

GENERIC STALL



Content

- Introduction
- Stall phenomenon
- AoA control
- Stall vs. Approach to stall
- Stall recovery
- Way forward: New procedure

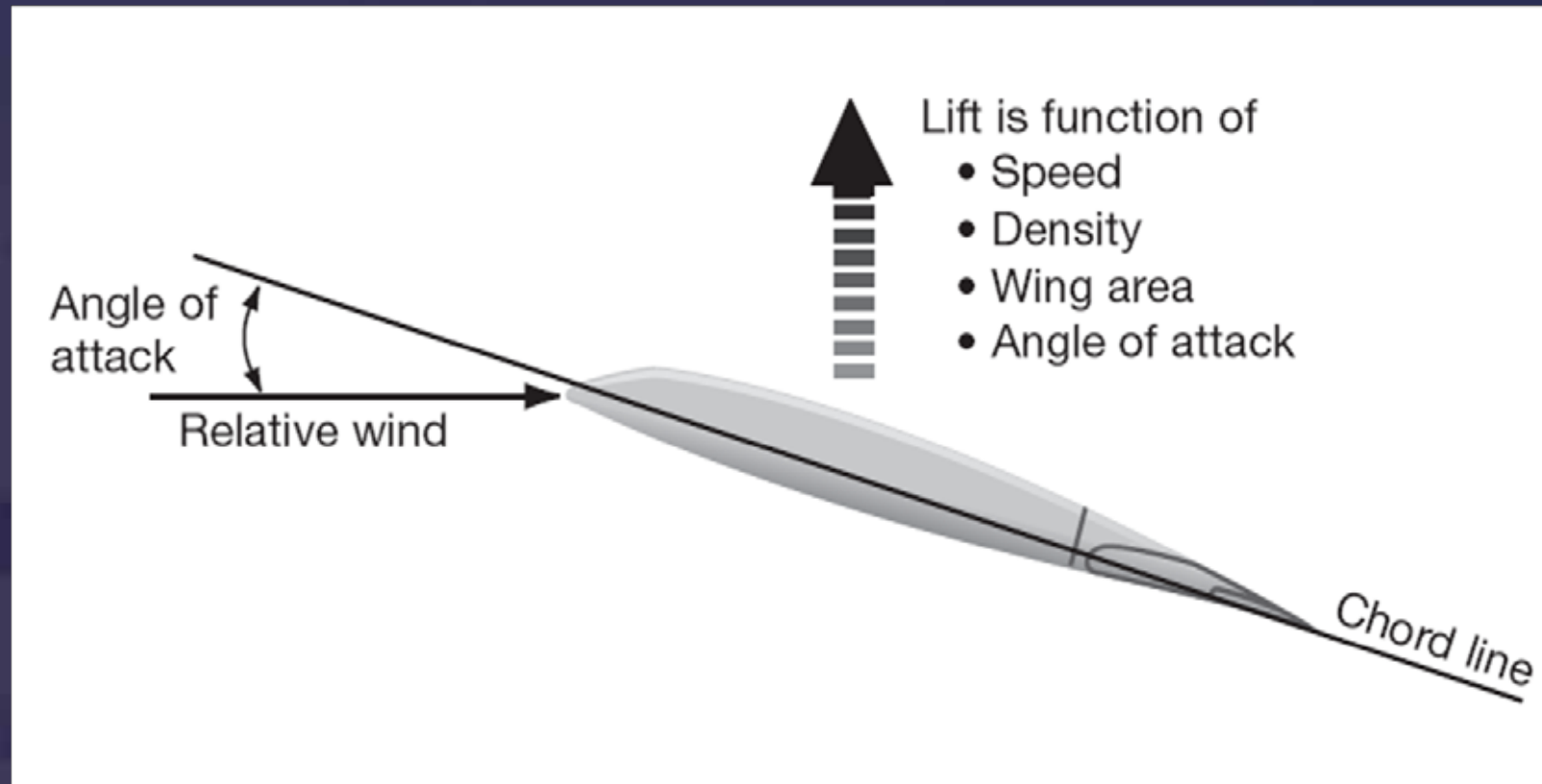
Introduction

- Accidents following failure to recover from stall still occur
- Stalls are frequently performed in flight test by all aircraft manufacturer for development and certification:
 - ▶ Unique experience to be shared with operational community
- Objective of this presentation: to make the operational community aware of **the need to change the current methods of STALL or APPROACH TO STALL recovery techniques**

