



International Civil Aviation Organization

MIDANPIRG/19 & RASG-MID/9 Meetings

(Saudi Arabia, 14-17 February 2022)

Agenda Item 5.8: CNS

Implementation of Automatic Dependent Surveillance - Broadcast (ADS-B)

(Presented by Saudi Arabia)

SUMMARY

This paper provides information on Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipage mandate in the kingdom of Saudi Arabia with an overview on the planning for the implementation of ADS-B ground surveillance system that will be used to enhance and expand Air Traffic services surveillance within Jeddah FIR. The paper proposes also to collect and share information on the level of ADS-B equipage through MIDRMA and to task ATM SG and CNS SG to develop guidance material to use ADS-B surveillance data for the provision of ATS within MID region.

Action by the meeting is in paragraph 6.

REFERENCE(S)

ICAO Annexes 10, Vol. IV and 11.
Doc 4444, PANS-ATM
Doc 9854, Global Air Traffic Management Operational Concept
Doc 9750, Global Air Navigation Plan
ICAO MID eANP Vol III, Part II, Table ASUR 3-1

1. INTRODUCTION

1.1 The Automatic Dependent Surveillance-Broadcast (ADS-B) is an advanced surveillance technology that combines an aircraft's positioning source, aircraft avionics, and a ground infrastructure to create an accurate surveillance interface between aircraft and air traffic control (ATC). Use of ADS-B Out will gradually move ATC from a radar-based system to an aircraft location system based on satellite-derived position and speed. Aircraft equipped with ADS-B Out equipment are able to continually broadcast information, such as identification, current position, altitude, and speed, through an onboard transmitter, which can be received by ADS-B ground stations and by other aircraft appropriately equipped.

1.2 ADS-B has been identified as an essential Radar-like component in enhancing global safety in ATS and achieving efficiency objectives that bring tangible operational benefits to aviation stakeholders. The ADS-B avionics is recognized as an enabler of the global ATM concept bringing cost-effective substantial safety & capacity benefits.

1.3 The ADS-B Out implementation in the Kingdom of Saudi Arabia (KSA) is aiming at providing en-route redundancy where Radar surveillance is already available. In addition, ADS-B Out is currently used to enhance the situational awareness of Air Traffic Controllers within Jeddah FIR (South-East ATC sector) non-radar areas (Empty quarter), and to be used as gap-filer for the surveillance coverage within Jeddah FIR. The Automatic Dependent Surveillance Broadcast “(ADS-B) OUT” transmissions on 1090MHz Extended Squitter data link will be used to support the provision of ATS surveillance services to eligible aircraft within specific areas/portions of KSA airspace.

2. ADSB-OUT MANDATE IN KSA

2.1 In March 2016, GACA issued GACAR Part 91 – General Operating and flight rules prescribing equipage requirements and performance standards for ADS-B Out equipment on aircraft operating in Class A and B airspace after 1st January 2020. GACAR Part 91 has defined the minimum broadcast Message Element (ME) and the performance requirements for ADS-B.

2.2 However, based on an assessment of the level of readiness of ADS-B ground infrastructure and ADS-B out aircraft equipage, it was decided to postpone the mandate for the carriage of ADS-B out equipment until 1st January 2023 to allow the aircraft owners, operators and Saudi Air Navigation Services provider (SANS) to have additional time and be ready for ADS-B operation by the applicability date. With this respect, the NOTAM ref: OEJD A1871/19 was issued on 31st December 2019 to inform all operators and KSA airspace users on the postponement of ADS-B out mandate.

2.3 As consequence, GACAR Part 91 ADS-B Out equipage requirements were amended to set the new effective date of ADS-B Out equipage mandate in KSA airspace to 1st January 2023 and expand the applicability mandate to airspace Classes C, D and E. Therefore, all aircraft intending to operate in Classes A,B,C,D, or E airspace must be equipped with a serviceable 1090 MHz ES ADS-B Out equipment by 1st January 2023. The amendment of GACAR Part 91 can be reached through the following link: <https://gaca.gov.sa/web/en-gb/page/new-regulations>.

3. ADS-B AVIONICS EQUIPAGE CERTIFICATION AND OPERATIONAL APPROVAL

3.1 The amendments of GACAR Part 91 § 91.135 (d), § 91.239 (b) and § 91.477 prescribe the ADS-B Out equipage and use requirements. These requirements state that Saudi Arabian registered Aircraft and foreign Civil Aircraft must be equipped with a serviceable 1090 MHz ES ADS-B equipment that has been certified in accordance with EASA CS-ACNS.D.ADSB, or FAA AC 20-165A – Airworthiness Approval of ADS-B. The amendment of GACAR Part 91 § 91.303 identifies airspace classes A, B, C, D and E where ADS-B Out equipage is mandatory for civil flights.

