



PMA209 RVSM Periodic Monitoring Reporting

17-19 October 2017
2017 ASE Workshop
FAA Tech Center, Atlantic City

PMA 209 develops, integrates, and delivers avionics solutions that meet customer requirements, enable interoperability, and maximize affordability.





DoD Responsibilities



PMA209 – Navy and Marines

- Determine Type/Model/Series (T/M/S) monitoring sample size
- Notify platform program office of their periodic monitoring requirement
- Collect/evaluate monitoring data
- Provide monitoring results and status

COMNAVAIRLANT (CNAL) - Navy and Marines

- Manage RVSM Authorizations for fleet aircraft
- Schedule RVSM Periodic Monitoring
- Direct Air Wings to conduct periodic monitoring

Platform Program Office

- Issue fleet release of RVSM capabilities.
- Manage RVSM Authorizations in conjunction with COMNAVAIRLANT
- Inform PMA209 of upcoming applicable avionics hardware/software upgrades and airframe changes

Wings/Squadrons

- Conduct RVSM Periodic Monitoring flights
- Investigate/resolve height-keeping performance errors
- Conduct training in operating procedures and practices for RVSM airspace
- Conduct RVSM maintenance and maintenance inspections



PMA209 Periodic Monitoring Requirements



- **Required to perform Periodic Monitoring in two year cycles**
 - The required number of aircraft from a group to be monitored is determined by PMA209 RVSM Subject Matter Experts (SMEs)
 - PMA209 can provide periodic monitoring Special Instructions (SPINS) for operators



Monitoring Methods



➔ **Aircraft Geometric Height Measuring Element (AGHME)** – with this method, the true altitude is currently measured by the ground-based AGHME multilateration technique systems operated by the FAA.



➔ **GPS-based Monitoring Unit (GMU)** – a portable device brought on board and operated by trained technicians. This method uses GPS data to collect the aircraft's position that is then used in the Altimetry System Error (ASE) process.



➔ **GPS Precise Positioning Service (PPS) Ownship Monitoring**– uses aircraft's GPS output, similar to GMU



➔ **Automatic Dependent Surveillance-Broadcast (ADS-B) Height Monitoring System (AHMS)** – provides a source of aircraft position data for use in the ASE calculations.

