**Comment Response Document (CRD)**
**to Notice of Proposed Amendment (NPA) 2007-05**

**for amending the Executive Director Decision No. 2003/12/RM of 5 November 2003 on general acceptable means of compliance for airworthiness of products, parts and appliances (« AMC-20 »)**

**Miscellaneous improvements to AMC-20 (Part 1: ADS-B-NRA)**

# Explanatory Note

## I. General

1. The purpose of the Notice of Proposed Amendment (NPA) 2007-05, dated 31 May 2007 was to propose an amendment to Decision N° 2003/12/RM of the Executive Director of 4 November 2003 on general acceptable means of compliance for airworthiness of products, parts and appliances (« AMC-20 »)

## II. Consultation

2. The draft Executive Director Decision amending Decision N° 2003/12/RM was published on the web site (http://www.easa.europa.eu) on 31 May 2007.

   By the closing date of 7 September 2007, the European Aviation Safety Agency ("the Agency") had received 99 comments from 18 National Aviation Authorities, professional organisations and private companies.

## III. Publication of the CRD

3. All comments received have been acknowledged and incorporated into this Comment Response Document (CRD) with the responses of the Agency.

4. In responding to comments, a standard terminology has been applied to attest the Agency's acceptance of the comment. This terminology is as follows:

   - **Accepted** – The comment is agreed by the Agency and any proposed amendment is wholly transferred to the revised text.
   - **Partially Accepted** – Either the comment is only agreed in part by the Agency, or the comment is agreed by the Agency but any proposed amendment is partially transferred to the revised text.
   - **Noted** – The comment is acknowledged by the Agency but no change to the existing text is considered necessary.
   - **Not Accepted** - The comment or proposed amendment is not shared by the Agency.

   The resulting text highlights the changes as compared to the current rule.

5. The Agency's Decision will be issued at least two months after the publication of this CRD to allow for any possible reactions of stakeholders regarding possible misunderstandings of the comments received and answers provided.

6. Such reactions should be received by the Agency not later than 11 March 2008 and should be submitted using the Comment-Response Tool at http://hub.easa.europa.eu/crt.

## IV. CRD table of comments, responses and resulting text

| (General Comments) | - |
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| comment | *1* comment by: *Austro Control GmbH*<br>Austro Control is fully supporting NPA 2007-05. |
| response | *Noted* |

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| comment | *53* comment by: *AEA*<br>The Association of European Airlines in general terms, supports this NPA, it is in everybody's best interests to have ADS-B embodied as soon as possible. |
| response | *Noted* |

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| comment | *65* comment by: *Swiss Federal Office of Civil Aviation (FOCA)*<br>Swiss FOCA agrees with EASA that option 2 should be the preferred one. The cost/benefit ratio seems to be promising. |
| response | *Noted* |

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| comment | *87* comment by: *Göran Hasslar*<br>All requirements uses the word 'should', it should be changed to 'shall'.<br><br>Justification:<br>The following text is from the ED-126 and only here as an example of how the words 'should' and 'shall' often are interpreted.<br><br>"…The use of the word "shall" indicates a mandated criterion; i.e. compliance with the criterion is mandatory and no alternative may be applied;<br><br>The use of the word "should" indicates that though the criterion is regarded as the preferred option, alternative criteria may be applied."<br><br>To my understanding, this is a document that clearly states the requirements that must be fulfilled in order to have systems that are interoperable and ensures a correct implementation of the application. |
| response | *Partially accepted*<br>Since AMC is by definition one, but not the only way of showing compliance with requirements, the wording "should" is used. However if within the context of the AMC it is needed to comply with specific paragraph of the AMC this will be expressed. |

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| comment | *92* comment by: *EUROCOPTER*<br>Eurocopter have no comment on NPA 2007-05 |
| response | *Noted* |

**A. Explanatory Note - I. General** p. 3

comment 2 comment by: *Boeing*

Generally throughout the NPA

Both the mandatory and the optional requirements use the word "should," making it unclear what is a firm requirement and what is optional. We recommend revising the text where necessary to use either "must" or "should" appropriately.

Justification:
Clarification

response *Partially accepted*

Since AMC is by definition one, but not the only way of showing compliance with requirements, the wording "should" is used. However if within the context of the AMC it is needed to comply with specific paragraph of the AMC this will be expressed.

comment 3 comment by: *Boeing*

Generally throughout the NPA

This NPA was generated specifically for the CASCADE Program, with the stated goal of using existing ELS/EHS/ES transponders that were designed and certified to DO-181C. However, there are several references in the NPA to other standards documents, some of which were released only in the last few months and that existing installations were not designed to. These documents include ED-102/DO-260 Original, DO-260 Change 1, and ED-126/DO-303.

Justification:
Ground mitigation of the above new standards should be clearly stated in the AMC.

response *Not accepted*

Re assessment of existing transponder is required to comply with the ADS-B-NRA function. This is not addressed in this AMC.

Independent of potential ground mitigation, the airborne side needs to comply with a certain set of requirements, as can be met through this AMC.

This concerns an air/ground interoperability issue. 1090 MHz ES receivers need to accommodate both standards. This is expressed in ED-126.

comment 4 comment by: *Boeing*

Generally throughout the NPA

References to AFM Limitations are too specific, since the manual is generally at a higher level. These references should be deleted or treated as in accordance with Section 9.3. of the proposed AMC.

Justification:
The proposed AMC makes numerous statements where the AFM should be used to document individual deviations from a specific requirement. In reviewing our existing AFM language for ELS / EHS / ES, Boeing uses more high-level language; i.e., either we comply with a function and it is certified, or we do not.

response *Not accepted*

The initial application is accepting certain deviations. Deviations are recorded in the AFM for transparency. For global implementation it can be expected that not all deviations are accepted, which makes recording in the AFM essential.
The information is needed by the flight crew to identify the aircraft ADS-B capability.

**A. Explanatory Note - V. Regulatory Impact Assessment** p. 4-7

comment *29* comment by: *AEA*

The whole chapter should be rewritten to reflect use of ADS-B in NRA as a first application, not as the only application.

It does not seem to be a reason why the use of ADS-B, as a surveillance source, should be limited to non radar areas. Obviously in those areas the use is most useful at this time, but the use elsewhere should certainly not be excluded.

Mentioning (1st paragraph) that the NRA "application is one way of using the "ADS-B out capability" is absolutely insufficient. Presenting it this way will encourage neither airspace users nor ATS-providers to implement this ADS-B application.

response *Not accepted*

The scope of the NPA is the ADS-B-NRA function only. Other applications will be covered in separate AMC.

comment *30* comment by: *AEA*

Mentions "slight reduction in fuel gas emission...". The reduction of emission is directly related to the efficiency/capacity improvement. In that respect the word "slight" is irrelevant (or should be use for both flight time, efficiency, capacity and for reduction in emissions.
REF V. Regulatory Impact Assessment

12. Impacts - iii. Environmental (page6)
and
14. Summary And Final Assessment (page 7)

response *Noted*

EASA agrees with the content of the comment, however, it will have no impact on the text of AMC 20-24.

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| comment | *36* comment by: *DGAC/DTI/CNS*<br><br>Item 13 "Equity and Fairness issues"<br><br>Change current text to "All applicants are equally affected. Further, it should be noted that many air transport category aircraft already carry adequate ADS-B out avionics, although they are not certified for use of the data transmitted. Such aircraft would be immediate candidates for certification."<br><br>Justification:<br>To be equipped with transponders capable of ADS-B extended squitter does not mean that an aircraft is adequately equipped for ADS-B. Connection to a GPS is also required whereas many aircraft only have connection with the FMS. |
| response | *Noted*<br><br>EASA agrees with the content of the comment, however, it will have no impact on the text of AMC 20-24. |

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| comment | *37* comment by: *DGAC/DTI/CNS*<br><br>Item 12 "Impact", safety aspect<br><br>At the end of the third paragraph, please add: "Except for the separation aspects, all those benefits apply to both IFR and VFR aircraft".<br><br>Justification:<br>In this document, we believe there is a need to distinguish between IFR and VFR aircraft from both benefits and requirements perspectives. |
| response | *Noted*<br><br>EASA agrees with the content of the comment. However, it will have no impact on the text of AMC 20-24. |

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| comment | *82* comment by: *IAOPA Europe*<br><br>9. Purpose and Intended Effect<br><br>This NPA 2007-05 addresses exclusively the usage of ADS-B in non-radar areas. So it misses the opportunity to give directions also for the usage of ADS-B in areas where radar-coverage exists, but nevertheless no radar service is provided to large parts of the airspace users. To these non-serviced parts belong mainly General Aviation flights operating under Visual Flight Rules, because these flights are not obliged to be in contact with ATC, or if in contact there is no obligation for ATC to provide them with Traffic Information.<br><br>Consequently this NPA or a separate NPA process initiated as soon as possible should address the usage of ADS-B in areas with radar-coverage for autonomous surveillance of aircraft not receiving radar-service.<br><br>Justification:<br>For GA-VFR the sole separation principle available today is see and avoid which is occasionally, but not reliably, supported by verbal Traffic Information from ATC. An electronic support of the see and avoid principle via ADS-B "sense and |

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| | avoid" would significantly reduce the risk of midair collissions. Although no official statistics exist, midair collisions are the cause for a higher number of fatalities just within the last 12 months (Zell am See/Austria, Puma vs. Katana with 8 fatalities - Aschaffenburg/Germany, Cessna vs. G109, 2 fatalities…).<br><br>The SESAR Project also supports in its Concept of Operations the idea of making ALL aircraft electronically visible via ADS-B. Nevertheless the provision of ADS-B for these purposes is not foreseen in NPA 2007-05.<br><br>Experience with the uncertified and widely spread "FLARM"-ADS-B-system has shown that industry standards clearly below the standards quoted in chapter 4 are already able to provide reliable information for collision avoidance.<br><br>It is not acceptable that Airliners and Gliders use Collision Avoidance Systems that are not compatible with each other. Who will volunteer to explain the non-compatibility of today´s anti-collision systems after a first big accident has occurred? |
| response | *Noted*<br><br>It is correctly stated that this NPA exclusively addresses the usage of ADS-B in non-radar environments. Other applications will be subject of future developments, and not part of the scope of this NPA. |

**B. Draft Decision - I. AMC 20-24** p. 9

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| comment | *89* comment by: *Göran Hasslar*<br><br>1. AMC 20-24 page 9<br><br>The title of the new AMC 20-24 should state the data link targeted in the document. Suggested new title is "**Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application <u>via 1090 ES</u>"** New text is underlined<br><br>Justification:<br>Other data links (e.g. VDL Mode 4) will be amended in EASA in the future (for the same application) and it should be easy to distinguish between the different documents. |
| response | *Accepted* |

**B. Draft Decision - I. AMC 20-24 - Preamble** p. 9

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| comment | *31* comment by: *AEA*<br><br>Item 1.3 mentions "other ADS-B based ground and airborne surveillance applications". Care should be taken that rulemaking for ADS-B-NRA is not overlimited (i.e. ADS-B-NRA tailored) such that for other already foreseen applications additional (avionics system) certification is required. |
| response | *Not accepted*<br><br>The scope of the CASCADE project is explained in general in this paragraph, |

and has no specific impact in the scope of this AMC.

comment

*32* comment by: *AEA*

Item 1.5 reflects in fact that reference is made to the ADS-B-NRA standard, implying that there will be other standards for functions referred to under item 1.3. (see previous comment).

response

*Noted*

Functions referred to under item 1.3. will have other standards that will be covered by AMC in the future.

comment

*38* comment by: *DGAC/DTI/CNS*

Item 1.2 second sentence

Change second sentence to "ADS-B-NRA would provide controllers with improved situational awareness of aircraft positions, and in consequence appropriate separation minima could be applied for IFR aircraft."