3.2 The Appendix C Section VII. to GACAR Part 91 prescribes the ADS-B Out equipment performance and installation requirements with the list of data items that must be broadcasted by ADS-B Out equipment. The data items include aircraft's identification, position, velocity and other information. An overview on GACAR Part 91 requirements related to ADS-B is provided in attachment A to this paper.

3.3 The ADS-B capabilities should be filled in item 10 as part of the description of aircraft equipment and capabilities related to communication, navigation and surveillance in accordance with ICAO Doc 4444- Appendix 2.

4. OVERVIEW OF ADS-B OUT IMPLEMENTATION WITHIN JEDDAH FIR

4.1 Under the implementation of ADS-B, Saudi Air Navigation Services adopted a comprehensive implementation plan to install and use ADS-B Ground surveillance system during the last quarter of 2020. This plan was impacted by restrictions imposed by COVID-19 pandemic and was reviewed with a tentative planning to re-activate the deployment activities by the first quarter of 2022.

4.2 The ADS-B Ground surveillance system will mainly include:

- a) Fifteen ADS-B Ground stations distributed to provide en-route redundancy where Radar surveillance is already available, to complement the radar network coverage and to expand Air Traffic Control (ATC) surveillance services within Jeddah FIR. The primary function of the ADS-B Ground Station is to receive 1090 MHz RF input on the Air Interface, extract data from the 1090 MHz ES messages, assemble the data as ADS-B Reports and send these reports over the Ground Interface through secure IP-based network;

- b) Surveillance Data Processing and Distribution (SDPD) which is multi-sensor tracking system. This system processes surveillance reports originating from different surveillance sources (radar and ADS-B Ground Stations) and fuses the associated reports into a unique system track. The system tracks are assembled into Messages and these messages are sent over the Ground Interface to be displayed and presented on the Situation Data Display (SDD) at Air Traffic Controller positions.

5. DISCUSSION

5.1 As ADS-B Out can provide air traffic controllers with real-time position/velocity information in all airspace that is more accurate than the information provided by radar systems (range dependent). With more accurate information, ATC will be able to separate safely aircraft with improved accuracy and timing leading to an increase of efficiency, and capacity that allows accommodation of traffic growth. Therefore, ADS-B Out equipage requirements and performance standards for fleet operating in the MID region can support the improvements in air traffic management.

5.2 At global level, the requirements on ADS-B surveillance accuracy and integrity are defined under Annex 10, Volume IV, Chapters 3 & 4. An excerpt of the main requirements are provided in attachment B to this paper. Moreover, ADS-B has been identified, under ICAO GANP, as ICAO ABSU ASUR B0-1 element that supports the provision of Air Traffic Services and operational applications at reduced cost and increased surveillance coverage.

5.3 At regional level, MIDANPIRG/17 agreed to monitor the surveillance capabilities in the MID Region through adding Surveillance Monitoring Matrix to the MID ANP Vol III, Part II and to add ADS-B Mandate column to the matrix (effective date and reference regulation - MID ANP Vol III, Part II, Table ASUR 3-1, Surveillance Implementation Monitoring Table refers). In addition, the MID Region Surveillance Plan (MID Doc 013) encourages MID States to consider emerging dependent Surveillance technologies (ADS-B and MLAT) in their National Surveillance Plans and to use incentive strategy with aircraft operators and airspace users to accelerate ADS-B equipage. The incentive approach might be financial or operational incentive or combined (e.g. Most Capable Best Served principle, waive fees).

5.4 As the percentage of ADS-B equipped aircraft is critical for the decision-making process for ADS-B deployment and its use for the provision of ATS surveillance within the MID Region, there is a need to monitor the level of ADS-B equipage at regional level and to encourage MID States to share information on the equipage of registered fleet.