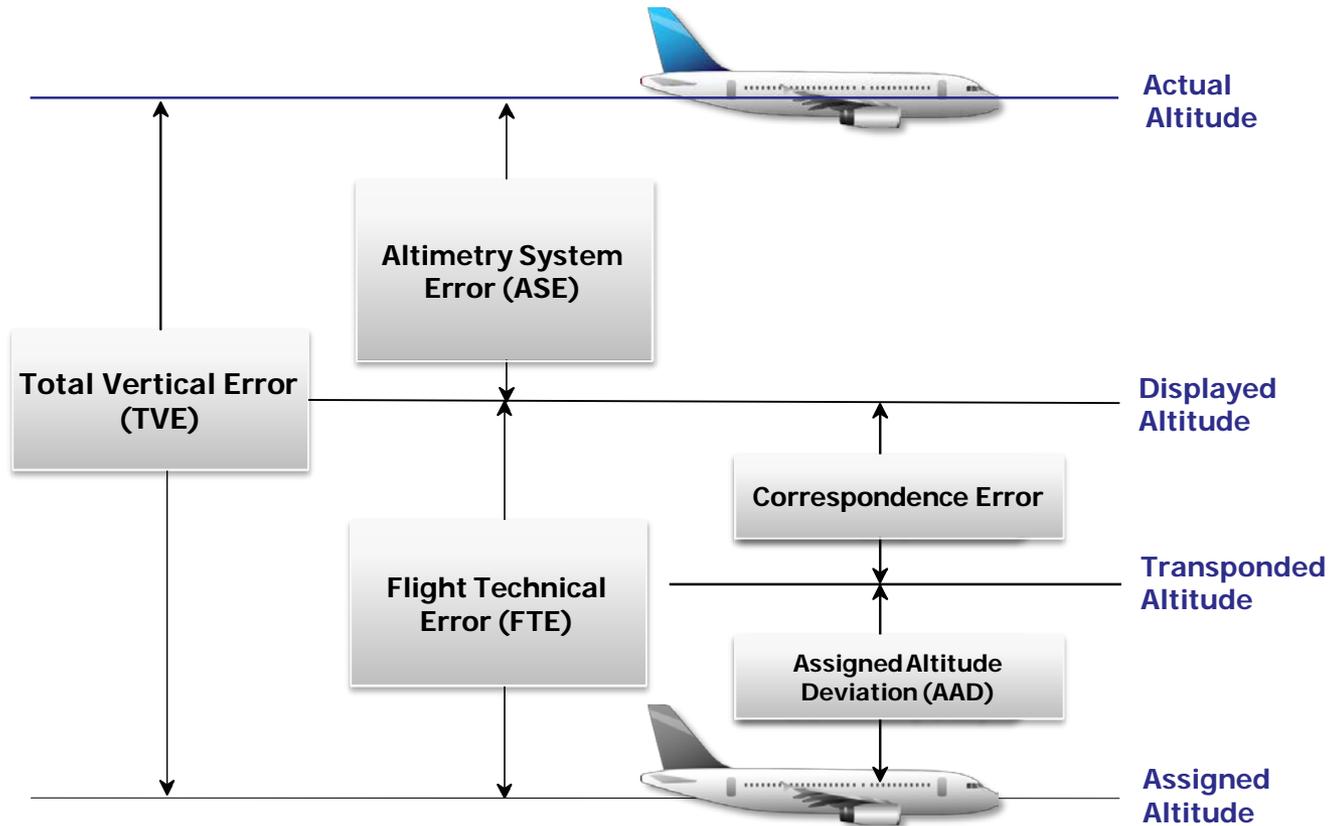


FAA

Source: William J. Hughes Technology Center



Types of Error





Monitoring Criteria

- The criteria for **non-compliant** aircraft to be applied by an Regional Monitoring Agency (RMA) are:

$$|TVE| \geq 300 \text{ ft (90 m)}$$

$$|ASE| \geq 245 \text{ ft (75 m)}$$

$$|AAD| \geq 300 \text{ ft (90 m)}$$

ICAO Doc 9574 para 4.17

- **PMA209 utilizes a more conservative non-compliant constraint for ASE of:**

$$|ASE| \geq 200 \text{ ft}$$

North American Approvals Registry and Monitoring Organization (NAARMO) set the **aberrant** value as:

$$|ASE| \geq 160 \text{ ft (49 m)}$$

$$|TVE| \geq 170 \text{ ft (52 m)}$$

Validity Indicator:

