

الهيئة العامة للطيران المدني
GENERAL CIVIL AVIATION AUTHORITY

AIR ACCIDENT INVESTIGATION SECTOR



United Arab Emirates

Unreliable Airspeed Indication

Airbus A340-600, ETD460, 3 Feb 2013 at 0049 UTC



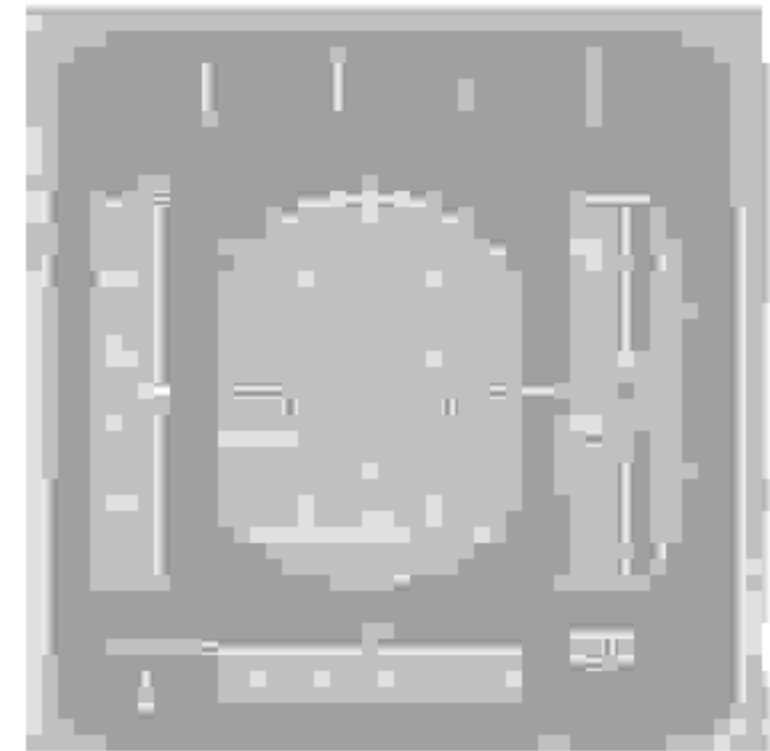
Unreliable Airspeed Indication

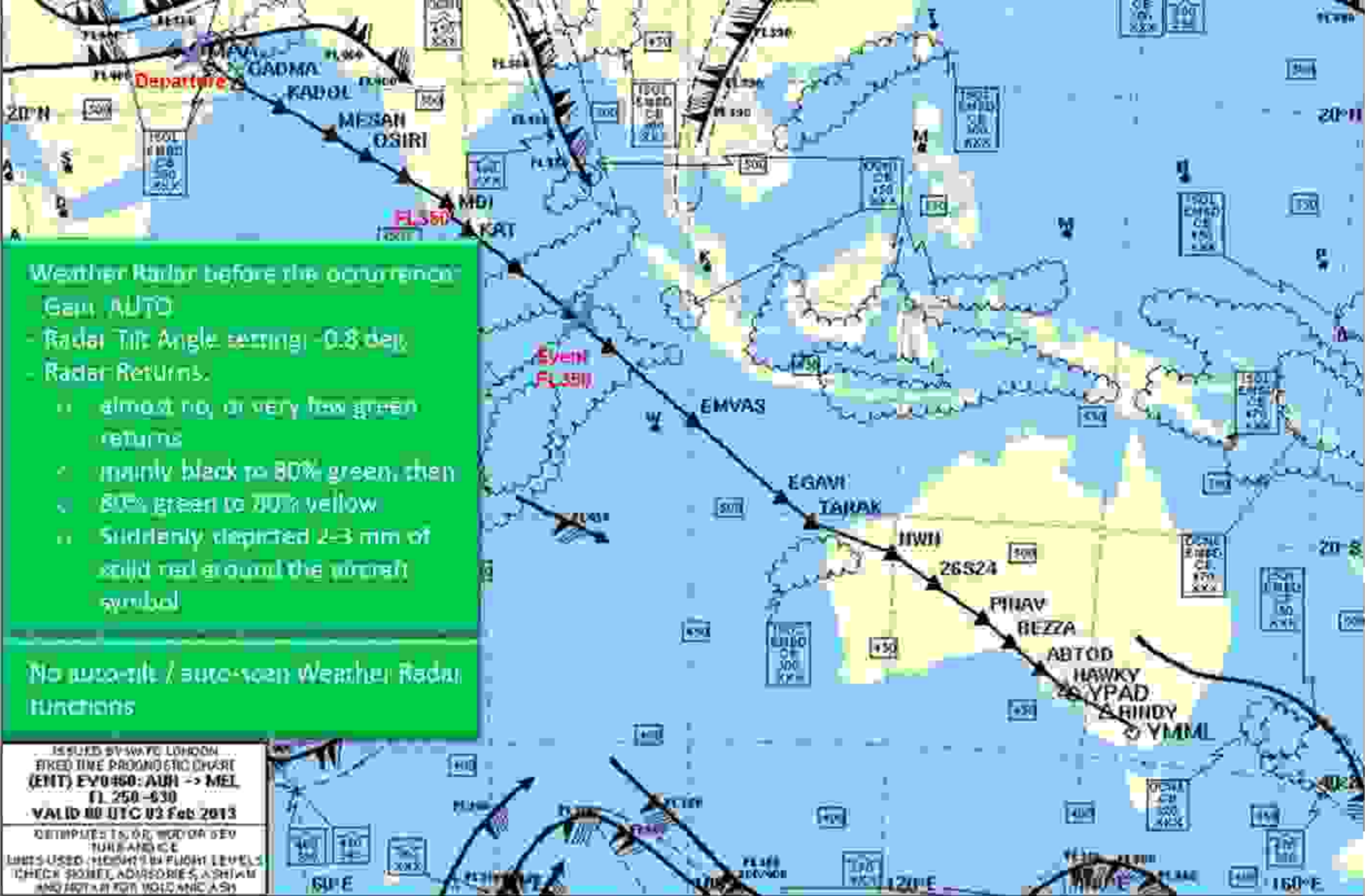
Notification to GCAA

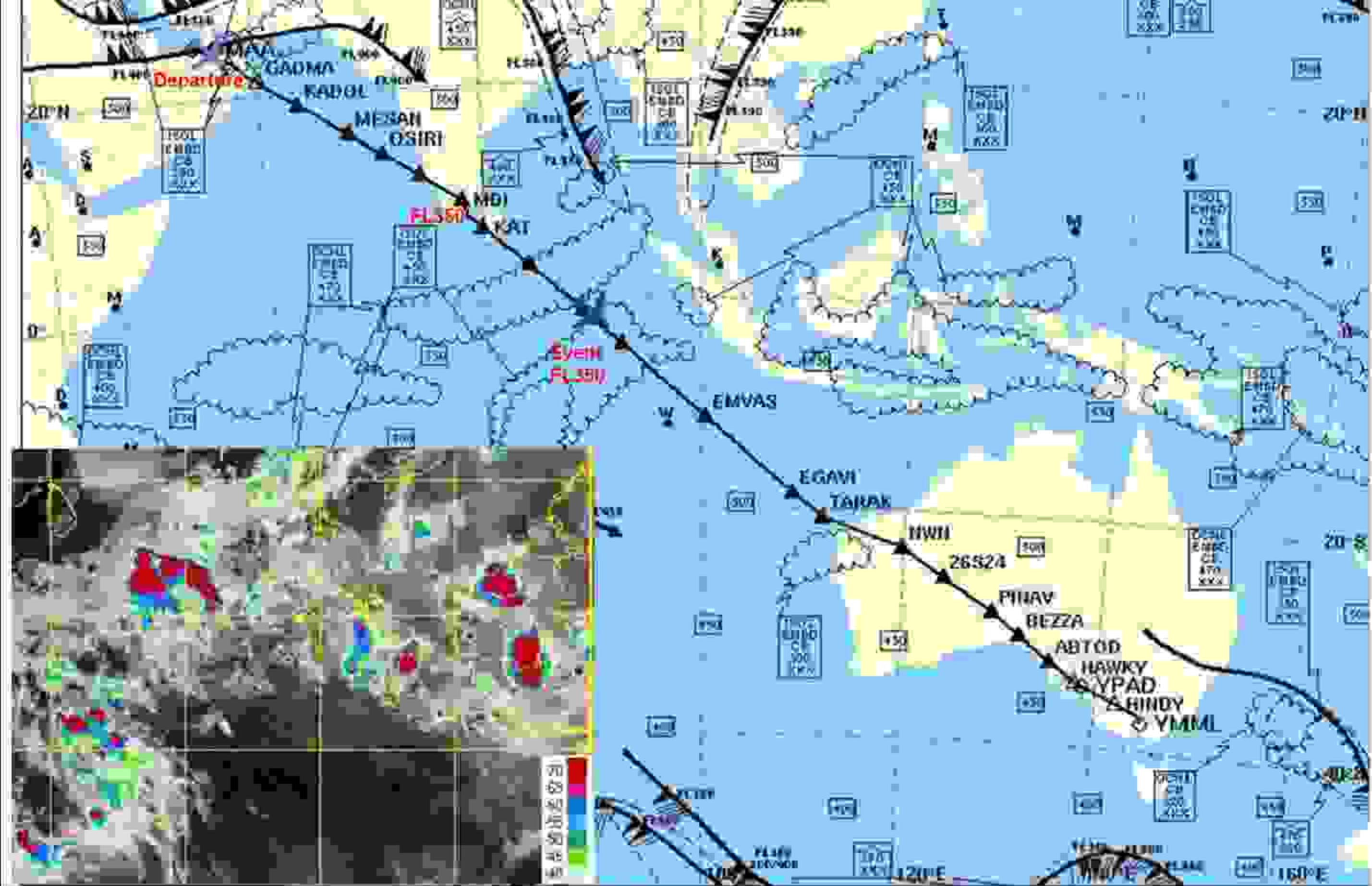
FDR preservation

Notification to ICAO &
BEA (State of Design &
Manufacture)

Accredited Representative









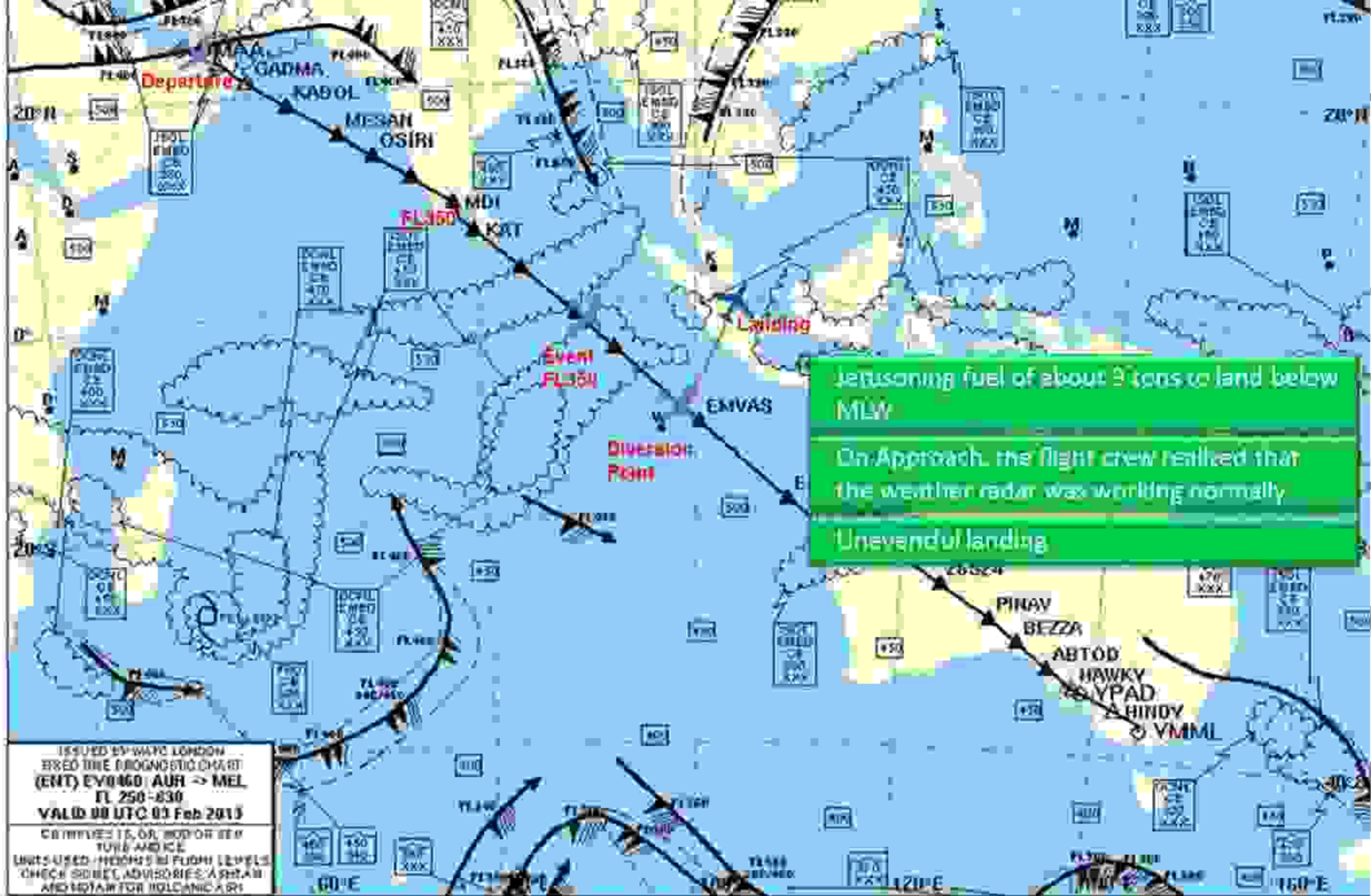
- The observation**
- Instances of altitude fluctuation
 - No stall warning or overspeed was triggered
 - AP disengagement after Flight Control Law reverted from Normal to Alternate
 - Attempting to re-engage the AP, neither AP1 nor AP2 could be re-engaged
 - Consideration of the loss of RVSM capability
 - Not ascertain the serviceability status of the weather radar
 - Diversion decision

ISSUED BY SWA FE LONDON
 FIXED TIME PROGNOSTIC CHART
 (ENT) EY0460: AUH -> MEL
 FL 250-630
 VALID 00 UTC 03 Feb 2013

ORIGIN: TAU, OR, WOODHAY
 TURBANCE
 LIMITS USED: HEIGHTS IN FLIGHT LEVELS
 CHECK FORECAST ADVISORIES, AIRMET
 AND NOTAMS FOR WOLC AND CAS







