

# ADS-B Rule and Installation Guidance



Federal Aviation  
Administration

Presented by: Don Walker

Date: June 2011



# Outline

- **U.S. ADS-B Rulemaking**
  - Airspace Rule
  - Rule performance requirements
- **AC 20-165**
  - Installation and airworthiness approval of ADS-B systems



# ADS-B Airspace Rule

- **Issued May 28, 2010**
- **Effective January 1, 2020**
- **Performance based rule**
- **ADS-B designated airspace**
  - Defined in 14 CFR § 91.225
- **ADS-B performance requirements**
  - Defined in 14 CFR § 91.227

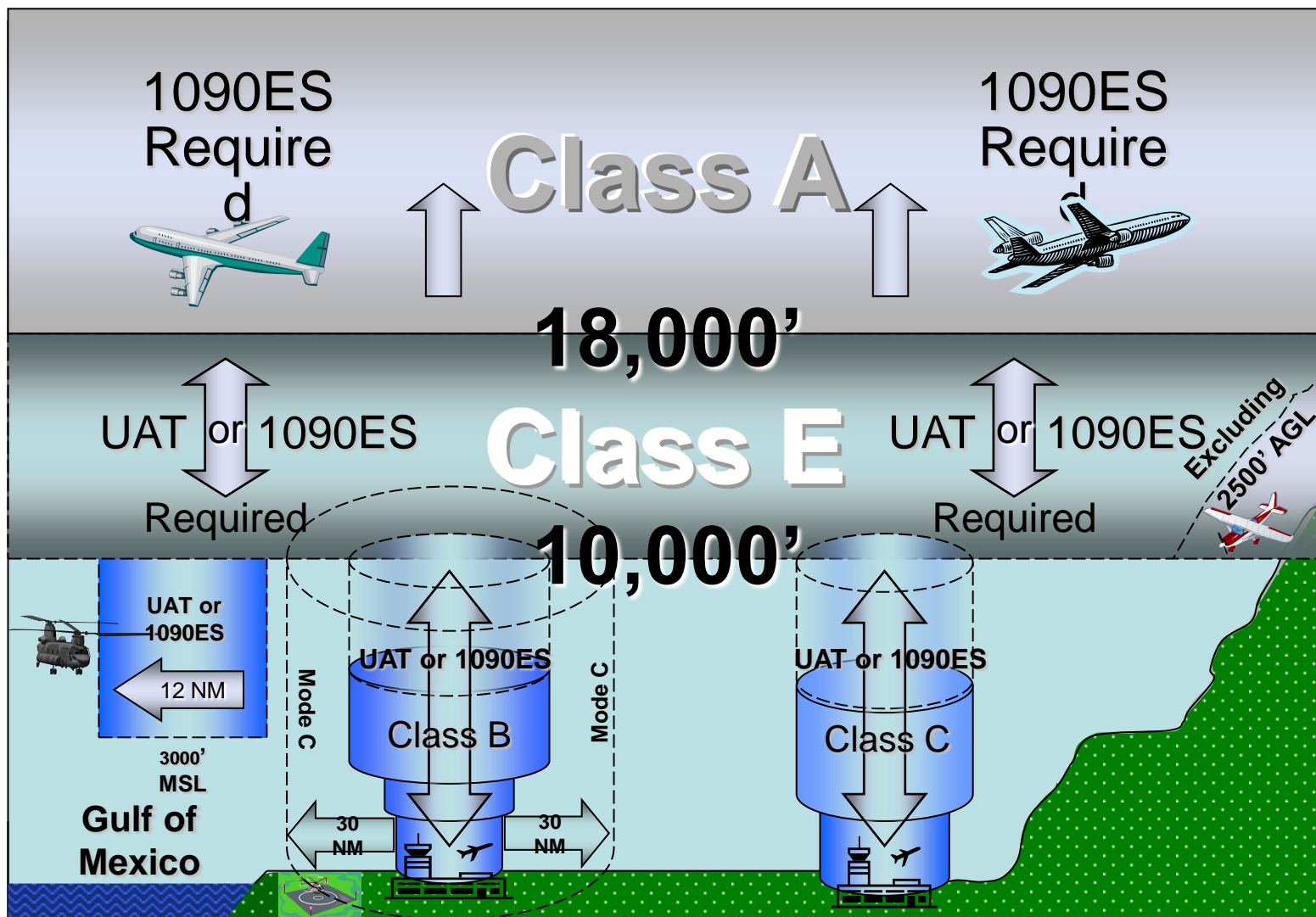


# ADS-B Airspace Rule § 91.225

- **Class A, B, C**
  - 1090ES required in Class A
- **Within 30NM of Appendix D airports**
  - 40 Busiest
- **Class E above 10,000' MSL**
  - Except below 2,500' AGL
- **In the GoMex above 3,000' MSL beyond the shoreline to 12NM**
- **Matches transponder required airspace**
  - With addition of GoMex airspace