C – Compliant

A – Aberrant

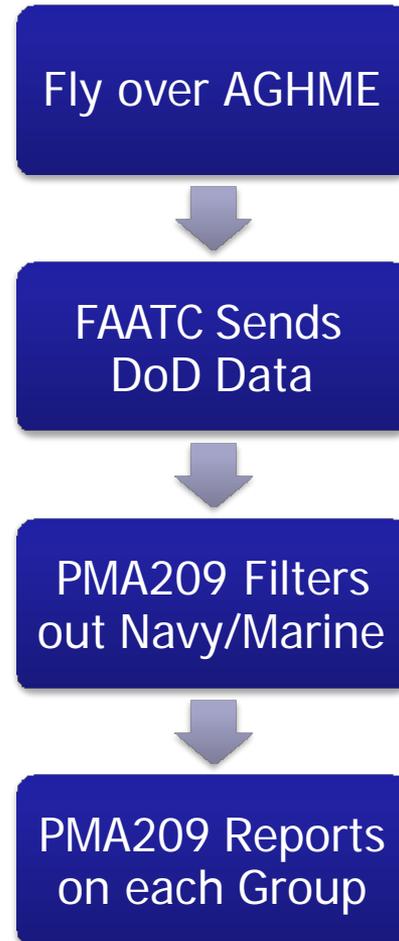
N – Non-Compliant



AGHME Process

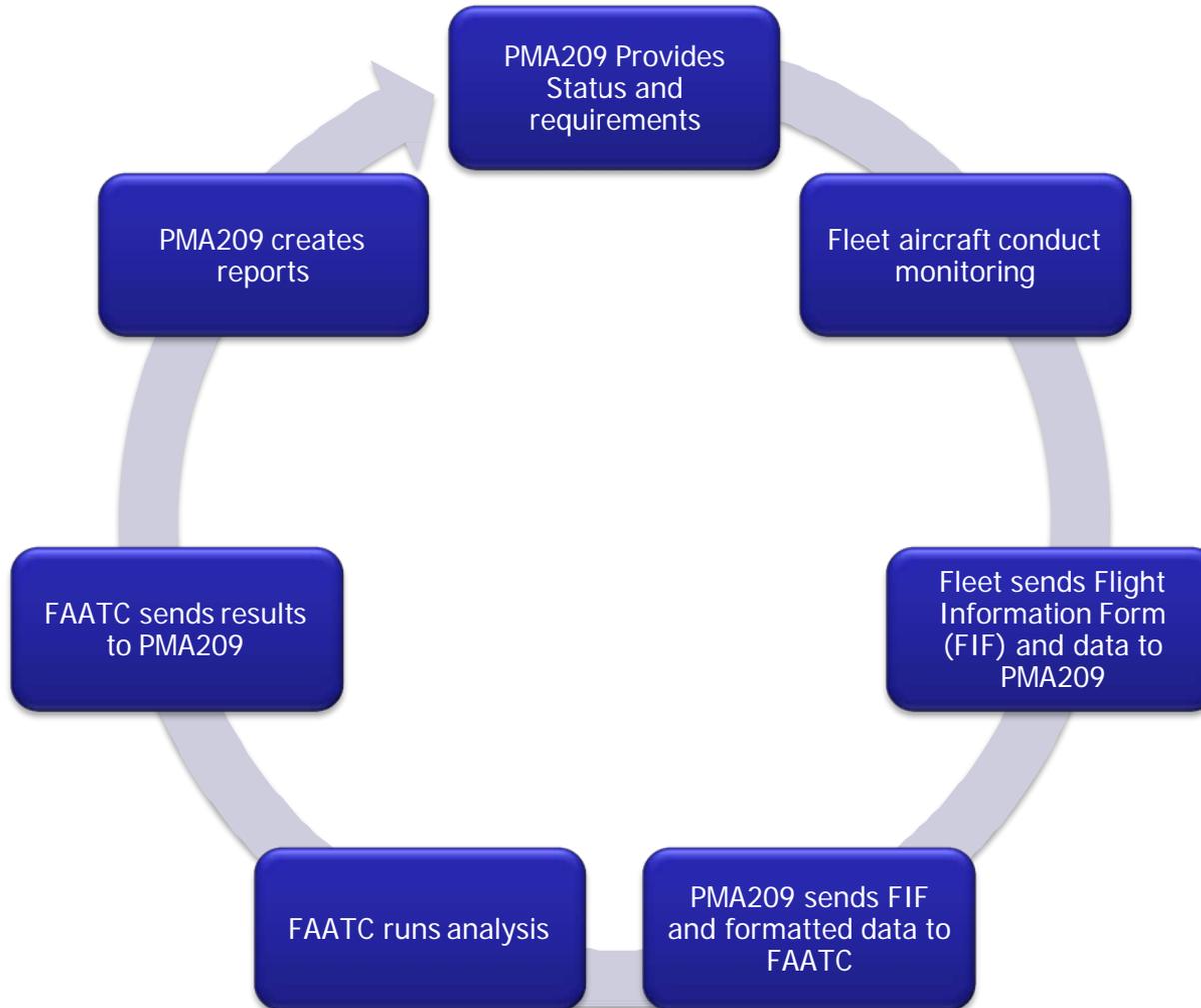


- **FAA Technical Center (FAATC) Maintains an abridged version of the U.S. RVSM Approvals database for DoD aircraft.**
- **Sent 15th of every month to DoD RVSM POCs**
- **PMA209 does own report for Navy and Marine aircraft**





