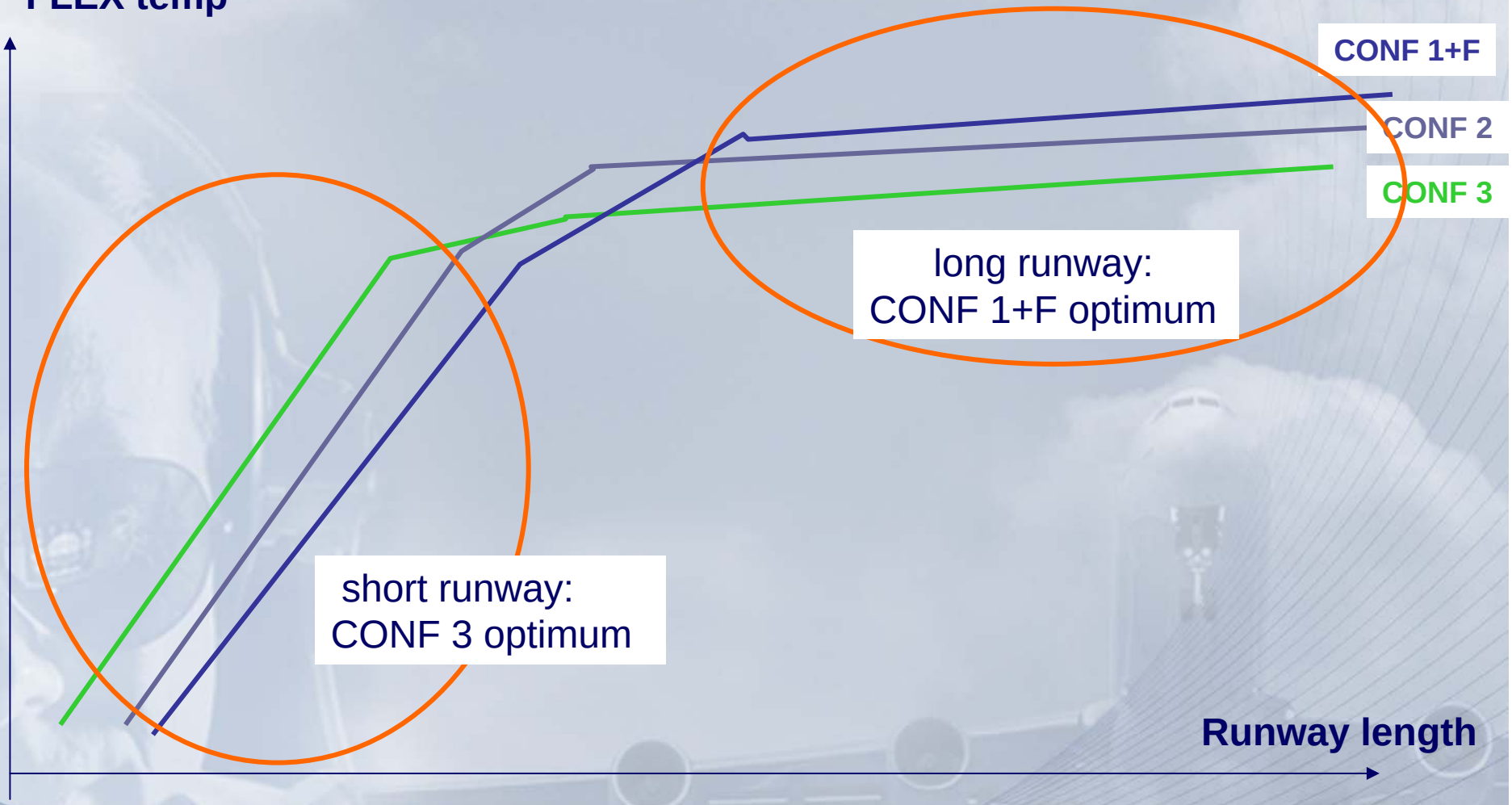
Flexible thrust

- Benefits of thrust reduction
  - save the engine life
  - improve engine reliability
  - reduce maintenance costs

