

Automatic Dependent Surveillance – Broadcast (ADS-B)

- Regulations & airspace
- Standards & guidance
- Exemption 12555
- Installation issues & the Performance Monitor
- ADS-B Web Resources

Flight Technologies and Procedures
Division (AFS-400)
September 2017



Federal Aviation
Administration



ADS-B Regulations & Airspace



ADS-B Out Regulations

Final Rules for ADS-B Out Equipage

- Published May 27, 2010; compliance date January 1, 2020
- Identifies certain airspace where ADS-B Out will be required and the performance requirements for ADS-B avionics
- § 91.225 specifies Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment and use including applicable airspace
- § 91.227 specifies Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment performance requirements
- **Important** - The rules apply to all aircraft in the that airspace, including foreign registered aircraft.
- Exceptions - The rule does not apply to aircraft
 - Not originally certificated with an electrical system, or
 - Not subsequently certified with such a system installed, including balloons and gliders

ADS-B Out Rule Summary

14 CFR 91.225 Extract

(a) After January 1, 2020, and unless otherwise authorized by ATC, no person may operate an aircraft in **Class A airspace** unless the aircraft has equipment installed that—

(1) Meets the **performance requirements in TSO-C166b**, Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Service-Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz); and

(2) **Meets the requirements of § 91.227.**

--- and ---

(b) After January 1, 2020, and unless otherwise authorized by ATC, no person may operate an aircraft below 18,000 feet MSL and in airspace described in paragraph (d) of this section unless the aircraft has equipment installed that—

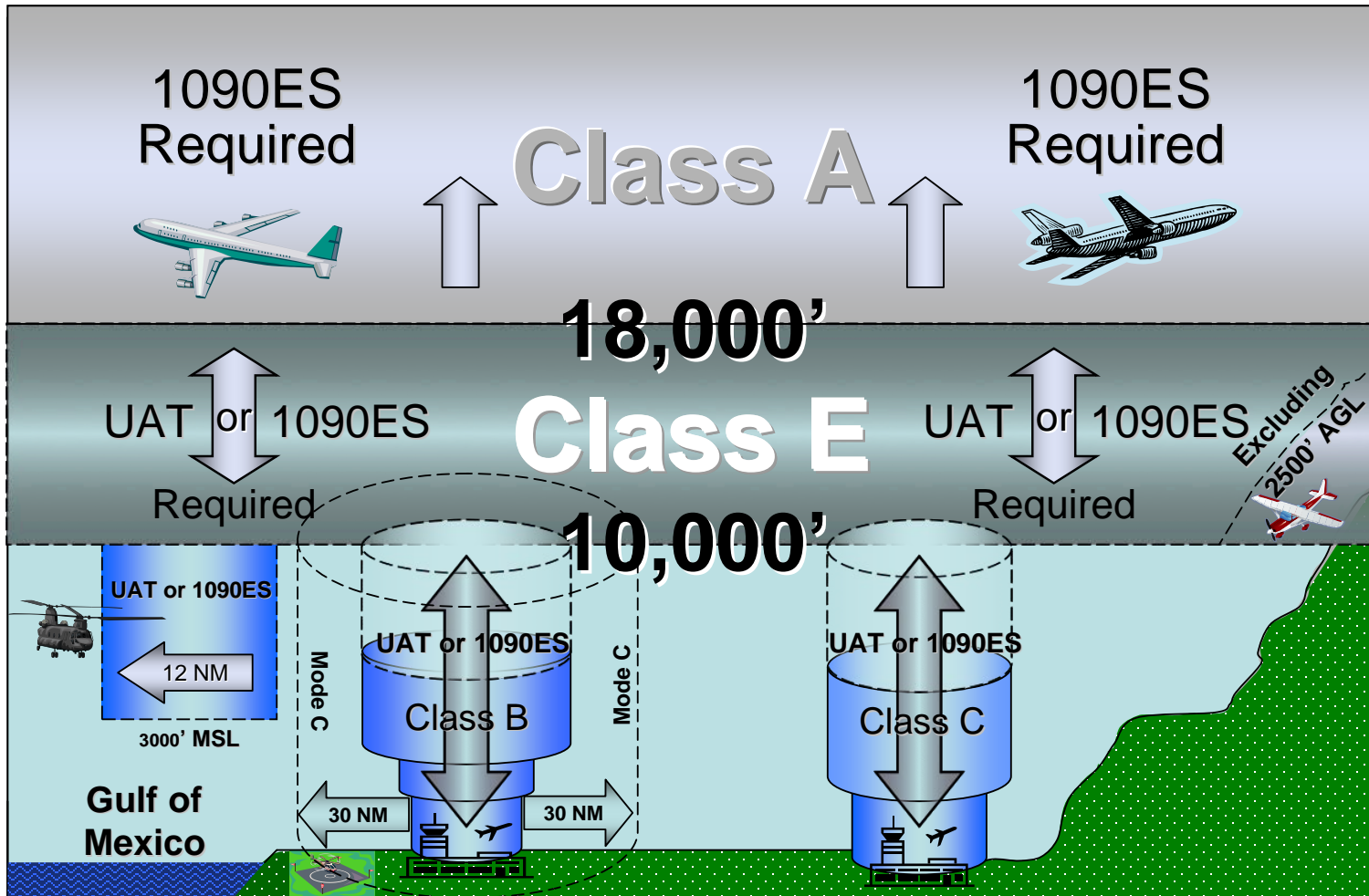
(1) Meets the **performance requirements** in—