Ownship/Pod Recording





Periodic Monitoring Tracking



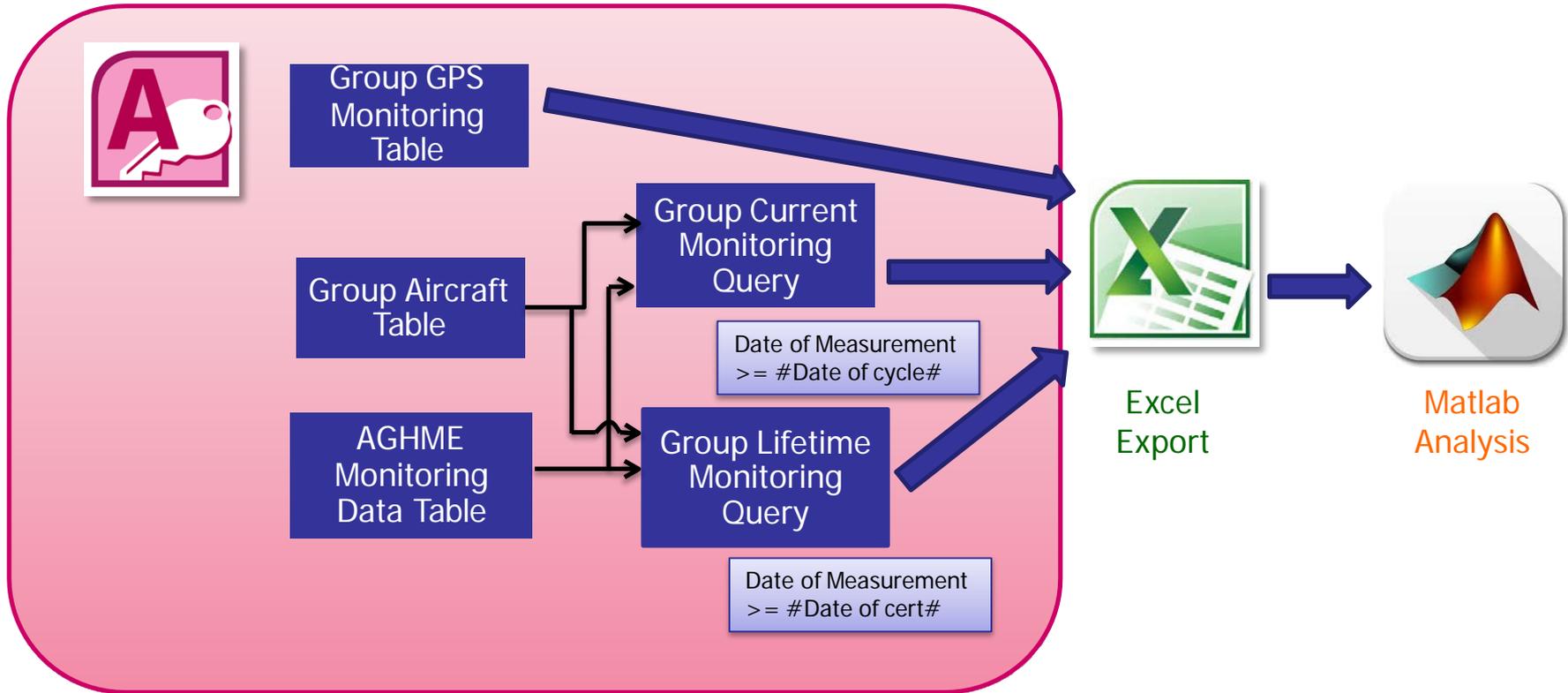
- **An Access database is maintained by the PMA209 Navigation team**