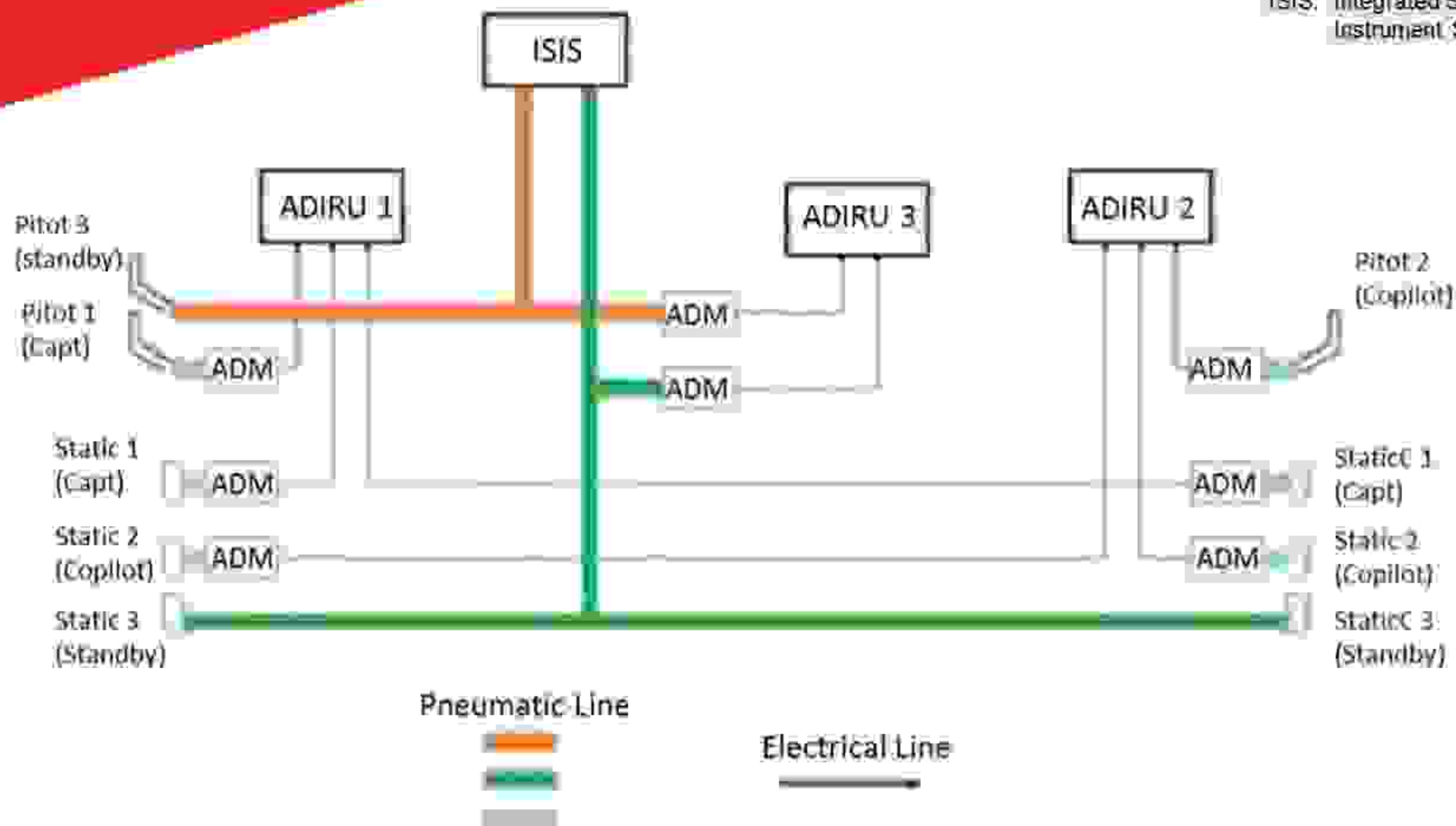
Airspeed Measuring System

Note

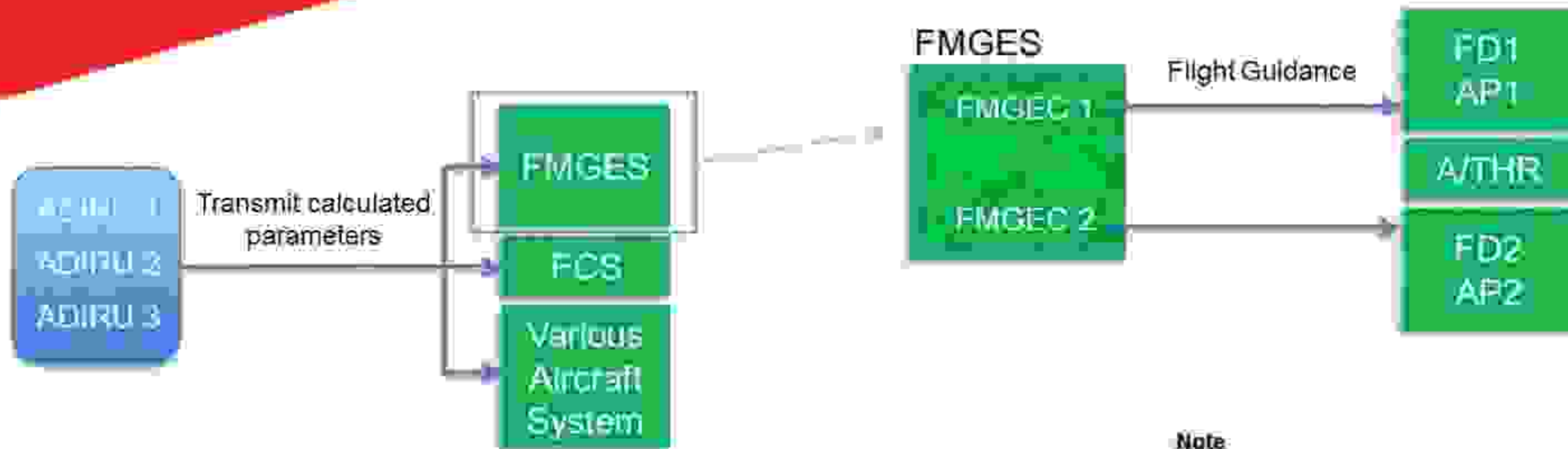
ADM: Air Data Module

ADIRU: Air Data Inertial Reference Unit

ISIS: Integrated Standby Instrument System



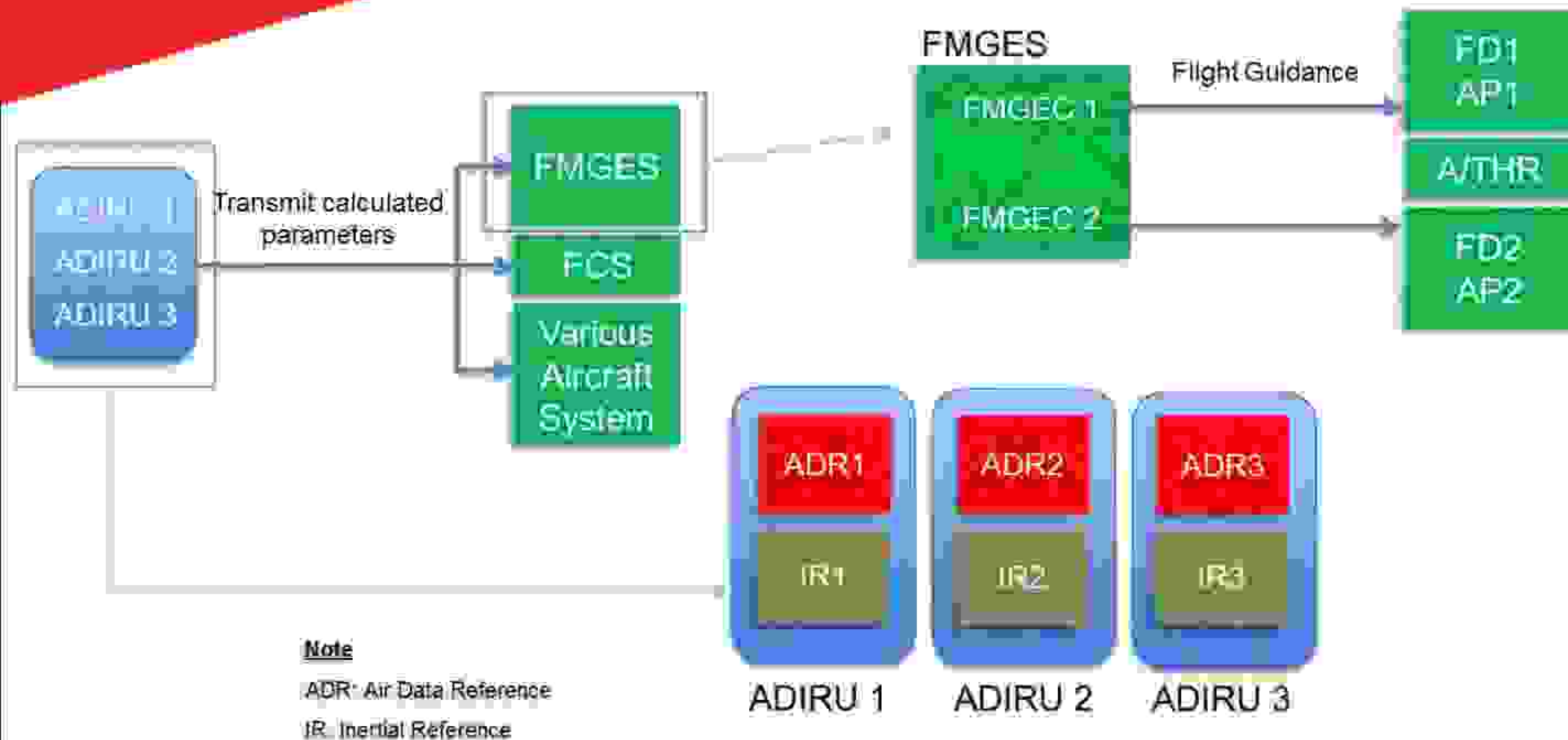
Flight Guidance System



Note:

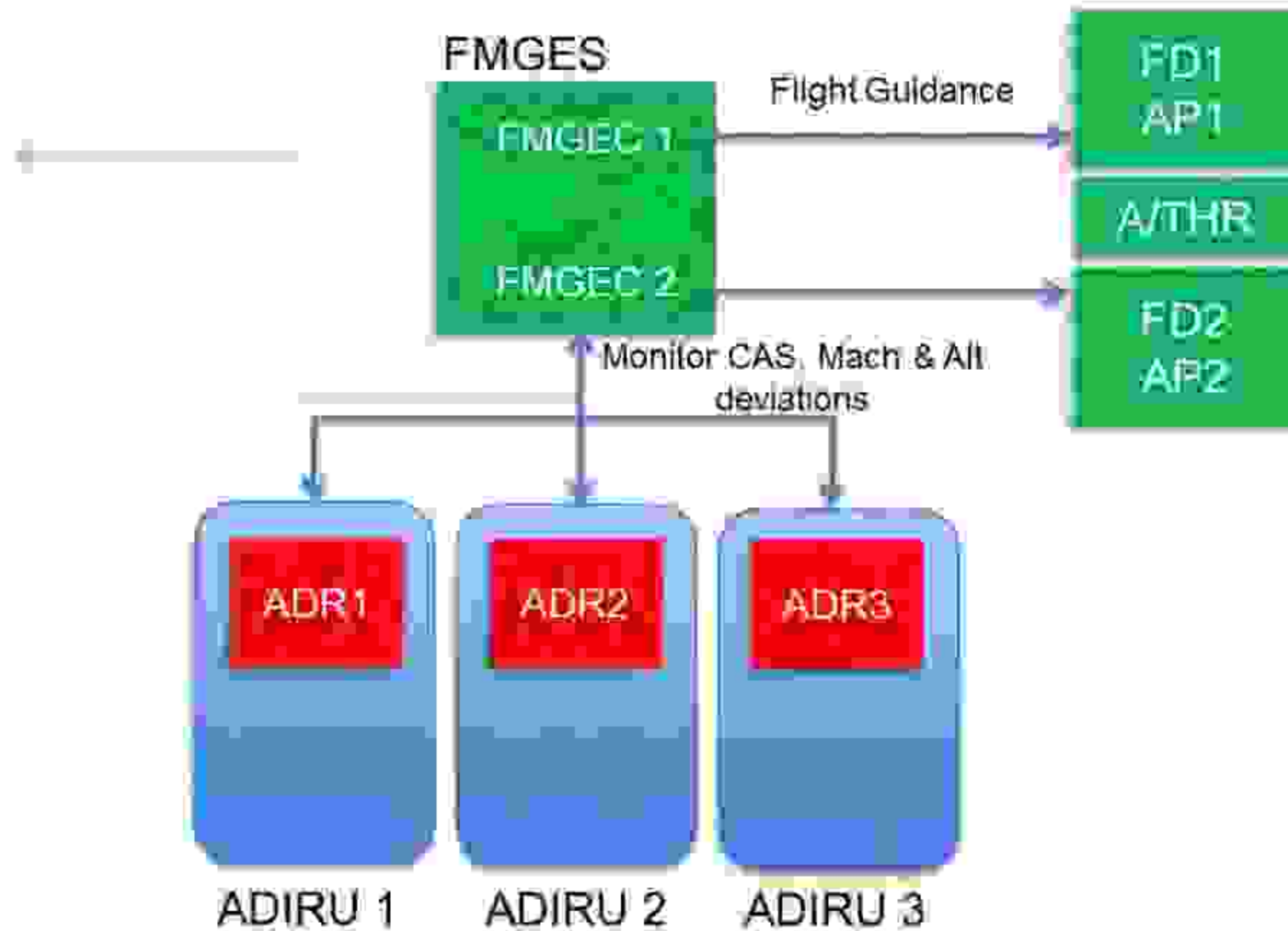
- FMGES: Flight Management Guidance and Envelope System
- FMGEC: Flight Management Guidance and Envelope Computer
- FCS: Flight Control System
- FD: Flight Director
- AP: Autopilot
- A/THR: Autothrust

Flight Guidance System



Flight Guidance System

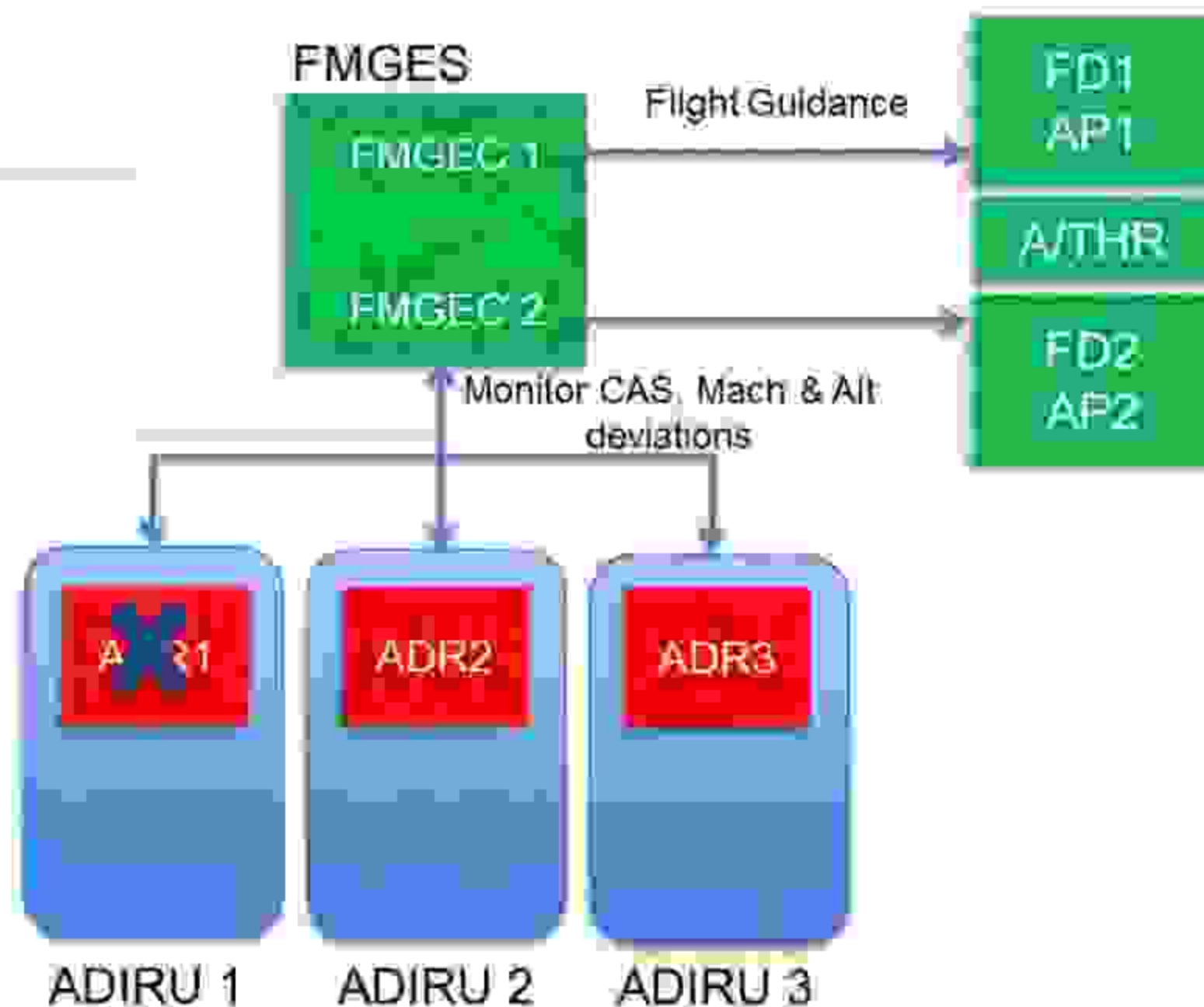
FMGEC – ADR Monitoring
(AF Disconnection Logic)