# ADS-B Airspace Rule § 91.225



# ADS-B Rule Performance Requirements § 91.227

- **Equipment Classifications**

- TSO-C166b
- TSO-C154c
- Earlier revisions not acceptable

- **Accuracy & Integrity Performance**

- |                                       |                       |
|---------------------------------------|-----------------------|
| – $NAC_p \geq 8$ ( $< .05\text{nm}$ ) | Position Accuracy     |
| – $NIC \geq 7$ ( $< 0.2\text{nm}$ )   | Position Integrity    |
| – $NAC_v \geq 1$ ( $< 10\text{m/s}$ ) | Velocity Accuracy     |
| – $SIL = 3$                           | Integrity Probability |
| – $SDA \geq 2$ (Major)                | Design Assurance      |

# ADS-B Rule Performance Requirements § 91.227

- **Broadcast Message Elements**

- NIC
- NAC<sub>P</sub>
- NAC<sub>V</sub>
- SDA
- SIL
- Lat/Long
- IDENT
- Baro Altitude
- Mode 3/A Code
- 24-bit Address
- TCAS Status
- TCAS Report
- Emitter Category
- Length/Width
- Velocity
- Flight ID
- Geometric Altitude
- ADS-B In Capability

- **Latency**

- Total Latency  $\leq 2.0$  seconds
- Uncompensated Latency  $\leq 0.6$  seconds

## § 91.215 and § 91.217

- **§ 91.215 ATC Transponder & Altitude Reporting**
  - Unchanged. Aircraft must still carry a transponder
- **§ 91.217 Correspondence between reported altitude and pilot's altitude**
  - Updated to address ADS-B
  - Must use same altitude source and encoder for ADS-B and transponder