Database contains:

- A table of monthly DoD AGHME reports from the FAA Tech Center
- A table to identify each group of aircraft
- Tables for Ownship Recording
- Queries for each aircraft group on their current monitoring period results and monitoring results since their initial certification

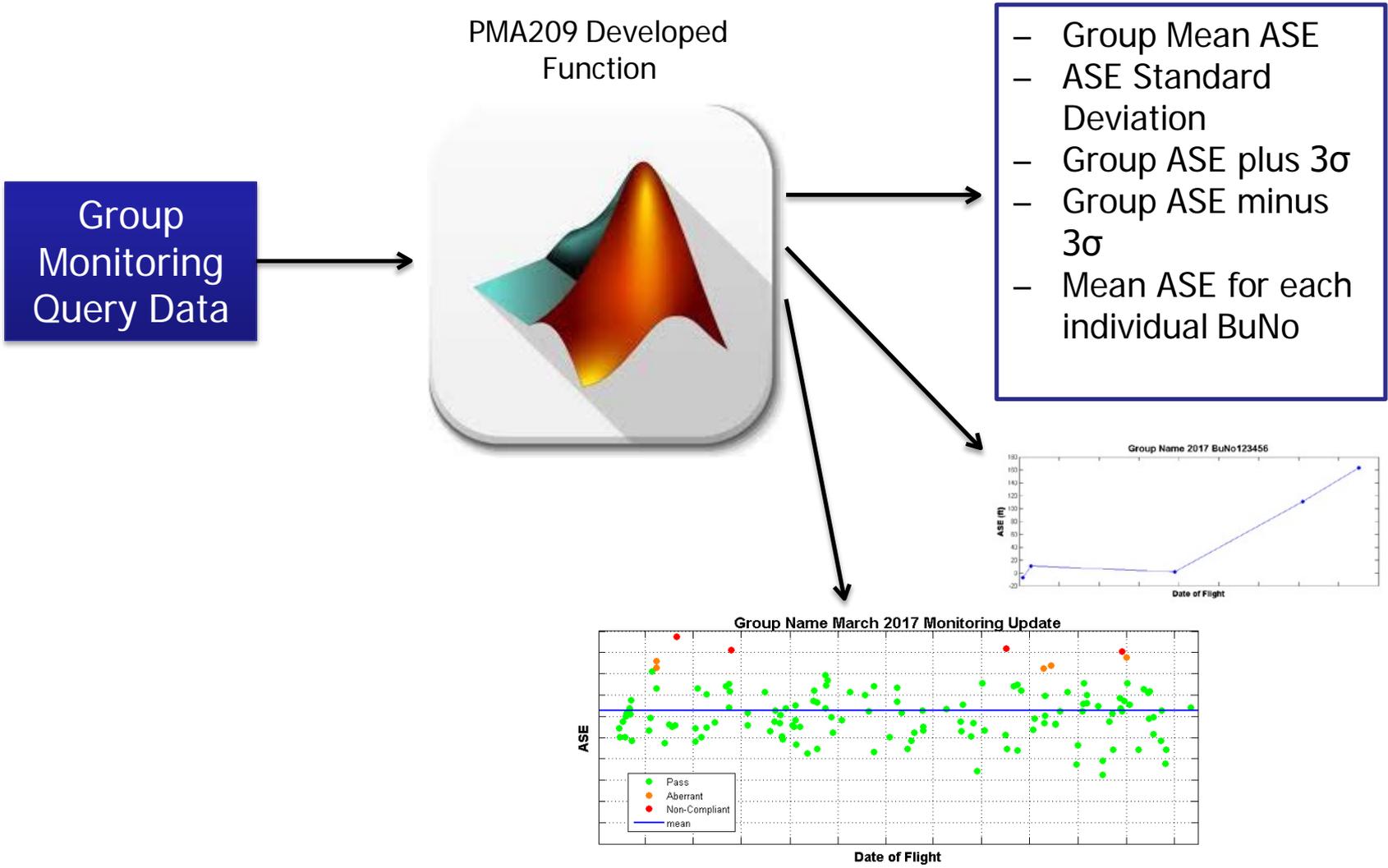


AGHME Flights Database Organization





Matlab Analysis





Group Mean ASE Calculation



$$f = \sum_{m=1}^n f_m$$

$$C = [C_1 \quad \dots \quad C_m]$$

$$f_m = \sum_{i=1}^n f_{mi}$$

$$\bar{C}_m = \frac{\sum_{i=1}^n C_{mi}}{f_m}$$

Calculate Mean for each Individual BuNo

$$\bar{C} = \frac{\sum_{m=1}^n \bar{C}_m f_m}{f}$$

Take the mean of the individual means to get the group mean

AC 91-85A:
 "A.5.2.1 The requirements in the *basic RVSM envelope* are as follows:
 1. At the point in the basic RVSM envelope where ASE_{mean} reaches its largest absolute value, the absolute value should not exceed 80 ft (25 m)."



Mean + 3σ

$$\sigma_{\text{BuNo}} = \sigma_{\text{BuNo}} \left(\frac{\sigma_{\text{BuNo}}}{\sigma_{\text{BuNo}}} \right)$$

Stdev of the entire group is the Stdev of the BuNo averages

$$\sigma_{+} = \text{ffoofffir} \left(\left| \frac{\sigma_{\text{BuNo}}}{\sigma_{\text{BuNo}}} \right| \right) + 3 \left(\text{ffoofffir}(\sigma_{\text{BuNo}}) \right)$$

$$\sigma_{-} = \text{ffoofffir} \left(\left| \frac{\sigma_{\text{BuNo}}}{\sigma_{\text{BuNo}}} \right| \right) - 3 \left(\text{ffoofffir}(\sigma_{\text{BuNo}}) \right)$$