(i) **TSO-C166b**; or

(ii) **TSO-C154c**, Universal Access Transceiver (UAT) Automatic Dependent Surveillance-Broadcast (ADS-B) Equipment Operating on the Frequency of 978 MHz; and

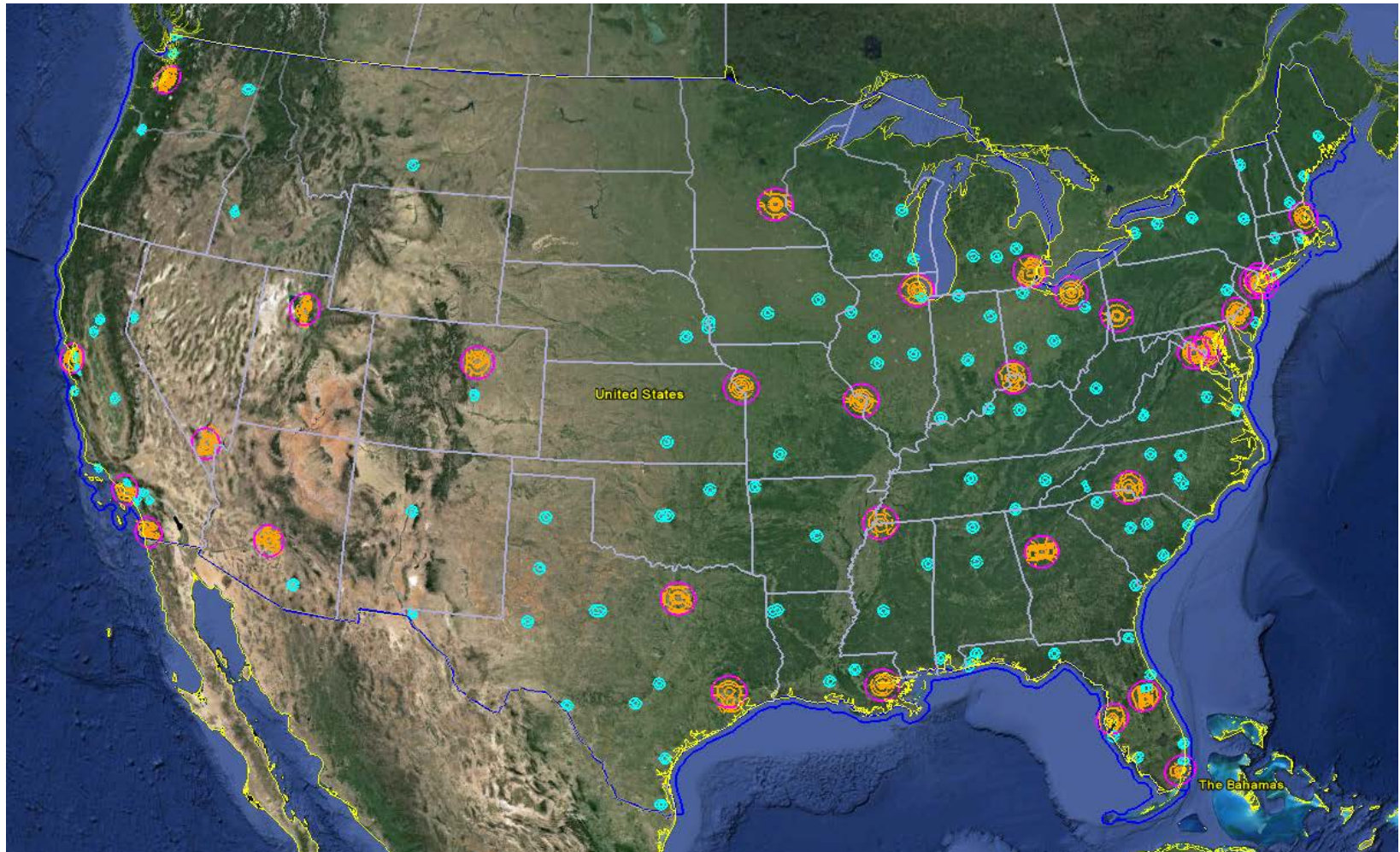
(2) **Meets the requirements of § 91.227.**