5.5 For the monitoring of aircraft operating from/to and through the MID region, the Middle East Regional Monitoring Agency (MIDRMA) can play a key role in collecting and sharing of information on the level of ADS-B equipage of the registered fleet and all flights operating from/to or through MID region. Therefore, the meeting is invited to consider the following draft conclusion and decision:

DRAFT MIDANPIRG CONCLUSION 19/XX: IMPLEMENTATION OF AUTOMATIC DEPENDENT SURVEILLANCE - BROADCAST (ADS-B)

That:

- a) States provide the MIDRMA on quarterly basis with the information on registered fleet equipped with ADS-B considering Annex 10 Volume IV requirements;*
- b) MIDRMA coordinates with MID States to collect information on all flights that have ADS-B capabilities and operating from/to and through MID region;*
- c) MIDRMA publishes statistics, on semi-annual basis, on the level of ADS-B equipage of the fleet registered by MID States and the flights operating from/to and through MID Region; and*
- d) MIDRMA functions and responsibilities be amended accordingly.*

DRAFT MIDANPIRG DECISION 19/XX: Development of ADS-B Guidance material

That ATM SG and CNS SG coordinate to develop guidance material to use ADS-B surveillance data for the provision of Air Traffic Services (ATS), where appropriate.

6. ACTION BY THE MEETING

6.1 The meeting is invited to:

- a) note the information provided in this paper;
- b) share information on the level of ADS-B equipage of fleet registered by MID States;
- c) encourage States to share information on their mandate for ADS-B implementation;
- d) discuss the possibility to develop regional guidance on use of ADS-B for the provision of Air Traffic Services;
- e) discuss and adopt the proposal for conclusion and decision provided under paragraph 5.5 of this paper.

— END —

Attachment A – Overview on GACAR Part 91 requirements related to ADS-B

ADS-B out Regulatory framework | GACAR Part 91 – General Operating & Flight Rules

<h3 style="margin: 0;">Aircraft Operators</h3> <p style="margin: 5px 0;">§ 91.231 Data Correspondence Between Automatically Reported Pressure Altitude Data and the Pilot’s Altitude Reference</p> <p style="margin: 5px 0;">§ 91.239 Use of ADS-B Out</p> <p style="margin: 5px 0;">§ 91.303(f) Operation of aircraft in certain designated classes of airspace</p> <p style="margin: 5px 0;">§ 91.477 Special Rules for Foreign Civil Aircraft.</p> <p style="margin: 5px 0;">Appendix C to GACAR part 91 (VII) ADS-B Out Mandate postponed from 1st Jan. 2021 to 1st January 2023</p>	<div style="text-align: center;"> <h2 style="margin: 0;"><u>GACA Aviation Standards</u></h2> <h3 style="margin: 0;"><u>GACA Regulations Updates Announcement</u></h3> </div> <p style="text-align: center; font-weight: bold;">This is an announcement from the Aviation Standards Legislation Department regarding Updates in GACA Regulations as follows:</p> <p style="font-size: small;">Part 091 - General Operating and Flight Rules</p> <p style="font-size: x-small;">Change History</p> <p style="font-size: x-small;">Version 11.0 – Amend ADS-B out aircraft installation requirement to January 1st, 2023. Docket Number [GR20-009] Dated 20/10/2020.</p> <hr/> <p style="font-size: x-small; margin: 0;">INFO OEJD A1433/20</p> <p style="font-size: x-small; margin: 0;">FROM: 20-11-04 13:00 TO: 21-02-04 23:59</p> <hr/> <p style="font-size: x-small; margin: 0;">E) THE OUTBREAK OF COVID-19 PANDEMIC AND ITS RESULTING IMPACT ON THE AVIATION SECT LED TO UNFORESEEABLE CIRCUMSTANCES TO ANSP AND ACFT OPR TO PURSUE THEIR ACT TO COMPLY WITH ADS-B OUT MANDATE AS DEFINED UNDER GACAR PART 91. AS A RESULT, THE DEADLINE FOR THE EQUIPAGE AND USE OF ADS-B OUT IN KSA AIRSPACE IS POSTPONED TO 1 JAN 2023 FOR ALL ACFT OPR AND GACAR PART 91 WILL BE AMD ACCORDINGLY.</p>
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GACAR Part 91 – General Operating & Flight Rules

Regulations - Chapter F. General Operating Rules Documents

Part 091 - General Operating and Flight Rules

Mode C data

§ 91.231 Data Correspondence Between Automatically Reported Pressure Altitude Data and the Pilot’s Altitude Reference.

- (a) No person may operate any automatic pressure altitude reporting equipment associated with a radar beacon transponder when deactivation of the equipment is directed by ATC.
- (b) No person may operate any automatic pressure altitude reporting equipment associated with a radar beacon transponder or with Automatic Dependent Surveillance–Broadcast (ADS–B) Out equipment unless the pressure altitude reported for ADS–B Out and Mode C or S is derived from the same source for aircraft equipped with both a transponder and ADS–B Out.

