Federal Aviation Administration

ADS- B Installation Guidance

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Outline

- Approval Policy
- AC 20-165 Overview
- The ADS-B System
- Testing
- AFM & ICAW
- Technical Challenges
- FAQ

Approval Policy

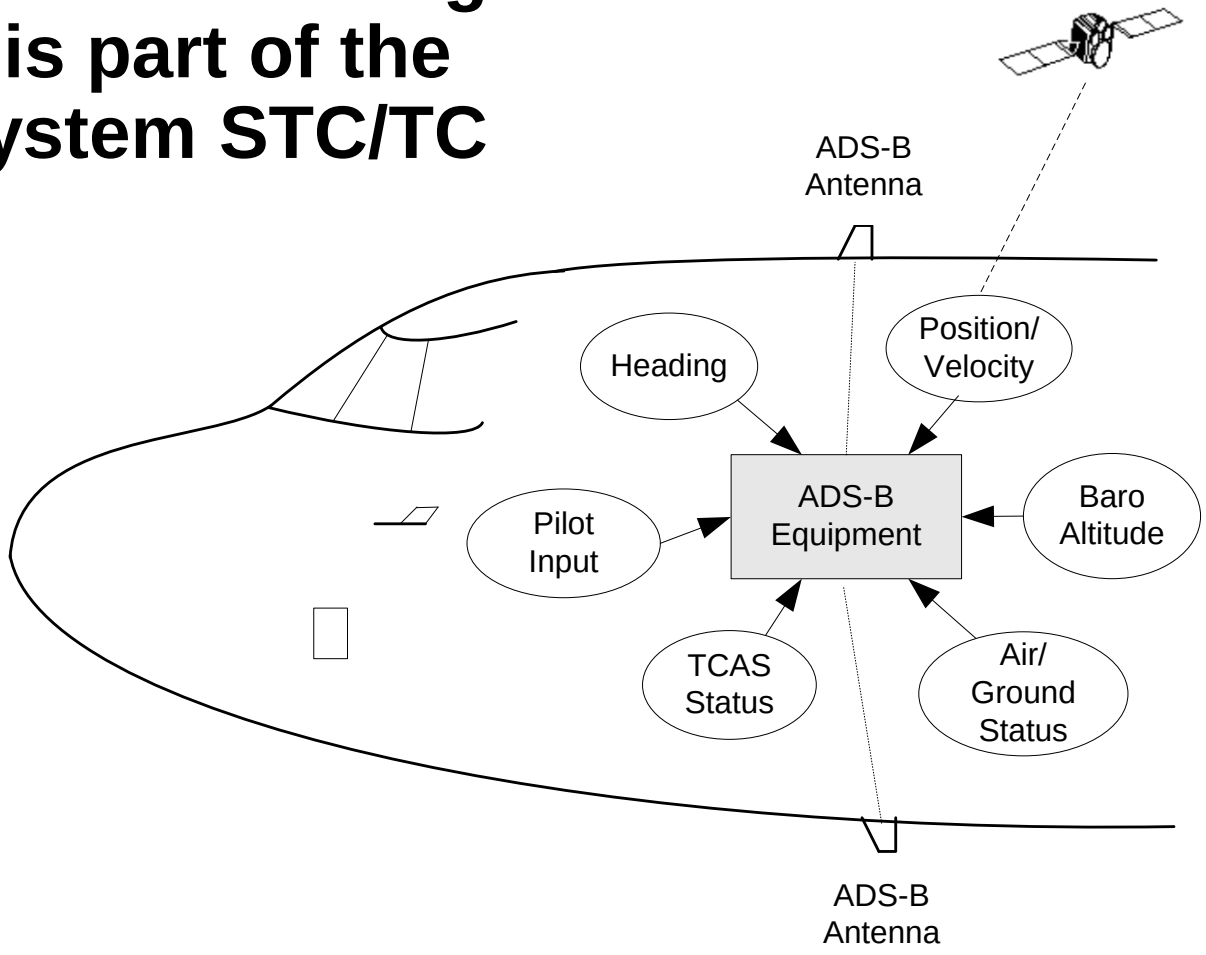
- **Applies only to version 2 ADS-B Out equipment installations**
- **To start, installation through STC/TC Only**
  - No field approvals initially
  - Conservative approach
    - Technical challenges
    - System immaturity
    - FAA & industry limited experience with ADS-B
- **No new STCs on “non-interference” basis**
  - Must stop the proliferation of unqualified avionics
- **STC may use DERs for portions of project**
- **AMLs are permitted when appropriate**