Justification:
Requirements provided within this document are derived from ED-126/DO-303 and are based on the most stringent surveillance service that can be implemented in the environments under consideration: application of reduced separation minima based on ADS-B. However, VFR a/c can also fly in these environments and can be displayed to only improve controllers situational awareness.

response

*Not accepted*

The preamble of this AMC is a general introduction explaining that the appropriate separation minima could be influenced (See also the response to comment 54). The improvement of situational awareness is not restricted to IFR only.

comment

*54* comment by: *Roland Mallwitz*

para 1.2
1. paragraph: "ADS-B-NRA separation would be much smaller than that used in current non-radar-airspace"

Comment: As indicated in the regulatory impact assessment the application is also envisaged for approach/departures withgaps in radar coverage. In such cases the expression "much" is questionable. In any case separation minima will depend on the environment and the approvall of the appropriate authority.

Proposal: ADS-B-NRA separation could be smaller than that used in current non-radar-airspace

end of 2. paragraph: "... in a way similar to what would be achieved by use of SSR radar."

Comment: This is expected by the community. However, larger perational experience is still missing (some issues will be implementation dependent).
Proposal: delete this part of sentence.

response | *Partially accepted*

The wording "much" will be removed. The reference to SSR radar is kept since it is considered a crucial reference. Paragraph 1.3 is amended to provide more clarity.

comment | *76* comment by: *NAV CANADA*

Please add Canada to the list of states planning to deploy ADS-B services using the 1090 Mhz transponder. Installation of one of five RUs on the coast of Hudson Bay has already been completed with the balance to be in place before the end of CY 2007. Reference Canadian AIC 18/07 for more details.

response | *Accepted*

comment | *83* comment by: *IAOPA Europe*

1 Preamble, 1.4 and 1.5

Besides Mode S 1090 ES another ADS-B enabler needs to be considered by EASA.

Justification:
This NPA focuses solely on Mode S 1090 ES as ADS-B enabler. In the USA the FAA has foreseen UAT as the second enabler beside Mode S 1090 ES, because the Mode S system would be severely congested by the data transfer of the fleet of all aircraft. Frequency congestion would also occur in Europe with the full fleet equipped, consequently another ADS-B enabler needs to be considered.

response | *Not accepted*

Not considered within the scope of this AMC.

For information:
Several data link studies show that, within Europe, the 1090 MHz ES data link is viable as a longer term solution. As a matter of fact, the most critical situation arises during the transition phase, when the older surveillance is still in place (Mode A/C SSR) and traffic has in the meantime grown (around 2015). With the reduction of SSR infrastructure and the use of 1090 MHz ES squitter also for WAM and ACAS (hybrid surveillance); the overall R/F link load will decrease beyond that date.

resulting text

**AMC 20-24**
**Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHz Extended Squitter.**

1 PREAMBLE

1.1 The scope of this Acceptable Means of Compliance (AMC) is the airworthiness and operational approval of the "Enhanced Air Traffic Services in Non-Radar Areas using ADS-B Surveillance" (ADS-B-NRA) application.

1.2 Operational benefits of the ADS-B-NRA application include the enhancement of the Air Traffic Control Service in current non-radar airspace. ADS-B-NRA would provide controllers with improved situational awareness of aircraft positions, and in consequence appropriate separation minima could be applied depending on the

environment and the approval of the competent authority. Current non-radar airspace is controlled using procedural methods which demand large separations. ADS-B-NRA separation minima would be smaller than that used in current non-radar airspace. Alerting Services in non- radar airspace will be enhanced by more accurate information on the latest position of aircraft.
Hence, it is expected that in areas where radar coverage is not feasible or not economically justified this application will provide benefits to capacity, efficiency and safety in a way similar to what would be achieved by use of SSR radar.
1.3 The European CASCADE programme is the mechanism for co-ordination of the European implementation of ADS-B (ADS-B-NRA and other ADS-B based ground and airborne surveillance applications). One of the programme's aims is to ensure harmonisation and efficiency of implementation.
1.4 CASCADE uses the globally interoperable 1090 MHz Extended Squitter (ES) data link technology, compliant with ICAO SARPS in Annex 10 and in line with the recommendations of the Conference ICAO ANC-11.
1.5 In parallel, the FAA, Airservices Australia and Nav Canada plan to deploy ADS-B using the same data link technology. It is assumed that aircraft will be interoperable with all implementation programmes using the EUROCAE/RTCA ADS-B-NRA standard (ED-126, DO-303).
1.6 The meaning of abbreviations may be found in Appendix 1.

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3 SCOPE
3.1 This AMC is applicable to the various ATS services contained in the ADS-B-NRA application, including separation services. This AMC fulfils the ADS-B-NRA Safety, Performance Requirements and Interoperability Requirements as established in EUROCAE ED-126[1], using the methodology described in EUROCAE document ED-78A[2].
AMC requirements are driven by the ED-126 requirements for a 5NM separation service (applicable to both en-route and TMA airspace).

*Note: the actual choice of ADS-B-NRA ATC service provision, including of the applicable separation minima, is at the discretion of the implementing Air Traffic Service Provider, and should be based on local safety cases.*

3.2 The AMC addresses the 1090 MHz Extended Squitter (ES) data link technology as the ADS-B transmit technology.[3]

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[1] ED-126: "Safety, Performance and Interoperability Requirements Document for ADS-B-NRA" Application.

[2] ED-78A: Guidelines for approval of the provision and use of Air Traffic Services supported by Data communications.

[3] Other, requirements compliant, ADS-B transmit systems (e.g. VDL Mode 4) are expected to be covered through separate regulatory material, as appropriate.

**B. Draft Decision - I. AMC 20-24 - Reference Documents** p. 10-11

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| comment | *56* comment by: *Roland Mallwitz*<br>Reference ED 73B:<br><br>comment: It would be worth to add a note, indicating that this document is being updated and ED-73C (harmonised with DO181D) is scheduled for 2nd quarter 2008.<br><br>Reference Doc9871<br><br>comment: publication due in 2007 |
| response | *Partially accepted*<br>It is not acceptable to add references to publications that have not yet been officially published. Therefore the suggested note is not added. Consistently the reference to Doc 9871 is removed since that is not yet published. |

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| comment | *72* comment by: *AIRBUS*<br>Paragraph 4.2<br><br>Remove the reference to EASA AMC 20-18 "Certification of Mode S Transponder Systems for Elementary Surveillance", as AMC 20-18 is not yet published. Keep only reference to JAA TGL13, Rev.1.<br><br>Justification:<br>AMC 20-18 is not yet developed by EASA although initially part of rulemaking task 20.006, "Miscellaneous Improvements to AMC 20" (planned 1q 2006).<br><br>Applicable Guidance Material for the certification of airborne Mode S Elementary Surveillance installation remains JAA TGL 13, Revision 1. |
| response | *Partially accepted*<br><br>The referenced document AMC 20-18 is replaced by AMC 20-13 Certification of Mode S Transponder Systems for Enhanced Surveillance |

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| comment | *75* comment by: *Walter Gessky*<br>Article 4.1 second bullet:<br>Is is recommended to add the following note:<br>The relevant paragraphs of Annex III to (EC) Nr. 3922/91 amended with (EC) 1899/2006 have to be applied instead of JAR OPS 1 beginning with 16. July 2008.<br><br>Justification:<br>EU-OPS has to be applied beginning with 16.7.2007.<br><br>In addition it should be notified that the NPA is supported. |
| response | *Accepted* |

Taking into account that EU-OPS is already adopted and will be coming into force on 16 July 2008, the reference to JAR-OPS 1 is changed to EU-OPS 1.

resulting text

**4 REFERENCE DOCUMENTS**

4.1 Related Regulatory Requirements

- ☐ CS/FAR 25.1301, 25.1307, 25.1309, 25.1322, 25.1431, 25.1581, or equivalent requirements of CS 23, 27 and 29, if applicable.
- ☐ EU-OPS 1.230, 1.420, 1.845, 1.865, 1040, 1.1045 and 1.1060, as amended, or, if applicable, equivalent requirements of JAR-OPS 3.
- ☐ National operating regulations.

4.2 Related EASA/JAA TGL/NPA/AMC (and FAA TSO) Material

- ☐ ETSO-2C112b: Minimum Operational Performance Specification for SSR Mode S Transponders (adopts ED-73B)
- ☐ ETSO-129A (TSO-129/TSO-129A): Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)
- ☐ ETSO-145/ETSO-146 (TSO-145/TSO-146; TSO-145A/TSO-146A): Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)
- ☐ AMC 20-13 Certification of Mode S Transponder Systems for Enhanced Surveillance
- ☐ JAA Temporary Guidance leaflet (TGL) 13, Revision 1: Certification of Mode S Transponder Systems for Elementary Surveillance

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4.5 Related ICAO Standards and Manuals

- ☐ PANS-ATM, Doc 4444, Amendment 4: Procedures for Air Navigation Services – Air Traffic Management
- ☐ Annex 10 (Volume III & IV): Aeronautical Telecommunications

## B. Draft Decision - I. AMC 20-24 - Assumptions p. 11-12

comment

*5* comment by: *Boeing*

Section 5.1.1. Consistency of position quality indicators with associated position information at time of transmission.

Replace the phrase *"In such cases"* with the following: *"In cases where position quality indicators are not consistent with actual position quality (e.g., due to uncompensated latency in position transmissions) …"*

Justification:
The phrase *"In such cases"* is ambiguous, and the suggested means of addressing misleading NUC or NIC, NAC indicators needs further elaboration.

response

*Accepted*

comment

*6* comment by: *Boeing*

Section 5.1.2. Encoding of NUC Quality Indicator (DO-260 compliant transponders), second paragraph, first sentence, which states:
*"In addition, prediction of actual RAIM function unavailability leading to temporary unavailability of the ADS-B-NRA service might be applied (announced in advance through e.g. NOTAMs). ..."*

Change the phrase *"might be applied"* to the following: *"might be applied during initial operations where the vast majority of aircraft use common RAIM algorithms ..."*

Justification:
Predictive RAIM is different for aircraft with different RAIM algorithms, e.g., TSO-C129a RAIM algorithms, aircraft using SA-off RAIM algorithms, aircraft using TSO-C145/C146 (WAAS) algorithms, etc. Generally, what is meant is the use of predictive RAIM for basic GPS systems using TSO-C129a RAIM algorithms. This may be acceptable for initial NRA use where the vast majority of aircraft are likely to use basic GPS RAIM algorithms based on SA-On assumptions, but is not supportive of more advanced GPS systems that are able to "coast through" most RAIM degradation periods for basic GPS systems. The NRA document does not to incorporate predictive RAIM into its system assumptions, and, therefore, this proposed NPA should add qualifying statements whenever citing the use of predictive RAIM functions.

response *Partially accepted*

This AMC addresses the air borne, and not the ground side of the ADS-B function.

However, certain assumptions are made for the ground side to mitigate identified permissible deviations to the target airborne requirements in the AFM.

The RAIM prediction mitigation was only mentioned as an example for the particular case of the NUC encoding case. In order to provide more generic information and avoid misinterpretation, the second paragraph will be removed.

comment *39* comment by: *DGAC/DTI/CNS*

Item 5.1

It is mentioned that "These deviations are considered operationally acceptable under the assumption that ground mitigation means as discussed in the following subsections, are implemented". However, an ATSP cannot know whether an aircraft is deviating from the target requirements and therefore it will have to implement those mitigations, reducing the expected benefits.

Furthermore, if mitigations means are not implemented, risks and/or limitations that follow should be described.

response *Partially accepted*

The explicit mention of any deviation to the target requirements in the AFM, allows an operator to react to a specific ATSP airspace regulation.

The consequence of not having the mitigations in place is that the ADS-B-NRA cannot be deployed to its full extent (or at all), at the discretion of an ATSP.

Paragraph 5.1 is amended to stress that the acceptance of deviations for initial implementation in this AMC reflects the current status.