Flight Guidance System

FMGEC – ADR Monitoring (AF Disconnection Logic)

If any of the 3 parameters is out of tolerance the associated ADR output is rejected

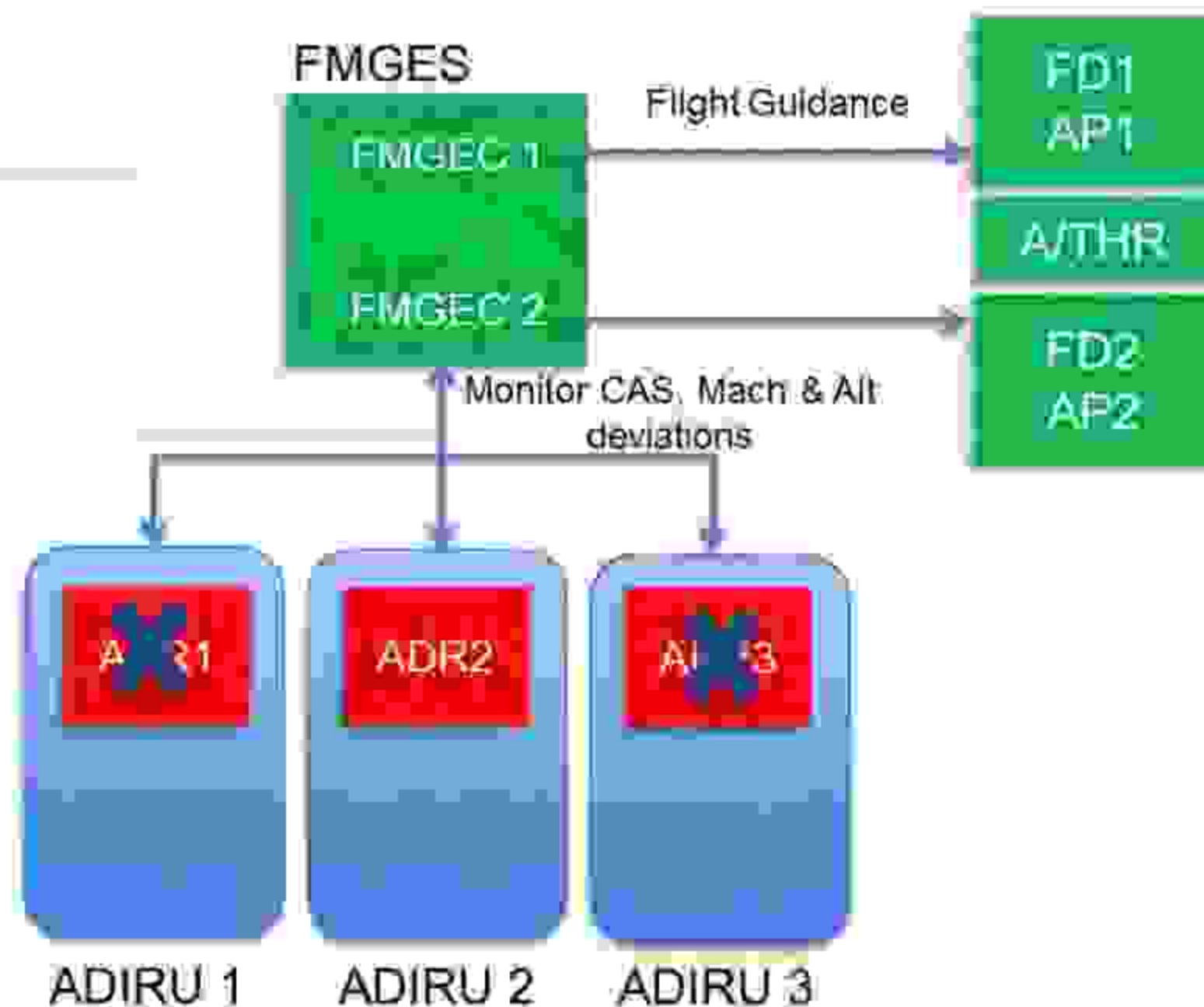


Flight Guidance System

FMGEC – ADR Monitoring (AF Disconnection Logic)

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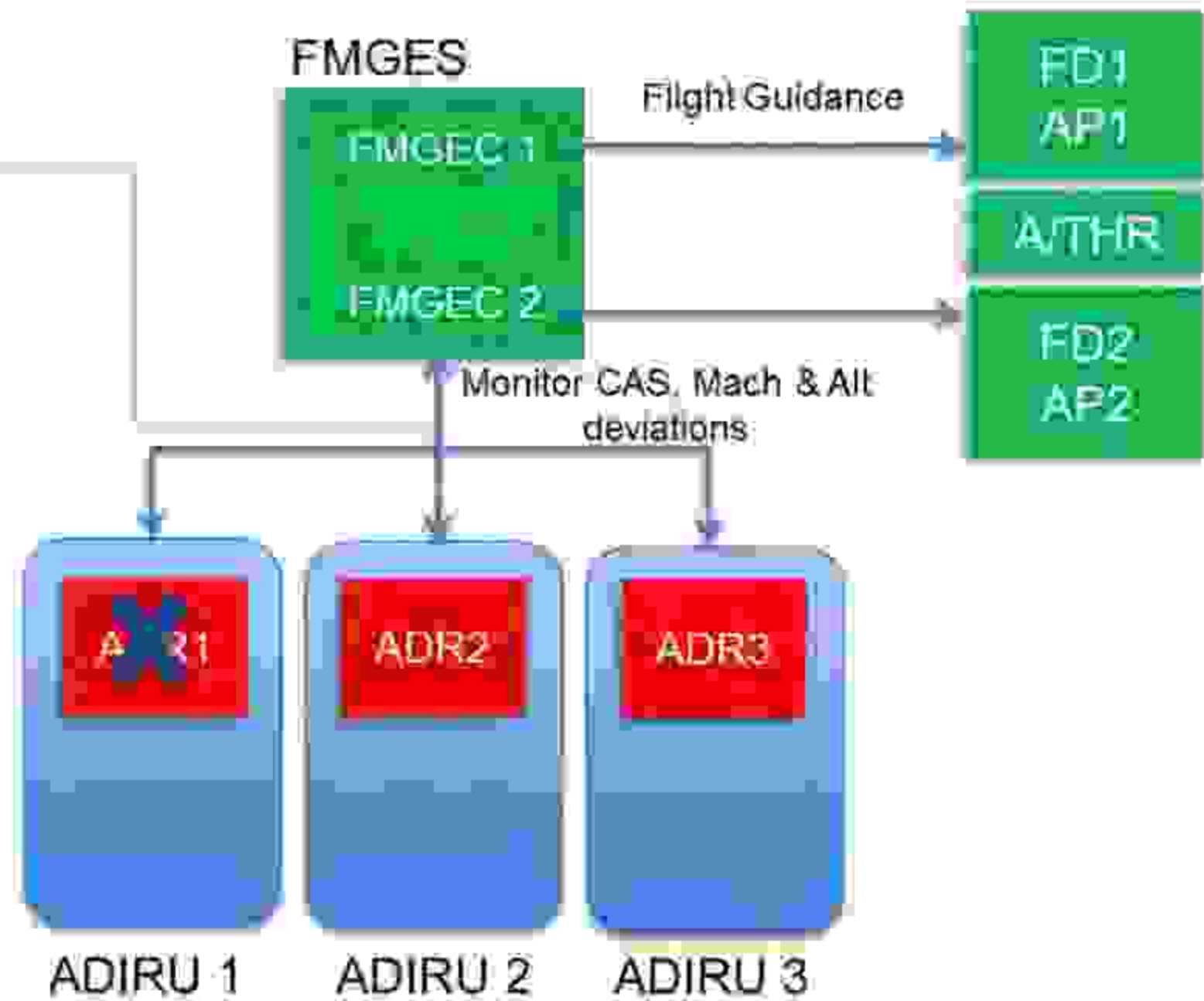
If one of the 2 remaining ADR outputs is out of tolerance, then FMGECs disconnected AP, A/THR & FD automatically



Flight Guidance System

FMGEC – ADR Monitoring (AF Disconnection Logic)

- If any of the 3 parameters is out of tolerance the associated ADR output is rejected
- If one of the 2 remaining ADR outputs is out of tolerance, then FMGECs disconnect AP, A/THR & FD automatically
- At least 2 valid ADR outputs return to within tolerance, the re-engagement of FDs & A/THR becomes possible



Flight Guidance System

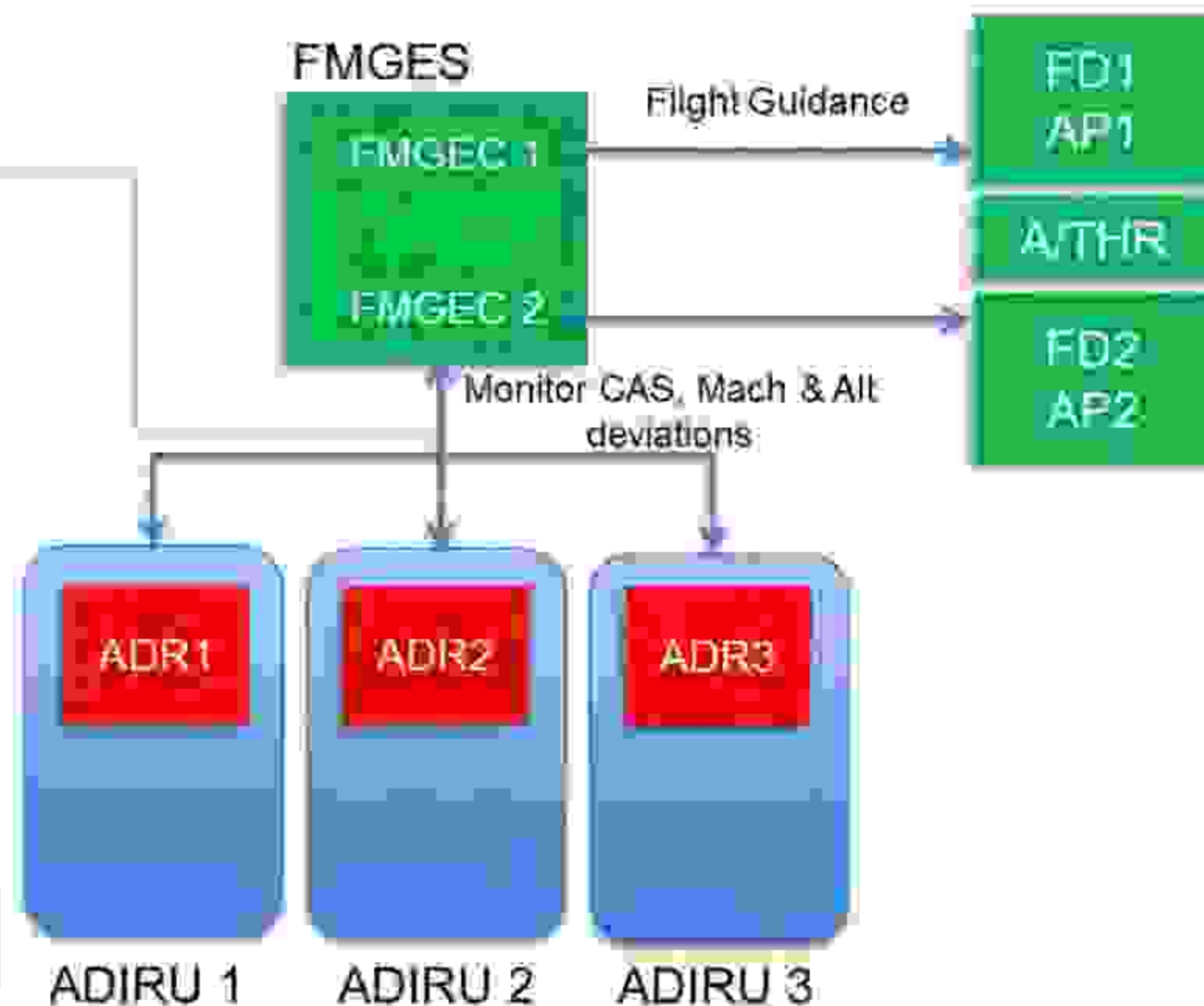
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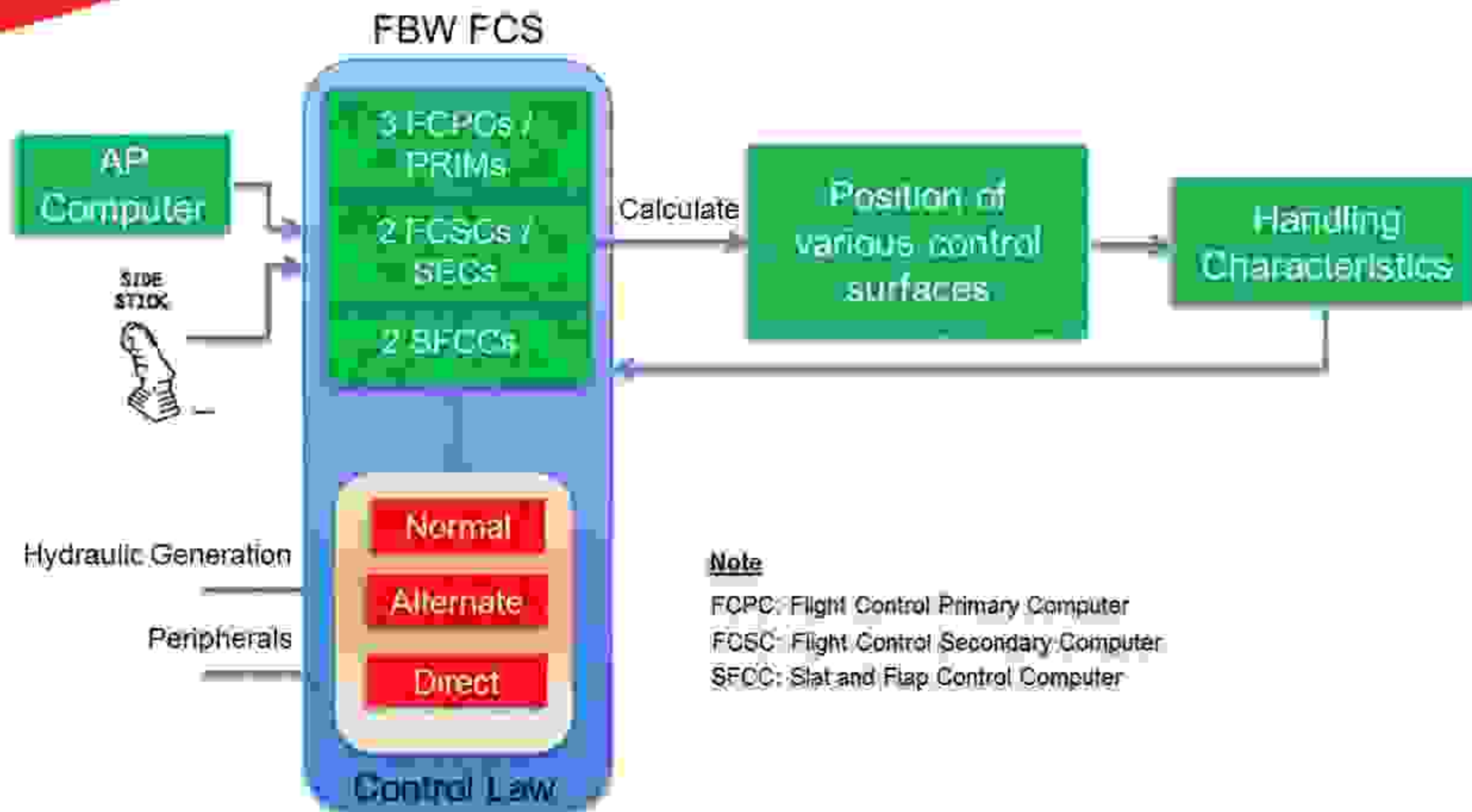
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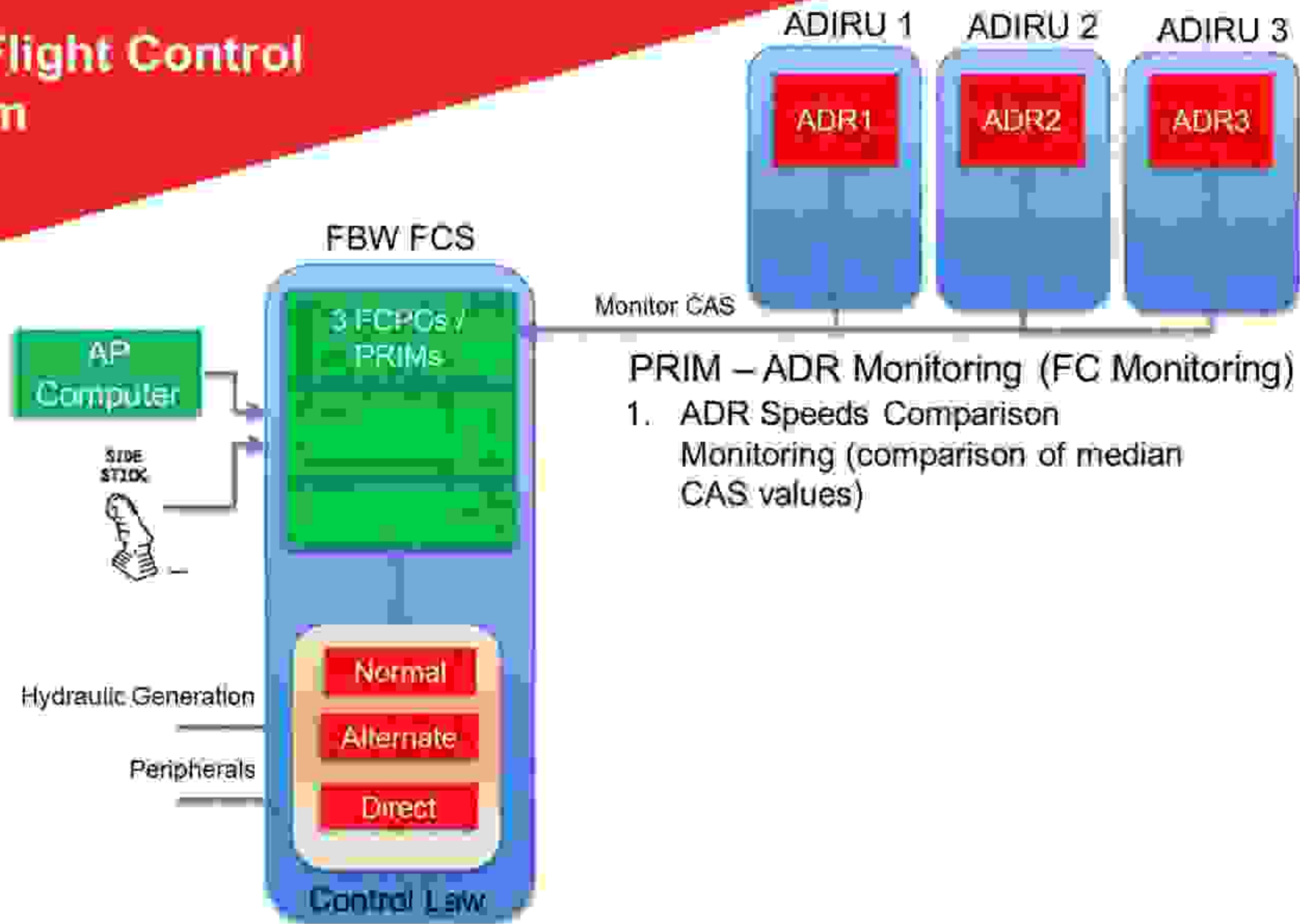
FD, A/THR & a part of AP logics are controlled by the FMGECs



