Outline

• Approval Policy
• AC 20-165 Overview
• The ADS-B System
• Testing
• AFM & ICAW
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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
For More Information:

Don Walker, AIR-130
Surveillance Team Lead
don.walker@faa.gov
Phone: 202-385-4821