§ 91.239 Use of ADS–B Out. Operation of ADS-B out equipment and temporary exemptions

- (a) Each PIC operating an aircraft equipped with ADS–B Out must operate this equipment in the transmit mode at all times unless otherwise instructed by the ATC.
- (b) When the ATC requests to terminate ADS-B transmissions, the PIC must comply with the ATC instructions if the flight deck control capabilities allow the flight crew to disable ADS-B OUT functions without affecting or disabling the operation of the aircraft transponder.
- (c) Requests for ATC authorized deviations from the requirements of this section must be made to the ATC facility having jurisdiction over the concerned airspace within the time periods specified as follows:

- (1) For operation of an aircraft with an inoperative ADS–B OUT, to the aerodrome of ultimate destination, including any intermediate stops, or to proceed to a place where suitable repairs can be made or both, the request may be made at any time.
- (2) For operation of an aircraft that is not equipped with ADS–B Out, the request must be made at least 24 hours before the proposed operation.



GACAR Part 91 – General Operating & Flight Rules

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Regulations - Chapter F. General Operating Rules Documents

Part 091 - General Operating and Flight Rules



ADS-B Equipage

§ 91.303 Instruments and Equipment Requirements: Powered Aircraft With Standard Airworthiness Certificates and Certificate of Authorization under GACAR Part-91.

(a) General. Except as provided in GACAR § 91.309, no person may operate a powered Saudi Arabian registered aircraft with a standard airworthiness certificate in any kind of operation described in paragraphs (c) through (u) of this section unless that aircraft contains the instruments and equipment specified in those paragraphs for that kind of operation, and those instruments and items of equipment are in operable condition and are used in accordance with the applicable requirements in Subpart B of this part. If two or more kinds of operations require the same item of equipment, only one such item is required, unless stated otherwise.

Para.	Kind of Operation	Required Instruments & Equipment
(f)	Operation of aircraft in certain designated classes of airspace.	<p>Class A Airspace</p> <p>(1) Two-way voice communications equipment capable of communicating with ATC on applicable frequencies.</p> <p>(2) During IFR: VOR, Tactical Air Navigation (TACAN), or RNAV equipment.</p> <p>(3) After 1 January 2023, ADS-B OUT equipment in accordance with the technical and performance defined under Section VII of Appendix C to this part.</p>

GACAR Part 91 – General Operating & Flight Rules

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ADS-B Equipage

§ 91.303 Instruments and Equipment Requirements: Powered Aircraft With Standard Airworthiness Certificates and Certificate of Authorization under GACAR Part-91.

(a) General. Except as provided in GACAR § 91.309, no person may operate a powered Saudi Arabian registered aircraft with a standard airworthiness certificate in any kind of operation described in paragraphs (c) through (u) of this section unless that aircraft contains the instruments and equipment specified in those paragraphs for that kind of operation, and those instruments and items of equipment are in operable condition and are used in accordance with the applicable requirements in Subpart B of this part. If two or more kinds of operations require the same item of equipment, only one such item is required, unless stated otherwise.

Para.	Kind of Operation	Required Instruments & Equipment
		<p>Class B Airspace</p> <p>(1) Two-way voice communications equipment capable of communicating with ATC on applicable frequencies.</p> <p>(2) During IFR: VOR, TACAN, or RNAV equipment.</p> <p>(3) Unless authorized by the ATC facility having jurisdiction over the concerned airspace, after 1 January 2023, ADS-B OUT equipment in accordance with the technical and performance requirements defined under Section VII of Appendix C to this part.</p>

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ADS-B Equipage

§ 91.303 Instruments and Equipment Requirements: Powered Aircraft With Standard Airworthiness Certificates and Certificate of Authorization under GACAR Part-91.

(a) General. Except as provided in GACAR § 91.309, no person may operate a powered Saudi Arabian registered aircraft with a standard airworthiness certificate in any kind of operation described in paragraphs (c) through (u) of this section unless that aircraft contains the instruments and equipment specified in those paragraphs for that kind of operation, and those instruments and items of equipment are in operable condition and are used in accordance with the applicable requirements in Subpart B of this part. If two or more kinds of operations require the same item of equipment, only one such item is required, unless stated otherwise.

Class C Airspace

(1) Two-way voice communications equipment capable of communicating with ATC on applicable frequencies.

(2) Unless authorized by the ATC facility having jurisdiction over the concerned airspace, after 1 January 2023, ADS-B OUT equipment in accordance with the technical and performance requirements defined under Section VII of Appendix C to this part.