FBW Flight Control System



FBW Flight Control System

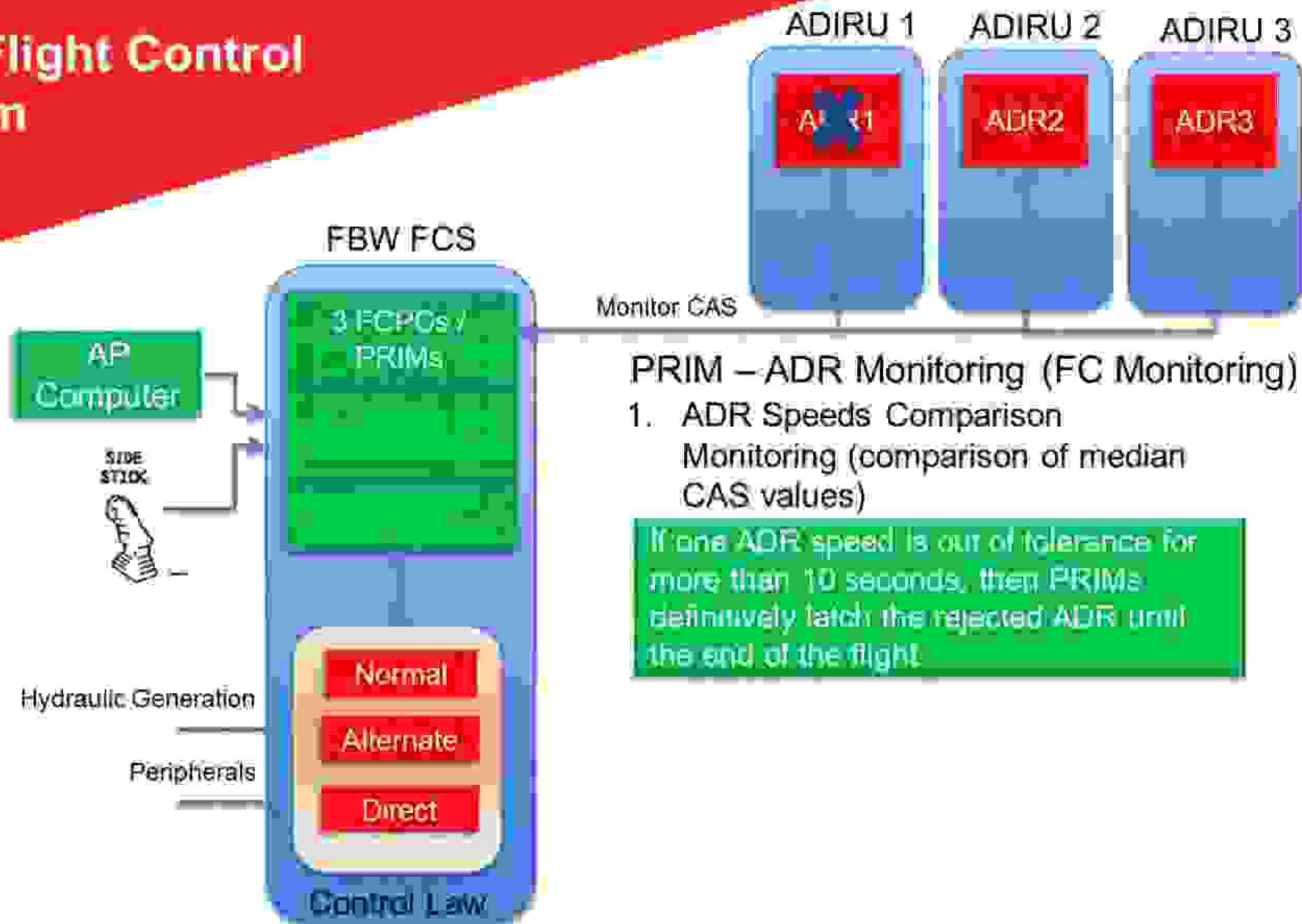


PRIM – ADR Monitoring (FC Monitoring)

1. ADR Speeds Comparison Monitoring (comparison of median CAS values)



FBW Flight Control System

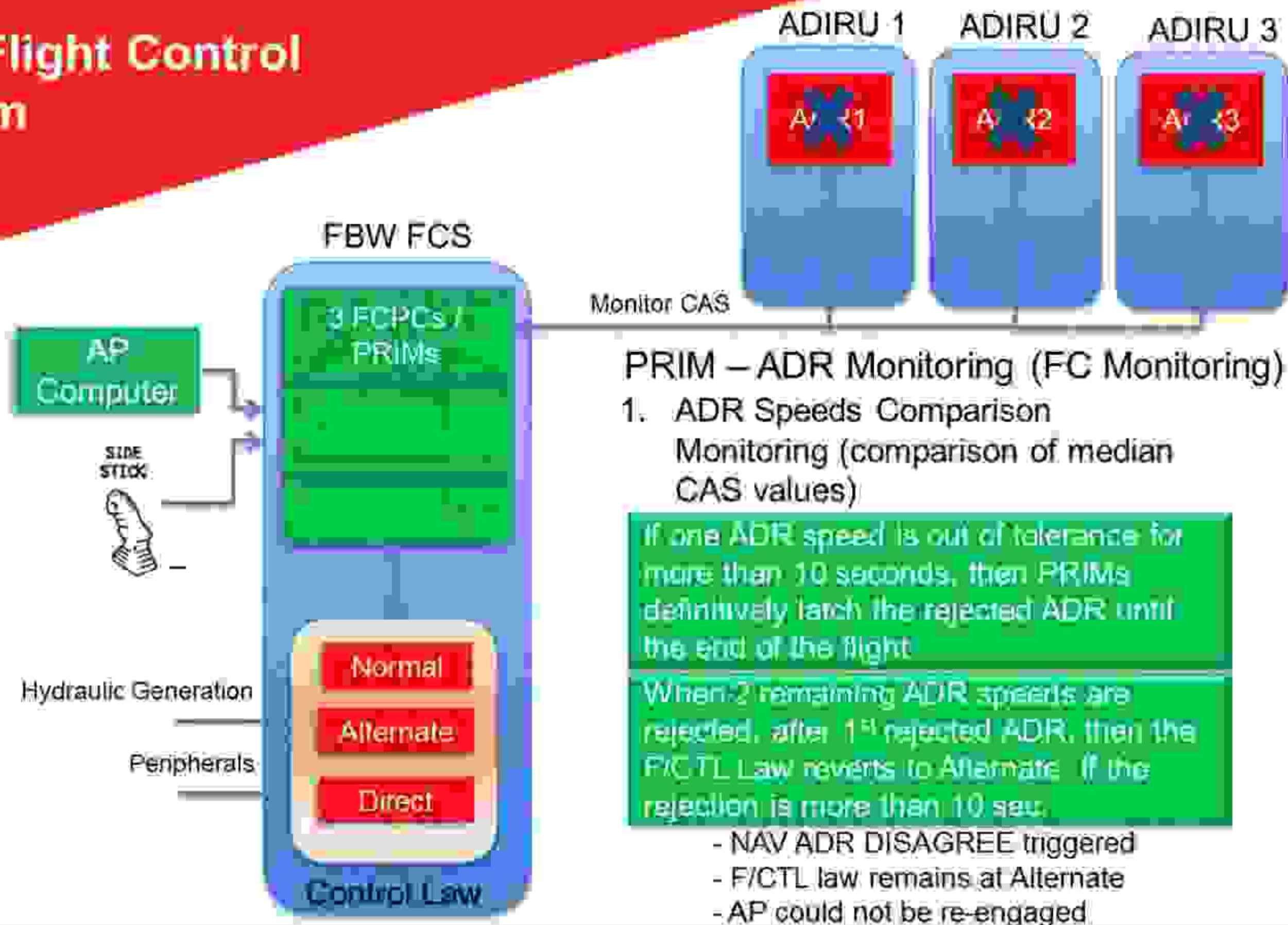


PRIM – ADR Monitoring (FC Monitoring)

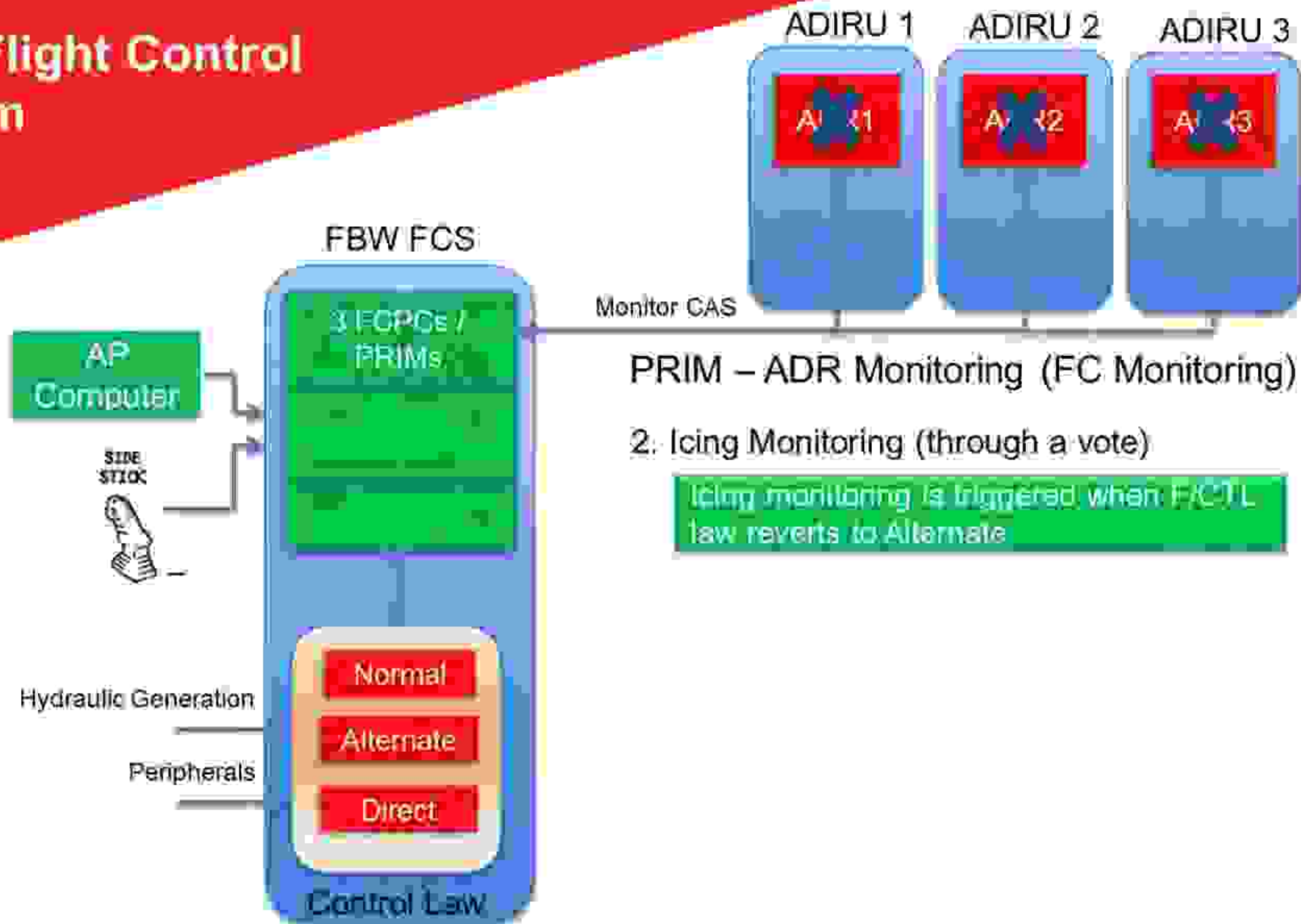
1. ADR Speeds Comparison Monitoring (comparison of median CAS values)

If one ADR speed is out of tolerance for more than 10 seconds, then PRIMs definitively latch the rejected ADR until the end of the flight.