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| comment | *40* comment by: *DGAC/DTI/CNS*<br><br>Item 5.1.1<br><br>It is proposed to change last sentence by<br><br>In such cases, the implementing ATSP might, for instance,<br><br>• treat the higher quality indicator encodings as an advised lower one (e.g. NUC=7 may be treated as NUC=5) or<br>• consider, for separation purpose, a quality indicator more stringent that the one stated in ED-126 (e.g. NUC =5 rather than NUC=4), which complies with ICAO circular 311.<br><br>Justification:<br>As an ATSP will never know whether an aircraft is "deviating or not", it is easier to take a safety margin, applicable to all aircraft, on the required quality indicator to reduce separation minima instead to individually change the NUC value. At least, both solutions shall be proposed. |
| response | *Partially accepted*<br><br>The change to the last sentence is accepted, except for *", which complies with ICAO circular 311",* since this is a circular which is also subject to change based on ED-126.<br><br>The justification is not shared; see also the response to comment 39. |

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| comment | *41* comment by: *DGAC/DTI/CNS*<br><br>Item 5.1.2<br><br>Pilots and controllers training procedures to account for the predicted unavailability of the RAIM functions are not defined (not in ICAO PANS ATM updated version, not in ED-126…).<br>This procedure should be defined before accepting deviation to agreed requirements. |
| response | *Noted*<br><br>No longer applicable since this sub-paragraph is removed following the response to comment 6. |

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| comment | *42* comment by: *DGAC/DTI/CNS*<br><br>Item 5.1.3<br><br>Pilots and controllers training procedures to mitigate transmission of only the generic emergency indicator have never been defined (not in ICAO PANS ATM updated version, not in ED-126…).<br><br>This procedure should be defined before accepting deviation to agreed requirements.<br><br>Justification:<br>Not to be able to differentiate between a 7500 and other emergency code may |

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| | lead to hazardous situation. |
| response | *Noted*<br><br>Defining pilot and controller training procedures to mitigate transmission of only the generic emergency indicator, and acceptance of these procedures resides with an implementing ATSP. It is not considered part of this AMC (see also comment No.39). |

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| comment | *55* comment by: *Roland Mallwitz*<br><br>para 5.1.1<br>"in such cases ..."<br><br>comment:<br><br>What cases? cannot understand reference. More explanation required. |
| response | *Partially accepted*<br><br>The wording "in such cases" is removed since it created ambiguity. Instead of more detailed explanation this paragraph is kept at a generic level. |

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| comment | *90* comment by: *Göran Hasslar*<br><br>5.1.3 Transmission of generic emergency indicator only<br><br>page 12<br><br>The paragraph should be deleted.<br><br>Justification:<br>The assumptions listed in paragraph 5 shall relate to the application in this document and not state how any discrepancies should be handled. ED-126 clearly requires that the discrete codes are to be sent in an emergency situation; hence this assumption in 5.1.3 is not linked to the application itself but to a discrepancy to the application. |
| response | *Not accepted*<br><br>The AMC defines the context and applicability of permissible deviations and related mitigations of this application (which are captured as assumptions). The main ground application interface is mentioned in these assumptions. |

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| comment | *101* comment by: *European Cockpit Association*<br><br>5.1.3<br><br>The procedures described in section 5.1.3 for pilots should be no different to the current ones used today on radar environments.<br><br>Current controller procedures for non radar environment in use today will be enhanced with the transmission of the generic emergency indicator alone, without the need for further Pilot radar environment procedures. |
| response | *Noted* |

Appropriate operational procedures can include the currently used procedures as mentioned in the comment.

resulting text

**5 ASSUMPTIONS**

Applicants should note that this AMC is based on the following assumptions.

5.1 Air Traffic Service Provider (ATSP)

ATSP implements the ADS-B-NRA application compliant with relevant requirements of the safety, performance and interoperability requirements of EUROCAE standard ED-126. Deviations from, or supplements to the established standards are assessed by the ATSP. Deviations that potentially impact the airborne domain should be assessed in coordination with relevant stakeholders as per ED78A.

Section 8 of this document, "Airworthiness Considerations", lists permissible deviations from the target requirements related to the use of existing aircraft installations in support of initial implementations. These deviations are currently considered operationally acceptable under the assumption that ground mitigation means as discussed in the following subsections, are implemented, at the discretion of the ATSP.

5.1.1 Consistency of position quality indicators with associated position information at time of transmission.

In cases where position quality indicators are not consistent with actual position quality (e.g., due to uncompensated latency in position transmissions), the implementing ATSP might:

- treat the higher quality indicator encodings as an advised lower one (e.g. NUC=7 may be treated as NUC=5) or,
- consider, for separation purpose, a quality indicator more stringent than the one stated in ED-126 (e.g. NUC =5 rather than NUC=4).

5.1.2 Encoding of NUC Quality Indicator (DO-260 compliant transponders)

In order to mitigate the encoding of the NUC quality indicator based on accuracy quality information (HFOM) in the case of the unavailability of the GPS RAIM function (i.e. unavailability of HPL information), the implementing ATSP may, for instance, rely on the analysis of the frequency and duration of the unavailability of the RAIM function (as part of the local safety assessment).

5.1.3 Transmission of generic emergency indicator only

....

**B. Draft Decision - I. AMC 20-24 - System Description** p. 12-13

comment *33* comment by: *AEA*

System Description refers to both DO-260 and D-260A, giving the impression that aircraft avionics requirements can vary. This will certainly result in adopting the lowest standard (DO-260) as the reference for the ground system, while in practice the majority of the avionics systems complies with the new standard DO-206A. Furthermore, there will be no incentive to upgrade from DO-260 to DO-260A.

response *Not accepted*

This AMC is to provide acceptable means of compliance that meet the current state of implementation. Because currently the majority of the implementation

deploys DO-260, this minimum standard is included to accelerate implementation.

comment

*91* comment by: *Göran Hasslar*

6 System description page 12-13

Move the text below in paragraph 6 to paragraph 8.3.4.

"The horizontal position accuracy and integrity requirements of the ADS-B-NRA application are associated with quality indicators which form part of the air-to-ground ADS-B message exchange. These are expressed by:

• A single parameter in ED-102/DO-260 compliant equipment (NUC), and by

• Three parameters in DO-260A compliant equipment (NIC, NAC, SIL);

and are encoded based on accuracy, integrity containment radius and integrity level information associated with the applicable horizontal position source.

Note: guidance on the quality indicators is provided in Appendix 4."

Justification:
Paragraph 8.3.4 handles the quality parameters and it seems to fit better there that in paragraph 6.

response

*Partially accepted*

The quality indicators are introduced in section 6 as part of the system description, and therefore kept. The detailed information is however moved to § 8.3.3.

resulting text

**6 SYSTEM DESCRIPTION**

The basic concept of ADS-B involves the broadcasting of surveillance information from aircraft via a data link.

To support the ADS-B-NRA application, the overall ADS-B avionics system (in the following referred to as "**ADS-B System**") would need to provide the following functions:

- Adequate surveillance data provision capability;
- ADS-B message processing (encoding and generation);
- ADS-B message transmission (1090 MHz ES airborne surveillance data-link);

Whereas the latter two functions are incorporated in the 1090 MHz ES ADS-B transmit system, the surveillance data provision is realised through various on-board surveillance data sources (e.g. horizontal position source, barometric altimetry, ATC transponder control panel).

The horizontal position accuracy and integrity requirements of the ADS-B-NRA application are associated with quality indicators which form part of the air-to-ground ADS-B message exchange. The interconnecting avionics architecture is part of the ADS-B System.

| **B. Draft Decision - I. AMC 20-24 - Functional Criteria** | p. 13 |
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| comment | *57* comment by: *Roland Mallwitz*<br>7.1, first bullet<br>comment: add at the beginning: "A unique..." |
| response | *Accepted* |

| | |
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| comment | *58* comment by: *Roland Mallwitz*<br>7.1, first bullet<br>comment: add at the beginning: "An unique..." |
| response | *Noted*<br>Double entered comment. See Comment 57 |

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| resulting text | 7.1 In line with ED-126 (section 4), the ADS-B System needs to meet the following surveillance data transmission requirements, as a minimum:<br>• A unique ICAO 24 bit aircraft address (contained within each ADS-B message transmission);<br>…. |

| **B. Draft Decision - I. AMC 20-24 - Airworthiness Considerations** | p. 13-18 |
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| comment | *7* comment by: *Boeing*<br>Section 8.1. Airworthiness Certification Objectives<br>The accuracy and integrity and integrity requirements in Section 8.1 should be developed from a system-level target of safety requirement of 2e-9, not 2e-12 as is currently referenced.<br>Justification:<br>The accuracy and integrity requirements referenced in ED-126/DO-303 for Non Radar Airspace (NRA) were developed from isolated surveillance radar performance values rather than by using equivalent system requirements and the accepted system design methodology (as expressed in U.S. Federal Aviation Regulation 25.1309 and JAA AC(J) 25.1309, which is accepted by FAA, EASA ,and most other regulatory agencies worldwide). The approach in ED-126, Appendix E, started from an assumption of a target level of safety of 2e-12, a value that is not met by most surveillance radars today. This approach resulted in the requirement for 0.5 NM positioning accuracy and 1.0 NM integrity limits for 5 NM separation in NRA using ADS-B. |
| response | *Not accepted* |

ED-126 provides the agreed and justified basis for the surveillance risk benchmark. In addition, the benchmark is in line with the related ICAO SASP work.

comment

*8* comment by: *Boeing*

Section 8.2.1.

Provide ground mitigation for existing equipment installations.

Justification:
The current RAIM integrity monitoring designs only address failures of the signal in space. They do not include GNSS receiver processing and STP monitoring. The end-to-end integrity requirement was not a requirement for the current Extended Squitter equipment.

response

*Not accepted*

This requirement addresses System integrity and not on-board integrity monitoring (e.g. RAIM). Also this AMC addresses the airborne, and not the ground side of the ADS-B function. Mitigation for ground side is outside of the scope of this AMC. High level requirements for the ground side are recorded as assumptions in Section 5.

comment

*9* comment by: *Boeing*

Section 8.2.3

It may be necessary to provide ground mitigation for existing equipment installations.

Justification:
An end-to-end latency requirement was not a requirement for the current Extended Squitter equipment.

response

*Noted*

Para 8.3.3. applies. The 1090 MHz ES equipment is part of the entire end-to-end ADS-B system the latency requirement applies to (hence, justification is irrelevant).

The fact that (some) current installations are not reflecting the effects of uncompensated latency in the Quality Indicator encoding is recognised in the AMC and assumed to be taken into account on the ground for initial ADS-B deployment (refer to paragraph 5.1.1).

comment

*10* comment by: *Boeing*

Section 8.3.3. -- Text relating to uncompensated latency

The proposed text regarding the degradation of the quality indicator for uncompensated latency was not a requirement for existing Extended Squitter equipment. Any action would need to be done on the ground receive side with currently fielded equipage.
The STP MOPS has recently added some NACp and NIC limiting related to transmit function latency, but this limiting only applies to future generation

equipment certified to DO-302 testing. We recommend adding a note after the second bullet in this proposed section to read:
*"See STP MOPS, DO-302, for an example of specific means of compliance to this requirement."*

Justification:
Current extended squitter equipment does not consider uncompensated latency in the transmit function, except to a limited degree within the transponder function itself. Similarly, the permissible deviation cited has not been implemented in current equipment, i.e. the NUC values encoded only reflect the accuracy of the position measurement and not any errors in downstream processing. The only thing that can be done with current equipment is to limit the NUC values (or NIC, NAC) based on measured or certified latency values.

response *Not accepted*

DO-302 has not been considered for the initial implementation of ADS-B-NRA application.

comment *11* comment by: *Boeing*

Section 8.3.5

There may be some ground mitigation required for existing Extended Squitter equipment.

Justification:
The requirements in DO-260-Original for NUC encoding included both accuracy and integrity all of the time. The proposed text is a new requirement from DO-260-Change 1.

response *Noted*

This section states the permissible deviation taking into account the related mitigations expressed in section 5.

comment *26* comment by: *DGAC France*

The horizontal position data 95% latency requirement of 8.2.3 is a high level requirement and a practical means of compliance must be elaborated in this AMC due to the difficulty encountered during previous certification exercises.
From DGAC experience applicants have problem to demonstrate a latency at 95%. In most of the cases the latency corresponds to the worst case figure. It means that the applicant is adding all the max latency values from box to box all along the chain through analysis and not through measurement.

In order to prevent endless discussion between authorities and applicants, EASA should develop a method or a specific MOC standardizing the latency demonstration at 95%.

response *Not accepted*

The high level requirements are kept in this section. Section 9.2 provides related AMC and guidance to practical means of compliance.