Understanding ADS-B Airspace



Visit <https://www.faa.gov/nextgen/equipadsb/airspace/>

ADS-B Out Airspace Below 10,000'



Standards & Guidance



U.S. Equipment Link (Frequency) Options

What You Need Based on Where You Fly

- For aircraft **operating in Class A (FL180 and above) or internationally**,
 - You must be equipped with a Mode S-transponder (1090ES) ADS-B transmitter.
- For aircraft **operating below 18,000 feet and within U.S. airspace**, you must be equipped with either a Mode S transponder
 - Mode S transponder-based (1090 MHz) ADS-B equipment that meets the performance requirements of Technical Standard Order TSO-C166b

- OR -

 - Universal Access Transceiver (UAT) equipment must meet the performance requirements of TSO-C154c. UAT equipment provides the ability to receive traffic and weather data provided by the FAA ADS-B network.

ADS-B Technical Guidance Documents

The Technical Standard Orders (TSOs) for ADS-B avionics were approved Dec. 2009. The rule requires:

- Equipment designed for 1090ES (1090 MHz) must meet **TSO-C166b** or later versions of this order; and
- Equipment designed for UAT (978 MHz) must meet **TSO-C154c** or later versions of this order.

Advisory Circulars

- **AC 90-114A Change 1, ADS-B Operations**
 - Provides guidance and information on ADS-B Out in accordance with 14 CFR 91.225 and 91.227. No OPS approval is required for ADS-B Out
- **AC 20-165B, Airworthiness Approval of ADS-B Out Systems**
 - Provides installation guidance for ADS-B Out systems
- **AC 20-172B, Airworthiness Approval of ADS-B In Systems and Applications**
 - Provides installation guidance for ADS-B In systems and applications
- **Aeronautical Information Manual**



Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, D.C.

TSO-C166b

Effective
Date: 12/02/09

Technical Standard Order

Subject: Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B) and Traffic Information Service - Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz)

1. **PURPOSE.** This technical standard order (TSO) is for manufacturers applying for a TSO authorization (TSOA) or letter of design approval (LODA). In it, we (the Federal Aviation Administration, or FAA) tell you what minimum performance standards (MPS) your 1090 MHz ADS-B and TIS-B equipment must first meet for approval and identification with the applicable TSO marking.
2. **APPLICABILITY.** This TSO affects new applications submitted after its effective date.



Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, D.C.

TSO-C154c

Effective
Date: 12/02/09

Technical Standard Order

Subject: Universal Access Transceiver (UAT) Automatic Dependent Surveillance-Broadcast (ADS-B) Equipment Operating on Frequency of 978 MHz

1. **PURPOSE.** This technical standard order (TSO) is for manufacturers applying for a TSO authorization (TSOA) or letter of design approval (LODA). In it, we (the Federal Aviation Administration, or FAA) tell you what minimum performance standards (MPS) your universal access transceiver (UAT) ADS-B equipment and/or UAT diplexers must first meet for approval and identification with the applicable TSO marking.
2. **APPLICABILITY.** This TSO affects new applications submitted after its effective date.

Exemption 12555



Performance Requirements

14 CFR 91.227

- **Consider the rule as having three parts:**
 - The airspace (defined in 14 CFR 91.225)
 - The ADS-B equipment (specified in 14 CFR 91.225) – 1090ES or UAT, and
 - The required performance and broadcast elements (14 CFR 91.227)
- **The position source (typically, GNSS) is an essential component of the ADS-B equipment and provides many of the required broadcast message elements:**
 - Useful ones – such as latitude and longitude, velocity, altitude
 - Performance ones – accuracy (NACp, NACv), integrity (NIC, SIL) and design assurance (SDA)
 - Two of these are the subject of Exemption 12555:
 - Navigation Integrity Category (NIC)
 - Navigation Accuracy Category for position (NACp)
 - Many elements are derived from the position source (i.e., GNSS)
 - The rule does not require a particular position source,
 - Only that you meet minimum performance values and broadcast **all** required message elements
 - Rule minimum performance values (NIC ≥ 7, NACp ≥ 8, NACv ≥ 1, SDA ≥ 2, SIL ≥ 3)