FBW Flight Control System



FBW Flight Control System

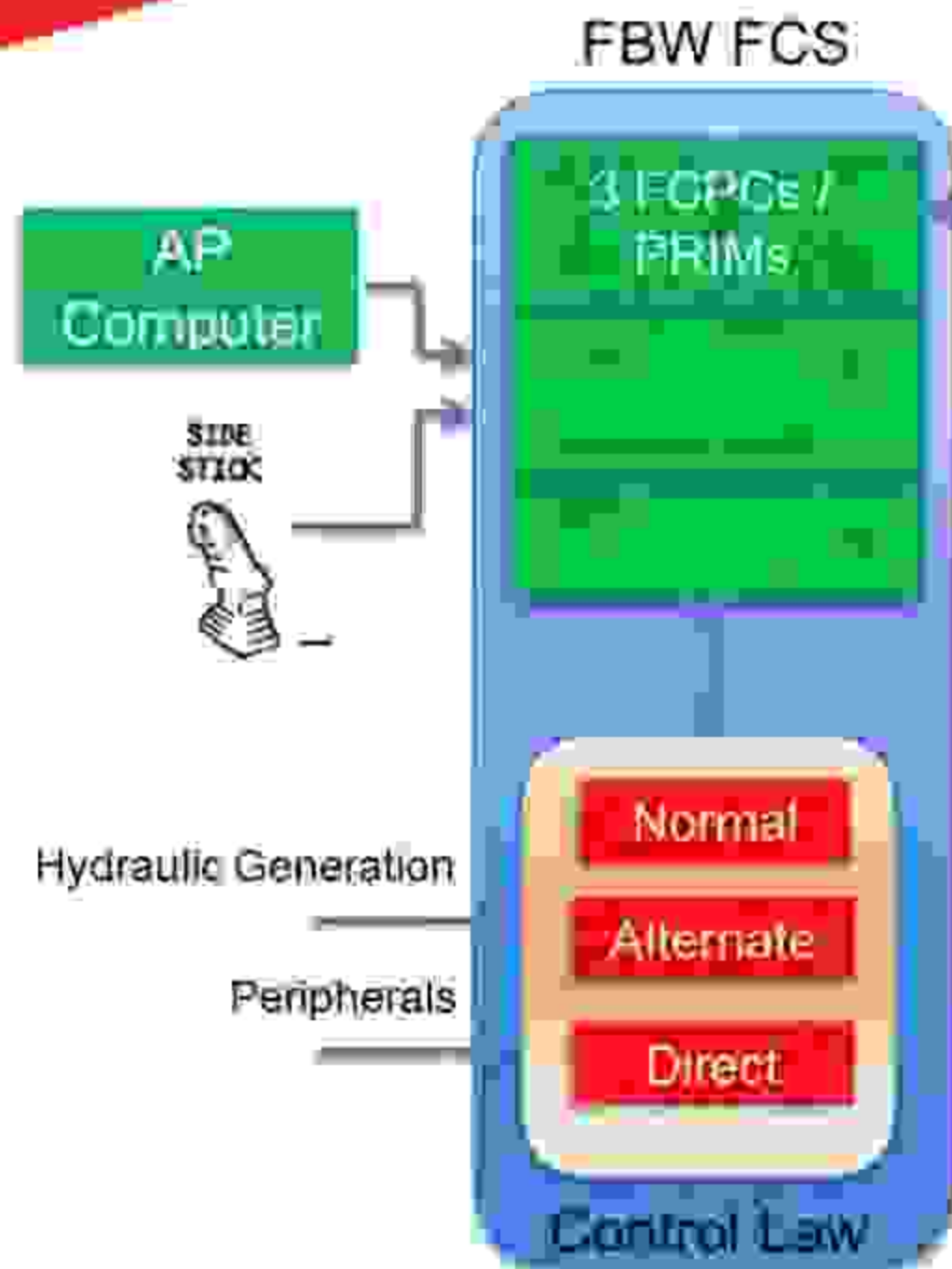


PRIM – ADR Monitoring (FC Monitoring)

2. Icing Monitoring (through a vote)

Icing monitoring is triggered when FACTL law reverts to Alternate

FBW Flight Control System



Monitor CAS



PRIM – ADR Monitoring (FC Monitoring)

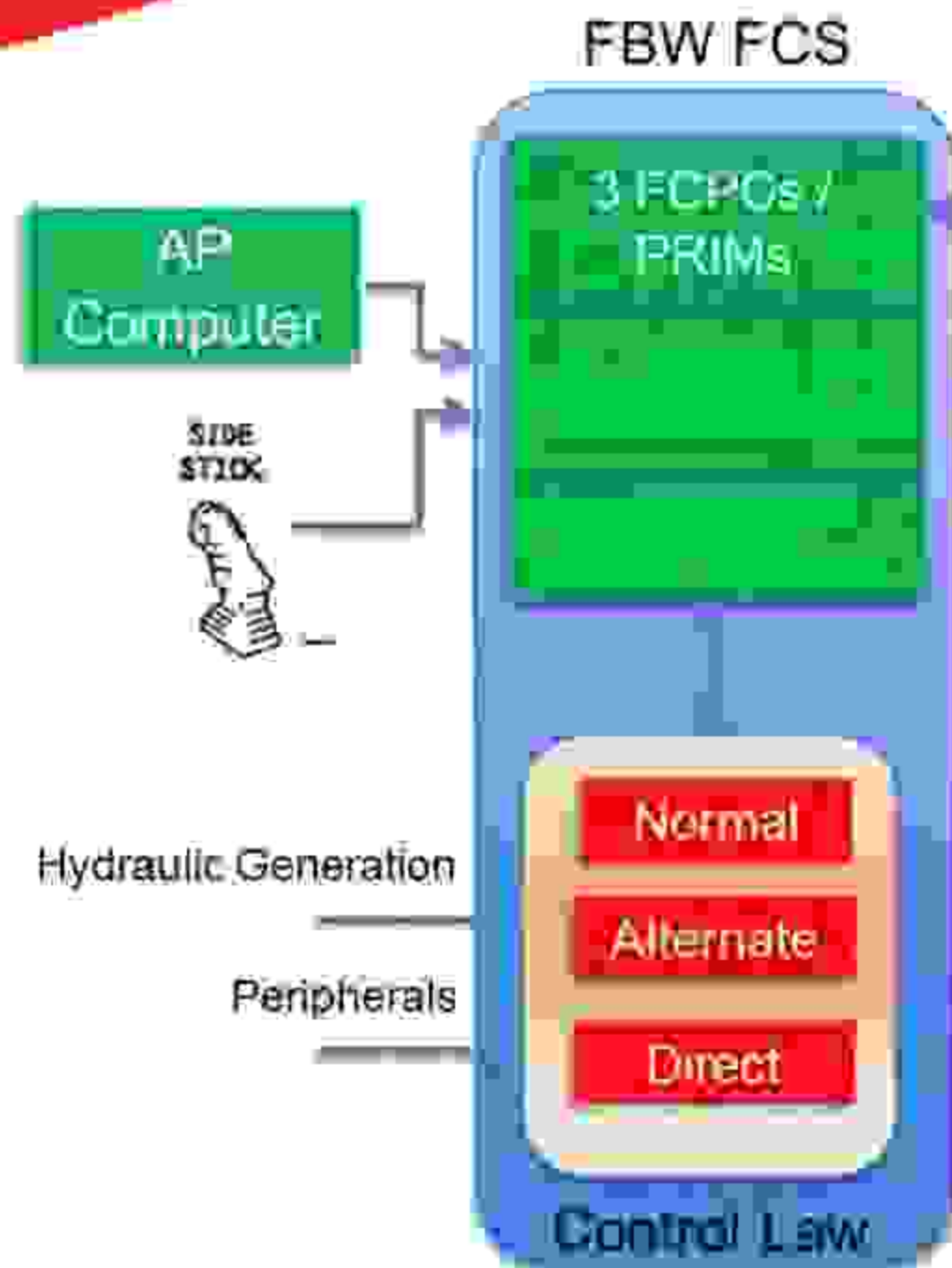
2. Icing Monitoring (through a vote)

Icing monitoring is triggered when FCTL law reverts to Alternate

After 10 sec of the triggering, if the 3 ADRs are used again, then FCTL law returns to Normal. If not, then



FBW Flight Control System



Monitor CAS



PRIM – ADR Monitoring (FC Monitoring)

2. Icing Monitoring (through a vote)

Icing monitoring is triggered when F/CTL law reverts to Alternate

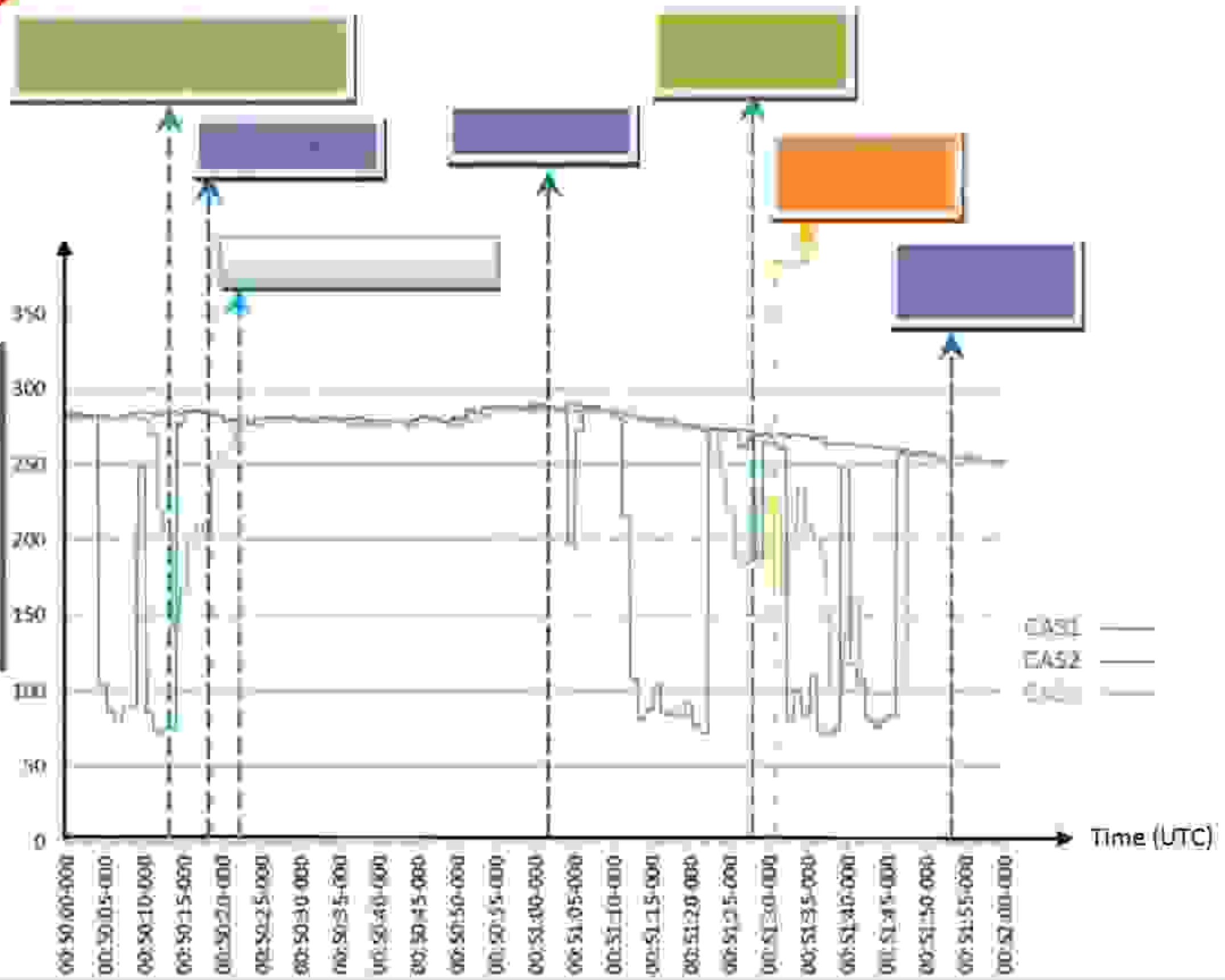
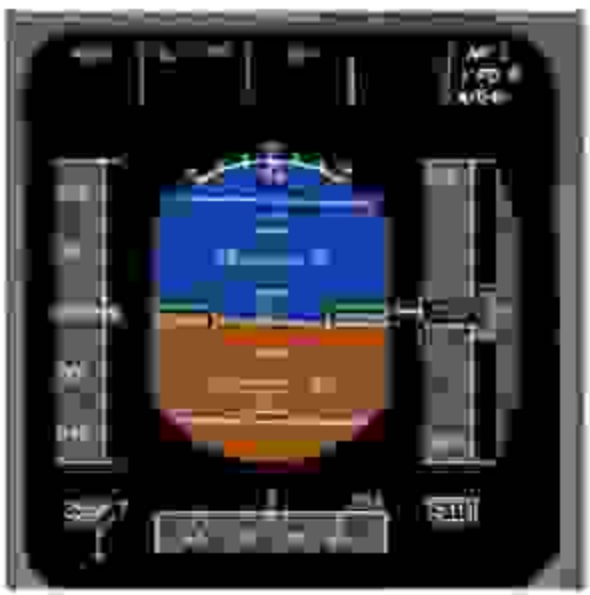
After 10 sec of the triggering. If the 3 ADRs are used again, then F/CTL law returns to Normal. If not, then

1. F/CTL law remains at Alternate
2. AP could not be re-engaged

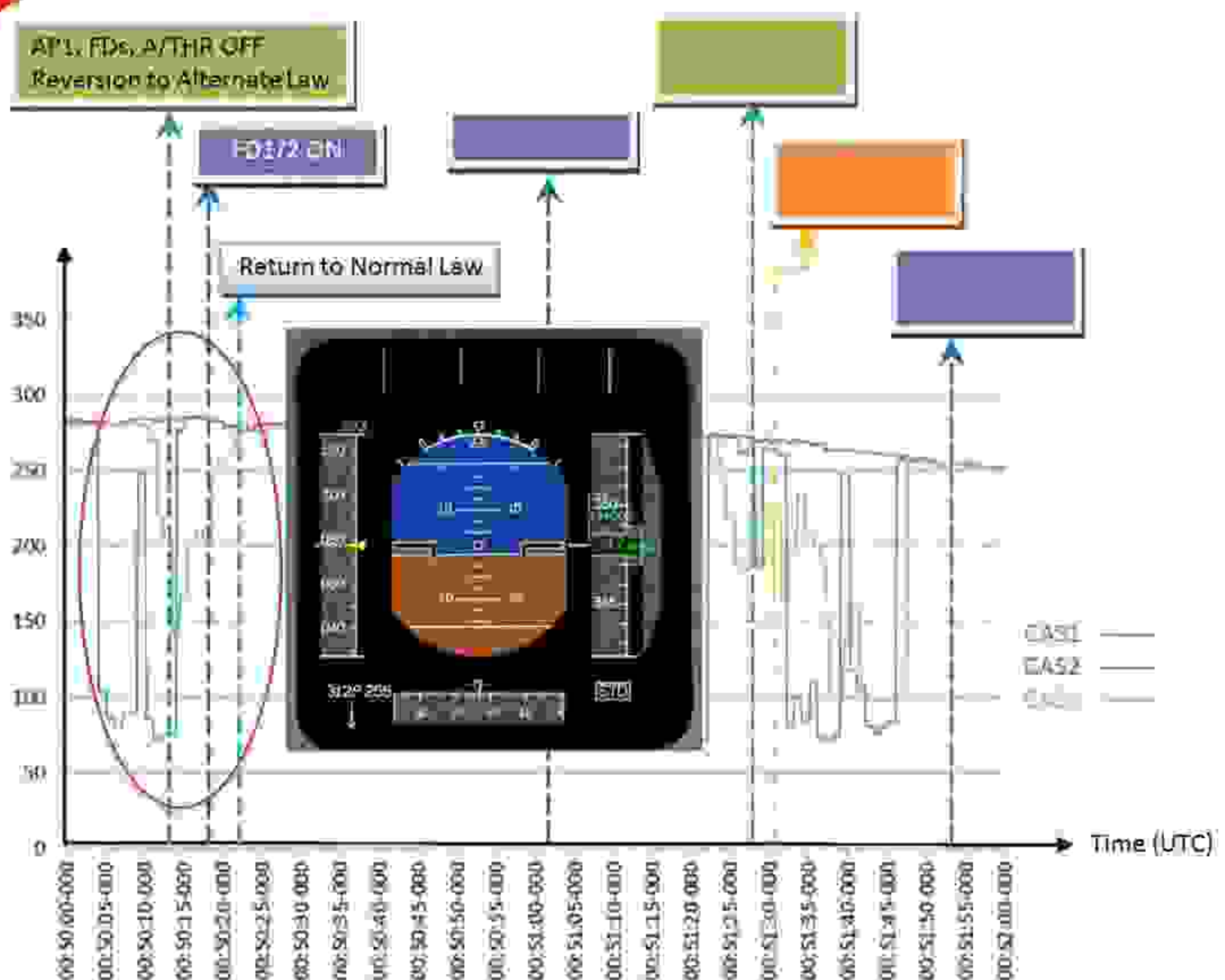
A part of AP logic is performed by the PRIMs