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| comment | *27* comment by: *DGAC France*<br><br>DGAC is concerned by the fact that Flight Deck Control Capabilities to disable the ADS-B function without disabling the operation of the ATC transponder function is only optional. On the other hand, we have to admit that most of today's installation have not an independent selection (dedicated ADS B on/off). However EASA should highly recommend such functionality or highlight that for future ADS B application the independent selection may become mandatory. The pressure for a design improvement should start now.<br><br>The proposed added paragraph informs the applicant that the Flight Deck Control Capabilities to disable the ADS-B function without disabling the operation of the ATC transponder function is recommended and will be most likely requested in the future.<br>It is thus proposed to add a note to subparagraph 8.9.4.2:<br><br>Note: It is recommended to implement an independent ADS-B disabling function. For future ADS B application such flight deck capability may become mandatory. It should be recalled that disabling the operation of the transponder function will disable also the ACAS function. |
| response | *Partially accepted*<br><br>A note is introduced to § 8.9.4.2. to recommend an independent disabling function for ADS-B. |

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| comment | *34* comment by: *AEA*<br><br>8.1 Airworthiness Certification Objectives (page13)<br><br>8.2 ADS-B System (page14)<br><br>8.3 ADS-B Transmit System (page14)<br><br>These items are written using the word "should" in most of the stated requirements, care should be taken that this does not result in a degradation of the overall function, i.e. 'ground' assuming that the functionality is not present (Why not use "shall" ?)<br><br>(Refer to appendix 2.2 for ground domain assumptions) |
| response | *Accepted*<br><br>Since AMC is by definition one, but not the only way of showing compliance with requirements, the wording "should" is used. However if within the context of the AMC it is needed to comply with specific paragraph of the AMC this will be expressed. |

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| comment | *35* comment by: *AEA*<br><br>8.5.3. There has been investments to get the 25 ft resoltuion for baro altitude, here again overall system performance will most probably be based on 100ft.<br><br>8.6.1. Rather than restating requirements for aircaft identification a reference should be made to the requirements for Mode-S Elementary Surveillance. |

response

*Not accepted*

Paragraph 8.5.3 is in line with Mode S regulation and therefore remains (see also comment 61).

Paragraph 8.6.1 is kept to render a self-contained document.

comment

*43* comment by: *DGAC/DTI/CNS*

Item 8.2.1

Note 1: this integrity level is required to adequately protect against the corruption of horizontal position data and horizontal position quality indicators when applying separation.

Note 2: a lower integrity level can be accepted for aircraft flying in areas where no reduced separation minima are applied.

Justification:
As currently written, this document only considers separation aspects (for requirements identification). However, it should also be recognised that displaying a/c on controllers working position in order to improve situational awareness will also bring some safety benefits.

response

*Partially Accepted*

Note 1 is accepted.

Note 2 is not accepted as a general applicable note because on aircraft certification level it can not be excluded that the aircraft is operated in area were reduced separation minima are applied.

comment

*44* comment by: *DGAC/DTI/CNS*

Item 8.3.3

For initial implementations, some aircraft installations may not take into account any (uncompensated) latency in the encoding of the position accuracy quality indicator as applicable at the time of transmission. Hence, such installations might transmit horizontal position quality indicators that are consistent with the associated position information only for lower quality indicator encodings but not higher ones (e.g. NUC=7). The applicant must establish the horizontal position quality indicators that are really consistent with the associated position information and demonstrate their correctness taking into account the (minimum) position source quality and any (uncompensated) maximum latency as expressed in 8.2.3. Such deviation from the above target requirement shall be listed in the Aircraft Flight Manual (refer to Section 9.3).

Justification:
This permissible deviation may be difficult for ATSP to interpret due to several reasons:

- The description of the operational impact is missing
- The mitigation means to be implemented is not really described and the

consequences if not implemented are not described.

- It is impossible to distinguish between an aircraft deviating or not.

An ATSP should know exactly which quality indicators it can rely on.

In addition, reference to NAC (e.g. NUC=5 or NAC=5; e.g. NUC=7 or NAC=7) shall be deleted in 8.3.3. Whatever the NAC, the a/c accuracy can be 95% of the time close to the upper bound. When adding the uncompensated latency, the NAC is no more correct.

response

*Not accepted*

The assumed mitigation on the ground side is through applying a lower quality indicator which expresses the position measurement performance (by design) plus the maximum allowed latency. This is the quality indicator the ATSP can rely on. As a consequence the ATSP has to assume that all aircraft use these deviations.

The ATSP will not be able to fully benefit from the airborne system potential performance qualifications; however the minimum safety requirements are reflected in this AMC. Although detailed descriptions of operational impacts are not provided, generic impacts are provided in § 5.1.1.

Ground side mitigations are not considered in this AMC.

comment

*45* comment by: *DGAC/DTI/CNS*

Item 8.3.5

In order to mitigate such deviation, flight crew have to informed the AT Controller when a RAIM outage is detected on board (refer to section 10.3).

Justification:
Airborne detection is the easiest way for an ATSP to know which aircraft are affected and to apply appropriate back-up procedures.

response

*Partially accepted*

The intent of this comment is included by a more general example in 10.2.3 of possible equipment anomalies.

comment

*46* comment by: *DGAC/DTI/CNS*

Item 8.4.8

Reference to item 8.4.9 (that does not exist) has to be changed to 8.4.7

In addition, last sentence "The use of such back-up data is at the discretion of the implementing ATSP" should be deleted.

Justification:
An ATSP has no means to know the source of the position data transmitted through ADS-B. What is important is to get the appropriate quality indicator.

response

*Partially accepted*

The reference in § 8.4.8 will be corrected to § 8.4.3. See also comment No. 68.

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| | It is accepted that the ATSP has no means to identify the source of the position data transmitted through ADS-B. The sentence will be deleted. |

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| comment | *47* comment by: *DGAC/DTI/CNS*<br><br>Item 8.9.2 & 8.9.3<br><br>Why are those two requirements considered as optional? |
| response | *Noted*<br><br>These paragraph reflect ED-126 stating that *"The provision of this information may be optional for some low capability aircraft fits that may be appropriate to certain local environments"* and the expectation that a signification proportion of such aircraft do indeed not implement the required control panels to feed the data. |

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| comment | *50* comment by: *Airservices Australia*<br><br>8.4.6.3.<br>Replace "For GNSS system compatible with (E)TSO C-129 (any revision), it is highly desired that the system incorporates Fault Detection" with "GNSS systems are required to support Fault Detection…."<br><br>Justification:<br>Fault detection and elimination (FDE) capability provides important protection for an ADS-B system. Without FDE capability, a satellite ranging error (eg runaway satellite clock) from a single satellite can cause a RAIM error to be declared and result in low integrity data to the ADS-B function – making ADS-B not useable. FDE capability will allow detection and elimination of the "bad" satellite. This capability should be required to improve overall ADS-B system availability.<br><br>FDE capability is a readily available in commercial GNSS receivers and MMRs. This requirement does not pose an unreasonable burden on the Industry. |
| response | *Noted*<br><br>Requiring FDE could indeed improve the system availability to meet the system continuity level. It however does not change that requirement as provided in 8.2.2. |

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| comment | *59* comment by: *Roland Mallwitz*<br><br>8.2.3.<br><br>comment: 1.5 s is mentioned as a 95% value. But the distribution allows indefinite tails. A maximum value has to be specified as well. Otherwise, two targets can be dispayed in different positions while they are at the same!<br><br>Proposal: max value could be e.g 3s.<br><br>general comment:<br>According to ISO Abbreviation for seconds is s |
| response | *Partially accepted* |

Specifying the 1.5 s as a 95% is consistent with navigation standards.
The ED-126 specification of a 95% implies that outliers are rather rare and not correlated (hence significant singular outliers are easily detected/filtered out on the ground). To exclude systematic outliers outside the 1.5 seconds, a limit of 3 seconds is introduced to be met in 99.9% of all ADS-B message transmission cases.

For clarity the abbreviation for seconds is not used here.

comment

*60* comment by: *Roland Mallwitz*

8.3.2

comment: ED-73B does not reflect Extended Squitter requirements, ED-73C will.

Proposal: Reference to ED 73C (and DO 181D) will be more appropriate

response

*Not accepted*

Extended Squitter requirements are in ED-73B (and DO-181C). Reference to ED-73C can not be included since this is not yet published.

comment

*61* comment by: *Roland Mallwitz*

para 8.3.6

comment: I am not familiar with the use of should and shall in this kind of document, but I would recommend "shall" for this para.

para 8.5

comment: A note should be added reflecting ICAO Annex 6 part 1 changes and requirements on barometric altitude data source (from 2009 for new aircraft, from 2012 for all part 1 aircraft)

para 8.8

comment: The permissible deviation should be granted only to ADS-B operation, which is not 1090 MHz Extended Squitter.

paras 8.9.4.2

comment: This requirement is based on historic experience with altitude reports and can be valid, when a non-ATC transponder based ADS-B transmit system is used. Modern transponders should identify invalid data in the incoming data stream and not transmit those invalid data. ATC transponders provide a "Squitter inhbit"-function. In this respect the requirement is not transponder but installation related.

response

*Partially accepted*

Since AMC is by definition one, but not the only way of showing compliance with requirements, the wording "should" is used. However if within the context of the AMC it is needed to comply with specific paragraph of the AMC this will be expressed.

8.5: Not accepted. The requirements are consistent with the elementary mode-S requirements. ICAO altitude source resolution requirements are related to data sources, not to the transponder.

8.8: It is not intended to exclude the DO-260/ED-102 compliant transponders having not the requested target capability.

8.9.4.2: This requirement is at system level, and not specific to the transponder or other details of the design.

comment *66* comment by: *AIRBUS*

Paragraph 8.2.1

Remove the reference to "Table 4 in Appendix 3" at the end of the paragraph.

Justification:
Table 4 in Appendix 3 gives integrity requirements for Barometric Altitude & Aircraft Identification parameters, but not for horizontal position & horizontal position quality indicators' parameters.

response *Accepted*

comment *67* comment by: *AIRBUS*

Paragraph 8.2.2

Remove the reference to "Table 4 in Appendix 3" at the end of the paragraph.

Justification:
Table 4 in Appendix 3 gives continuity requirements for Barometric Altitude & Aircraft Identification parameters, but not for the (overall) ADS-B System.

response *Accepted*

comment *68* comment by: *AIRBUS*

Paragraph 8.4.8, first sub-paragraph.

This paragraph refers to § 8.4.9, which does not exist in the proposed Draft Material AMC 20-24.

Justification:
Replace reference to § 8.4.9 by reference to § 8.4.3.

response *Accepted*

The reference in item 8.4.8 will be corrected to 8.4.3.

comment *74* comment by: *EADS - APSYS*

§ 8 Airworthiness considerations
§ 8.2.1: "The (overall) [airborne] ADS-B system integrity level …is 10-5/fh…"

§ 8.2.2: "The (overall) [airborne] ADS-B system continuity level is 2*10-4/fh…"

For the reason that these performance figures are possibly a key factor in the achieved target level of safety of ADS-B NRA operations, this paragraph should specify more explicitly that:

☐ These performance figures have been set for the "ADS-B out" function, to be used in ADS-B NRA operations as laid down by ED 126 and its preliminary safety assessment;

☐ Compliance with these performance figures do not constitute per se a demonstration that the safety objectives of ADS-B NRA operations allocated to airborne avionics are achieved;

☐ This demonstration of safety will be conducted by the ATSP intending to operate ADS-B NRA and will be approved by its Regulatory Authority.

It is proposed that these comments be introduced as additional notes or footnotes, for information to applicants.

Justification:
Some particular aspects of the safety assurance context of ADS-B NRA operations might appear unfamiliar for the operators or their suppliers.

response *Partially accepted*

The suggested notes will be added for clarity at the end of § 8.2.1 and 8.2.2. However the last note is replaced by a reference to § 3.1 that contains the proposed information.

comment *79* comment by: *UK CAA*

8.4.6.2

Believe it should state "compliant with" not "compatible with".

response *Accepted*

comment *84* comment by: *IAOPA Europe*

8. Airworthiness Considerations

For light aircraft a reduction of the Certification Requirements and the Implementation of a "Light Standard" has to be considered.