Position Source Characteristics

Operational Impacts

- **There are three common position sources in use for ADS-B:**
 - GPS that behave as if Selective Availability (SA) is still active (SA-On);
 - GPS that behave as if SA has been deactivated (SA-Aware), and
 - GPS that have Satellite Based Augmentation System (SBAS) such as the U.S. Wide-Area Augmentation System (WAAS)
- **Selective Availability (SA) Impact**
 - SA-On and SA-Aware GPS have been shown to have brief periods where they produce NIC and NACp below the rule performance requirements, particularly when there are a reduced number of GPS operational satellites.
 - This could have an impact on an operator's ability to comply with the rule or gain access to rule airspace at desired times on desired routes.
 - Analysis has shown that SA-On GPS receivers will fail to achieve the NIC requirements with high availability (equal to or greater than 99.9% availability) under many expected GPS constellation conditions.
 - SA-Aware GPS receivers will have improved performance over SA-On and are likely to meet the NIC and NACp requirements when the GPS constellations has a large numbers of satellites
 - SBAS receivers use additional signals from geostationary satellites specifically designed for aviation use for improved availability and not affected by SA
 - SA-On and SA-Aware are widely used in current air transport aircraft
 - Operators must consider these characteristics and the impact on flight operations

Exemption 12555 Summary

- It is not an extension of the rule compliance date
- It is a five year limited exemption only from 91.227(c)(1)(i) & (iii) – the NIC and NACp requirements – under the following conditions and limitations:
 - Each operator seeking exemption must notify the FAA of their intent to comply
 - Operators covered under the exemption must develop and execute a plan to equip their aircraft to meet the requirements of 14 CFR § 91.227(c) prior to January 1, 2025.
 - Operators of SA-Aware equipped aircraft are not required to conduct preflight verification. They are exempted from the performance requirements in 14 CFR § 91.225 when their ADS-B Out equipment is not predicted to meet the requirements of § 91.227(c)(1)(i) and (iii).
 - Operators of SA-On equipped aircraft must conduct preflight verification. They may operate in airspace specified in § 91.225 when their ADS-B Out equipment does not meet the requirements of § 91.227(c)(1)(i) and (iii) **and** the FAA determines there is a backup means of surveillance
 - The FAA will make this determination available through the SAPT.

Exemption 12555 Process

- Exemption process reference documents
 - FAA Order N8900.418 (Notice) Exemption 12555 Notification and Implementation Process
 - Information for Operators (InFO) 16003, Exemption 12555 Process
 - Exemption 12555, “Fact Sheet”
- Operator notifies FAA of intent to comply via a Letter of Intent (LOI)
 - Files the letter as an attachment to a comment to the docket folder Regulatory Docket No. FAA-2015-0971 on Regulations.gov
 - Letter must include acknowledgement of the conditions and limitations of this exemption as the basis for continued operation in “rule airspace”
- Operator sends copy of LOI to principal inspector or brings to FSDO
 - POI/FSDO issues/updates A005 with Exemption 12555 based on letter
- Operator submits plans for upgrading equipment to Director Flight Standards by August 1, 2018
 - Submits electronically to 9-AWA-Equip.2020@faa.gov
 - AFS-430 monitors docket, “maintains” upgrade plans database for monitoring progress and reporting to Equip 2020
 - AFS-430 coordinates with AFS-360 and AIR-130 to ensure plans are reasonable and identify any equipage “chokepoints”
- AFS-1 issues exemption cancellation notice at end of exemption period
- NOTE: Documents can be found at, www.faa.gov/nexgen/equipadsb/exemption

Advisory Circular (AC) 90.114A CHG1

Preflight Requirements

- **AC published March 7, 2016**
- **Summarizes the performance characteristics of SA-ON and SA-AWARE GPS and impact on rule performance –**
 - SA-ON and SA-Aware may have periods where NIC and NACp are less than the rule requirements
- Operators with these systems are expected to perform a preflight availability prediction to ensure compliance
 - Some GPS receivers manufactured with a TSO-C129a approval are SA-Aware, so have the same NACp and NIC availability as TSO-C196() approved equipment.
 - “If ADS-B Out performance becomes deficient during flight in § 91.225 airspace, ATC may require the aircraft to exit the airspace.”