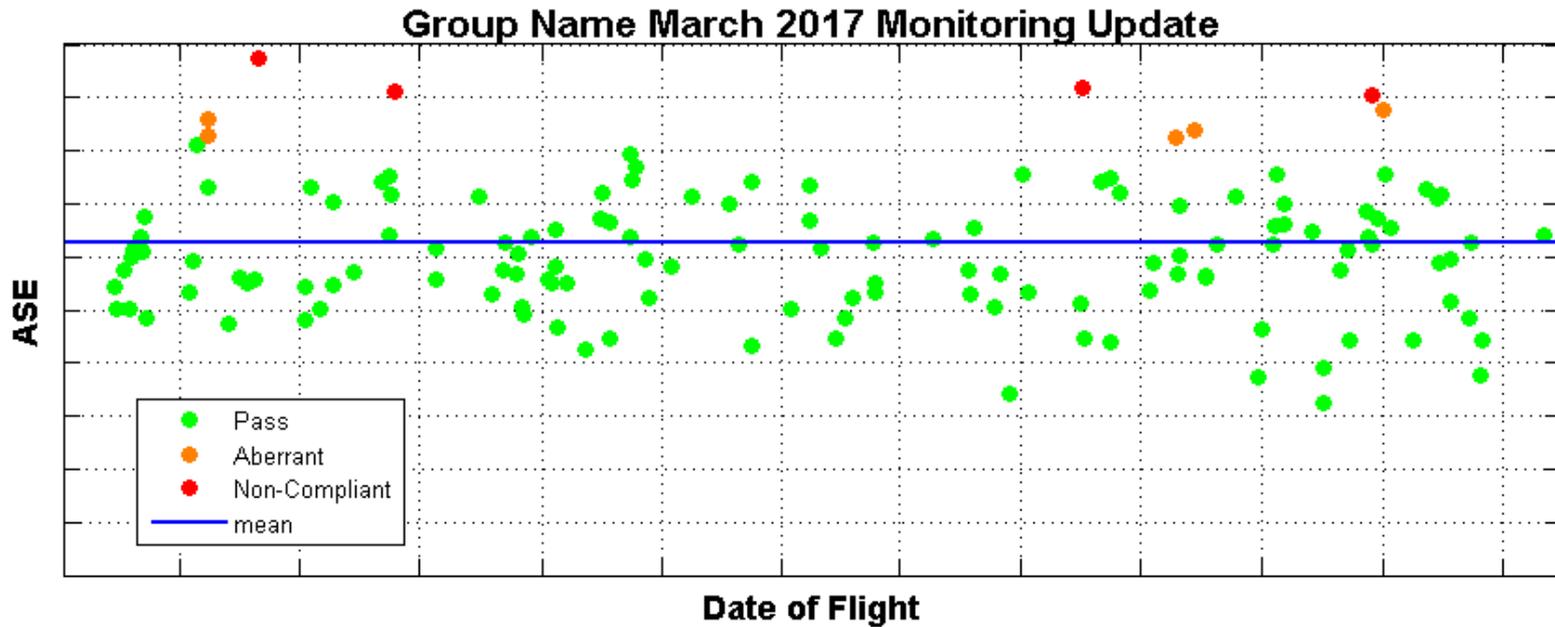
AC 91-85A:
"A.5.2.1 The requirements in the *basic RVSM envelope* are as follows:
2. At the point in the basic RVSM envelope where ASEmean plus ASE3 SD reaches its largest absolute