Justification:
The more accurate and precise ADS-B systems are, the more expensive and heavy in weight they become. Today´s ADS-B standards have lead to systems that are tailored for commercial airliners, but too expensive and too heavy for light aircraft. Consequently a new "light" certification standard for ADS-B has to be considered for light aircraft if the equippage of all aircraft is the objective. The SESAR Concept of Operations clearly describes the objective of making all aircraft electronically visible in a 2020 or later European non-radar environment.
Experience with the uncertified and widely spread "FLARM"-ADS-B-system has

shown that industry standards clearly below the standards quoted in chapter 4 "Reference Documents" are already able to provide reliable information for collision avoidance.

It is not acceptable that Airliners and Gliders use Collision Avoidance/ Traffic Information Systems that are not compatible with each other. (Who will volunteer to explain the non-compatibility of today´s anti-collision systems after a big accident has occurred?)

response *Noted*

It is agreed that the issue of making all aircraft electronically visible needs to be addressed. However it is considered outside of the scope of this NPA which is intended to provide AMC for this specific application only.

It should also be mentioned that industry development of ADS-B transmitter only equipment is being considered.

comment *85* comment by: *Göran Hasslar*

8.3.3 "Permissible deviation for initial implementations", page 14

Remove the text relating to "Permissible deviation for initial implementations".

Justification:
As there is no definition of an "Initial implementation" it is not clear what is meant; and hence cannot be stated in a certification document. Of course discrepancies could occur and should then be assessed by the implementer in question to find a suitable means to handle it. It is then up to EASA to accept or reject the assessment.

If stated in this document we could have installations made in 2020+ stating that it is an initial implementation. It could then be the case that no-one will ever fulfill the requirements stated herein and hence not fulfill the ED-126 if discrepancies are listed as okay in the document.

response *Not accepted*

"Initial implementations" cover the use of existing avionics for early ADS-B deployment in "pocket" areas across Europe. This will be superseded by the "SPI IR" process targeting at an ADS-B out avionics mandate in the 2015 timeframe. "SPI IR" MoC (incl. EASA material) will ask for full compliance with the target requirements (ADS-B-NRA, ADS-B-RAD).

comment *86* comment by: *Göran Hasslar*

8.3.5 "Permissible deviation for initial implementations" page 15

Remove the text relating to "Permissible deviation for initial implementations".

Justification:
As there is no definition of an "Initial implementation" it is not clear what is meant; and hence cannot be stated in a certification document. Of course discrepancies could occur and should then be assessed by the implementer in question to find a suitable means to handle it. It is then up to EASA to accept or reject the assessment.

If stated in this document we could have installations made in 2020+ stating that it is an initial implementation. It could then be the case that no-one will ever fulfill the requirements stated herein and hence not fulfill the ED-126 if discrepancies are listed as okay in the document. ED-126 clearly requires that the NAC/NUC shall be based on the HPL. The requirement in the ED-126 document is there for a reason and I find no justification here to why an initial implementation could be made without this function.

response *Not accepted*

"Initial implementations" cover the use of existing avionics for early ADS-B deployment in "pocket" areas across Europe. This will be superseded by the "SPI IR" process targeting at an ADS-B out avionics mandate in the 2015 timeframe. "SPI IR" MoC (incl. EASA material) will ask for full compliance with the target requirements (ADS-B-NRA, ADS-B-RAD).

NUC encoding based on HPL is part of the AMC requirement. The permissible deviation from this and the associated mitigation means are clarified. It is also noted that ED-126 also addresses the permissible rare encoding of NUC based on HFOM (refer to "IR 17").

comment *88* comment by: *Göran Hasslar*

8.8.2 "Permissible deviation for initial implementations" page 18

Remove the text relating to "Permissible deviation for initial implementations".

Justification:
As there is no definition of an "Initial implementation" it is not clear what is meant; and hence cannot be stated in a certification document. Of course discrepancies could occur and should then be assessed by the implementer in question to find a suitable means to handle it. It is then up to EASA to accept or reject the assessment.

If stated in this document we could have installations made in 2020+ stating that it is an initial implementation. It could then be the case that no-one will ever fulfill the requirements stated herein and hence not fulfill the ED-126 if discrepancies are listed as okay in the document. ED-126 clearly requires that the discrete codes are sent in an emergency situation. The requirement in the ED-126 document is there for a reason and I find no justification here to why an initial implementation could be made without this function.

response *Not accepted*

"Initial implementations" cover the use of existing avionics for early ADS-B deployment in "pocket" areas across Europe. This will be superseded by the "SPI IR" process targeting at an ADS-B out avionics mandate in the 2015 timeframe. "SPI IR" MoC (incl. EASA material) will ask for full compliance with the target requirements (ADS-B-NRA, ADS-B-RAD).

comment *94* comment by: *European Cockpit Association*

In line with ECA comments on para 5.1.3, para 8.8.2 regarding 'permissible deviation for initial implementations' should be amended as follows:

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| | 'For initial implementations, irrespective of whether the flight crew selects the discrete emergency codes 7500, 7600 or 7700, only the generic emergency indicator will be transmitted satisfying this requirement. Such deviation from the requirement should be listed in the Aircraft Flight Manual (refer to Section 9.3).' |
| response | *Not accepted*<br><br>The generic emergency indicator alone does not satisfy the related procedures. Hence, procedural amendments are expected to be required. |

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| comment | *95* comment by: *Certification Office*<br><br>Paragraph 8.3.2<br><br>What are considered as relevant tests mentioned in the paragraph? "For 1090 MHz Extended Squitter ADS-B transmit systems, this should be demonstrated by the relevant tests documented in:" |
| response | *Noted*<br><br>All general tests and specific tests regarding the input, processing (e.g. encoding, extrapolation) and output of the data items listed under section 7.1. are considered "relevant tests". |

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| comment | *96* comment by: *Certification Office*<br><br>Paragraph 8.3.7<br><br>"Transmitter antenna installation needs to comply with guidance for installation of ATC transponders to ensure satisfactory functioning." Is there any specific requirement to be followed? If there is no any specific antenna installation guidance, this item may be removed. |
| response | *Partially accepted*<br><br>A reference to ED-73B will be added that contains guidance for transmitter antenna installation. |

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| comment | *97* comment by: *Certification Office*<br><br>Paragraph 8.4.8<br><br>It mentions item 8.4.9, but it does not exists. |
| response | *Accepted*<br><br>The reference in item 8.4.8 will be corrected to 8.4.3. |

resulting text

**8 AIRWORTHINESS CONSIDERATIONS**

8.1 Airworthiness Certification Objectives

For the purposes of the ADS-B-NRA application, the ADS-B System installed in the aircraft needs to be designed to deliver data that satisfy the airborne domain requirements in line with ED-126 Section 3.4, (Appendix 3 provides a summary for information purposes).

8.2 ADS-B System

8.2.1 The (overall) ADS-B System integrity level with respect to the processing of horizontal position data and horizontal position quality indicators, covering the processing (and data exchange) chain from horizontal position data source(s) to ADS-B transmit data string encoding) needs to be 10-5/fh (refer also to Table 1 in Appendix 3).

*Note 1: this integrity level is required to adequately protect against the corruption of horizontal position data and horizontal position quality indicators when applying separation;.*

*Note 2: These performance figures have been set for the "ADS-B out" function, to be used in ADS-B NRA operations as laid down by the Operational Safety Assessment in Annex C of ED 126;*

*Note 3: Compliance with these performance figures do not constitute per se a demonstration that the safety objectives of ADS-B NRA operations allocated to avionics are achieved;*

*Note 4: Also refer to § 3.1.*

8.2.2 The (overall) ADS-B System continuity level needs to be $2*10^{-4}$/fh (refer also to Table 1 in Appendix 3).

*Note 1: These performance figures have been set for the "ADS-B out" function, to be used in ADS-B NRA operations as laid down by the Operational Safety Assessment in Annex C of ED 126;*

*Note 2: Compliance with these performance figures do not constitute per se a demonstration that the safety objectives of ADS-B NRA operations allocated to avionics are achieved;*

*Note 3: Also refer to § 3.1.*

8.2.3 The latency of the horizontal position data, including any uncompensated latency, introduced by the (overall) ADS-B System does not exceed 1.5 second in 95 % and 3 seconds in 99.9 % of all ADS-B message transmission cases (refer also to Table 1 in Appendix 3).

8.3 ADS-B Transmit System

8.3.1 Compliance with the air-ground interoperability requirements, as specified in ED-126 and presented in Section 7.1 and Appendix 4, needs to be demonstrated.

8.3.2 For 1090 MHz Extended Squitter ADS-B transmit systems, this should be demonstrated by the relevant tests documented in:

- ED-73B/ETSO-2C112b (or DO-181C);
- ED-102, as a minimum, or an equivalent standard which is acceptable to the Agency (e.g. DO-260 or DO-260A).

8.3.3 ADS-B transmit systems need to transmit horizontal position quality indicators consistent with the associated position information at the time of transmission.

For the expression of the position accuracy quality, the related indicator should therefore reflect:

- The quality (in terms of both integrity and accuracy) of the position measurement itself; and
- Any (uncompensated) latency incurring prior to transmission.

*Note: guidance on the quality indicators is provided in Appendix 4.*

The applicant needs to demonstrate the correctness of consistent quality indicator encodings in line with (minimum) position source quality and any (uncompensated) maximum latency as expressed in 8.2.3.

Permissible deviation for initial implementations:

For initial implementations, some aircraft installations may not take into account any (uncompensated) latency in the encoding of the position accuracy quality indicator as applicable at the time of transmission. Hence, such installations might transmit horizontal position quality indicators that are consistent with the associated position information only for lower quality indicator encodings[1] (e.g. NUC=5 or NAC=5) but not higher ones (e.g. NUC=7 or NAC=7). Such deviation from the above target requirement need to be listed in the Aircraft Flight Manual (refer to Section 9.3).

8.3.4 The value of the horizontal position quality indicators need to be based on the integrity information for the encoding of the ED-102/DO-260 related NUC and the DO-260A related NIC quality indicator, as related to the horizontal position sources.

In addition, the encoding of the DO-260A NAC quality indicator needs to be based on the accuracy information of the horizontal position sources.

8.3.5 In case of ED-102/DO-260 based ADS-B transmit systems, the NUC Quality Indicator value need to be encoded based on the integrity containment radius[2] only.

Permissible deviation for initial implementations:

For initial implementations, some GNSS position source based aircraft installations may encode the NUC Quality Indicator on accuracy quality information (HFOM) under rare satellite constellation circumstances leading to the temporary unavailability of the integrity monitoring (RAIM) function (i.e. unavailability of integrity containment radius calculation). Such deviation from the above target requirement need to be listed in the Aircraft Flight Manual (refer to Section 9.3).

8.3.6 If the ADS-B transmit system does not have a means to determine an appropriate integrity containment radius and a valid position is reported, then the Quality Indicator (i.e. NUC or NIC) need to be encoded to indicate that the integrity containment radius is unknown (i.e. NUC/NIC should be set to 'zero').

8.3.7 Transmitter antenna installation needs to comply with guidance for installation of ATC transponders to ensure satisfactory functioning. (Also refer to ED-73B).

8.3.8 If more than one ADS-B transmit system is installed, simultaneous operation of both transmit systems needs to be prevented.

8.4 Horizontal Position Data Sources.

8.4.1 The requirements on horizontal position data sources are based on the ED-126 safety and performance assessments.

8.4.2 Components of horizontal position data sources external to the aircraft ADS-B system (such as the GNSS space segment) fall outside these airworthiness considerations. Such external components are assumed to operate in accordance with their specified nominal performance[3].

Nevertheless, failures of the external data source components are required to be detected through on-board monitoring (as expressed in section 8.4.3).