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ADS-B Out mandate for foreign A/C

§ 91.477 Special Rules for Foreign Civil Aircraft.

(b) Navigation and communication equipment for flights within the Kingdom of Saudi Arabia. No person may operate a foreign civil manned aircraft within the Kingdom of Saudi Arabia unless—

(vi) After 1 January 2023, all foreign civil aircraft intending to operate in Classes A,B,C,D, or E airspace must be equipped with a serviceable 1090 MHz ES ADS-B equipment that has been certified in accordance with EASA CS-ACNS.D.ADSB, or FAA AC 20-165A – Airworthiness Approval of ADS-B; and

ADS-B Out Equipment Standards

APPENDIX C TO GACAR PART 91 – PERFORMANCE AND INSTALLATION STANDARDS FOR CERTAIN REQUIRED EQUIPMENT

VII. ADS-B Out.

(b) All Extended Squitter (ES) ADS-B and Traffic Information Service-Broadcast (TIS-B) equipment operating on the radio frequency of 1090 MHz must meet the requirements in FAA TSO-C166b and the requirements in paragraphs (c) through (f) of this appendix. After 1 January 2021, the equipment must also meet FAA TSO-C166b and requirements of paragraphs (c) through (f) of this appendix.

(c) 1 090 MHz ES broadcast links and power requirements:

(1) Aircraft operating in Classes A , B, C, D, or E airspace must have equipment installed that meets the antenna and power output requirements of Class A1, A1S, A2, A3, B1S, or B1 equipment as defined in FAA TSO-C166b. ES ADS-B and TIS-B Equipment Operating on the Radio Frequency of 1 090 MHz

GACAR Part 91 – General Operating & Flight Rules

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APPENDIX C TO GACAR PART 91 – PERFORMANCE AND INSTALLATION STANDARDS FOR CERTAIN REQUIRED EQUIPMENT

VII ADS-B Out.

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- Equipment designed for 1090ES (1090 MHz) must meet **TSO-C166b** or later versions of this order



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)

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Airworthiness Approval of Automatic Dependent Surveillance - Broadcast (ADS-B) Equipment
Date: 12/07/15
AC No: 20-165B
Initiated By: AIR-152

This advisory circular (AC) provides guidance for the installation and airworthiness approval of Automatic Dependent Surveillance - Broadcast (ADS-B) Out systems in aircraft.

- Radio Technical Commission for Aeronautics – RTCA DO-260B, Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)

GACAR Part 91 – General Operating & Flight Rules

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APPENDIX C TO GACAR PART 91 – PERFORMANCE AND INSTALLATION STANDARDS FOR CERTAIN REQUIRED EQUIPMENT

VII ADS-B Out.

(c) 1 090 MHz ES broadcast links and power requirements:

(1) Aircraft operating in Classes A, B, C, D, or E airspace must have equipment installed that meets the antenna and power output requirements of Class A1, A1S, A2, A3, B1S, or B1 equipment as defined in FAA TSO-C166b. ES ADS-B and TIS-B Equipment Operating on the Radio Frequency of 1 090 MHz

(a) Class A equipment includes Classes A1, A1S, A2 and A3 as defined in RTCA DO-260B. We require 1090 MHz airborne Class A equipment to receive both ADS-B, ADS-R, and TIS-B messages, deliver ADS-B, ADS-R, and TIS-B reports, and transmit ADS-B messages. Class A equipment can also be defined as transmit only or receive only. Follow guidance in RTCA DO-260B paragraph 2.1.12.1 for transmit only or paragraph 2.1.12.2 for receive only equipment.

(b) Class B equipment includes Classes B1, and B1S as defined in RTCA DO-260B. Class B equipment is only required to transmit ADS-B messages



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)

- Radio Technical Commission for Aeronautics – RTCA DO-260B, Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)

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APPENDIX C TO GACAR PART 91 – PERFORMANCE AND INSTALLATION STANDARDS FOR CERTAIN REQUIRED EQUIPMENT

VII. ADS-B Out.

(d) ADS-B Out Performance Requirements for NAC_p, NAC_v, NIC, SDA, and SIL --

(1) For aircraft broadcasting ADS-B Out as required under GACAR §§ 91.239(a) and (b)--

(i) The aircraft's NAC_p must be less than 92.6 m (0.05 NM).

(ii) The aircraft's NAC_v must be less than 10 m/s.