value, the absolute value should not exceed 200 ft (60 m)."



ASE Plot



Example of an ASE plot for an Aircraft Group*



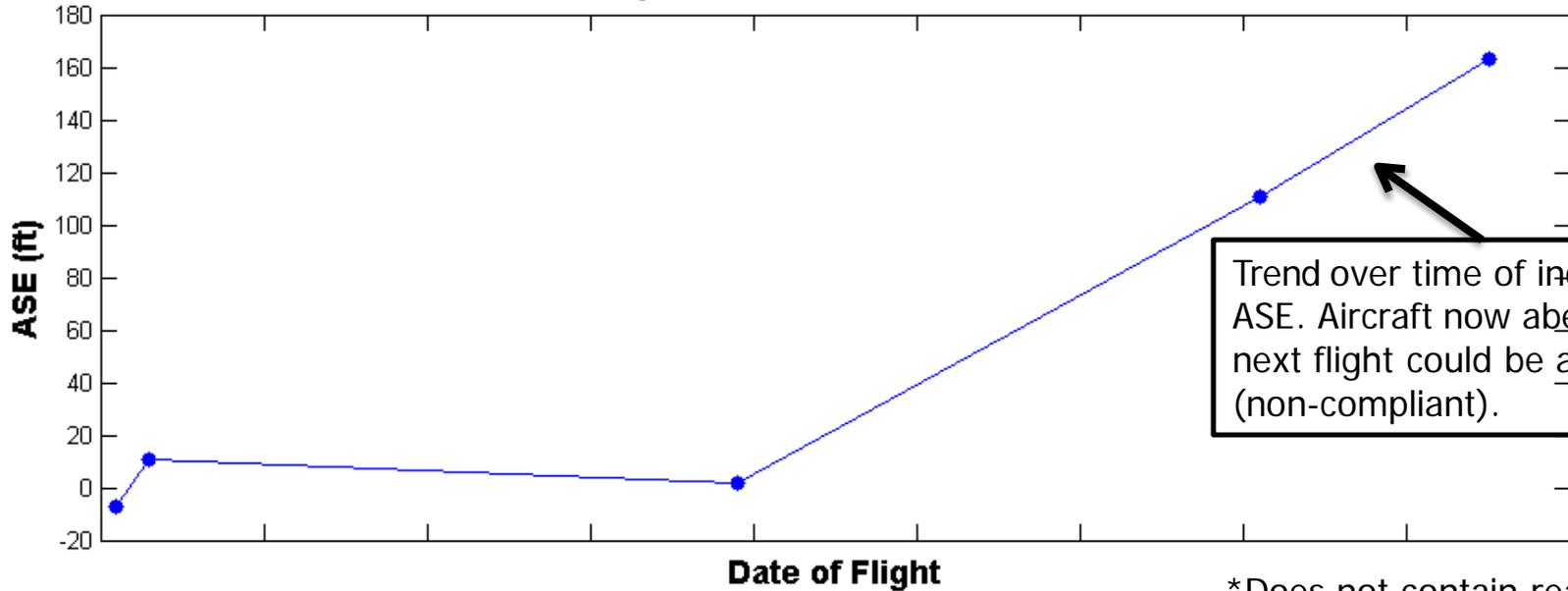
*Plot does not contain real aircraft data, example only.