# AC 20-165

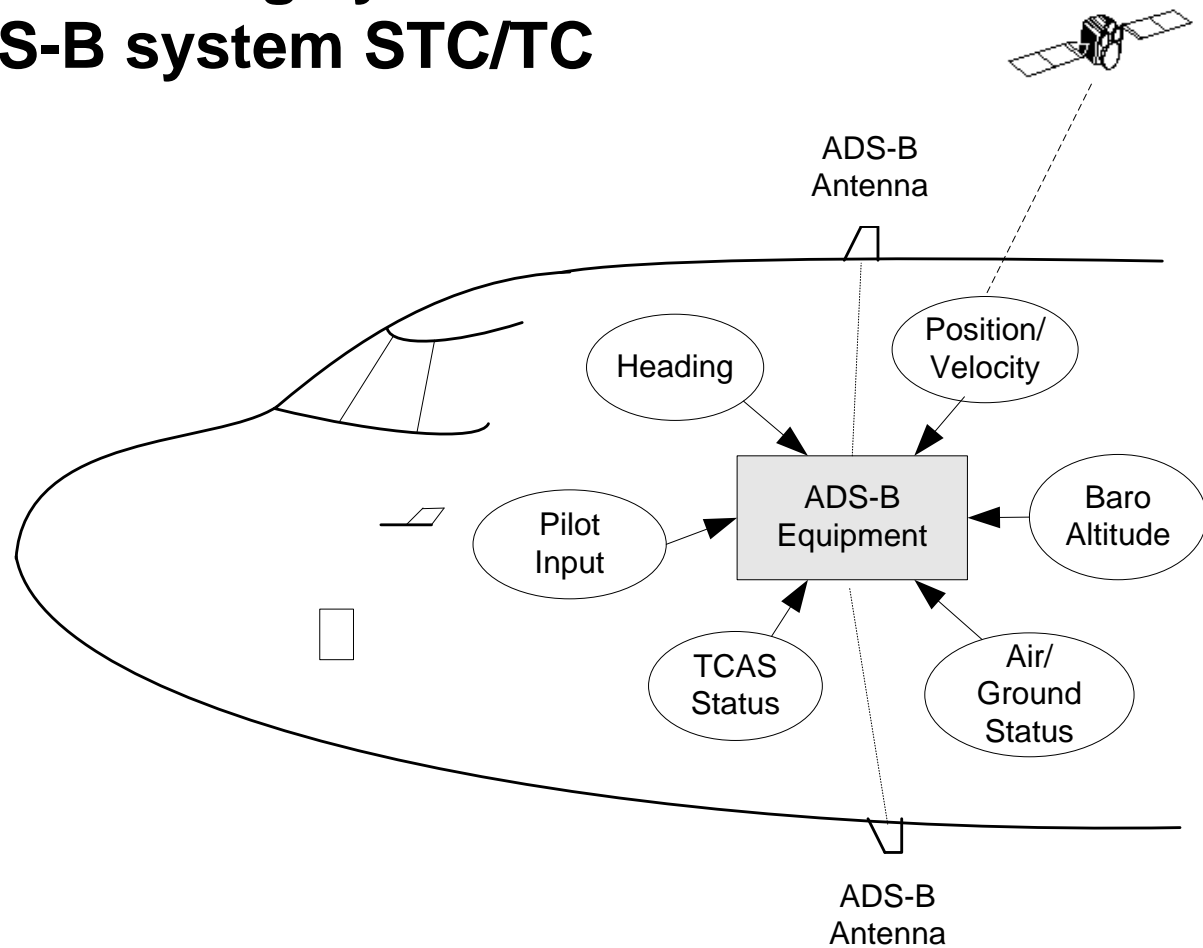


# AC 20-165 Overview

- **Installation & airworthiness approval of ADS-B systems**
- **Evaluate compliance with 14 CFR § 91.227**
  - Based on 91.227 compliance being the intended function
- **Written for initial STC/TC applications**
  - Can be used for follow-on STC/TC
- **Scope:**
  - TSO-C166b and TSO-C154c equipment
  - ADS-B Out (Not ADS-B In)
- **Two audiences in mind: installers & designers**

# The ADS-B System

- Each of the interfacing systems is part of the ADS-B system STC/TC



# Position Source Guidance

- **AC 20-165 appendix 2 outlines additional requirements for ADS-B position sources**
  - A GNSS TSO alone is not enough to support ADS-B
- **GNSS to ADS-B interface**
  - Design analysis required of all GNSS/ADS-B interfaces
- **GNSS velocity accuracy**
  - Most GNSS equipment does not have a velocity accuracy output
  - FAA has approved a method to qualify a GNSS to minimum requirements
  - GNSS manufacturer will have to run this test on their equipment and provide results to installers

# Barometric Altitude

- **Aircraft altitude MUST come from the same altitude source as the transponder**
  - Using an altitude source that is different from the transponder's can cause altitude discrepancies
- **No new accuracy requirements**
- **No new resolution requirements**



# Automatic Determination of Air-Ground Status

- **ADS-B transmits two different types of position messages:**
  - Surface
  - Airborne
- **Aircraft must be able to automatically determine air-ground status to transmit correct position message**



# Pilot Interface

- **Pilot must enter**
  - Mode 3/A Code
  - Ident
  - Emergency Status
  - Call sign / Flight Id (if not permanently set)
- **HIGHLY recommend single point of entry for transponder and ADS-B (UAT) systems**
  - Dual entry will require applicant to demonstrate likelihood of entering differing mode 3/A codes, or forgetting to enter Mode 3/A code into both boxes is remote
  - Dual entry will require applicant to demonstrate that dual entry does not increase pilot workload, especially during emergency

# TCAS II

- **If the aircraft has a TCAS II installed, it must be interfaced to the ADS-B**
- **The ADS-B transmits:**
  - Whether a TCAS II is operating
  - TCAS II RA message
- **Interface of the TCAS II to the ADS-B does not change the design assurance requirements of the ADS-B**





# Heading

- **If the aircraft has a heading source installed, then it is highly recommended (but not mandatory) to provide heading**
- **Heading is only transmitted on the surface**
- **If heading not available, ADS-B must transmit ground track from the position source**
  - GPS ground track becomes unusable at low speed
  - Recommend GPS invalidate ground track at low speeds
  - If GPS does not invalidate, ADS-B must invalidate

# ADS-B Antenna

- **Single bottom mounted antenna is OK**
  - However doesn't change any TCAS II or transponder antenna requirements
- **Reusing transponder antenna is OK**
- **TSO-C154c diplexer is OK**
  - Used in UAT systems to allow ADS-B and transponder to use the same antenna

# AC Overview: System Design Assurance (SDA)

- **End-to-end design assurance (for position) includes:**
  - Position source
  - ADS-B
  - Intermediary equipment
- **Set SDA = 2 without analysis if:**
  - GPS and ADS-B are directly connected, and
  - Using a TSO'd GPS and a TSO'd ADS-B
- **System safety assessment derived SDA if:**
  - Using a non-GPS position source, or
  - Using a intermediary equipment like a data concentrator

# AC Overview: System Latency Assessment

- **Two Latency Requirements:**
  - Total Latency  $\leq$  (2.0 seconds)
  - Uncompensated Latency  $\leq$  (0.6 seconds)
- **Latency analysis not required if:**
  - ADS-B system directly connected to a TSO-C145/146/196 GPS
- **Latency analysis required if:**
  - Using a TSO-C129 GPS, or
  - Using a non-GPS position source, or
  - Using an intermediary device (data concentrator)