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Aerodynamic Review



$$\text{Lift} = \frac{1}{2} \rho \cdot S \cdot V^2 \cdot C_l$$

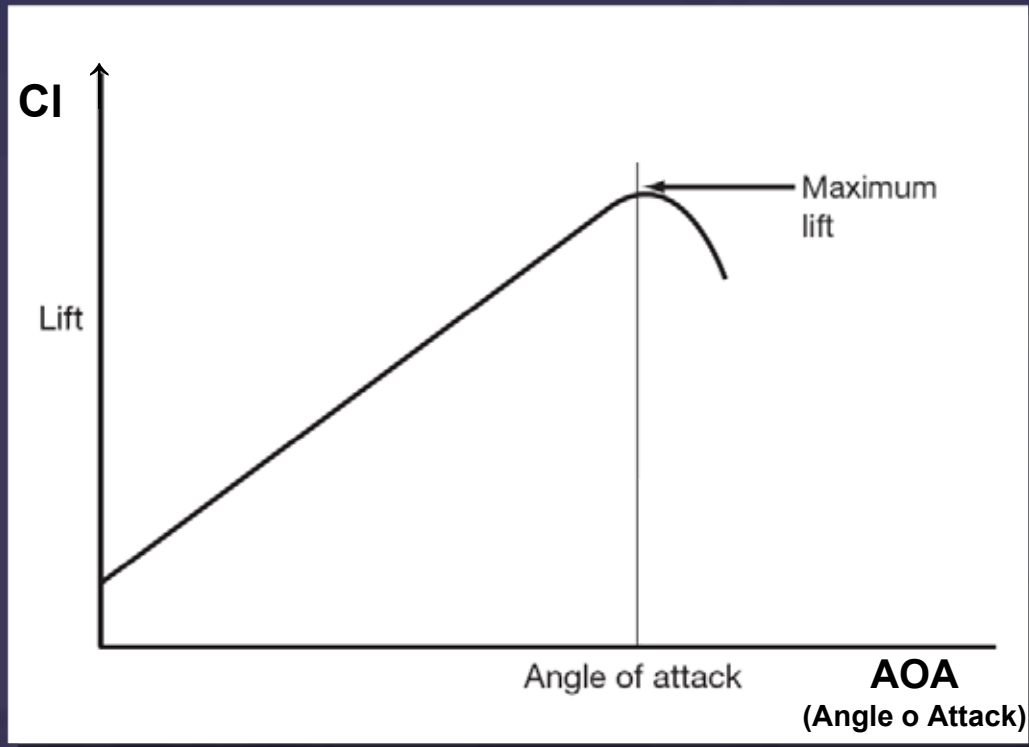
ρ : air density

S : wing surface