Trend Analysis



Group Name 2017 BuNo123456*



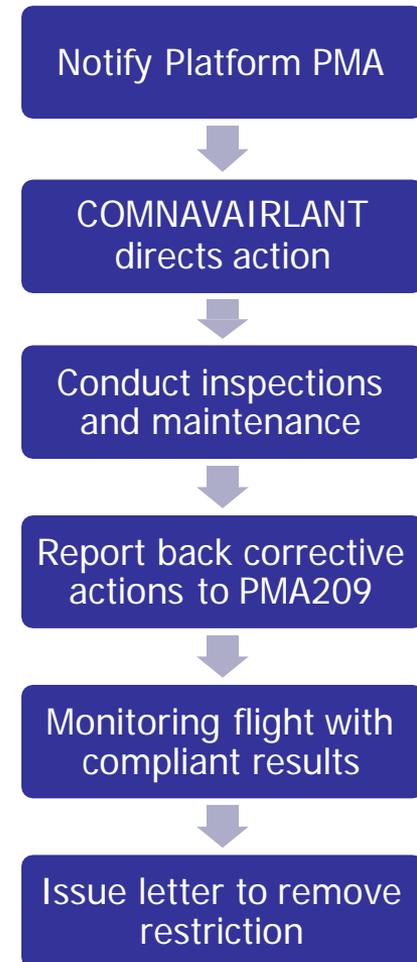


Non-Compliant Aircraft



The incidence of height-keeping performance errors that can be tolerated in an RVSM environment is small.

- Affected BuNo is restricted from RVSM operations.
- Wing must take action to investigate all possible causes they deem appropriate and correct the conditions causing the failure.
- Some possible causes are faulty air data system, fuselage mold line changes, operational error, inadequate maintenance procedures, and configuration deviations.
- A successful monitoring flight shall be flown on the affected BuNo to remove the RVSM restriction.





Aircraft Group Report



- **Report Layout:**

- Purpose of report
- Definitions of ASE and Validity Indicator
- Current Monitoring Cycle Data
 - Includes BuNo, Date of Measurement, Validity Indicator, and ASE
- Group Statistics
 - Contains ASE mean for the entire group as well as each individual BuNo
 - Contains mean +/- 3σ
 - Only the final report of a monitoring period contains statistics for lifetime RVSM. (This requires additional data analysis)



Bi-annual Reporting



- **A PMA209 letter and report are provided every six months to each aircraft group PMA and COMNAVAIRLANT to notify of monitoring progress.**
- **PMA209 Letter contains:**
 - Dates of monitoring cycle
 - Number of required RVSM monitoring flights for that cycle
 - Number of completed flights in that cycle
 - Reference monitoring methods



Questions?



Contact: rvsm@navy.mil