Airspeeds Timeline

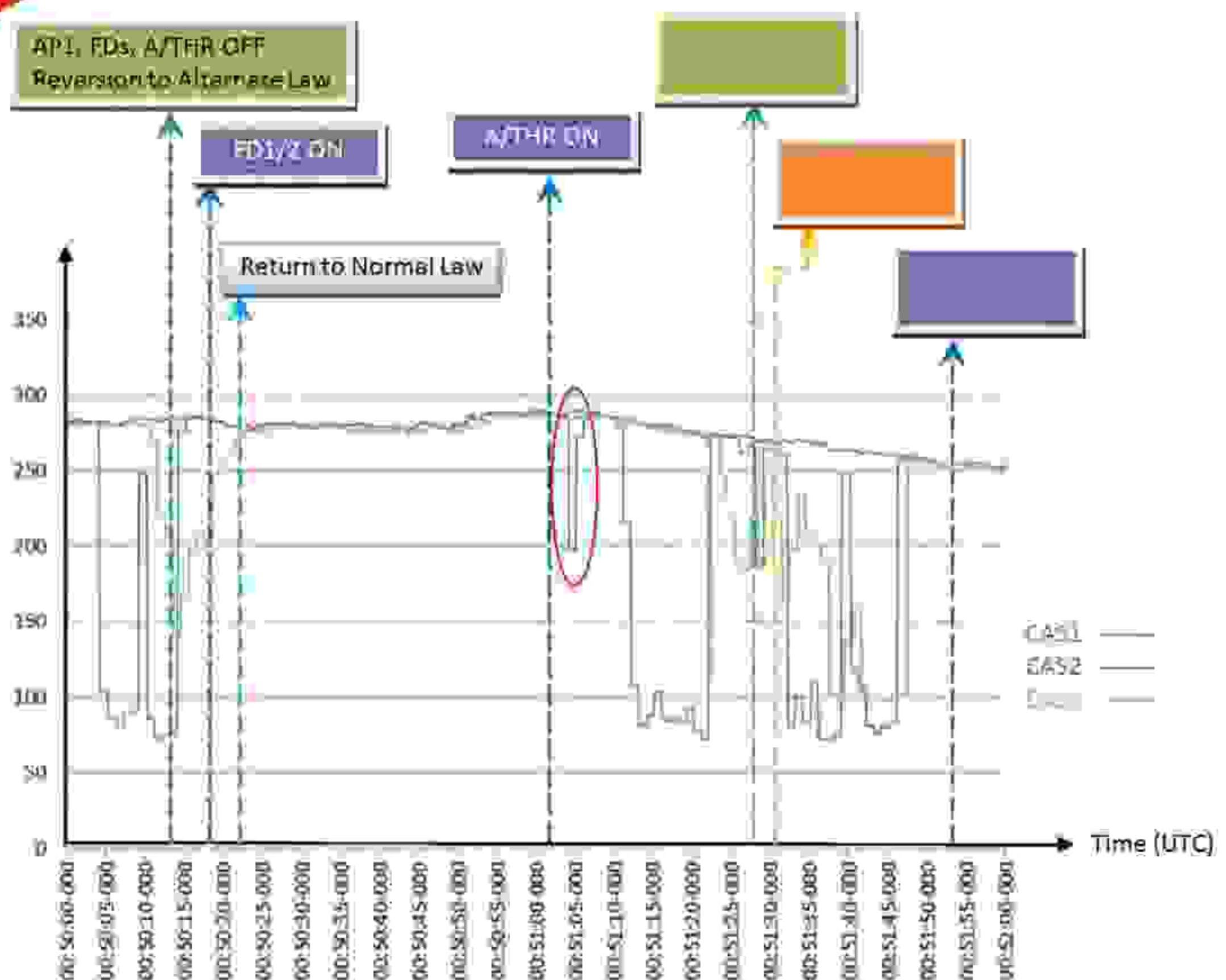
Before the event



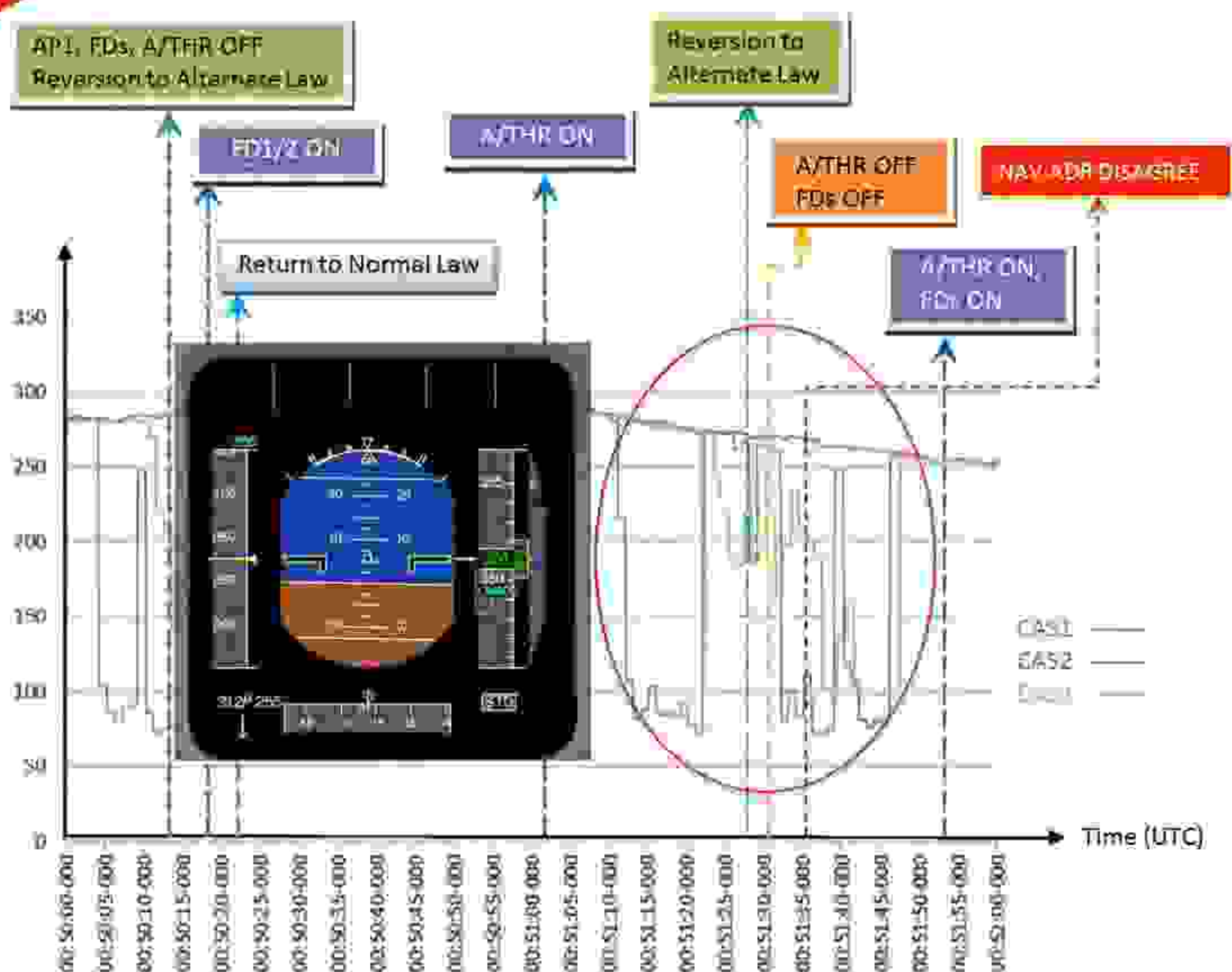
Airspeeds Timeline



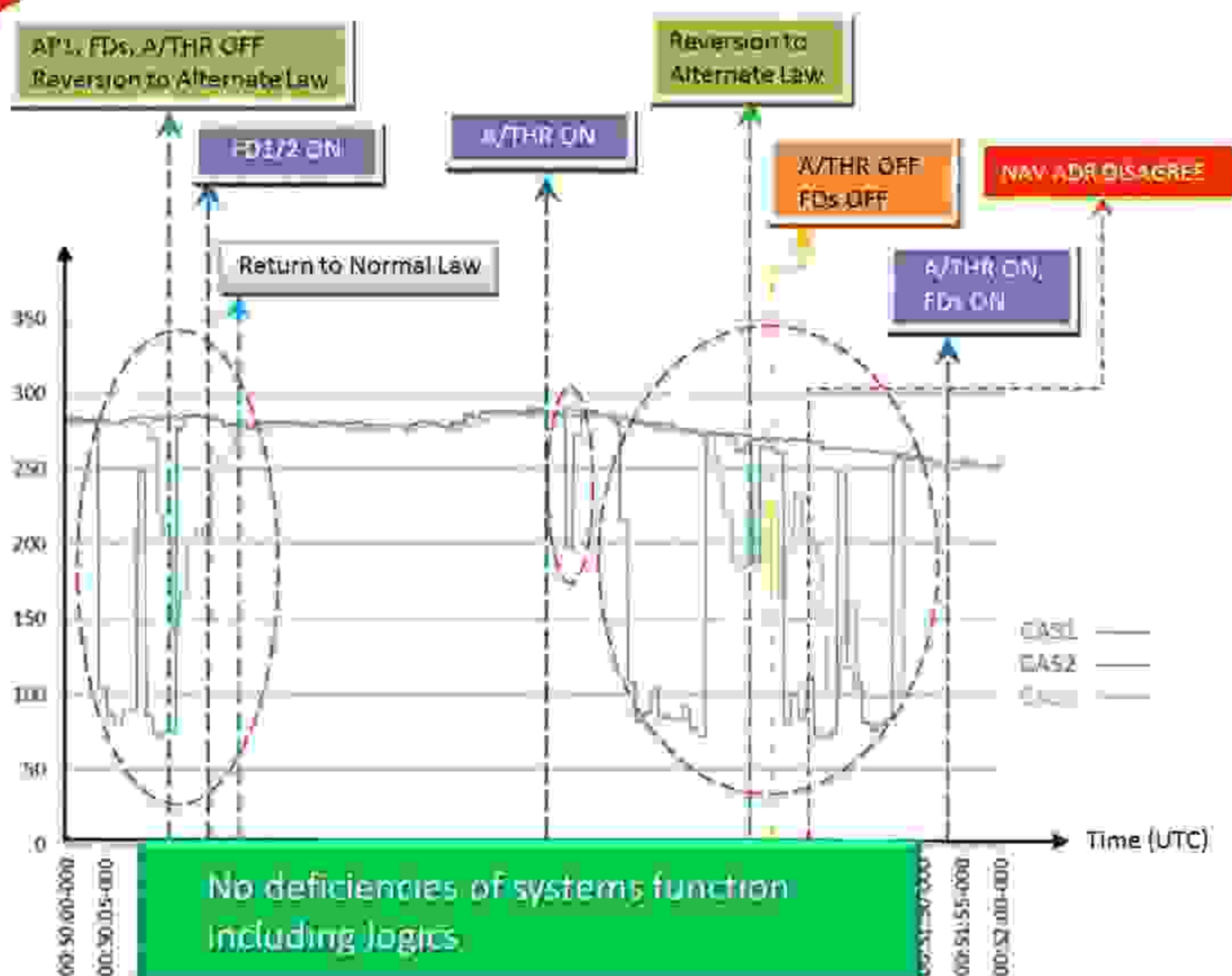
Airspeeds Timeline



Airspeeds Timeline



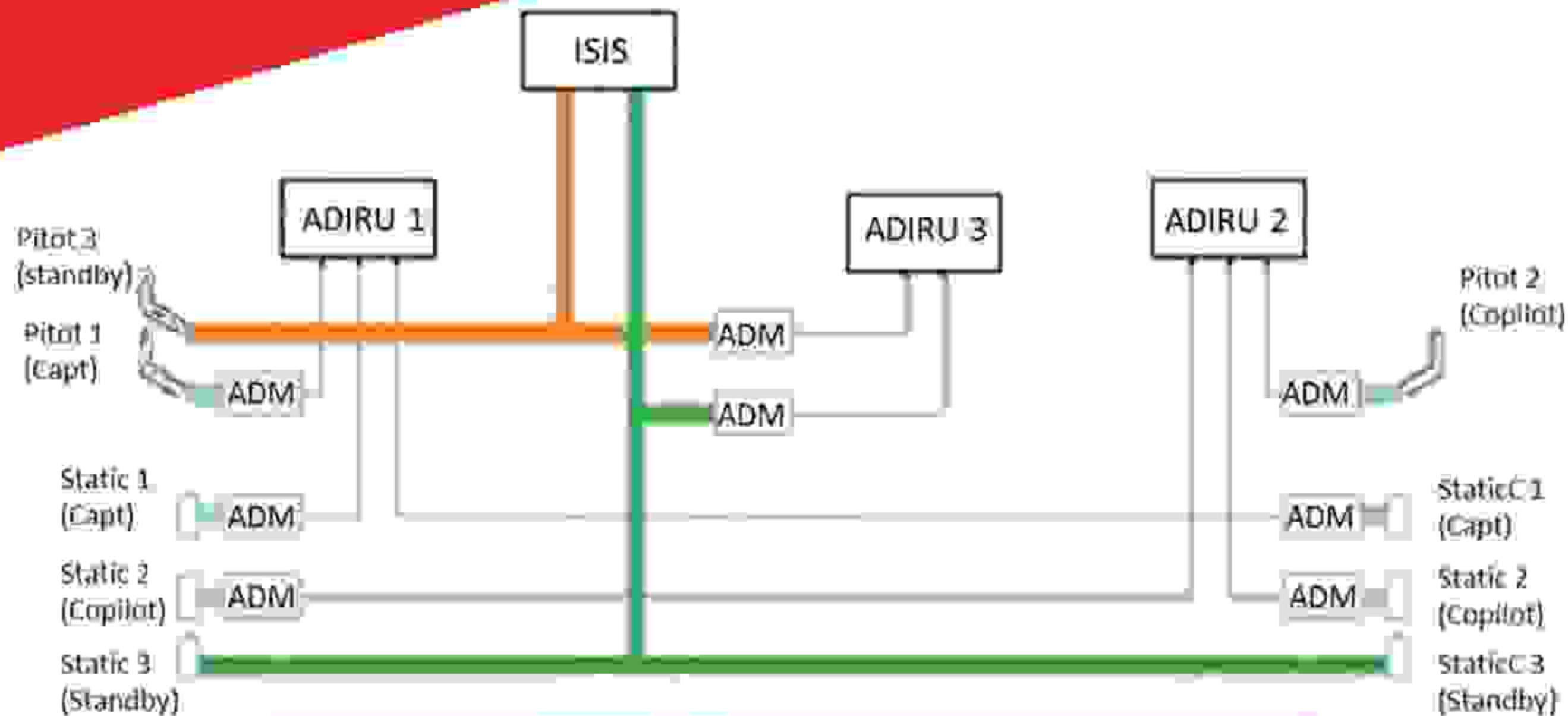
Airspeeds Timeline



No deficiencies of systems function including logics



Pitots



The Airspeed Indication fluctuations were caused by intermittent blockages by ice crystals of the left pitot probes