AC 90.114A CHG1

Preflight Requirements

- **Preflight availability prediction methods**

- Operator's own tool that accurately predicts the performance for their aircraft.
 - The tool needs to account for the GPS satellites that are in service at the time of the prediction, account unique characteristics of the GNSS receiver, aircraft integration or installation;
 - The FAA does not evaluate or approve a particular tool, but may evaluate the basis of the operator's determination that the tool is appropriate to their aircraft,
- FAA provided Service Availability Prediction Tool (SAPT)
 - Either flight plan interface or XML batch submission
- NOTAMS to be issued for GNSS and SAPT outages
- Operators with SBAS systems need only check NOTAMS

AC 90.114A CHG1

Preflight Requirements

■ Prediction results

- SA-On or SA-Aware **without** exemption,
 - In the event of prediction of NACp and NIC non-compliance - operator must request an ATC authorized deviation, delay, re-route or not depart
- SA-On **with exemption**,
 - In the event of prediction of NACp and NIC non-compliance operator may operate where ADS-B is required **provided** other FAA surveillance is predicted to be available
 - SAPT must be used to determine if other surveillance is predicted to be available, but must be done no more than 2 hours prior to departure
- FAA will issue NOTAMS for:
 - Outages of GNSS – scheduled and unscheduled
 - ATC may revert to alternate surveillance in affected areas
 - SAPT unavailable
 - ATC will authorize flights with NACp and NIC performance outages

Who is expected to conduct preflight availability prediction?

Equipment	2020 - 2024		After 2024
	Exemption 12555	No Exemption 12555	
SA ON (TSO-C129)	Yes SAPT will determine backup surveillance & exemption authorizes flight if NIC/NACp < 7/8	Yes Operator must contact ATC to obtain authorization if NIC/NACp < 7/8	Yes Operator must contact ATC to obtain authorization if NIC/NACp < 7/8
SA AWARE (TSO-C196)	No Exemption authorizes flight without the need for preflight prediction	Yes Operator must contact ATC to obtain authorization if NIC/NACp < 7/8	Yes Operator must contact ATC to obtain authorization if NIC/NACp < 7/8
SBAS (TSO-C145 or 146)	No	No	No

Equip 2020 Outreach

NextGen website

Fact Sheet: Exemption No. 12555
FAA Flight Technologies and Procedures Division, AFS-400

NOTICE U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
National Policy
N 8900.342

SUBJ: Exemption 12555 Notification and Implementation Process

1. Purpose of This Notice. This notice explains the Exemption No. 12555 certificate-holding district offices (CHDO), principal inspectors (PI), and aviators (ASD) of the procedures for processing an operator's notification of Exemption 12555.

InFO
Information for Operators
InFO 16003
DATE: 2/17/16
Flight Standards Service
Washington, DC

http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/info
An InFO contains valuable information for operators that should help them meet certain administrative, regulatory, or operational requirements with relatively low urgency or impact on safety.

Subject: Exemption 12555 Process

Purpose: This InFO explains the process for operating under Exemption 12555 and summarizes the associated conditions and limitations.

Background: In 2010, the Federal Aviation Administration (FAA) published the Automatic Dependent Surveillance-Broadcast (ADS-B)-Out rule. This rule created Title 14 of the Code of Federal Regulations

Advisory Circular

Subject: Automatic Dependent Surveillance-Broadcast Operations **Date:** 3/7/16 **AC No:** 90-114A
Initiated by: AFS-400 **Change:** 1

1. PURPOSE. The intent of this advisory circular (AC) is to facilitate operations using Automatic Dependent Surveillance-Broadcast (ADS-B) technology in compliance with Title 14 of the Code of Federal Regulations (14 CFR) part 91, §§ 91.225 and 91.227, which are codified



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NextGen Equip ADS-B

Starting January 1, 2020, you must be equipped with ADS-B Out to fly in most controlled airspace. Federal Regulations 14 CFR 91.225 and 14 CFR 91.227 contain the details. Find out how you should equip your aircraft depending on where you fly, what equipment has been FAA certified and other useful information.

Print Share

Where is ADS-B airspace? ✓ If you need a transponder to fly today, then you need to equip

Isn't equipment expensive? ✓ Equipment costs have significantly decreased

Get the Facts about ADS-B

Don't I have plenty of time? If you wait until 2019 for an installation appointment you'll be in crowded company.

Research

What you need based on where you fly

Installation

Things to consider before, during, and after

Capabilities

What you can do with ADS-B technology

ADS-B Out Equipped?

E-mail us with your N-number, ADS-B transmitter and GPS make/model numbers to find out if your equipment is working properly.

ADS-B / TIS-B / FIS-B Problem Report

Have a TIS-B, FIS-B, or ADS-B problem to report? Fill out [this form](#) and

Exemption 12555

The FAA has granted Exemption 12555 with a strict, limited timeframe in which operators must equip with new navigation receivers. [Click here](#) for information and materials needed to obtain Exemption 12555.