V : CAS

C_l : lift coefficient

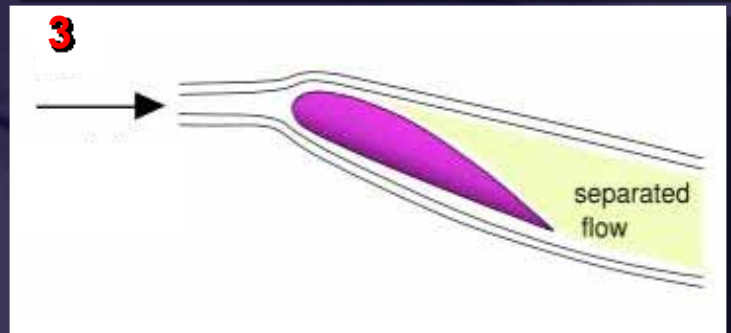
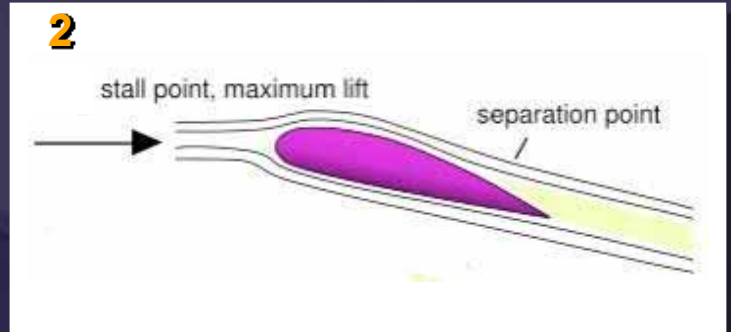
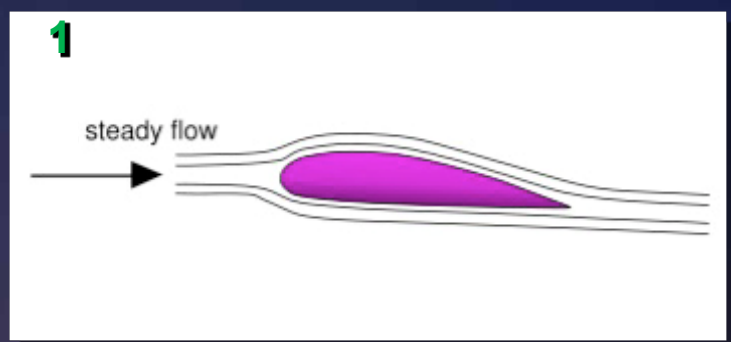
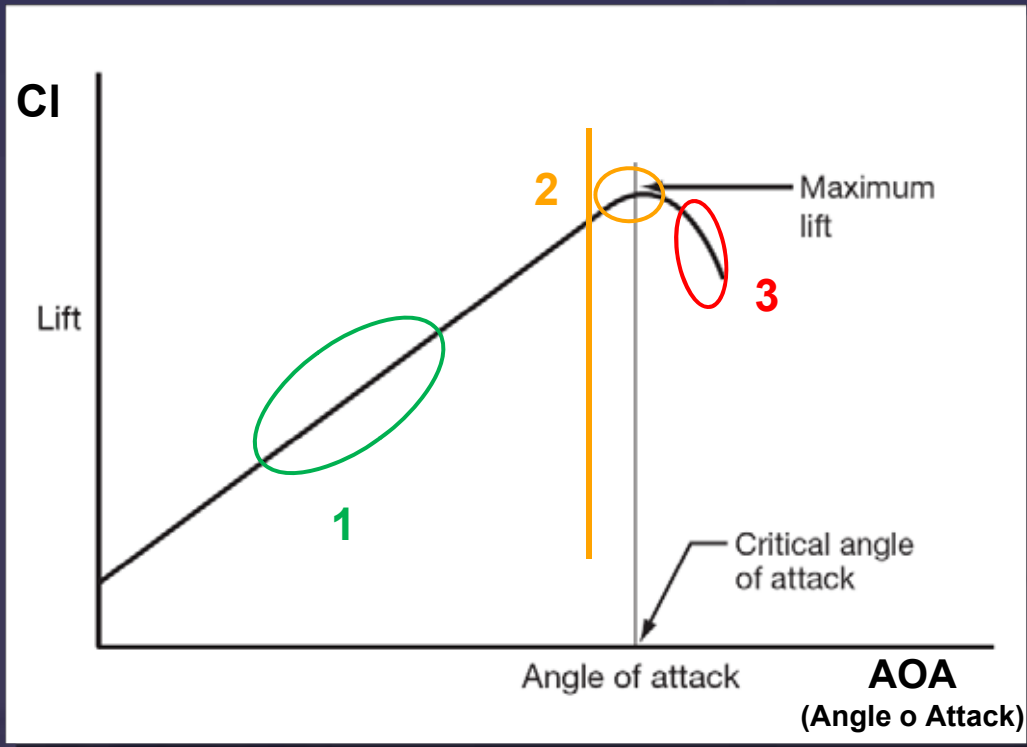
Lift Coefficient