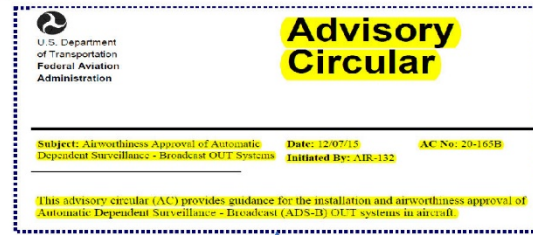
(iii) The aircraft's NIC must be less than 370.4 m (0.2 NM).

(iv) The aircraft's SDA must be 2, and

(v) The aircraft's SIL must be 3.

(2) Changes in NAC_p, NAC_v, SDA, and SIL must be broadcast within 10 seconds.

(3) Changes in NIC must be broadcast within 12 seconds.



- Radio Technical Commission for Aeronautics – RTCA DO-260B, Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)

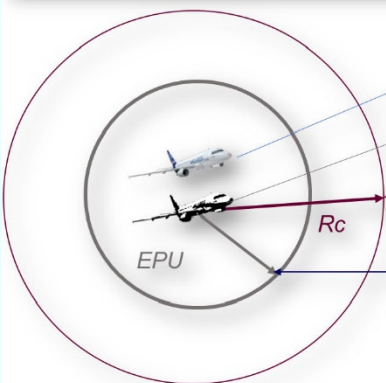
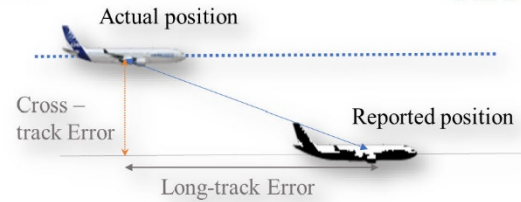
Accuracy & integrity Performance
 – NAC_p ≥ 0.05nm, 95%, NIC ≥ 0.2nm, NAC_v <10ms
 – Surveillance Integrity Level (SIL) ≥ 3
 – System Design Assurance (SDA) ≥ 2



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Cont'd

Accuracy & integrity Performance
 – NAC_p ≥ 0.05nm, 95%, NIC ≥ 0.2nm, NAC_v <10ms
 – Surveillance Integrity Level (SIL) ≥ 3
 – System Design Assurance (SDA) ≥ 2



- Actual position
- Reported position
- NIC: Integrity containment radius (0-11)**
- SIL: probability actual position is outside NIC circle (0-3)
- NAC_p: 95% bound on position accuracy (0-11)**
- EPU: Estimated Position Uncertainty



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Advisory Circular

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APPENDIX C TO GACAR PART 91 – PERFORMANCE AND INSTALLATION STANDARDS FOR CERTAIN REQUIRED EQUIPMENT

VII. ADS-B Out

(d) ADS-B Out Performance Requirements for NACp, NACv, NIC, SDA, and SIL —

(1) For aircraft broadcasting ADS-B Out as required under GACAR §§ 91.239(a) and (b)—

- (i) The aircraft's NACp must be less than 92.6 m (0.05 NM).
- (ii) The aircraft's NACv must be less than 10 m/s.
- (iii) The aircraft's NIC must be less than 370.4 m (0.2 NM).
- (iv) The aircraft's SDA must be 2, and
- (v) The aircraft's SIL must be 3.

(2) Changes in NACp, NACv, SDA, and SIL must be broadcast within 10 seconds.

(3) Changes in NIC must be broadcast within 12 seconds.

NIC Encoding

Value	Radius of Containment	NACp	Horizontal Accuracy Bound
0	Unknown	0	EPU ≥ 18.52 km (10nm)
1	R _c < 37.04 km (20.0 nm)	1	EPU < 18.52 km (10nm)
2	R _c < 14.816 km (8.0 nm)	2	EPU < 7.408 km (4nm)
3	R _c < 7.408 km (4.0 nm)	3	EPU < 3.704 km (2nm)
4	R _c < 3.704 km (2.0 nm)	4	EPU < 1852 m (1nm)
5	R _c < 1.852 km (1.0 nm)	5	EPU < 926 m (0.5nm)
6	R _c < 926 m (0.5 nm)	6	EPU < 555.6 m (0.3nm)
6	R _c < 555.6m (0.3 nm)	7	EPU < 185.2 m (0.1nm)
7	R _c < 370.4 m (0.2 nm)	8	EPU < 92.6 m (0.05nm)
8	R _c < 185.2 m (0.1 nm)	9	EPU < 30 m
9	R _c < 75 m	10	EPU < 10 m
10	R _c < 25 m	11	EPU < 3 m
11	R _c < 7.5 m		