Installation Issues & Performance Monitor



Post-Installation Issues Identified

- **As aircraft are equipped, a number of avionics and operational issues have been identified through performance monitoring.**
- **Incorrect or missing message elements**
 - Incorrect emitter Category
 - Intermittent or no barometric altitude
 - Intermittent or no geometric altitude
 - Intermittent, incorrect or no flight ID
 - No Mode 3/A code
 - Non-compliant Integrity & Accuracy
- **Operational issues**
 - Call sign mismatch (CSMM)
 - Once equipped, ADS-B must be on at all times

ADS-B Performance Monitor

Primary Purpose

- Support FAA Flight Standards by monitoring & recording all ADS-B Out aircraft operations in the National Airspace System (NAS) & generating reports about adherence to 14 CFR § 91.227 requirements in § 91.225 airspace.

Secondary Purposes

- Support avionics certification test flights.
- Monitor ADS-B equipage and growth.
- Support avionics performance trend analysis.

ADS-B Performance Monitor

Generates two types of reports:

- Performance report
- Certification report

Performance report

- For field approvals and post installation performance verification

Certification report

- For avionics certification of new ADS-B systems per AC 20-165B section 4.3.1.1.2
- E-mail: 9-avs-air-130fltest@FAA.gov

Public ADS-B Performance Report (PAPR)

- Owners/operators can quickly and easily validate if their equipment is working properly independently
- <https://adsbperformance.faa.gov/PAPRRequest.aspx>

Call Sign Mismatch (CSMM)

- **CSMM**
 - Occurs anytime the aircraft identification listed on a flight plan does not exactly match the aircraft identification transmitted by the ADS-B transmitter. (91.227(d))
 - Causes the air traffic controller to receive an automated warning which increases workload.
 - Most of the errors are pilot input or training errors, some are installation related, about 10% are ATC related.
- **Changeable Flight ID**
 - If you use a changeable flight ID, you need to make sure the equipment you purchase allows changes.
- **Pilots must adhere to proper Flight ID entry procedures**

ADS-B Web Resources



Web Site for Answers about ADS-B

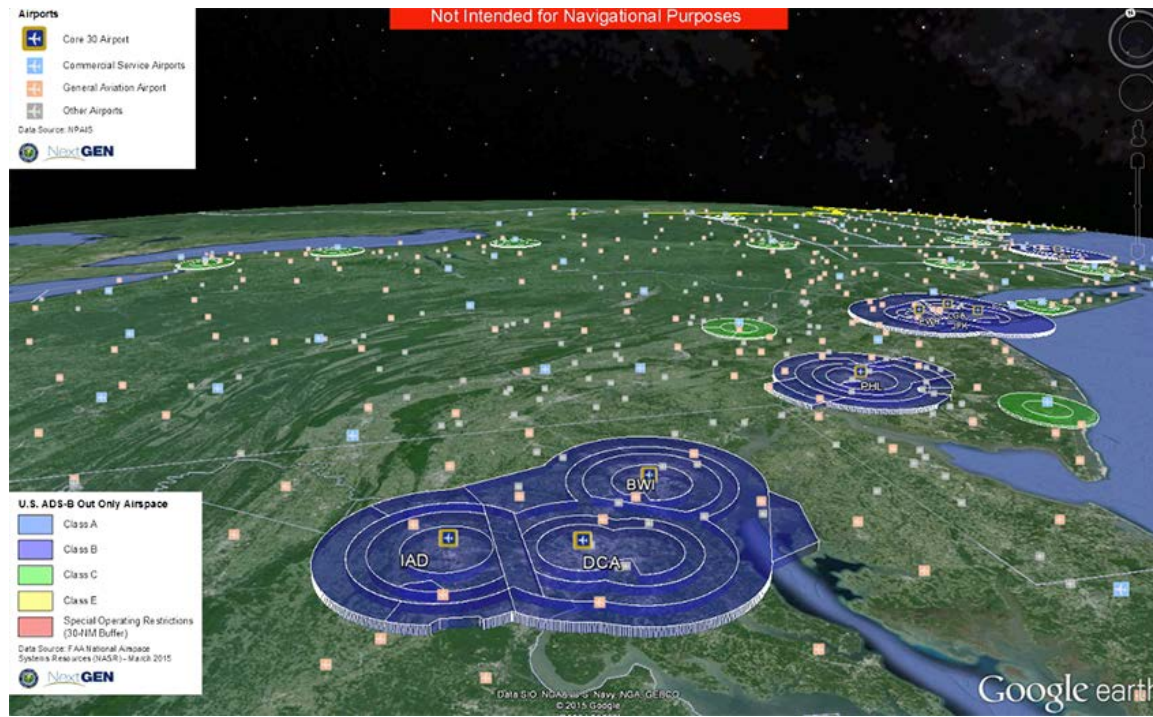
Get answers at the NextGen Equip ADS-B website:
www.faa.gov/go/equipadsb

One-stop location for information about:

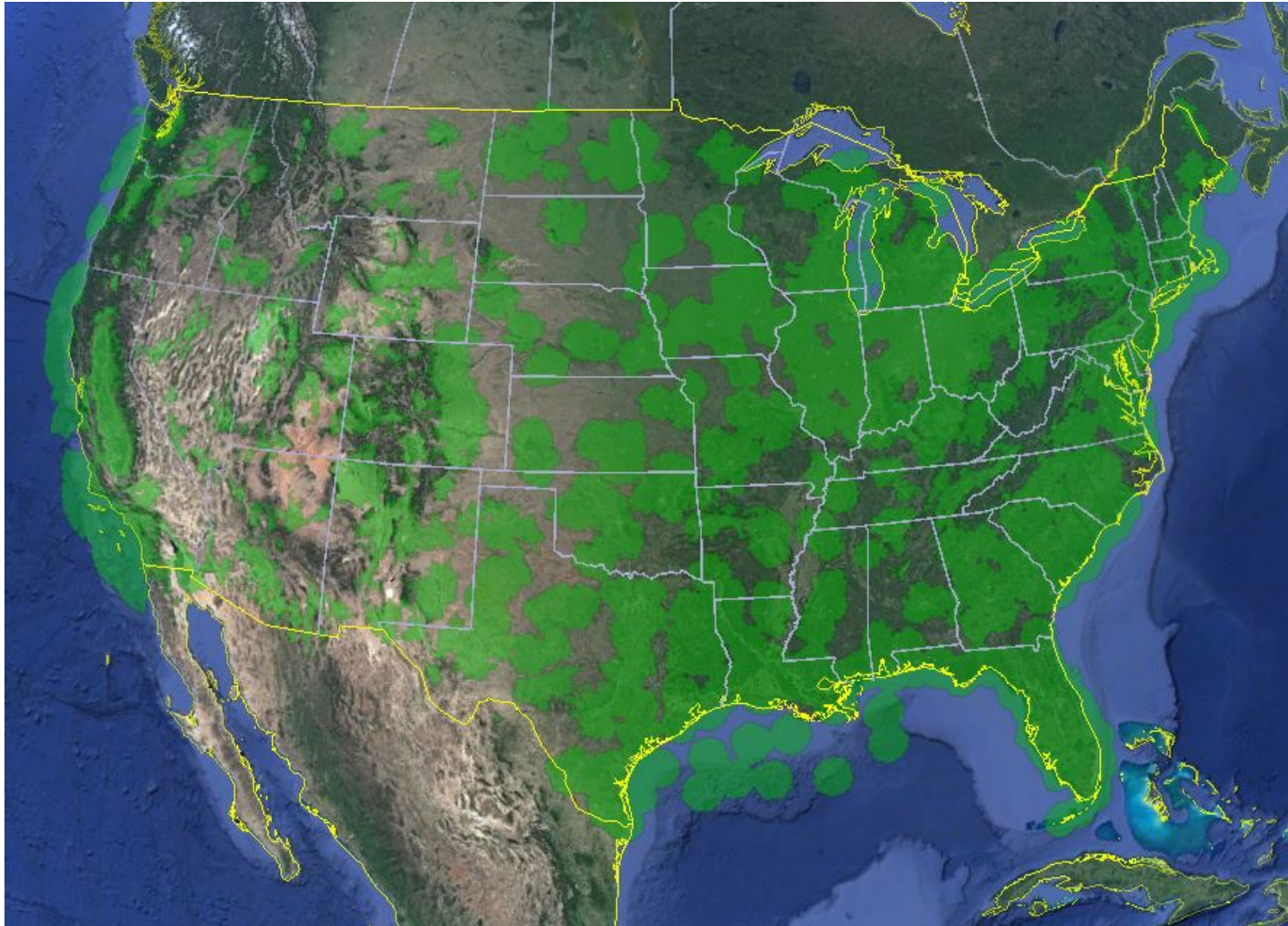
- Compliant ADS-B equipment
- Searchable list of equipment by aircraft make & model
- Interactive Map of ADS-B airspace
- Benefits of ADS-B Out and ADS-B In
- Federal Regulations and Advisory Circulars
- Frequently Asked Questions
- ADS-B Equipage Decision Flowchart