- Cl has a direct relationship to AoA

For a given configuration, a given speed and a given altitude,
The Lift is only linked to AoA

Stall



- Cl has a direct relationship to AoA
- At a given AoA, the air flow separates from the profile, the Cl drops \Rightarrow The wing profile is stalled

For a given aircraft configuration and speed,
An aircraft stalls for a given AoA



Stall

- **Stall is an AoA problem only**

- ▶ For a given load factor, the loss of speed leads to increase the AoA, which could reach the stall AoA

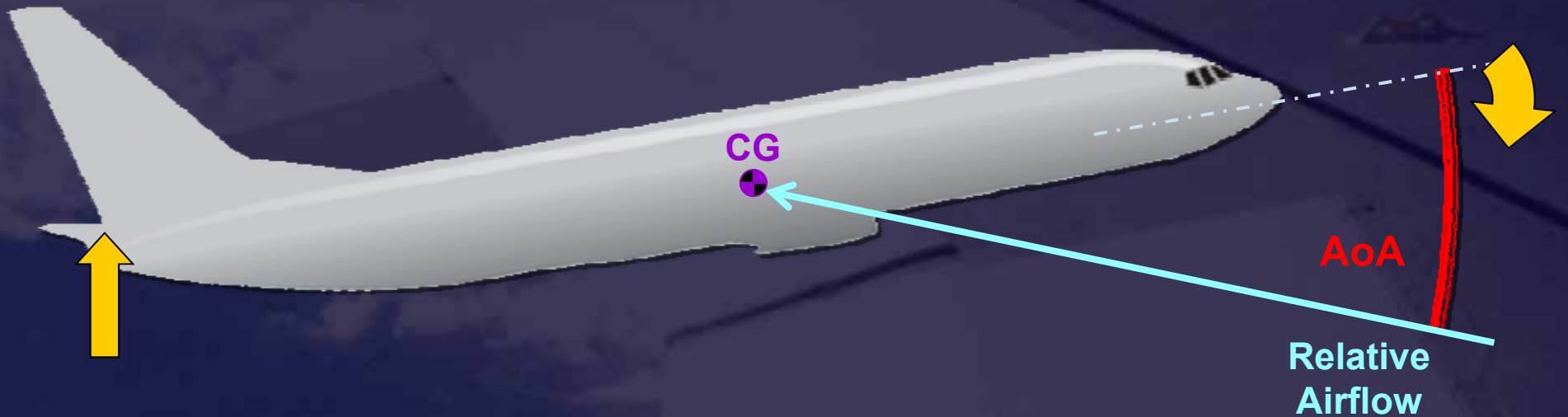
**Stall is an AoA problem only
It is NOT directly a speed issue**