Flexible thrust



Flexible thrust

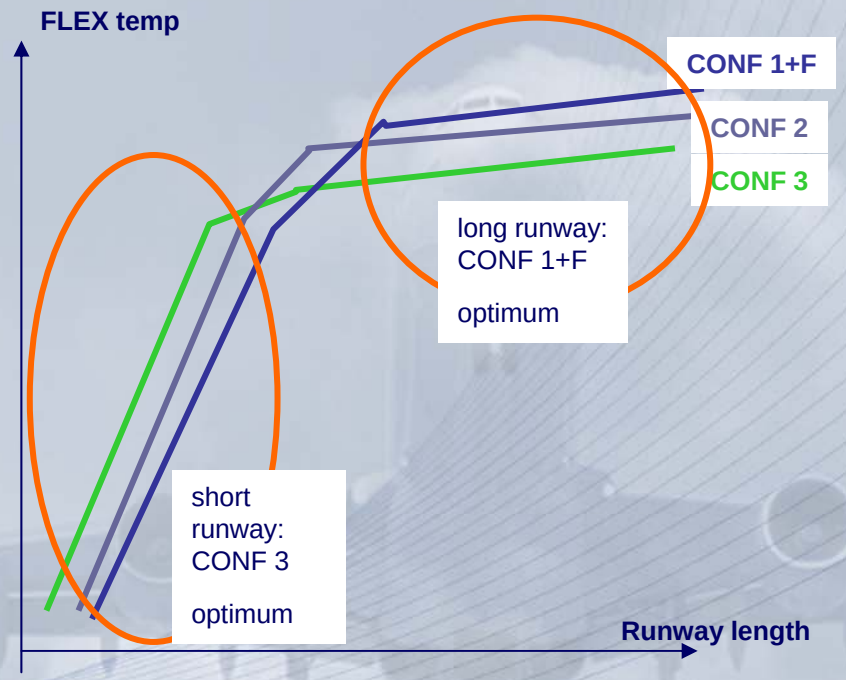


Valid for all Airbus types, but A340-500/600, for which CONF3 is in most cases the optimum ,whatever the runway length

Flexible thrust

- Flexible thrust should not be used in the following conditions:
  - Contaminated runway
  - Windshear expected

- Optimization of flexible thrust :
  - CONF 3 on short runways
  - CONF 1+F on long runways



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Choice of takeoff configuration

CONF1+F on long runways not advisable:

- On high altitude airports
- On badly paved runway
- On aircraft prone to tailstrike