EPU Estimated Position Uncertainty

Accuracy & integrity Performance

- NACp ≥ 0.05nm, 95%, NIC ≥ 0.2nm, NACv <10ms
- Surveillance Integrity Level (SIL) ≥ 3
- System Design Assurance (SDA) ≥ 2

Value	Velocity Accuracy Bound (Estimated Velocity Uncertainty)
0	≥ 10 m/s or unknown
1	< 10 m/s
2	< 3 m/s
3	< 1 m/s
4	< 0.3 m/s



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APPENDIX C TO GACAR PART 91 – PERFORMANCE AND INSTALLATION STANDARDS FOR CERTAIN REQUIRED EQUIPMENT

VII. ADS-B Out

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- (iii) The aircraft's NIC must be less than 370.4 m (0.2 NM).
- (iv) The aircraft's SDA must be 2, and
- (v) The aircraft's SIL must be 3.

(2) Changes in NACp, NACv, SDA, and SIL must be broadcast within 10 seconds.

(3) Changes in NIC must be broadcast within 12 seconds.

SDA Value	Supported Failure Condition Note 2	Probability of Failure Causing Transmission of False or Misleading Information Note 3.4	Software & Hardware Design Assurance Level Note 1.3
0	Unknown/ No safety effect	> 1x10 ⁻³ Per-hour or Unknown	N/A
1	Minor	≤ 1x10 ⁻³ Per-hour	D
2	Major	≤ 1x10 ⁻⁵ Per-hour	C
3	Hazardous	≤ 1x10 ⁻⁷ Per-hour	B

Note 1: Software design assurance pursuant to RTCA/DO-178C, *Software Considerations in Airborne Systems and Equipment Certification*, or equivalent. Airborne electronic hardware design assurance pursuant to RTCA/DO-254, *Design Assurance Guidance for Airborne Electronic Hardware*, or equivalent.

Note 2: Supported failure classification defined in AC 25.1309-1(), AC 23.1309-1(), and AC 29-2().

Table D-4. SIL Encoding

Value	Probability
0	> 1x10 ⁻³ or unknown
1	≤ 1x10 ⁻³
2	≤ 1x10 ⁻⁵
3	≤ 1x10 ⁻⁷

Accuracy & integrity Performance

- NACp ≥ 0.05nm, 95%, NIC ≥ 0.2nm, NACv <10ms
- Surveillance Integrity Level (SIL) ≥ 3
- System Design Assurance (SDA) ≥ 2



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Accuracy & integrity Performance
 – NAC_p ≥ 0.05nm, 95%, NIC ≥ 0.2nm, NAC_v <10ms
 – Surveillance Integrity Level (SIL) ≥ 3
 – System Design Assurance (SDA) ≥ 2

SDA Value	Supported Failure Condition Note 2	Probability of Failure Causing Transmission of False or Misleading Information Note 3,4	Software & Hardware Design Assurance Level Note 1,3
0	Unknown/ No safety effect	> 1x10 ⁻³ Per-hour or Unknown	N/A
1	Minor	≤ 1x10 ⁻³ Per-hour	D
2	Major	≤ 1x10 ⁻⁵ Per-hour	C
3	Hazardous	≤ 1x10 ⁻⁹ Per-hour	B

Note 1: Software design assurance pursuant to RTCA/DO-178C, *Software Considerations in Airborne Systems and Equipment Certification*, or equivalent.
 Airborne electronic hardware design assurance pursuant to RTCA/DO-254, *Design Assurance Guidance for Airborne Electronic Hardware*, or equivalent.
 Note 2: Supported failure classification defined in AC 25.1309-10, AC 23.1309-10, and AC 29-20.

(2) **Major Failure Conditions:** Failure conditions that would reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions to the extent that there would be, for example, a significant reduction in safety margins or functional capabilities, a significant increase in crew workload or in conditions impairing crew efficiency, or discomfort to occupants, possibly including injuries.

(3) **Hazardous Failure Conditions:** Failure conditions that would reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions to the extent that there would be:

- (i) A large reduction in safety margins or functional capabilities;
- (ii) Physical distress or higher workload such that the flightcrew cannot be relied upon to perform their tasks accurately or completely; or
- (iii) Serious or fatal injury to a relatively small number of the occupants.

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(e) **Minimum broadcast message element set for ADS-B Out.** Each aircraft must broadcast the following information, as defined in FAA TSO-C166b. The pilot must enter information for message elements listed in paragraphs (e)(7) through (e)(9) of this section during the appropriate phase of flight.