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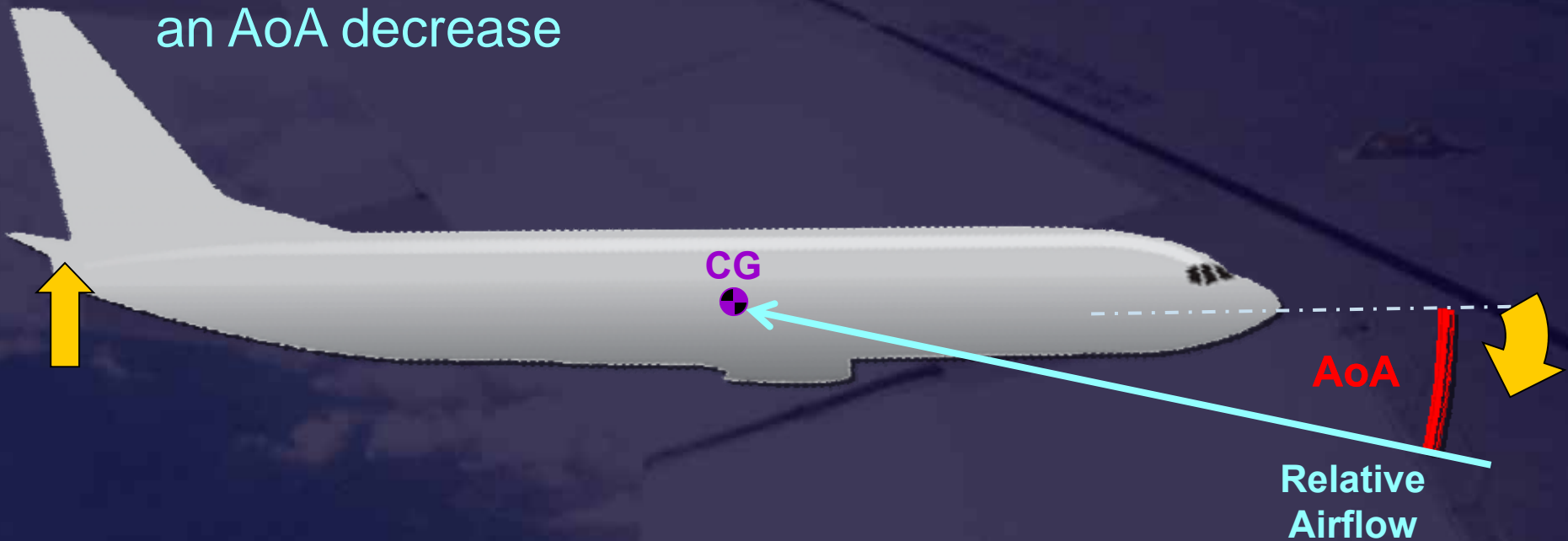
AoA Control

- **The pitch control is a direct AoA command**
 - ▶ The elevators control DIRECTLY the AoA
 - ▶ A nose down command has an IMMEDIATE effect: an AoA decrease