8.4.3 Any eligible horizontal position data source needs to meet the following minimum requirements (refer also to Table 2 in Appendix 3):

- Correct encoding of quality indicator information in line with the actual

performance of the selected horizontal position data source(s), i.e. in relation to position integrity containment bound (ED-102/DO-260 and DO-260A ADS-B transmit systems) and position accuracy (DO-260A ADS-B transmit systems);

- Position source failure probability: $10^{-4}$ per hour[4];
- Position integrity alert failure probability, commensurate with the performance characteristics of GNSS integrity monitoring[5]: $10^{-3}$ (per position source failure event);
- Position integrity time to alert: 10 seconds.

8.4.4 If available and valid, integrity containment radius information should be provided to the ADS-B transmit system from the position data source, or equivalent, on the same interface as and together with each positional data.

8.4.5 If the integrity containment radius is not provided by the horizontal position data source, the ADS-B transmit system may use other means to establish an appropriate integrity containment radius[6], provided a requirements compliant integrity alert mechanism is available.

8.4.6 Use of GNSS Systems as Primary Position Data Source.

8.4.6.1 GNSS is considered as primary horizontal position data source for the provision of an acceptable accuracy and integrity performance in support of the ATC separation services contained within the ADS-B-NRA application.

The ED-126 safety and performance assessments are based on the specified performance and characteristics of GNSS systems, including receiver autonomous integrity monitoring. Therefore, for GNSS systems as specified in section 8.4.6.2, a safety and performance demonstration is not required.

8.4.6.2 If GNSS is used as a positional source, the GNSS system should be either compliant with:

- ETSO C-129A, TSO C-129 or TSO C-129A; or
- ETSO C-145/C-146 or TSO C-145A/C-146A,

capable of delivering position data with a periodic interval of at least 1.2 s [7].

8.4.6.3 For GNSS systems compatible with (E)TSO C-129 (any revision), it is highly desired that the system incorporates Fault Detection and Exclusion capability as defined in AC 20-138A, Appendix 1, "GPS as a Primary Means of Navigation for Oceanic/Remote Operations".

8.4.7 Use of Alternative Compliant Position Data Sources

As the ED-126 safety and performance assessments are based on the performance and characteristics of GNSS systems, for alternative position sources a dedicated safety and performance assessment is required to demonstrate compliance with the ED-126 requirements.

8.4.8 Use of Temporary Back-up Position Data Sources.

Back-up position data sources not complying with the requirements referred to in section 8.4.3 may prove very useful in enhancing the continuity of ADS-B surveillance provision during temporary outages of the primary (or equivalent alternative) position data sources.

Any such back-up position data source needs to report its accuracy and integrity performance to the ADS-B transmit system, in a format compliant with ED-102/DO-260 or DO-260A, as appropriate.

8.5 Barometric Altitude Data Sources.

8.5.1 Pressure altitude provided to the ADS-B transmit system needs to be in accordance with existing requirements for ATC transponders.

8.5.2 The digitizer code selected needs to correspond to within plus or minus 38.1 m (125 ft), on a 95% probability basis, with the pressure-altitude information (referenced to the standard pressure setting of 1013.25 hectopascals), used on board the aircraft to adhere to the assigned flight profile. (ICAO Annex 10, Vol IV, 3.1.1.7.12.2.4. See also EUROCAE ED-26).

The performance of the encoders and of the sensors needs to be independent from the pressure setting selected.

8.5.3 The transponder should indicate correctly the altitude resolution (quantisation) used, i.e. 25ft (from an appropriate source, default resolution) or 100ft (Gillham's coded source, permissible alternative resolution).

The conversion of Gillham's coded data to another format before inputting to the transponder is not permitted unless failure detection[8] can be provided and the resolution (quantisation) is set in the transmitted data to indicate 100ft.

8.5.4 In case more stringent barometric altimetry requirements are applicable in line with e.g. airspace requirements (e.g. RVSM) or other function requirements (e.g. ACAS II), then these requirements and their related regulation take precedence.

8.6 Aircraft Identification.

8.6.1 Identification needs to be provided to the ADS-B transmit system so that the information is identical to the filed ICAO flight plan. This information may be provided from:

- A flight management system; or
- A pilot control panel; or
- For aircraft, which always operate with the same flight identification (e.g. using registration as the flight identification) it may be programmed into equipment at installation.

8.6.2 In case no ICAO flight plan is filed, the Aircraft Registration needs to be provided to the ADS-B transmit system.

8.7 Special Position Identification (SPI)

For ATC transponder-based ADS-B transmit systems, the SPI capability needs to be provided. The SPI capability should be integrated into the transponder functionality and should be controlled from the transponder control panel.

8.8 Emergency Status/Emergency Indicator.

8.8.1 When an emergency status (i.e. discrete emergency code) has been selected by the flight crew, the emergency indicator needs to be set by the ADS-B transmit system.

8.8.2 For ATC transponder-based ADS-B transmit systems, the discrete emergency code declaration capability should be integrated into the transponder functionality and should be controlled from the transponder control panel.

Permissible deviation for initial implementations:

For initial implementations, instead of the required transmission of the discrete emergency codes 7500, 7600 and 7700 when selected by the flight crew, the transmission of only the generic emergency indicator can satisfy this requirement Such deviation from the above target requirement needs to be listed in the Aircraft Flight Manual (refer to Section 9.3).

8.9 Airworthiness Considerations regarding Optional Provisions.

8.9.1 Ground Velocity (OPTIONAL).

Ground velocity, e.g. from an approved GNSS receiver, in the form of East/West and North/South Velocity (including a velocity quality indicator) is recommended to be provided.

8.9.2 Special Position Identification (SPI) (OPTIONAL).

For non-ATC transponder-based ADS-B transmit systems (i.e. installations based on dedicated ADS-B transmitters), a discrete input or a control panel should be provided to trigger the SPI indication.

8.9.3 Emergency Status/Emergency Indicator (OPTIONAL).

For non-ATC transponder-based ADS-B transmit systems (i.e. installations based on dedicated ADS-B transmitters), a discrete input or a control panel should be provided to indicate the emergency status (discrete emergency code).

8.9.4 Flight Deck Control Capabilities (OPTIONAL).

8.9.4.1 Means should be provided to the flight crew to modify the Aircraft Identification information when airborne.

8.9.4.2 Means should be provided to the flight crew to disable the ADS-B function on instruction from ATC without disabling the operation of the ATC transponder function.

Note: It is recommended to implement an independent ADS-B disabling function. For future ADS-B application such flight deck capability may become mandatory. It should be recalled that disabling the operation of the transponder will disable also the ACAS function.

8.9.4.3 Means should be provided to the flight crew to disable the transmission of the barometric altitude.

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[1] This is a consequence of the definition of the quality indicator encoding describing an interval of values between a lower and an upper bound (refer also to Appendix 4.2). For instance, a NUC=5 encoding expresses an upper bound of position accuracy quality indication of 0.3NM whilst a NUC=7 encoding expresses an upper bound of 0.05NM. Therefore, in case of e.g. the actual GNSS position source performance, a NUC=5 encoding provides sufficient margin to also correctly express the effects of on-board uncompensated latency whilst this is not the case for a NUC=7 encoding any more.

[2] I.e. GNSS conformant HPL/HIL information.

[3] For GNSS based systems, this includes satellite constellation aspects.

[4] For GNSS based position sources, the failure occurs outside the aircraft system and is therefore expressed as per ATSU-hour. Proof of compliance of alternative solely aircraft based sources should take this into account and might have to express the requirement as $10^{-5}$ per flight hour (i.e. for the en-route environment).

[5] As realised through receiver autonomous integrity monitoring (RAIM), including its characteristics of increasingly less likely to fail for position errors beyond the horizontal protection limit. Within ED-126, the position source failure is modelled as a bias error that equals the integrity containment radius.

[6] E.g. HPL/HIL based upon known RAIM protection threshold.

[7] ETSO C-145/C146 provides additional capabilities compared with ETSO C129A such as: processing of GPS without Selective Availability, processing of SBAS signals when available and Fault Detection Exclusion as a basic function. Therefore ETSO C145/146 usually provides higher quality integrity values than ETSO C-129A equipment.

[8] For instance, this need can be satisfied by means of dual independent altitude corrected sensors together with an altitude data comparator (which may be incorporated and enabled in the ADS-B transmit system).

**B. Draft Decision - I. AMC 20-24 - Compliance with this AMC** p. 18-19

comment *12* comment by: *Boeing*

Section 9.3.1

We recommend deleting the last sentence of the section, since it is not relevant to the Aircraft Flight Manual (AFM).

Justification:
The AFM may need to state that the aircraft is capable of supporting ADS-B NRA operations compliant with AMC20-xxx. However, the AFM is typically written at a very high level and limitations and deviations, such as those proposed, should be included in other documents, such as training manuals.

response *Partially accepted*

The AFM need to state compliance and if deviations are applicable. Additional information may be included or referred to.

comment *25* comment by: *DGAC France*

DGAC considers that there should be a requirement for the the issuance of an interoperability document which would provide information on

- the approved application (e.g. ADS-B out function approved only in NRA airspace with 5 Nm separation),
- the aircraft system design and output parameters,
- the standards used for the compliance (e.g. ED and/or DO references),
- the limitation and/or deviations of the system and the proposed workarounds (technical , crew procedure,…) and finally
- the proposed Normal crew procedures for this application.

This Interoperability document should be referenced in the AFM and is really essential for the operator to demonstrate that the ADS-B system he has and crew procedures he implements match with the airspace environment.

In addition present subparagraph 9.3.2 is misleading because there is no "coordinated exemption policy for ADS-B NRA applications" as it is the case for Mode S enhanced surveillance for instance. If there

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| | is a missing mandatory parameter either the approval can not be granted or the here above proposed interoperability document should address this problem (limitation/deviation).<br><br>It is thus proposed to rewrite paragraph 9.3 - Aircraft Flight Manual - as follows:<br><br>" 9.3 Aircraft Flight Manual<br><br>9.3.1 The Aircraft Flight Manual (AFM) or the Pilot's Operating Handbook (POH), whichever is applicable, should provide at least a statement of compliance that the ADS-B System complies with this AMC 20-24. The AFM should also include a reference to the interoperability document defined in 9.3.2. ~~any permissible deviations, including those stated in this document13, as appropriate.~~<br><br>~~9.3.2 Where, at the time of certification, the system configuration is such that the ADS-B System is unable to transmit specific mandatory aircraft derived parameters, as permitted by the coordinated exemption policy, the Limitations Section should identify these parameters.~~<br><br>9.3.2 The applicant should issue an interoperability document providing information<br><br>- on the approved application (e.g. ADS B out function approved only in NRA airspace with 5 Nm separation),<br><br>- on the aircraft system design and output parameters (type of parameters, GICBs registers,…),<br><br>- on the standards used for the compliance (e.g. ED and/or DO references),<br><br>- on the limitation and/or deviations of the system and on the proposed workarounds (technical , crew procedure,…) including any permissible deviations as stated in this AMC [13], and finally<br><br>- on the proposed Normal crew procedures for this ADS B out application.<br><br>This document should be used by the operator to demonstrate that the installed ADS B system and proposed crew procedures match with the airspace environment. " |
| response | *Partially accepted*<br><br>9.3.1 The issuance of an interoperability document is tailored to a specific local implementation. The aim of this AMC is to provide generic ED-126 compliance. Paragraph 9.3.1. is kept to provide the minimum required information. References to additional specification are not considered minimum requirements.<br><br>9.3.2 The introduction of an interoperability document is not considered. Therefore the proposed change to 9.3.2 is not accepted. Since it is correctly stated that there is no coordinated exemption policy, paragraph 9.3.2. is removed. |

resulting text

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9.3 Aircraft Flight Manual

9.3.1 The Aircraft Flight Manual (AFM) or the Pilot's Operating Handbook (POH), whichever is applicable, needs to provide at least a statement of compliance that the ADS-B System complies with this AMC20-24 and if deviations are applicable. Deviations, including those stated in this document[1], as appropriate may be included or referred to.

9.4 Existing installations

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[1] Refer to sections 8.3.3, 8.3.5 and 8.8.2.

**B. Draft Decision - I. AMC 20-24 - Operational Considerations** p. 19-21

comment

*13* comment by: *Boeing*

Section 10.3.2.2, Item (h), Handling of data source errors

We suggest either deleting Item (h), since it is not functionally relevant to currently fielded ADS-B systems; or incorporating it into Section 10.2.3.