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
  - Unless, IM calls out specific position source where performance was demonstrated during the design approval process

Position Source Guidance

- **GNSS velocity accuracy**
  - Most GNSS equipment does not have a velocity accuracy output
  - FAA has approved a method to statically qualify a GNSS to minimum requirements
  - GNSS manufacturer will have to run this test on their equipment and provide results to installers

Position Source Guidance (cont)

- **NIC limiting**
  - RAIM based GNSS HPL calculations are only accurate to about 0.1nm…however many GNSS's can output a HPL much smaller 0.1nm
  - Either the GNSS or the ADS-B needs to limit the NIC to ≤ 8 in this case
- **Types of position sources**
  - TSO-C129 GNSS (Availability ≥ 89%)
  - TSO-C196 GNSS (Availability ≥ 99%)
  - TSO-C145/C146 GNSS (Availability ≥ 99.9%)
  - Tightly Coupled GNSS/IRS (issue paper)
  - Other position sources (issue paper)

Barometric Altitude

- **Altitude MUST come from the same altitude source as the transponder**
- **No new accuracy requirements**
- **No new resolution requirements**
- **Discourage Gillham encoders**

Automatic Determination of Air-Ground Status

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

Automatic Determination of Air-Ground Status

- **Multiple sources needed to determine air-ground status**
  - WOW switch + GPS velocity
  - GPS velocity + airport database + geometric altitude
  - GPS velocity + airspeed
- **Will require new computations for many light GA aircraft**
  - Comparison of a single ground speed is usually not acceptable
  - Functionality demonstrated during flight test

Pilot Source Guidance

- **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

- **Heading is optional, but highly encouraged if the aircraft has a heading source installed**
- **Heading only transmitted on 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
    - Prefer exact inhibit speed to be provided by GPS vendor
    - If not provided by GPS vendor, default inhibit should be 7 knots

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 and intermediary equip
- **All systems must address SDA**
  - Not just 91.227 compliant systems
- **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 intermediary equipment like a data concentrator

AC Overview: System Latency Assessment

- **All systems must address latency**
  - Not just 91.227 compliant systems
- **Two Latency Requirements:**
  - Total Latency (2.0 seconds)
  - Uncompensated Latency (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**
  - Initial STC (not each install)
  - Retrieve data from FAA
  - Post flight data analysis
  - A process is in place to retrieve data, but its 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."

Flight Manual

- **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
  - However…European draft rule includes a 24-month inspection
- **Compliance Monitor**
  - FAA ground system will monitor ADS-B, compare to radar when available, and highlight non-compliant aircraft

Continuing Airworthiness

- **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

Technical Challenges

- **Non-GNSS position sources**
- **Single point of entry (Mode 3/A)**
- **GNSS to ADS-B interface**
  - Data concentrators
- **Non-rule compliant systems**
- **Air-ground status**

FAQ cont.

- **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
- **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

FAQ cont.

- **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
- **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

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
- **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
- **Can we apply for a STC AML**
  - Yes

FAQ cont.

- **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 ≈ 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 ≤ 8
- **Can I hook up selected altitude to meet the proposed European Rule?**
  - Yes, follow the ADS-B equipment manufacturer's guidance

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
- **Can we use DERs?**
  - Yes

FAQ cont.

- **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
- **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

FAQ cont.

- **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.
- **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.

Summary

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