AoA Control

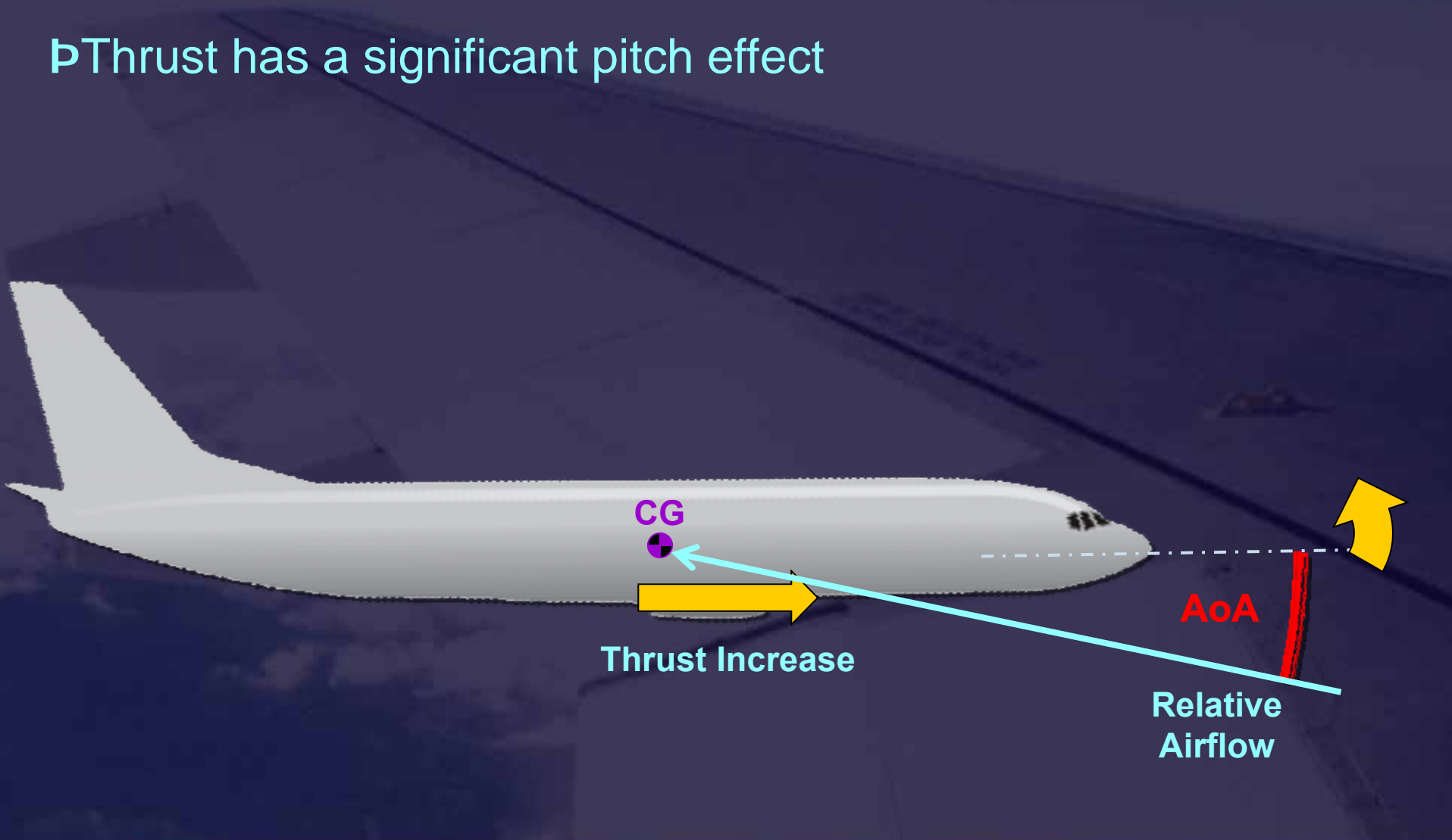
- **The pitch control is a direct AoA command**
 - ▶ The elevators control DIRECTLY the AoA
 - ▶ A nose down command has an IMMEDIATE effect: an AoA decrease