Pitots

No failure of the Probe Heat Computer



No evidence that the intermittent blockages were due to malfunction in the pitot heating system



Weather Radar

- Capabilities

- Detection of wet particles (rain, wet hail, and wet snow)
- Limited detection of dry hail, ice crystals, and dry snow
- Weather Radar without auto-tilt and auto-scan function



Optimized on observation of the most reflective part of the cloud



Weather Radar

- Features



Radar lift angle

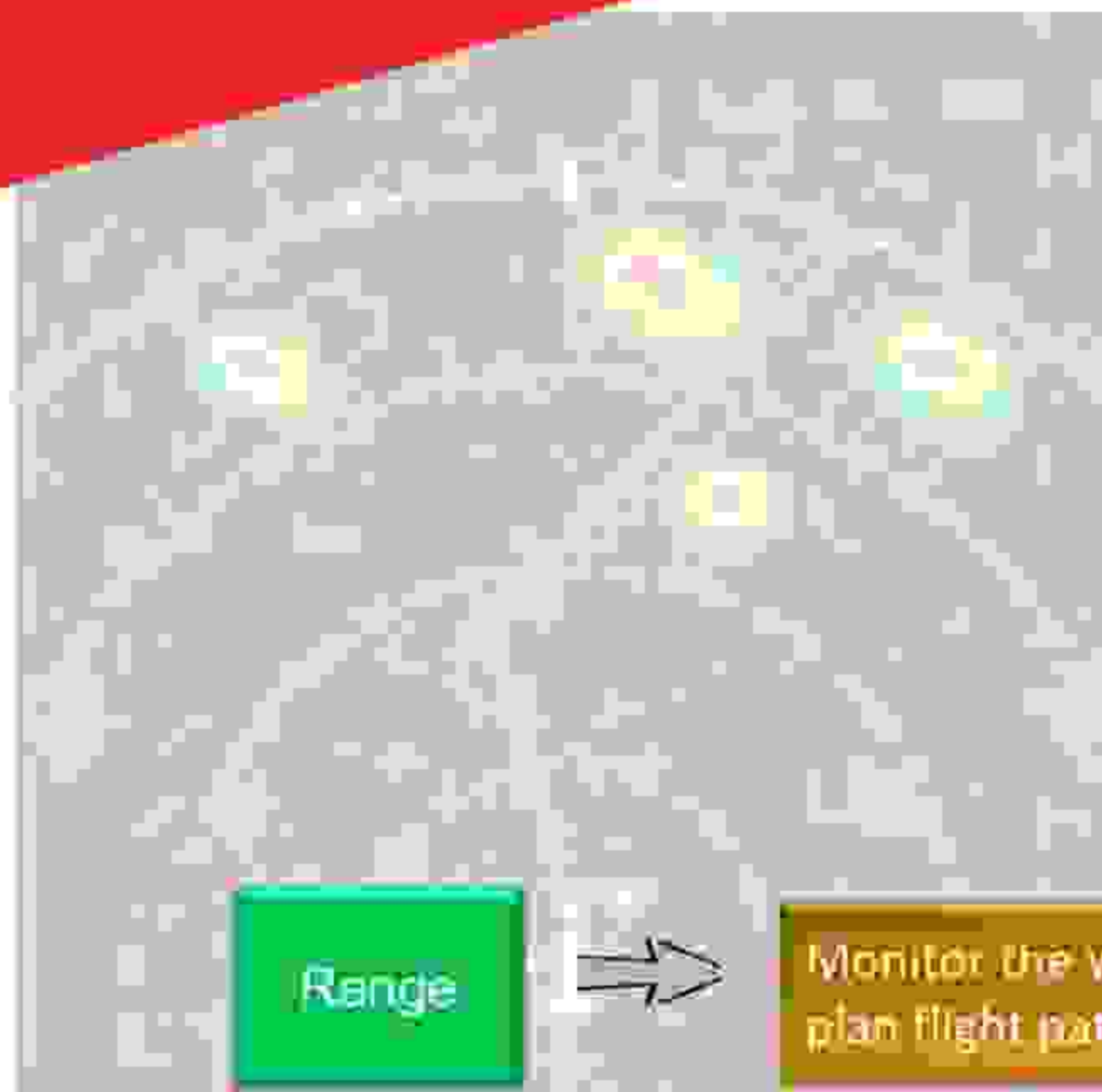


Angle between the center of the beam and the horizon



Weather Radar

- Features



NO Range = 40 NM



NO Range = 20 NM

Monitor the weather at long and short ranges to efficiently plan flight path change, and to avoid blind alley effect

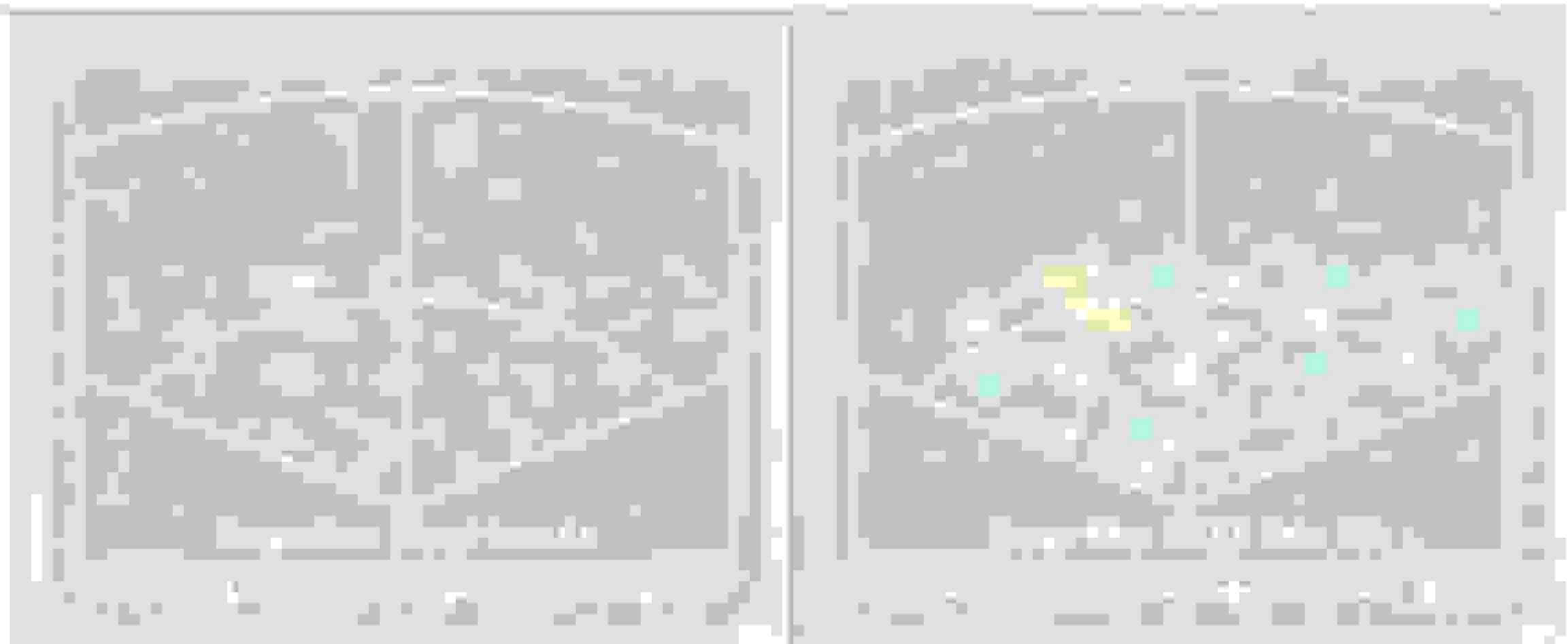
Weather Radar

- Features

Gain

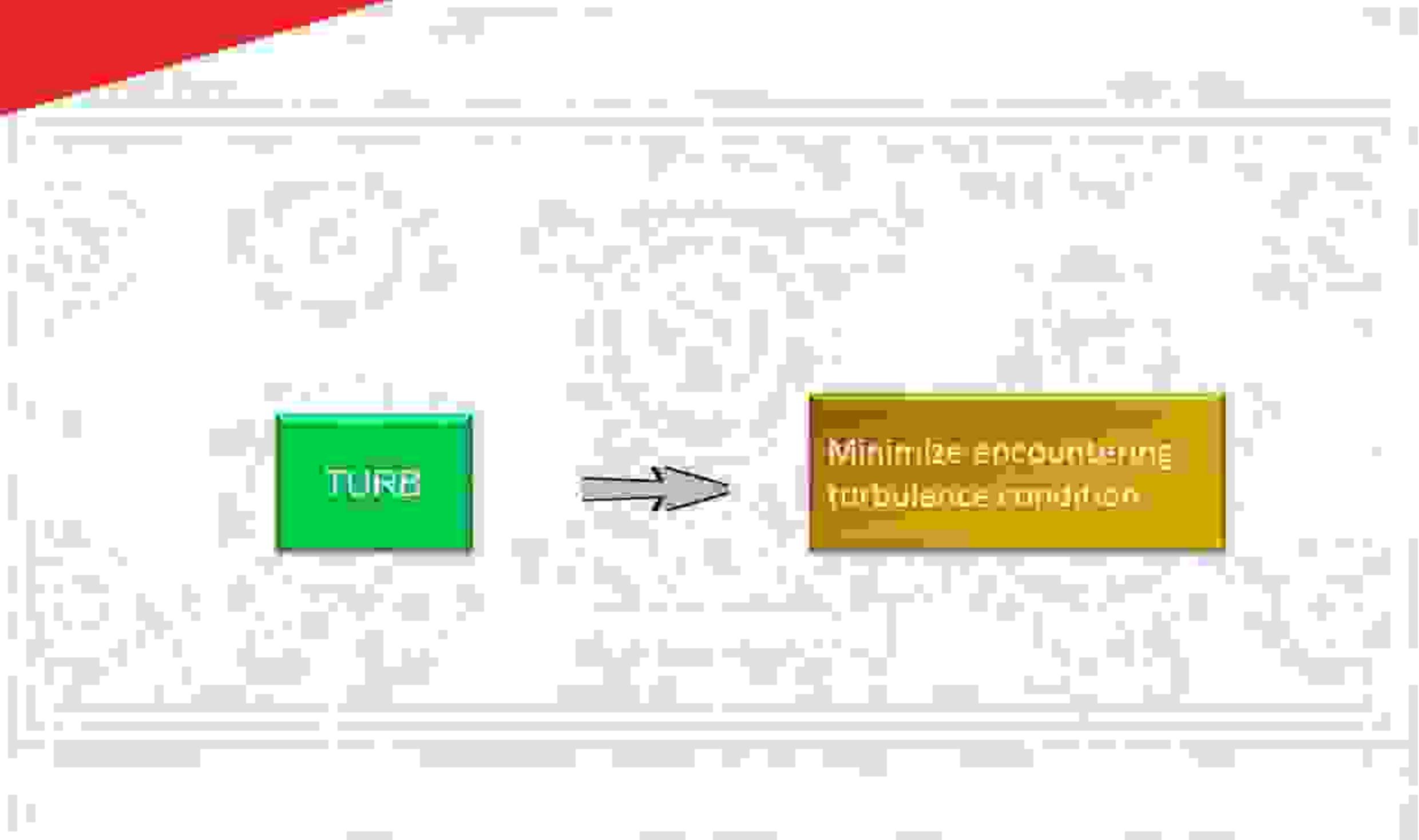


Adjusts the sensitivity of the receiver to differentiate the reflectivity of cloud parts

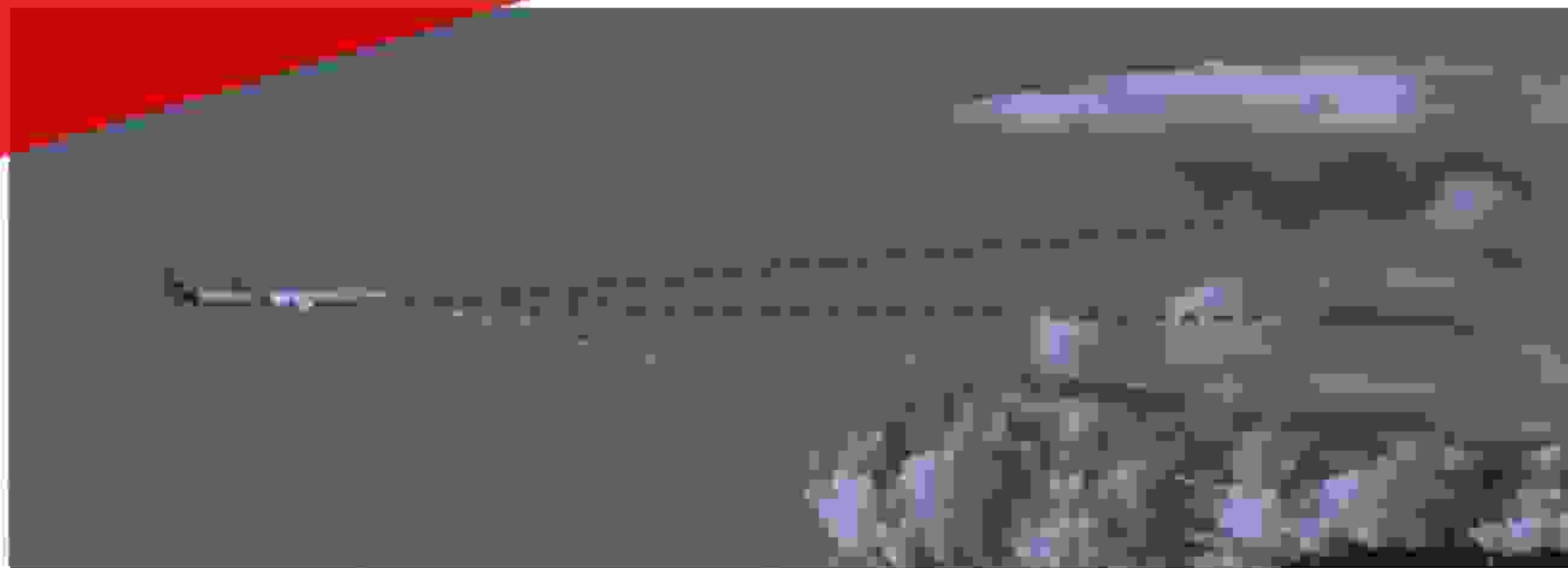


Weather Radar

- Features



Weather Radar



The upper level of a thunderstorm cells, that contains ice crystals, provides weaker returns than the middle part, which is full of water or wet hail.

Weather Radar (Cont.)

Antenna
Tilt

Range

Gain

TURE

- Use the Wx radar to detect/analyze/avoid significant weather

- Periodically scan vertically, using the Tilt function

- Periodically scan horizontally, using Range Change

- The shape/colour/size of returns are factors to interpret the weather

- Effective management of the antenna tilt along with an appropriate Range selection

- Use Gain in AUTO mode for detection and initial evaluation of the displayed weather

- Use Manual Gain control to analyze the weather in detail

- Wet turbulence can be detected up to 40 NM

Weather Radar (Cont.)



inefficient use of the Weather Radar, such that the incorrect high tilt setting, caused the radar to scan only the upper (less reflective) part of the cell.