- (1) The length and width of the aircraft;
- (2) An indication of the aircraft's latitude and longitude;
- (3) An indication of the aircraft's barometric pressure altitude;
- (4) An indication of the aircraft's velocity;
- (5) An indication of whether TCAS II or ACAS is installed and operating in a mode that can generate resolution advisory (RA) alerts;
- (6) If an operable TCAS II or ACAS is installed, an indication if a resolution advisory (RA) is in effect;
- (7) An indication of the Mode 3/A transponder code specified by ATIS;
- (8) An indication if the flight crew has identified an emergency, radio communication failure, or unlawful interference;
- (9) An indication of the aircraft's 'IDENT' to ATIS;
- (10) An indication of the aircraft's emitter category;
- (11) An indication of whether an ADS-B In capability is installed;
- (12) An indication of the aircraft's geometric altitude;
- (13) An indication of the Navigation Accuracy Category for Position (NAC_p);
- (14) An indication of the Navigation Accuracy Category for Velocity (NAC_v);
- (15) An indication of the Navigation Integrity Category (NIC);
- (16) An indication of the System Design Assurance (SDA); and
- (17) An indication of the Source Integrity Level (SIL).

Broadcast Message Elements

– NIC	– 24-bit Address	– Geometric Altitude
– NAC _p	– Lat/Long	– ADS-B In Capability
– NAC _v	– Baro Altitude	– Mode 3/A
– SDA	– Velocity	– Flight ID
– SIL	– TCAS Status	
– IDENT		

- Uncompensated Latency ≤ 2.0 seconds
- Compensated Latency ≤ 0.6 seconds

Attachment B – Excerpt from Annex 10 Vol. IV, Chap. 3 & 4 - Requirements on surveillance accuracy and integrity

Chapter 3

Annex 10 — Aeronautical Telecommunications

3.1.2.8.6.2 *ME: Message, extended squitter*. This 56-bit (33-88) downlink field in DF = 17 shall be used to transmit broadcast messages. Extended squitter shall be supported by registers 05, 06, 07, 08, 09, 0A {HEX} and 61-6F {HEX} and shall conform to either version 0, version 1 or version 2 message formats as described below:

- a) Version 0 ES message formats and related requirements report surveillance quality by navigation uncertainty category (NUC), which can be an indication of either the accuracy or integrity of the navigation data used by ADS-B. However, there is no indication as to which of these, integrity or accuracy, the NUC value is providing an indication of.
- b) Version 1 ES message formats and related requirements report surveillance accuracy and integrity separately as navigation accuracy category (NAC), navigation integrity category (NIC) and surveillance integrity level (SIL). Version 1 ES formats also include provisions for enhanced reporting of status information; and
- c) Version 2 ES message formats and related requirements contain the provisions of version 1 but further enhance integrity and parameter reporting. Version 2 ES formats separately report position source integrity from the integrity of the ADS-B transmitting equipment. Version 2 ES formats also separate vertical accuracy reporting from horizontal position accuracy, remove vertical integrity from position integrity, and provide for the reporting of the SSR Mode A code, GNSS antenna offset and additional horizontal position integrity values. Version 2 ES formats also modify the target state report to include selected altitude, selected heading, and barometric pressure setting.

4.5.1.3 PASSIVE SURVEILLANCE

4.5.1.3.1 EXTENDED HYBRID SURVEILLANCE

4.5.1.3.1.1 Systems using extended hybrid surveillance mode shall establish a track in such a way that no interrogations are performed, i.e. acquiring the track through exclusive use of ADS-B extended squitter, when the following conditions are met:

- a) own aircraft position data meets the following minimum level of quality:
 - 1) own aircraft horizontal position uncertainty (95 per cent) is < 0.1 NM; and
 - 2) own aircraft horizontal position integrity shall be such that the probability of an undetected position error, which is greater than 0.6 NM radius, is less than 1×10^{-7} .
- b) the received signal strength is equal or less than $-68 \text{ dBm} \pm 2 \text{ dB}$ (extended hybrid surveillance minimum triggering level), or own aircraft is operating on the surface; and
- c) the intruder data quality meets the following minimum requirements:
 - 1) the ADS-B version number ≥ 2 ;
 - 2) the reported NIC ≥ 6 ($< 0.6 \text{ NM}$);
 - 3) the reported NACp ≥ 7 ($< 0.1 \text{ NM}$);
 - 4) the reported SIL = 3;
 - 5) the reported SDA = 2 or 3; and
 - 6) the barometric altitude is valid.