AoA Control

- Aircraft with engine below aircraft CG

↳ Thrust has a significant pitch effect

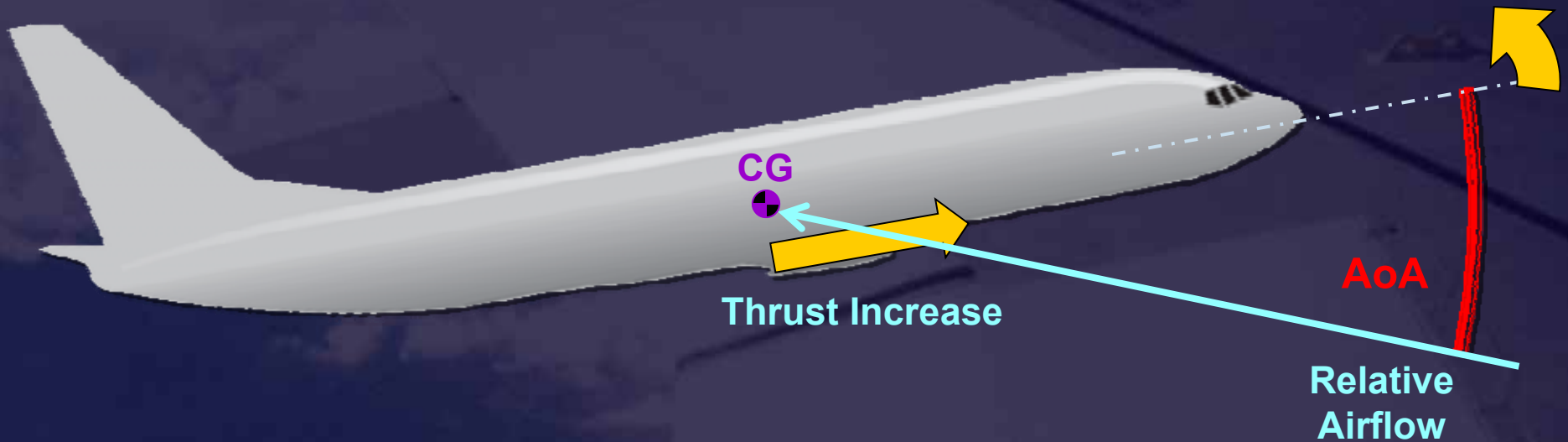


AoA Control

- Aircraft with engine below aircraft CG

↳ Thrust has a significant pitch effect

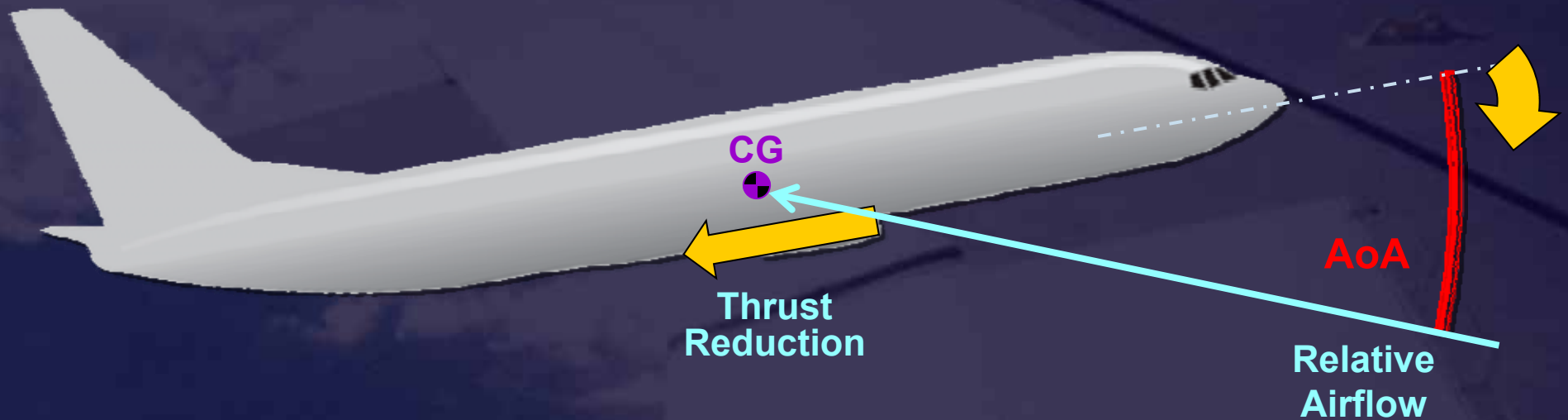
Thrust increase \Rightarrow AoA increase