# Testing

- **Ground test**
  - Majority of testing will be done on the ground
  - Utilizing test sets similar to transponder test sets
- **Flight test against ground system**
  - For initial STC only (not each install)
  - Retrieve data from FAA
  - Post flight data analysis
  - A process is in place to retrieve data, but it is not mature...contact AIR-130 with any issues
- **Transmit power tests**
  - Ground tests
  - Utilize standard transponder-like test equipment

# Flight Manual

- Update applicable portions of the flight manual
- AC 20-165 has a sample (basic) flight manual example
- 14 CFR § 91.227 compliant systems should add the following statement to the flight manual

**“The installed ADS-B out system has been shown to meet the equipment requirements of 14 CFR § 91.227.”**

- Mode S transponder based systems must now remain “On” with altitude reporting when on the surface
  - Similar to operation at ASDE-X airports

# Continuing Airworthiness

- **No ADS-B addition to Part 43**
  - As of now, there is no 24-month transponder-like test requirement
- **Compliance Monitor**
  - FAA ground system will monitor ADS-B, compare to radar when available, and highlight non-compliant aircraft
- **Transponder & altimeter checks unchanged**
- **Maintenance & design changes to interfacing systems**
  - Must update ICAWs to ensure maintenance actions or design changes to interfacing systems don't impact ADS-B performance and continued airworthiness

# For More Information:

**Don Walker, AIR-130  
Surveillance Team Lead**  
**[don.walker@faa.gov](mailto:don.walker@faa.gov)**  
**202-385-4821**





# Backup slides/FAQs



# FAQ

- **Can a TSO-C129 SA On GPS qualify as an ADS-B position source:**
  - Maybe. The GPS must meet all AC 20-165 appendix 2 requirements
  - Availability will be a concern for many operators
- **Do I have to equip with WAAS?**
  - No. However WAAS will provide the best availability
- **What happens if I equip with a position source with low availability?**
  - You could be denied access to the airspace when the position source is unable to meet the performance requirements
- **Does every installation need a flight test?**
  - No. Only initial STC/TC

## FAQ (Cont)

- **Does my system need separate indications for a system fault and an ADS-B function failure.**
  - No. If the same indication is used for both failures the flight manual must describe how to differentiate as well as any implications
- **My INS velocity is better than my GPS velocity, why can't I use the INS velocity?**
  - TSO-C166b and TSO-C154c require the position and velocity come from the same position source
- **Can I hook up selected altitude to meet the proposed European Rule?**
  - Yes, follow the ADS-B equipment manufacturer's guidance
- **Can we apply for a STC AML**
  - Yes.



## FAQ (Cont)

- **Do I need a new UAT ADS-B antenna if I already have a transponder antenna?**
  - No. TSO-C154c provides standards for a diplexer that can allow the existing transponder antenna to be shared with the ADS-B
- **Why do I have to limit the NIC if I use a GPS with a RAIM based integrity?**
  - RAIM based integrities are only accurate down to  $\approx 0.1$  nm
  - However, some GPS equipment will output a lower integrity (HPL/HIL)
  - In this case, either the GPS or the ADS-B needs to ensure the NIC is  $\leq 8$
- **Can we use DERs? Yes**

## FAQ (Cont)

- **Do UAT systems require a single point of entry for the Mode 3/A code, Ident, and emergency code?**
  - No...However....
  - We strongly discourage dual entry systems
  - Applicant must demonstrate that the likelihood of a pilot error resulting in the transmission of different Mode 3/A codes is **remote**
  - Applicant must also demonstrate that dual entry of emergency code will not cause additional workload during emergency ops
- **How will light GA aircraft without WOW switches automatically determine their air-ground status**
  - Vendors may integrate algorithms using the GPS and other available sources to determine the air-ground status



# FAQ (Cont)

- **How do I determine the SDA?**
  - Aircraft with a TSO'd GPS connected directly to a TSO'd ADS-B may set the SDA=2 without further analysis
  - Aircraft with other architectures will complete a system safety analysis to set SDA
- **Do interfacing systems, like the GPS, have to be installed under STC/TC:**
  - No, if the GPS received a field approval, it can be part of the ADS-B system STC.
- **Do I have to add a display that indicates the ADS-B position source in use?**
  - No, if the flight manual describes the conditions that impact position source selection
- **My GPS doesn't provide velocity accuracy, how do I set  $NAC_V$ ?**
  - RTCA has developed a test which, when run and passed by the GPS vendor, allows the ADS-B system to pre-set the  $NAC_V$  to 1.