

# 1<sup>st</sup> Asia Pacific Workshop on Flying at High Altitude under Adverse Weather Conditions



## High Altitude Maneuvering in Adverse Weather - An Operational Perspective

Captain Peter Bowyer, Technical & Safety Pilot, The Boeing Company

### Organisers



### Supporting Partners



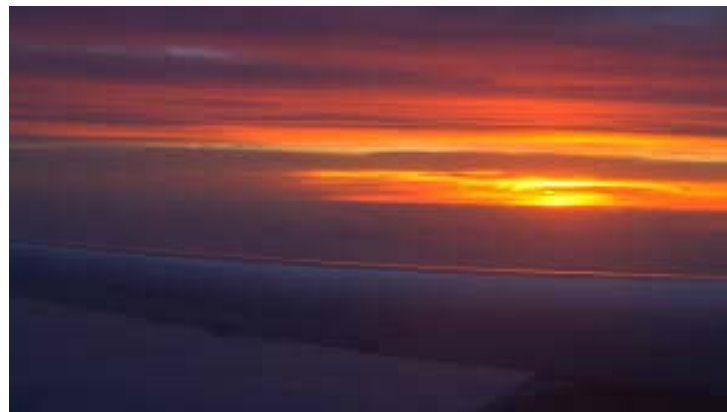
# An Operational Perspective

## High altitude? Maneuvering? Weather?



# Just another flight..

Optimum cruise altitude  
Waypoint time & fuel checks complete  
Winds & enroute weather as forecast  
Destination & alternate weather checked  
AFTN logged on  
Selcal checked  
Monitoring 121.5Mhz & 126.95Mhz...

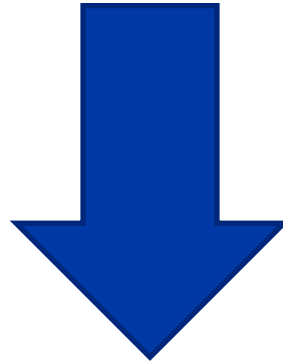


## However –

Light turbulence  
Shifting of the cruise wind  
Fluctuation of the airspeed  
Line of thunderstorms on the weather radar  
St. Elmo's Fire on the forward screen  
Flashes of lightening on the horizon.....



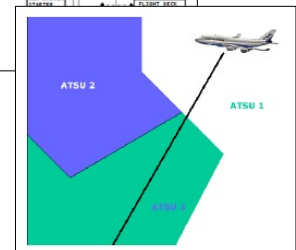
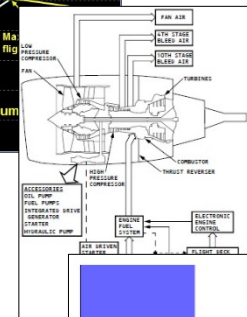
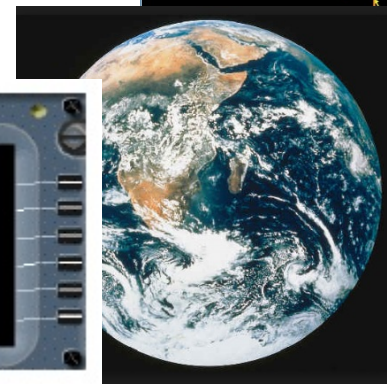
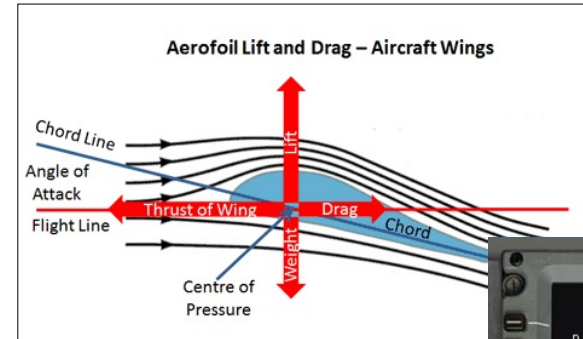
# Knowledge, Preparedness & the Use of Real Time Information



Flight Crew Knowledge & Skill  
Aircraft Equipment & Technology  
Training Scenarios

# Flight Crew Knowledge & Skill

- Aerodynamic knowledge
- Engine performance
- Monitoring of the PFD
- Manual flight path management
- Automated flight path management
- QRH memory items
- Seasonal knowledge of weather systems & Ice Crystal Icing
- Inflight contingencies & weather avoidance routines
- Spatial/situation awareness
- Use of TCAS
- Position reporting
- Upset Prevention & Recovery
- CRM & TEM