Choice of takeoff configuration

Choice of takeoff configuration

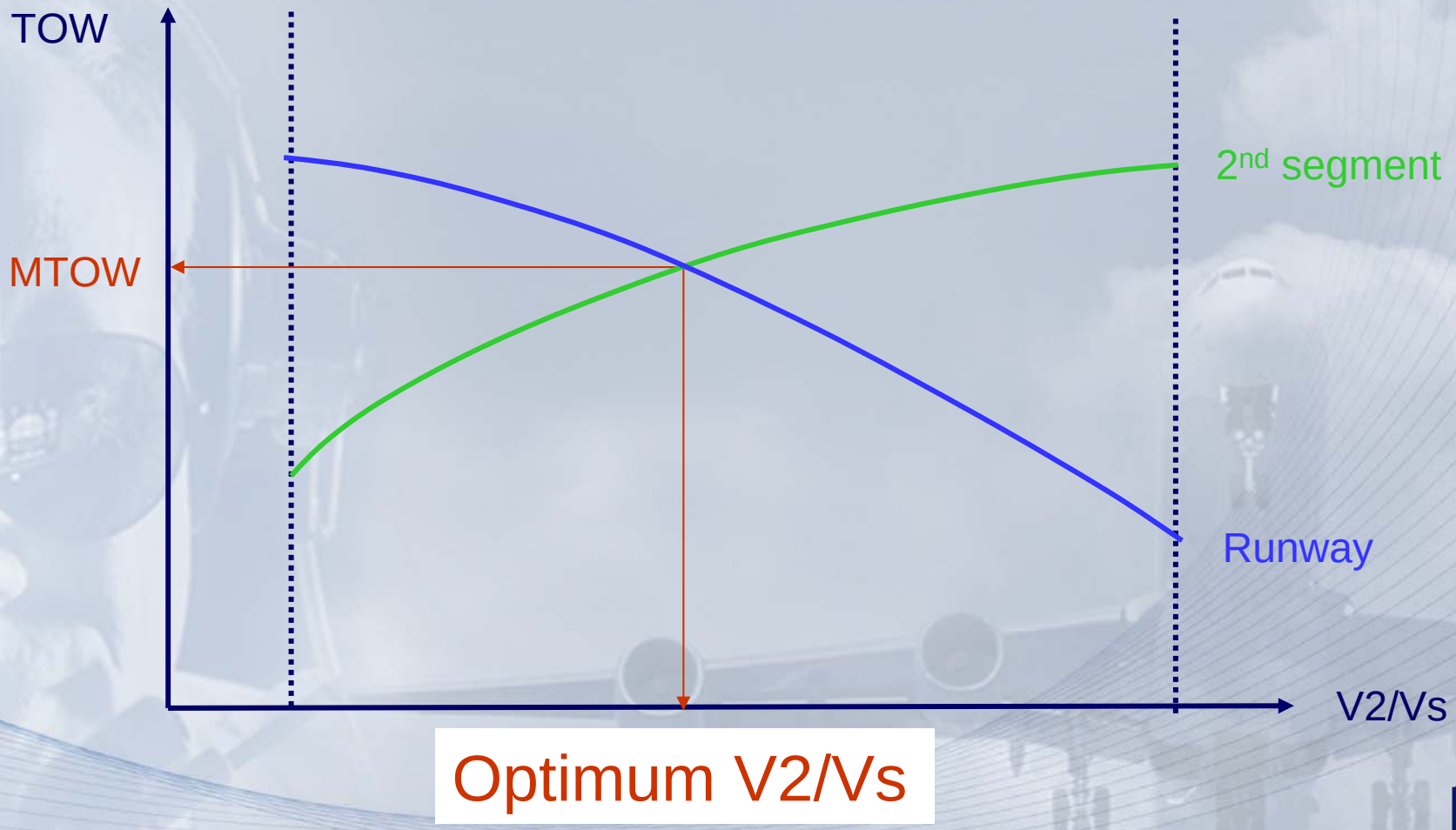
- Tailstrike events in airline operation at takeoff:
  - Few on Single Aisle aircraft (since ELAC modification in 1995):
    - 2 on A321
    - 5 on A320
  - 1 on A330, due to early rotation
  - Several on A340

Choice of takeoff configuration

- 4 engine aircraft more prone to tailstrike:
  - Lower thrust/weight ratio than twin engine aircraft
  - Takeoff speeds closer to VMU