Justification:
Handling of data source errors is an FMS and flight crew function that has nothing specifically to do with the ADS-B system, and in NRA training, i.e. if there is a known source error, the flight crew may deselect a bad sensor or preferentially use another sensor in the Navigation function. However, this function is outside the ADS-B transmit function and will not generally affect the ADS-B source selection.

response

*Partially accepted*

Depending on the system design the misleading navigation information could be transmitted by the ADS-B system, and in that case specific flight crew might apply. A reference to 10.2.3. is added to (h) as this is one but not the only possible action required.

comment

*28* comment by: *DGAC France*

The Flight Deck Control Capabilities to disable the ADS-B function without disabling the operation of the ATC transponder function is currently only optional. It is therefore very important to inform the operator that disabling the operation of the ADS B function will also disable the ACAS function if there is not an independent selection. Following an ATC instruction requiring to disable the ADS B function the crew must be fully aware that ACAS function will be no more operative. It could have safety repercussion in particular in Non Airspace Radar area.

It is thus proposed to add a new subparagraph 10.2.4 as follows:

"10.2.4 When there is not an independent Flight Deck Control selection between the ADS-B function (ADS-B on/off) and the ATC transponder function, the crew must be fully aware that disabling the ADS B function will also lead to disable the ACAS function "

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| response | *Partially accepted*<br><br>A new sub-paragraph is introduced, however some text changes are introduced. |

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| comment | *62* comment by: *Roland Mallwitz*<br><br>para 10.1.3<br><br>comment: substitute "should"<br><br>proposal: A unique ICAO 24 bit aircraft address has been assigned ... |
| response | *Not accepted*<br><br>The operational considerations are provided as guidance and are as such not mandated within the context of this AMC. The wording "should" is therefore retained. |

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| comment | *69* comment by: *AIRBUS*<br><br>Paragraph 10.2.3<br><br>Replace ADS system by ADS-B system<br><br>Justification:<br>To ensure consistency within the whole document |
| response | *Accepted* |

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| comment | *77* comment by: *NAV CANADA*<br><br>10.2.2<br><br>DCPC is defined in the Canadian context as VHF voice so therefore will be required in all Canadian application equivalent to current radar application. Our documents will read "shall" or "must" verses "should". |
| response | *Accepted*<br><br>Since AMC is by definition one, but not the only way of showing compliance with requirements, the wording "should" is used. However if within the context of the AMC it is needed to comply with specific paragraph of the AMC this will be expressed. |

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| comment | *98* comment by: *Certification Office*<br><br>Paragraph 10.3.2 (b)<br><br>Please, confirm if the only ADS-B associated phraseology is the one mentioned in the ICAO PANS 4444. If there is any other standardized phraseology to be considered, please specify them. |
| response | *Noted*<br><br>Only PANS-ATM/Doc 4444 applies. |

resulting text

**10 OPERATIONAL CONSIDERATIONS**

10.1 General

10.1.1 The installation should be certified according to airworthiness considerations in section 8 prior to operational approval.

10.1.2 The assumptions in section 5, concerning Air Traffic and Communications Services Providers, and Aeronautical Information Services, should have been satisfied.

10.1.3 A unique ICAO 24 bit aircraft address should be assigned by the responsible authority to each airframe.

10.2 Operational Safety Aspects.

10.2.1 In all cases, flight crews should comply with the surveillance provisions, schedules and relevant procedures contained in the Aeronautical Information Publications (AIP) published by the appropriate authorities.

10.2.2 Direct controller-pilot VHF voice communications must be available at all times.

10.2.3 If flight crew receive equipment indications showing that position being broadcast by the ADS-B system is in error (e.g. GPS anomaly), they should inform the ATSP, as appropriate, using any published contingency procedures.

10.2.4 When there is not an independent Flight Deck Control selection between the ADS-B function (ADS-B on/off) and the ATC transponder function, the crew must be fully aware that disabling the ADS-B function will also lead to disable the ACAS function.

10.3 Operations Manual and Training.

10.3.1 Operations Manual.

10.3.1.1 The Operations Manual should include a system description, operational and contingency procedures and training elements for use of the ADS-B-NRA application.

10.3.1.2 The Operations Manual, preferably section B, should contain the operational aspects described in this guidance material.

10.3.1.3 Operators operating under the provisions of ICAO Annex 6 Part II "International General Aviation – Aeroplanes" are not required to have an operations manual.

However, in order to use ADS-B applications, the operator should develop similar training and operational procedures to the ones described in this guidance material. This material may need to be approved by the State of Registry of the operator in accordance with national practice and sight of this approval may be required by the ADS-B navigation service provider.

10.3.2 Flight Crew Training

10.3.2.1 Aircraft operators should ensure that flight crew are thoroughly familiar with all relevant aspects of ADS-B applications.

10.3.2.2 Flight crew training should address the:

a) General understanding of ADS-B-NRA operating procedures;

b) Specific ADS-B associated phraseology;

c) General understanding of the ADS-B technique and technology;

d) Characteristics and limitations of the flight deck human-machine interface, including an overview of ADS-B environment and system descriptions;

e) Need to use the ICAO defined format for entry of the Aircraft Identification or Aircraft Registration marking as applicable to the flight;

*Note 1: ICAO Document 8168-OPS/611 Volume I (Procedures for Air Navigation Services) requires that flight crew of aircraft equipped with Mode "S" having an aircraft identification feature should set the aircraft identification into the transponder. This setting is required to correspond to the aircraft identification that has been specified at Item 7 of the ICAO flight plan and consists of no more than seven characters. If the aircraft identification consists of less than seven characters, no zeros, dashes or spaces should be added. If no flight plan has been filed, the setting needs to be the same as the aircraft's registration, again, up to a maximum of seven characters.*

*Note 2: The shortened format commonly used by airlines (a format used by International Airlines Transport Association (IATA)) is not compatible with ICAO provisions for the flight planning and ATC services used by ATC ground systems.*

f) Operational procedures regarding the transmission of solely the generic emergency flag in cases when the flight crew actually selected a discrete emergency code (if implemented, refer to section 8.8) and SPI;

g) Indication of ADS-B transmit capability within the ICAO flight plan but only when the aircraft is certified according to this AMC;

h) Handling of data source errors (e.g. discrepancies between navigation data sources)(refer to 10.2.3);

i) Incident reporting procedures;

j) Crew Resources Management and associated human factors issues.

10.4 Incident reporting

Significant incidents associated with ATC surveillance information transmitted by the ADS-B data link that affects or could affect the safe operation of the aircraft will need to be reported in accordance with EU-OPS 1.420 (or national regulations, as applicable).

10.5 Minimum Equipment List

The MEL will need to be revised to indicate the possibility of despatch of aircraft with the ADS-B system unserviceable or partially unserviceable.

**B. Draft Decision - I. AMC 20-24 - Minimum Equipment List** p. 21

comment *14* comment by: *Boeing*

Section 11.1, Minimum Equipment List (MEL)

Please include reference to JAA Master Minimum Equipment List Procedures Manual in this proposed section.

Justification:
It is our understanding that the "applicable exemption criteria" will be as defined in the JAA Master Minimum Equipment List Procedures Manual, which is a reference manual used by Joint Operations Evaluation Boards to approve

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| | MEL content. |
| response | *Not accepted*<br><br>The section 11 of this AMC is addressing the operational aspects and therefore concerns the MEL. The JAA MMEL Procedure Manual is guidance to assist in the assessment process and not specific for certain system applications. It is therefore not added as a reference in this system specific AMC.<br>JOEB does not approve MEL but MMEL produced by the TC/STC holders. |

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| comment | *80* comment by: *UK CAA*<br><br>Paragraph 11<br><br>Paragraph 11 should refer to "Master Minimum Equipment List", as opposed to "Minimum Equipment List". It should be noted that a revision to the MMEL will only be required if dispatch with ADS-B inoperative / partially inoperative is to be permitted (under conditions to be specified in the MMEL). If flight is not permitted with the system inoperative / partially inoperative, it should not be listed in the MMEL.<br><br>Justification:<br>Incorrect statement. |
| response | *Partially accepted*<br><br>Also referring to comment 14 it is clear that section 11 is confusing in respect of the operational or airworthiness aspects. Since operational considerations are addressed, it will be re-numbered to 10.5.<br><br>It is the Agency position that provisions should be in the AMC to allow the despatch of aircraft with ADS-B system unserviceable. However, it is accepted that the paragraph in the AMC may be confusing that is why the paragraph has been revised. |

resulting text

*Paragraph 11 has been renumbered to 10.5. Therefore paragraph 12 and 13 are renumbered.*

**11 MAINTENANCE**

11.1 Maintenance tests should include a periodic verification check of aircraft derived data including the ICAO 24 bit aircraft address using suitable ramp test equipment. The check of the 24 bit aircraft address should be made also in the event of a change of state of registration of the aircraft.

11.2 Maintenance tests should check the correct functioning of system fault detectors (if any).

11.3 Maintenance tests at ADS-B transmit system level for encoding altitude sensors with Gillham's code output should be based on the transition points defined in EUROCAE ED-26, Table 13.

11.4 Periodicity for the check of the ADS-B transmitter should be established.

**12 AVAILABILITY OF DOCUMENTS**

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**Appendix 1.2: Abbreviations** p. 23

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| comment | *81* comment by: *UK CAA*<br>Appendix 1.2<br>Appendix 1.2, Abbreviations – Change MEL to MMEL, Master Minimum Equipment List.<br>Justification:<br>Incorrect statement. |
| response | *Not accepted*<br>See response to comment 14. |

**Appendix 2.2: Summary of core ADS-B-NRA Ground Domain Assumptions** p. 24

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| comment | *48* comment by: *DGAC/DTI/CNS*<br>Delete last bullet.<br>Justification:<br>At first, this assumption is not part of ED-126/DO-303. In addition, it has demonstrated that RAIM outage prediction tools do not provide usable information for the controllers due to the different RAIM avionics capabilities. |
| response | *Accepted*<br>Changed in accordance with the final version of ED-126. |

resulting text

**Appendix 2.2: Summary of core ADS-B-NRA Ground Domain Assumptions**

- Controller operating procedures are assumed to be unaffected by the selection of an ADS-B data link, i.e., the ADS-B data link is assumed to be transparent to the controller.
- Air Traffic Controllers are assumed to follow existing procedures for coordination and transfer of aircraft. This applies to coordinating appropriate information with downstream units and complying with local agreements established between ATC units regarding separation standards to be established prior to entry into a bordering ATC unit.
- Appropriate ATS authorities are assumed to provide controllers with adequate contingency procedures in the event of ADS-B failures or degradation.
- It is assumed that there is a monitoring capability in the ADS-B Receive Subsystem that monitors the health and operation of the equipment and sends alerts and status messages to the Air Traffic Processing Subsystem.