Pilot Judgment – sequence of actions, appropriate to the specific circumstance



# Aircraft Equipment & Technology

- Primary Flight Display
- Primary Navigation Display
- Use of weather radar
- RNP & XTE
- HUD
- ACARS & Data link
- TCAS
- RCAS – EBAWRCA
- Stall warning
- Internet



# Roll Command Augmentation System (RCAS)

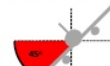
Also known as -

- Roll/Yaw Asymmetry Alert
- Roll Authority Alert
- Roll Command Arrow

## "ROLL RIGHT (LEFT)"

Alert Sets When:

- 45° of Bank has been exceeded
  - Regardless of the Autopilot state of engagement
- PFD / HUD alerting features:
- A sweeping red arced roll command arrow graphically illustrates ROLL RIGHT
  - The Bank Angle and Slip/Skid indicators outline and fill
  - Correlated aural "ROLL RIGHT" (or "ROLL LEFT")
  - HUD capture bar and Altitude Mode



## BANK ANGLE Callout Integration

NORMAL FLIGHT ENVELOPE, MANUAL & AUTOMATED FLIGHT

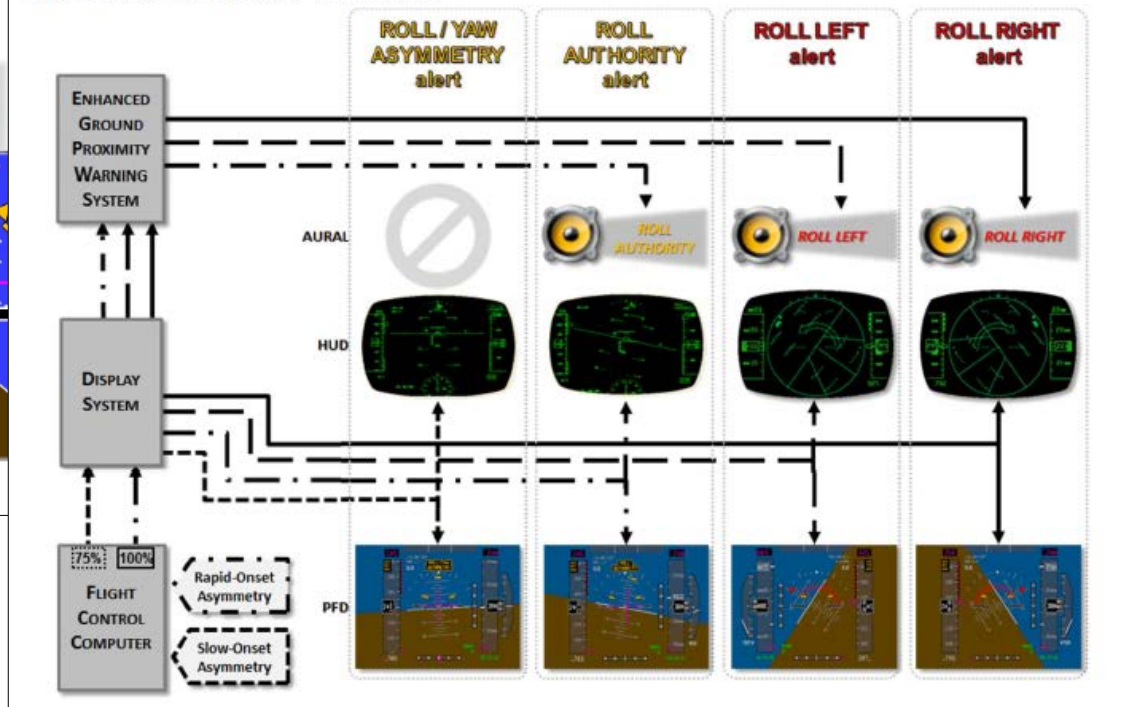
Existing  
BANK ANGLE Callouts

New

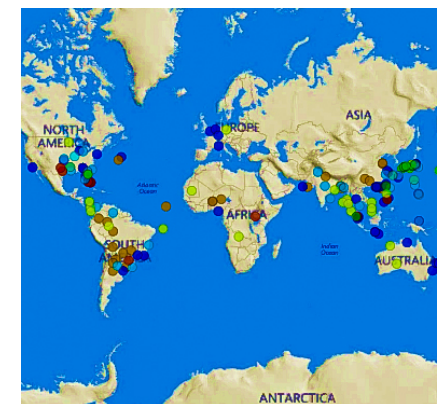
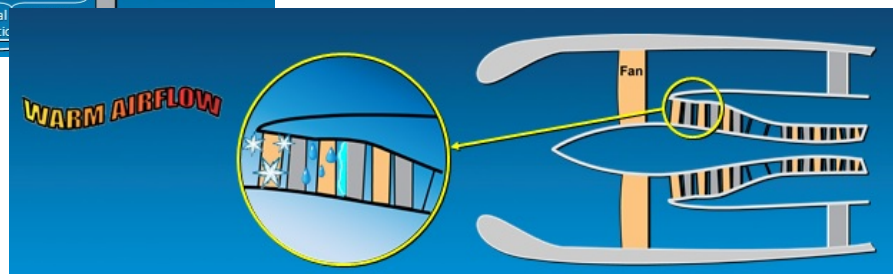
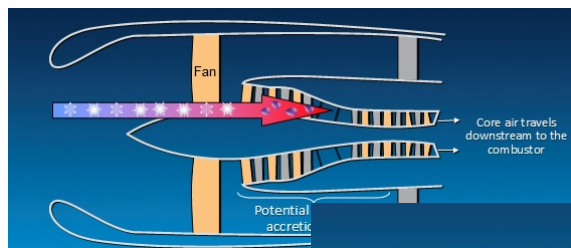
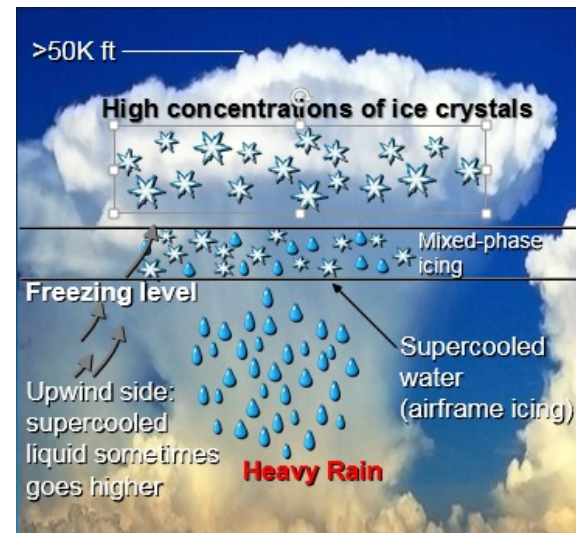