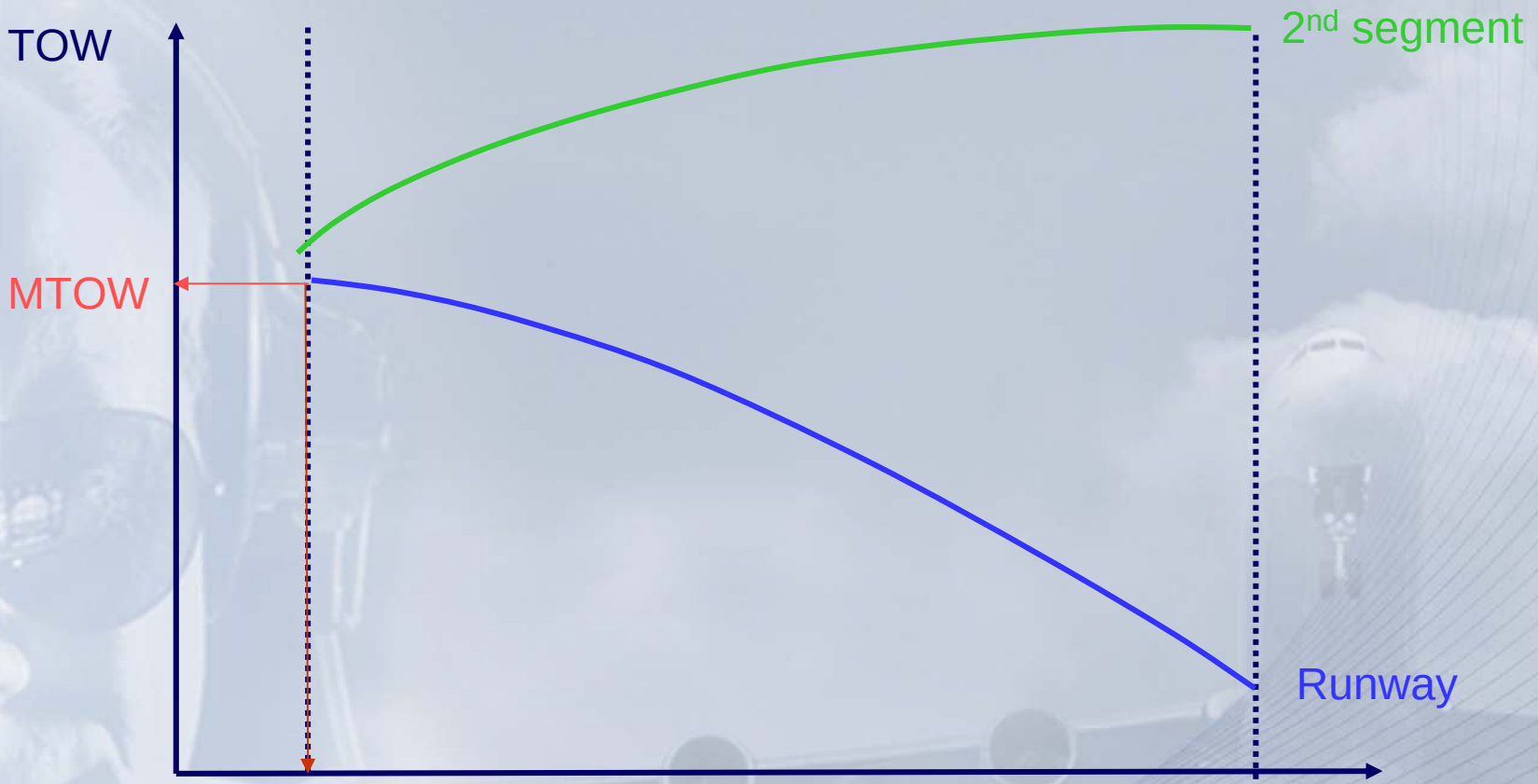
Choice of takeoff configuration

- Twin engine aircraft: usually not at minimum speeds



Choice of takeoff configuration

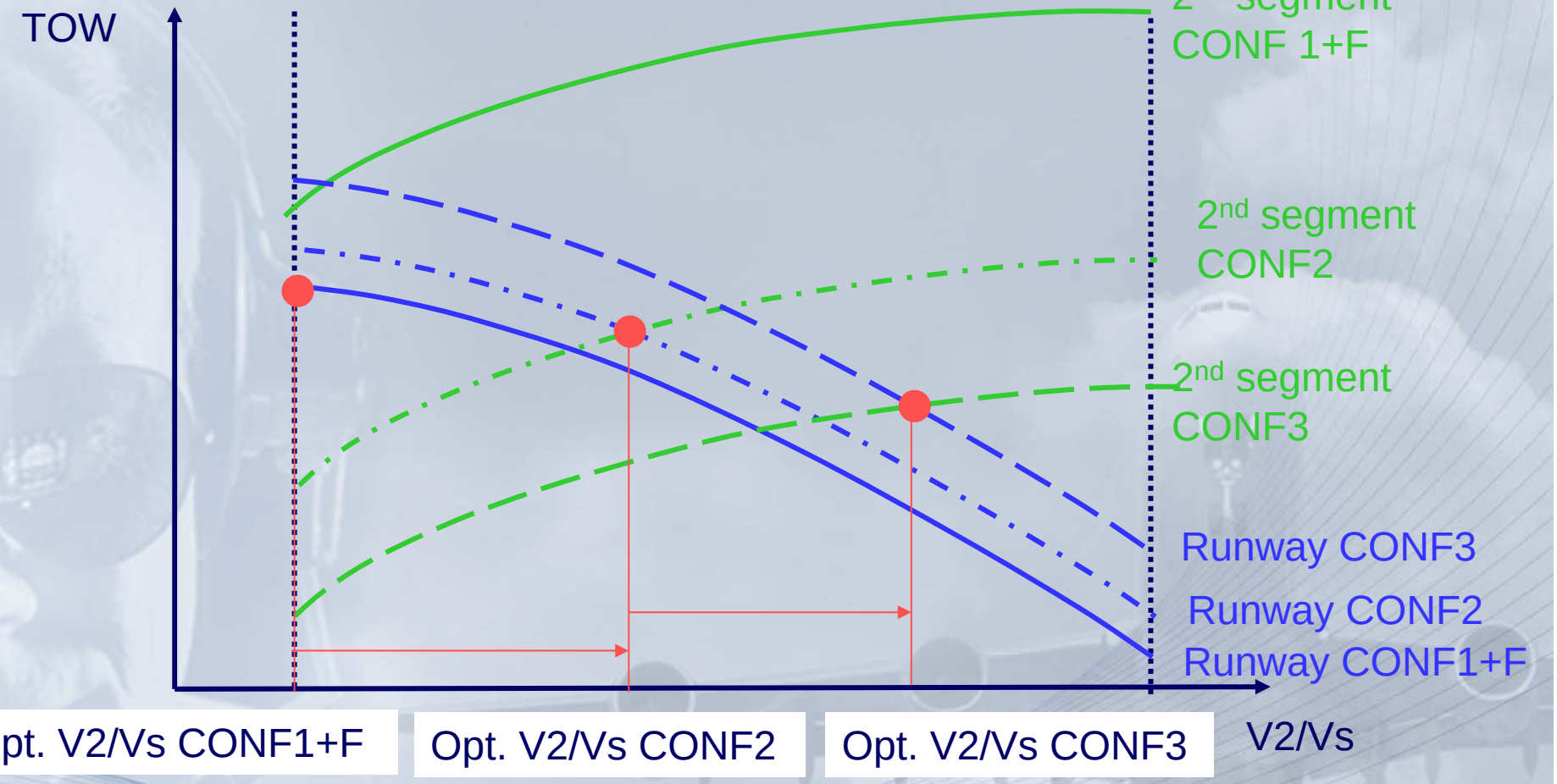
- 4 engine aircraft: very often at low speeds