Use the ADS-B Airspace Map to Understand Rule Airspace

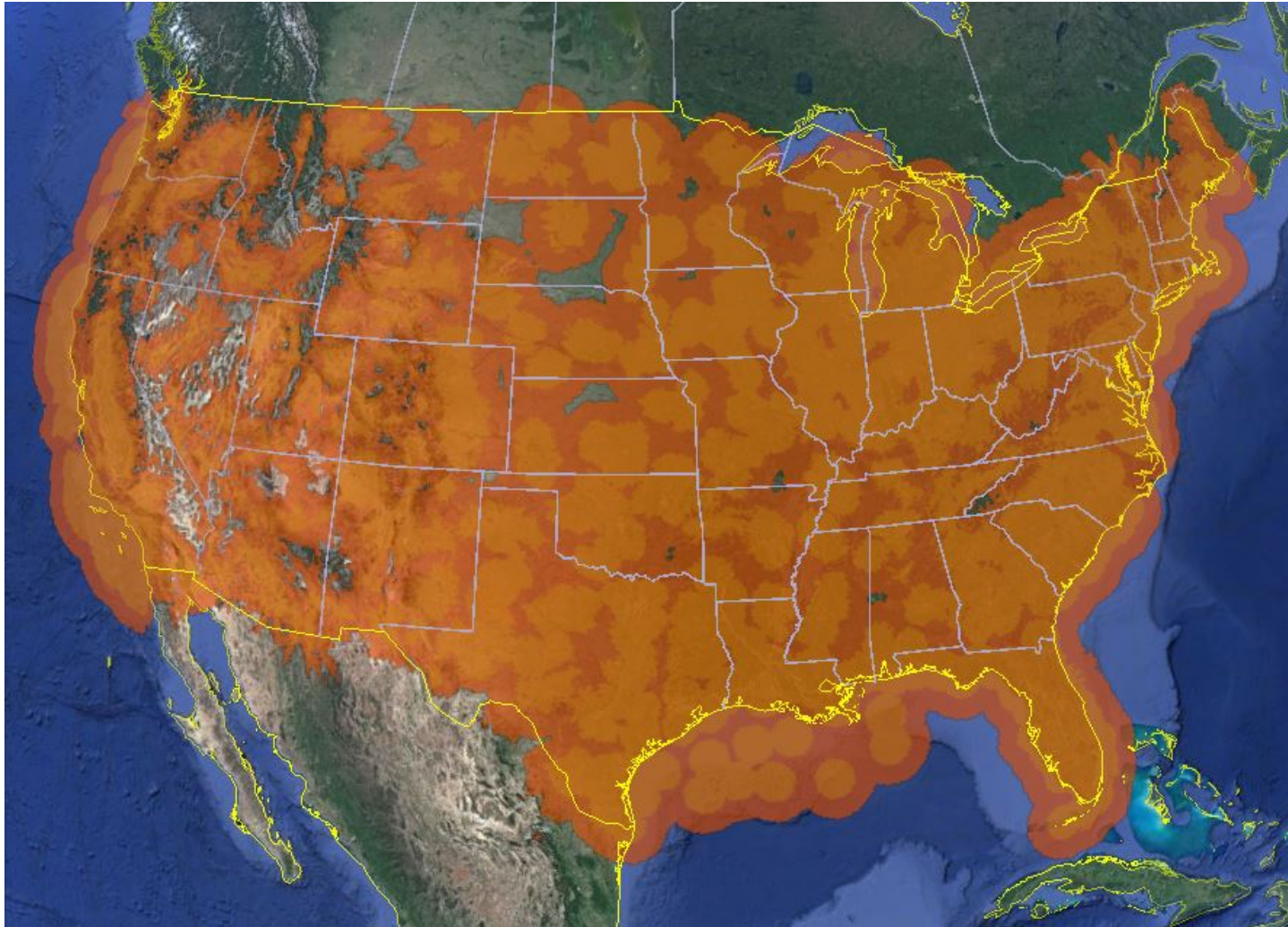
- Use Google Earth on your device as the platform.
- Download the ADS-B airspace map information from the FAA's web site.
- See where ADS-B rule airspace will be where you fly.



ADS-B Coverage at 500 Feet



ADS-B Coverage at 3000 Feet



Automatic Dependent Surveillance-Broadcast (ADS-B)



Federal Aviation
Administration

Avionics Database and Equipage Levels

Avionics Searchable Database

- The manufacturers are the best source for specific avionics solutions.
- The FAA maintains a searchable database of ADS-B avionics solutions provided by the manufacturers of all commercial and GA aircraft.
- http://www.faa.gov/nextgen/equipadsb/adsb_ready/

ADS-B Out Equipage Levels

- The FAA publishes ADS-B Out equipage levels by link type (1090ES, UAT, dual) and industry segment (GA, air carrier, etc.) showing the number of aircraft equipped to meet the ADS-B requirements.
- <http://www.faa.gov/nextgen/equipadsb/levels/>

Approved Installations

The NextGen Equip ADS-B Website at <http://www.faa.gov/nextgen/equipadsb/> contains lists of FAA approved ADS-B installations

- List of [FAA Approved V2 ADS-B Out Avionics](#)
- List of [FAA Approved V2 ADS-B In Avionics](#)