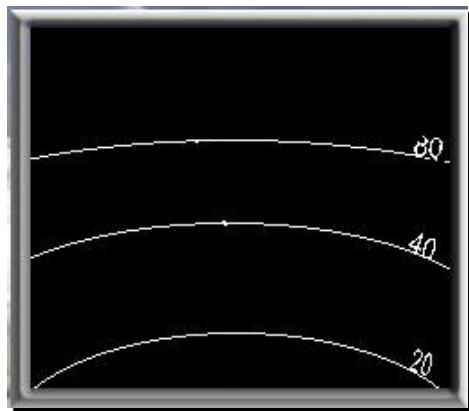
ROLL LEFT / ROLL RIGHT  
Warnings



## System Architectural Overview



# Ice Crystal Icing (ICI)





## Weather avoidance

## Turbulence

## Startle effect

## Ice accumulation

## Unreliable airspeed – Manual flight

## CPDLC routines

## Communications

## Overspeed

## Underspeed

## Stall recovery

## Upsets

## TCAS at maximum altitude

## System degradation

## Drift down



# Conclusions

## **High altitude basics –**

The maximum altitude at which an aircraft can be operated is the lowest of –

Maximum certified altitude – Structural Limitation

Thrust limited altitude – Thrust Limitation

Buffet or maneuver limited altitude – Aerodynamic Limitation

## **To avoid –**

Be proactive and use all available information resources

Request early avoiding action

## **Caught in the adverse weather -**

Be aware – at altitude the operational envelope is reduced

Be alert – no time for complacency

Recognise and confirm the situation

Do not over control – use small, smooth control inputs in pitch and roll

Communicate with ATC and other aircraft in your vicinity

Team work is paramount