Optimum V2/Vs

Choice of takeoff configuration

- Increase in flaps setting increases the V2/Vs:



Choice of takeoff configuration

- The risk of tailstrike can be minimized by increasing the flaps setting.
- Twin-engine aircraft: low risk.

- A340-200: lower risk of tailstrike due to shorter fuselage allowing a higher pitch attitude at takeoff
- A340-500/600: CONF 3 is the optimum configuration for takeoff
- A340-300: possibility to increase the tail clearance at lift-off:
  - Higher flaps setting → lower flexible temperature

Choice of takeoff configuration

A340313 - JAA	CFM56-5C4 engines	Default -	36	DRY
Wind 0 KT QNH 1013.25 HPA Air cond. AC OFF Anti-icing AI OFF Dry check		Elevation 0 FT TORA 3500 M Ins temp 15 C TODA 3500 M rwy slope 0.00% ASDA 3500 M	0 obstacle	NO DERATE

OAT C	CONF 1+F	CONF 2	CONF 3
45	250.5 3/3	251.9 3/3	248.8 3/3
52			230.9 3/3
54		229.6 3/3	3/3
55	229.3 3/3	227.2 3/3	223.6 3/3

1=1st segment 2=2nd segment 3=runway length 4=obstacles
5=tire speed 6=brake energy 7=max weight 8=final take-off 9=VMU

Min V1/VR/V2 = 128/131/138
CHECK VMU LIMITATION
Correct V1/VR/V2 = -0.2 KT/1000 KG

Choice of takeoff configuration

- Effect of a higher flaps setting on tail clearance:
  - CONF 1+F to CONF 2 : 0.6 to 0.9 ft
  - CONF 2 to CONF 3 : 0.9 to 1 ft

  - CONF 1+F to CONF 3 : 1.5 to 1.9 ft

- Effect of a higher flaps setting on flexible temperature:
  - CONF 1+F to CONF 2 : generally less than 1°C
  - CONF 2 to CONF 3 : generally less than 2°C