AoA Control

- Aircraft with engine below aircraft CG

↳ Thrust has a significant pitch effect

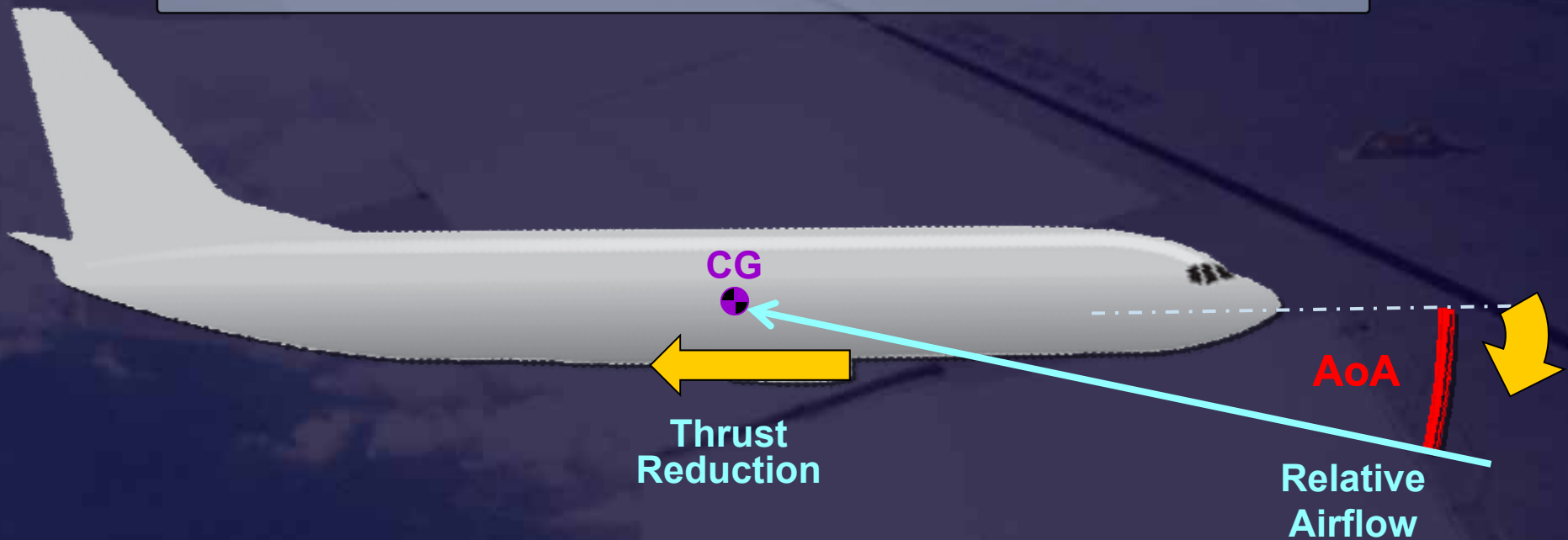


AoA Control

- Aircraft with engine below aircraft CG

↳ Thrust has a significant pitch effect

Thrust reduction \Rightarrow AoA decrease



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Stall vs. Approach To Stall

- The traditional APPROACH TO STALL training is characterized by a controlled deceleration to stall warning, followed by a power recovery with minimum altitude loss
- The difference between an APPROACHING STALL and an ACTUAL STALL is not easy to determine, even for specialists
- In numerous accidents, the APPROACH TO STALL procedure was applied whereas the aircraft was actually stalled

Approach To Stall Recovery

- Classical Approach to stall procedure focuses:
 - ▶ On thrust application
 - ▶ Minimum loss of altitude
- It is NOT appropriate for EVERY stall condition:
 - ▶ Possible inability to reduce AoA with the TOGA thrust application
 - ▶ Recovery may require thrust reduction
 - ▶ Recovery from a stall may require altitude loss

**A single procedure has to be defined
focusing on AoA reduction**

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Stall Recovery

As soon as any stall indication is recognized

• “NOSE DOWN PITCH CONTROL.....APPLY”:

▶ **AoA must be reduced to regain lift:**

- Apply nose down pitch order on the side-stick
- If needed, reduce thrust in case of lack of pitch down authority
- Ensure wings are level

AoA comes first...

Stall Recovery

When out of stall

- INCREASE ENERGY

- ▶ Thrust increase smoothly as needed

Notes:

- . Immediate maximum thrust application upon stall recognition is not appropriate
- . Thrust has an adverse effect on AoA for aircraft with under wing mounted engines
- . Due to the engine spool up time, the aircraft speed increase that results from thrust increase, is slow and does not enable to reduce the AOA instantaneously

- ▶ Ensure that speed brakes are retracted

- ▶ Recover smoothly the initial flight path

AoA comes first, energy second

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New Procedure

- **Spirit of what is the new procedure**

- ▶ One single procedure to cover ALL stall conditions
- ▶ Get rid of TOGA as first action
- ▶ Focus on AoA reduction

New Procedure

- **The stall recovery procedure is available on the Airbus World portal and will be dispatched to operators as follows:**

- ▶ **A318/319/320/321 aircraft:**

- FCOM volume 3 Temporary Revision number 323-1
- QRH Temporary Revision number 727-1

- ▶ **A330 aircraft:**

- FCOM volume 3 Temporary Revision number 552-1
- QRH Temporary Revision number 353-1

- ▶ **A340 aircraft:**

- FCOM volume 3 Temporary Revision number 512-1 (A340-200/-300)
- FCOM volume 3 Temporary Revision number 513-1 (A340-500/-600)
- QRH Temporary Revision number 369-1

- ▶ **A380 aircraft:**

- FCOM Procedures / Non-ECAM Abnormal and Emergency Procedures / Operating Techniques

- ▶ **In addition, the Flight Crew Training Manuals will be revised accordingly**

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Stall