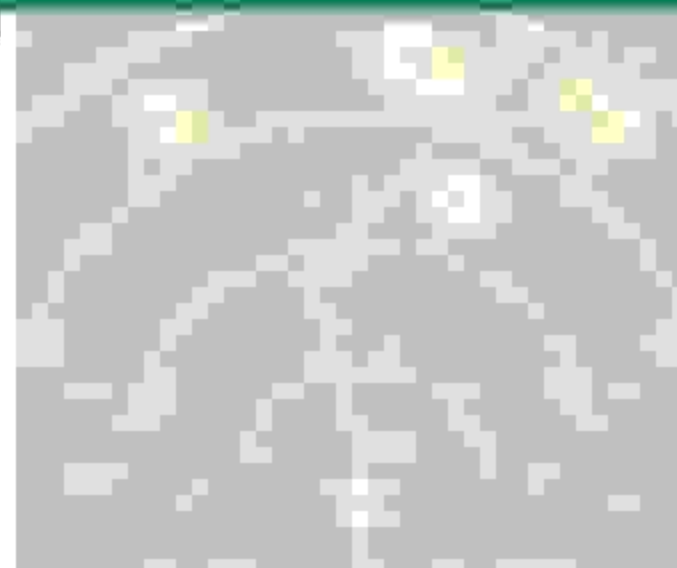


Figure 1. High Tilt

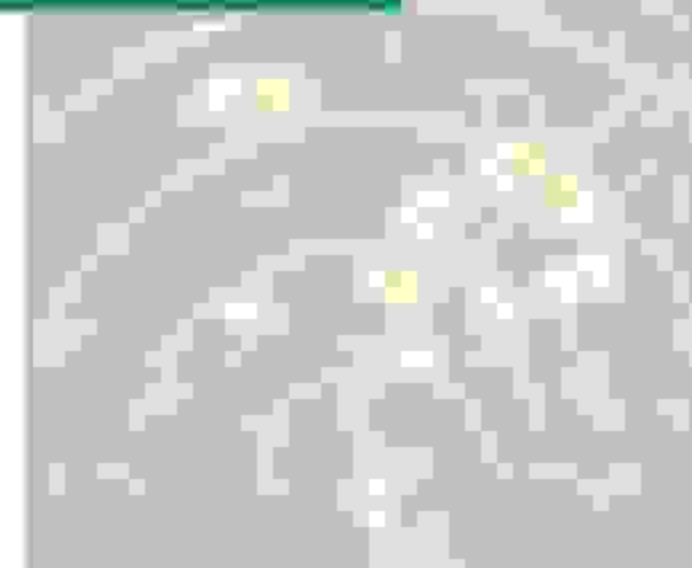
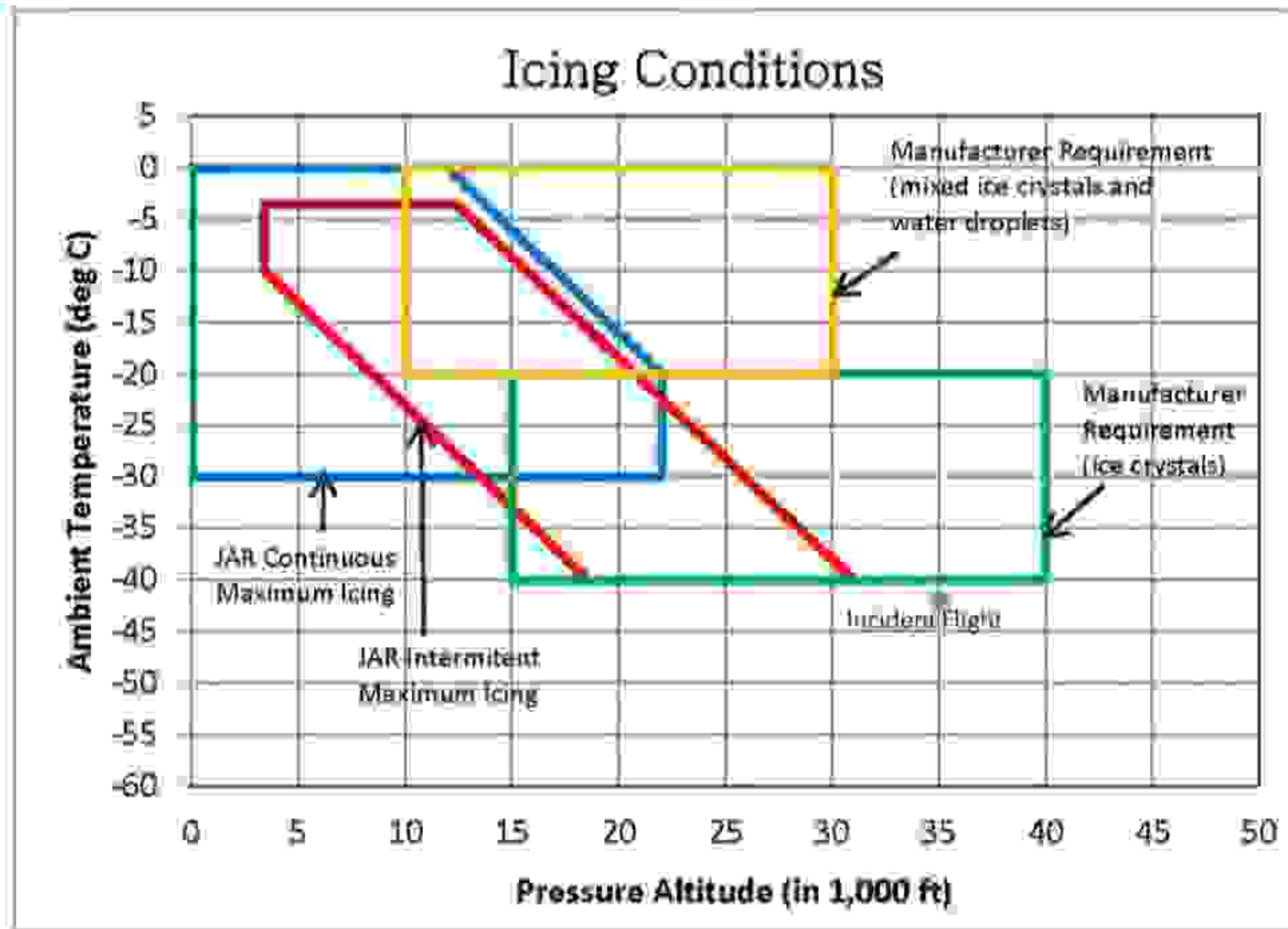
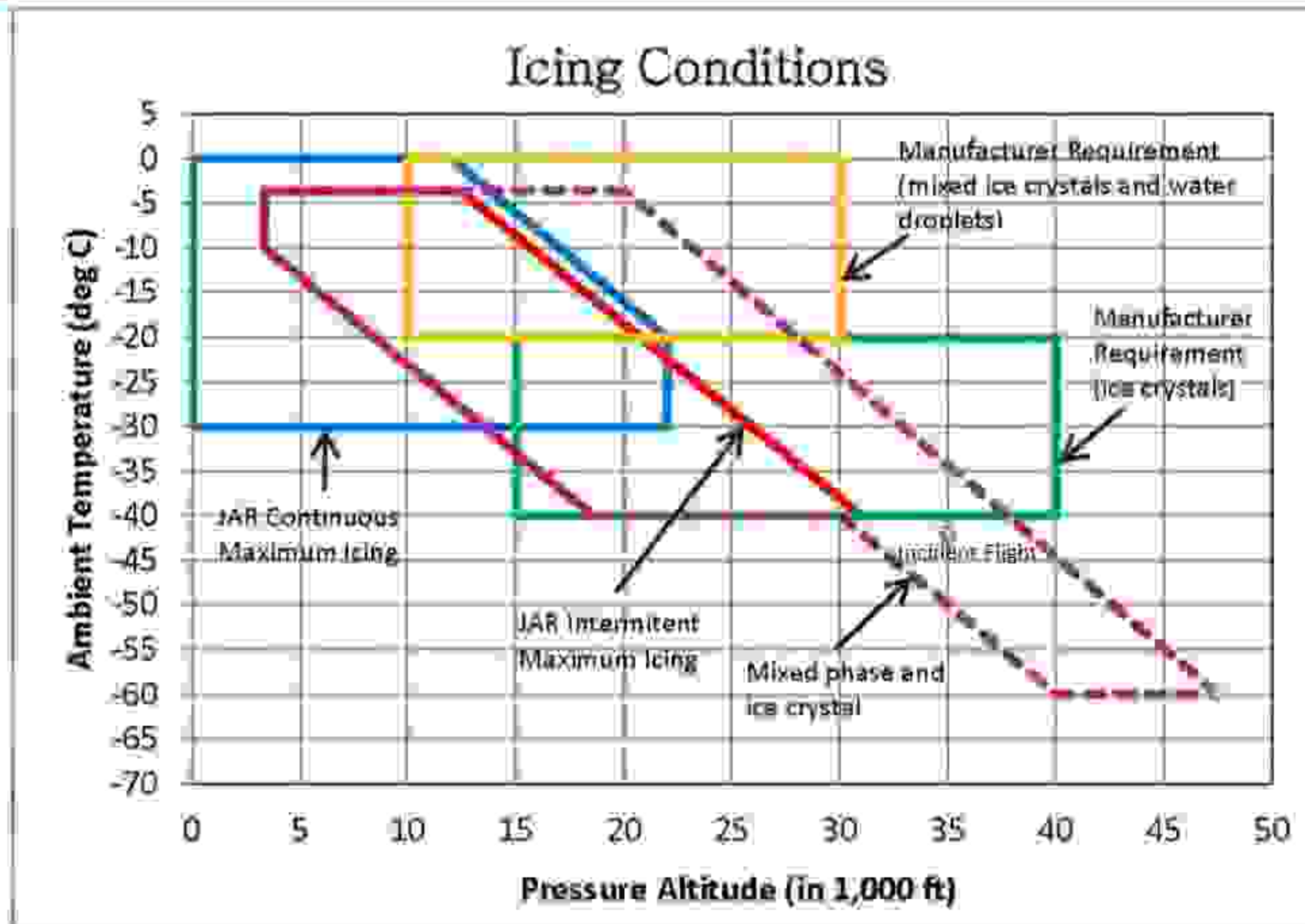


Figure 2. Low Tilt

JAR25 & Manufacturer Requirement



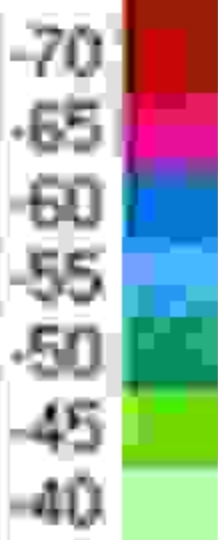
New CS-25 / Amdt 16



Cause of the Incident

Accumulation of ice crystals

Intermittent obstruction of left side Pitot probes



Contributing Factors

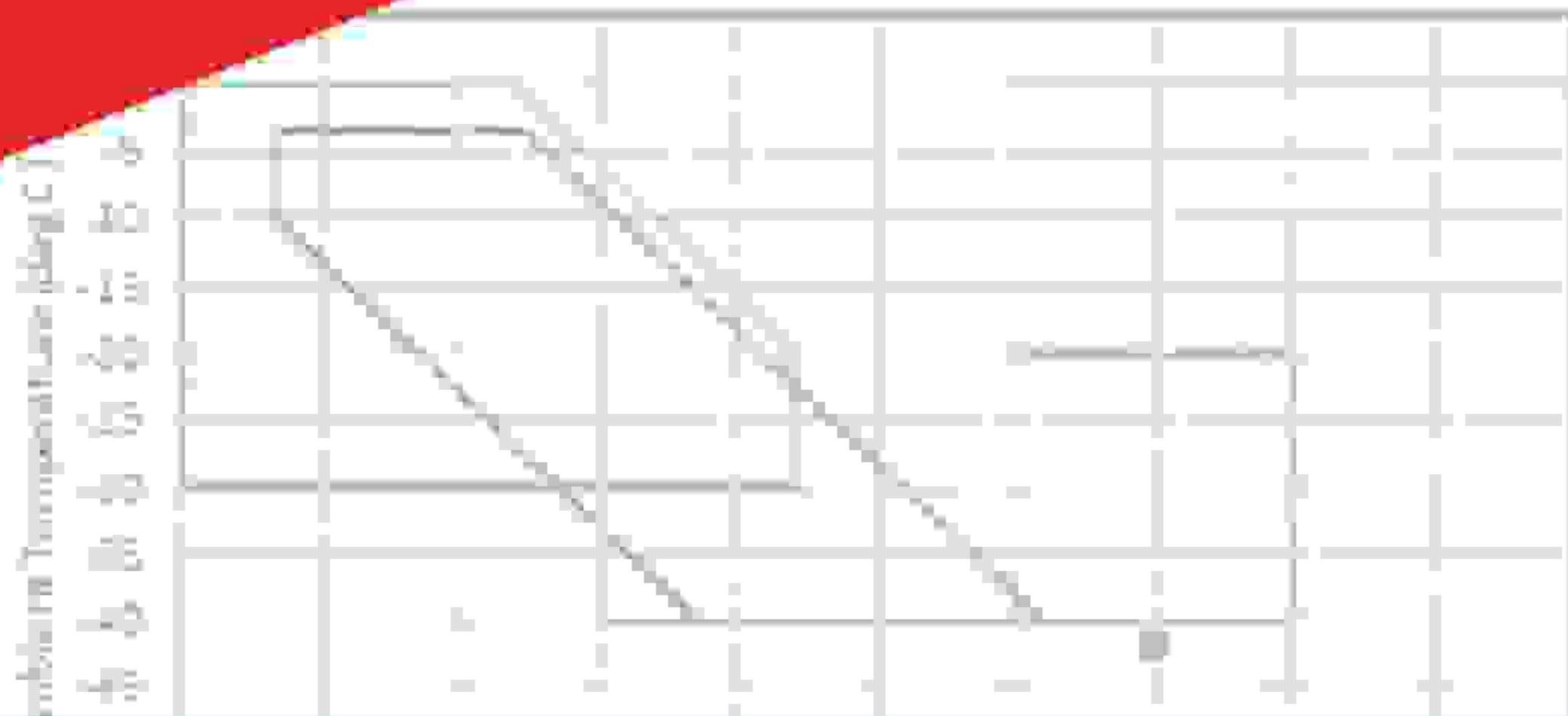
An incorrect radar tilt angle setting



no timely detection of the CB that could have triggered the crew to take the necessary avoidance maneuvers

Contributing Factors

Icing Conditions



The ambient temperature and the Aircraft altitude were beyond the icing envelope of the *JAR* specification and the manufacturer's requirements.

Safety Recommendations

Four Safety Recommendations



Etihad

EASA

GCAA



Safety Recommendations

to Etihad

Add to the existing initial and refresher type training syllabi optimum technique using the manual weather radar



maximize the weather survey and detection functions



Safety Recommendations

to EASA



Certification Specifications

CS-25

Acceptable Means of Compliance

AMOC

Large Aeroplanes

CS-25

CS-25

Consider mandating the qualification aspects of the Pitot probes in icing conditions to the new requirements of CS-25, Amendment 16



forward fitting to all aircraft types in production and for retrofitting to aircraft in-service

Safety Recommendations

to GCAA

1st Recommendation

Establish communication with the type certification authorities



Examine the 'ice protection CS' regarding aircraft operating outside the older applicable certification specification, JAR 25, and the new EASA CS-25, Amendment 16



Safety Recommendations

to GCAA

2nd Recommendation

Take the necessary action in requiring operators in the United Arab Emirates



include optimum techniques of using manual weather radars in initial and refresher type training syllabi



THANK YOU

<https://www.gcaa.gov.ae/en/ePublication/Pages/InvestigationReport.aspx>