  - CONF 1+F to CONF 3 : generally 2 to 3°C

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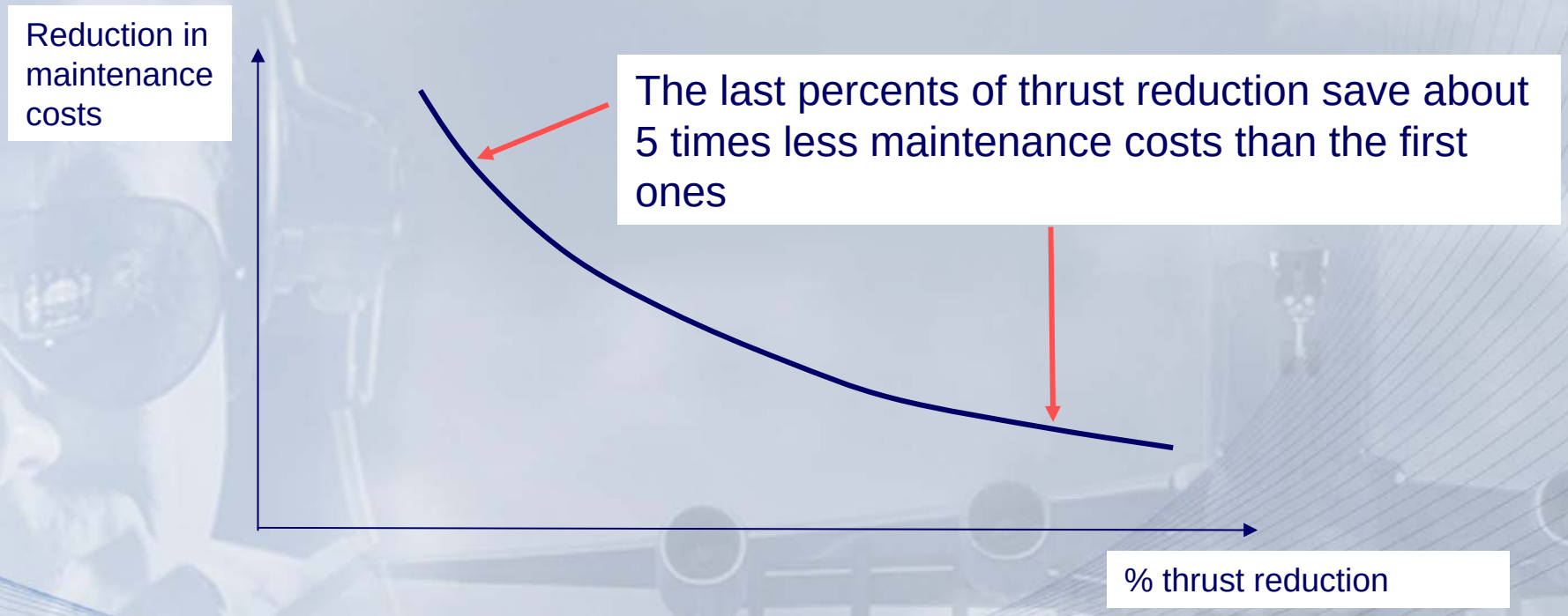
Choice of takeoff configuration

- For the A 340, possibility to increase the tail clearance at lift off by 1 to 2 ft at the expense of 2 to 3°C of flexible temperature.
- Effect of thrust reduction on maintenance costs:



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Conclusion

- Recommendations published in the FCOM:

TAKEOFF PROCEDURE

Depending on environmental takeoff conditions, the following procedure is recommended.

CONDITIONS	PROCEDURE	REASON
Dry or wet, well paved runway	Use flap setting giving the optimum performance. If takeoff performance is not limiting, consider the use of higher flap setting.	Extend engine life/improve aft body clearance.
High altitude takeoff	— Use CONF2/CONF3	Improve comfort.
Badly paved runway or Accelerate stop distance limited runway	— Use CONF2/CONF3 or — Move towards left side of the takeoff chart.	Improve comfort. Improve stopping distance.
Windshear expected along takeoff path	— Use maximum thrust.	Maintain acceleration capability.
Contaminated runway	— Use maximum thrust. (flex forbidden).	Improve stopping distance Decrease time on runway. Required by regulations.

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Conclusion

- ✓ Contaminated runway: TOGA and configuration giving the lowest speeds
- ✓ Windshear conditions: TOGA and lowest flaps setting
- ✓ High altitude or badly paved runway: Flexible thrust, and preferably CONF2/CONF3
- ✓ Other conditions,for all Airbus types, except A340-200/300: Maximize flexible temperature, but consider a higher flaps setting if it decreases the takeoff speeds, at the expense of a few degrees of flexible temperature (For A340-500/600, CONF3 is the best as well for flex as for tailclearance).
- ✓ Other conditions for A340-200/300: Flexible thrust and preferably CONF2 or CONF3:
  - ✓ The highest flaps setting when flexible temperature is well above Tref (~ 15°C above)
  - ✓ Only one step of flap higher when flexible temperature is close to Tref

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