**Appendix 3: Summary of ADS-B-NRA Airborne Safety and Performance Requirements** p. 25-26

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|---|---|
| comment | *15* comment by: ***Boeing*** |
| | Appendix 3, Table 2, Minimum Horizontal Position Source Requirements -- [Issue: Deletion of TMA requirements]<br><br>Clarify that only the 5 nm separation standard used in Table 2 is supported by the AMC in Section 3, Scope.<br><br>Clarify that Table 2 is intended to support both En-Route and TMA services for ADS-B-NRA operations.<br><br>Justification:<br>Table 2 summarizes the NRA En-Route requirements. The title of Appendix 3 – "Summary of ADS-B-NRA Airborne Safety and Performance Requirements " – is misleading, as half the material relating to TMA requirements and 3 nm separations has been deleted. The text needs to clarify that ONLY the 5 nm separation standard in the NRA is supported in the proposed NPA document. We recommend that this be inserted at the front of the document as well, i.e., the reader should not have to get to Appendix 3 before discovering that the document does not support a 3 nm separation standard for TMA operations. |
| response | *Partially accepted*<br><br>A clarification of the scope of this AMC to 5NM separation standard only is added to paragraph 3.1. |

| | |
|---|---|
| comment | *16* comment by: ***Boeing*** |
| | Appendix 3, Table 2, Minimum Horizontal Position Source Requirements -- Row referring to accuracy probability<br><br>We recommend adding "95%" to the horizontal position source accuracy requirement.<br><br>Justification:<br>This is the accepted industry probability requirement for horizontal position accuracy. |
| response | *Accepted*<br><br>"(95%)" is added after Accuracy. |

| | |
|---|---|
| comment | *17* comment by: ***Boeing*** |
| | Appendix 3, Table 2, Minimum Horizontal Position Source Requirements<br><br>We suggest replacing the proposed two rows for "Source Failure Probability" and "Alert Failure Probability" with a single row titled "Containment Probability Risk," showing the requirement specified at 10-5 / flight hour, consistent with both the NRA SPR and the certified hazard level for GPS source equipment intended for Major hazard level operations. |

| | |
|---|---|
| | Justification:<br>The position containment radius probability level is expressed in terms of $10^{-7}$/flight hour; whereas, the NRA safety and performance requirements (SPR) only require a $10^{-5}$/flight hour limit. The NPA should match the SPR. |
| response | *Not accepted*<br><br>There is a $10^{-7}$ position measurement integrity failure (combination of source = satellite failure and RAIM failure) and $10^{-5}$ ADS-B system integrity.<br><br>Both are expressed as separate requirements within the ED-126 safety assessment (and hence need to be stated to drive the NPA positioning source requirements).<br><br>ED-126 also expresses a "compound requirement" as stated by Boeing. However, this reflects a convention in that the SIL parameter expresses both position source and system integrity. As the latter determines the smaller value of both, it drives the SIL encoding (SIL=2) (and hence the "compound requirement" wording). |

| | |
|---|---|
| comment | *18* comment by: *Boeing*<br><br>Appendix 3, Table 2, Minimum Horizontal Position Source Requirements -- First ***Note*** following the table.<br><br>We suggest deleting the first ***Note***.<br><br>Justification:<br>There is no inherent reason that existing DO-260-based equipment should have a requirement on containment radius that is twice as stringent as newer systems. The NUC encoding requirements with which existing equipment complies provide sufficient granularity of the containment radius. |
| response | *Not accepted*<br><br>NUC also expresses an accuracy quality (i.e. NAC=5). By virtue of the NUC-NIC/NAC mapping table, the NAC drives the row to be chosen for NUC (i.e. NUC=4, i.e. 1NM). |

| | |
|---|---|
| comment | *19* comment by: *Boeing*<br><br>Appendix 3, Table 2, Minimum Horizontal Position Source Requirements -- Second and third paragraph after the fourth ***Note*** following the table<br><br>We suggest deleting the second and third paragraphs under the fourth note (which relate to uncompensated latency), and making it clear in the document that this effect is to be mitigated on the ground for initial applications, if necessary.<br><br>Justification:<br>The second paragraph is problematic. Currently fielded equipment does not account for uncompensated latency prior to transmission, but only encodes the accuracy and containment radius of positioning source equipment. It is recommended that the position quality indicators be limited on the ground receive side if currently fielded equipment is to be used. |
| response | *Not accepted* |

The note provides background on the relationship between position accuracy (effectively expressed at time of measurement and latency up to the time of transmission). Hence, the requirement of correct Quality Indicator encoding at the time of transmission is not intended to be addressed here.

comment

*20* comment by: *Boeing*

Appendix 3, Table 3, Other Minimum ADS-B Surveillance Data Requirements

We recommend making it clear that ground mitigation is required for initial applications that only contain the emergency indicator flag.

Justification:
The current ES parameter list in DO-181C does not include the Emergency Status register (6.1), only an emergency indicator flag in register 05. Although there is a waiver in Sect. 8.8.2 for DO-260 systems for this requirement, there should be language in Table 3 to clarify this.

response

*Not accepted*

The purpose of the Appendix is to summarise the target ED-126 requirements as the key AMC reference. Also refer to paragraph 8.1.

The actual certification material resides in the Main Body of the document and therefore is the correct place to deal with permissible deviations from the target requirements.

comment

*21* comment by: *Boeing*

Appendix 3, Table 3, Other Minimum ADS-B Surveillance Data Requirements -- Row related to Aircraft Identification, SPI, Emergency Status

We recommend adding a note indicating that Emergency Status is optional for existing equipment.

Justification:
The current ES parameter list in DO-181C does not include the Emergency Status register (6.1), only an emergency indicator flag in register 05. Although there is a waiver in Sect. 8.8.2 for DO-260 systems for this requirement, we suggest there still should be a note with Table 3.

response

*Not accepted*

The purpose of the Appendix is to summarise the target ED-126 requirements as the key AMC reference. Also refer to paragraph 8.1.

The actual certification material resides in the Main Body of the document and therefore is the correct place to deal with permissible deviations from the target requirements.

comment

*22* comment by: *Boeing*

Appendix 3, Table 4, Failure condition categories

Please note that RAD SPR considers data corruption of barometric altitude and aircraft identification to be a Major level hazard.

response | *Noted*

The reference to AMC20-18 is incorrect and is replaced by AMC20-13. The on-going work on ADS-B-RAD is expected to lead, by comparison to radar, to the same requirements as for Mode A/C/S (and ADS-B-NRA), i.e. "minor".

comment | *49* comment by: *DGAC/DTI/CNS*

Change

"An uncompensated latency of 1.5 seconds translates into a dilution of accuracy and latency in the order to 450 meters (assuming an aircraft speed of 600 knots in en-route airspace). This value of 450 meters has to be added to the actual accuracy performance of the horizontal position source(s), the sum of which has to be within the required bounds"

to

"An uncompensated latency of 1.5 seconds translates into a dilution in the order to 450 meters (assuming an aircraft speed of 600 knots in en-route airspace). This value of 450 meters has to be added to the actual performance of the horizontal position source(s), the sum of which has to be within the required bounds".

Justification:
Accuracy is not the only performance criteria to be impacted by the uncompensated latency.

response | *Accepted*

comment | *51* comment by: *AEA*

Appendix 3 refers to Horizontal Position Source, relative to the expected separation standard of 5NM. The ADS-B function based on satellite navigation potentially provides a much higher accuracy.

Certifying a system in accordance with this requirement will result in the dilemma outlined above, for any new function with tighter accuracy requirements the avionics system will have to be recertified.

response | *Noted*

This AMC addresses the ADS-B-NRA function (essentially in support of an initial ADS-B out deployment).

At the same time, the AMC drives a requirement for a GNSS-based position source that will indeed satisfy e.g. tighter accuracy requirements. Hence, for the other ADS-B applications currently being standardised, no re-certification is expected to be required in that regard.

comment | *52* comment by: *AEA*

Table 2 refers to uncompensated latency and the possible dilution effect on accuracy. It would be better to:

specify the max latency of the overall system in case of uncompensated

latency (e.g. in the ground system, to correct for latency using the time-stamp of the transmitted hor. postion data.
Latency is a characteristic of any surveillance system, processing of traditional radar data also takes time and causes latency. One of the advantage of using ADS-Bcould actually be the reduction of latency with respect to present radar (just think of the time it takes to make one radar-sweep).

response

*Not accepted*

This table provides a summary of ED-126, and such will not be altered.

ED-126 chose to express a 95% (and not a maximum) requirement.

1090 ES does not include a timestamp. Hence, the ground has no knowledge of the actual time-of-measurement of the ADS-B information.

comment

*63* comment by: *Roland Mallwitz*

Table 1

reflect comment 59 on para 8.2.3 (max value to cut distribution tails)

response

*Noted*

Specifying the 1.5 s as a 95% is consistent with navigation standards.

The ED-126 specification of a 95% implies that outliers are rather rare and not correlated (hence significant singular outliers are easily detected/filtered out on the ground).

comment

*70* comment by: *AIRBUS*

Appendix 3 Table 1 - "ADS-B System Integrity Requirement"

Replace "ADS-B system Integrity" by "Horizontal Position and Horizontal Position Quality Indicator(s)" in Appendix 3 Table 1 (in the column "parameter")

Justification:
The ADS-B System integrity requirement set up in Appendix 3 Table 1 is not relevant as inconsistent with ED-126/DO-303 and its interpretation developed through Section 8.2.1 & Appendix 3 Table 4.

The integrity levels to be demonstrated at airborne level for the certification of an ADS-B Out installation supporting 5NMx5NM Non Radar Airspace Air Traffic Service are:

1.E-05/FH for the horizontal position parameter and the horizontal position quality indicators parameter as set in Section 8.2.1 of proposed Draft AMC 20-24;

The classification of the Failure Conditions dealing with the erroneous transmission of the Barometric Altitude parameter and of the Aircraft Identification parameter is MINOR as for the Mode S Elementary Surveillance (cf. TGL 13 Rev.1, Annex 1, Table 2).

| | |
|---|---|
| response | *Accepted* |

| | |
|---|---|
| comment | *73* comment by: *AIRBUS*<br><br>Table 3 & Table 4 in Appendix 3.<br><br>Remove the reference to EASA AMC 20-18 "Certification of Mode S Transponder Systems for Elementary Surveillance", as AMC 20-18 is not yet published. Keep only reference to JAA TGL13, Rev.1.<br><br>Justification:<br>AMC 20-18 is not yet developed by EASA although initially part of rulemaking task 20.006, "Miscellaneous Improvements to AMC 20" (planned 1q 2006).<br><br>Applicable Guidance Material for the certification of airborne Mode S Elementary Surveillance installation remains JAA TGL 13, Revision 1. |
| response | *Partially accepted*<br><br>AMC20-18 will be replaced by AMC 20-13. |

resulting text

**Appendix 3: Summary of ADS-B-NRA Airborne Safety and Performance Requirements**

| Parameter | Requirement |
|---|---|
| Horizontal Position and Horizontal Position Quality Indicator(s) | $10^{-5}$/fh |
| ADS-B System Continuity | $2*10^{-4}$/fh |
| Horizontal Position Latency[1] | 1.5 sec/95% |

**Table 1:** Overall Minimum Airborne ADS-B System[2] Requirements

| Parameter | Requirement |
|---|---|
| Horizontal Position Source | |
| ☐ Accuracy (95%) | ☐ 5 NM Sep: 926 m |
| ☐ Integrity | |
| ☐ Containment Radius (Rc) | ☐ 5 NM Sep: Rc=2 NM |
| ☐ Source Failure Probability | 10-4/h[3] |
| ☐ Alert Failure Probability | $10^{-3}$ (per position source failure event) |
| ☐ Time to Alert | ☐ 5 NM Sep: 10 sec |

**Table 2:** Minimum Horizontal Position Source Requirements

***Note:*** *for DO-260 based ADS-B transmit systems, the related encoding of the horizontal position quality indicator through the Navigation Uncertainty Category (NUC) effectively leads to a containment radius requirement of 1NM for a 5 NM separation service.*

***Note:*** *accuracy and integrity containment radius requirements are expressed here as guidance to related horizontal position source regulation (refer to section 8.4).*

***Note:*** *the containment bound requirements reflect the outcomes of both the collision risk assessment (CAP) and time-to-alert assessment.*

***Note:*** *the accuracy and integrity containment radius requirements have to be met*

*by the horizontal position source, taking into account the effects of on-board latency (if not compensated for).*

*An uncompensated latency of 1.5 seconds translates into a dilution in the order to 450 meters (assuming an aircraft speed of 600 knots in en-route airspace). This value of 450 meters has to be added to the actual performance of the horizontal position source(s), the sum of which has to be within the required bounds.*

*The GNSS equipment specified in 8.4.6 meets the overall accuracy and integrity requirements, including the effects of an uncompensated latency of maximum 1.5 second accumulated up to the time of transmission.*

[1] Uncompensated delay measured from to the time of validity of position measurement until ADS-B transmission (i.e. at RF level).

[2] As defined in section 6.

[3] For GNSS based functions, expressed as an assumption of GNSS performance.

| **Parameter** | **Requirement** |
|---|---|
| Barometric Altitude | ☐ Accuracy: as per the installed sensors (refer to section 8.5.2)<br><br>☐ Maximum Latency: 1 sec (as for SSR) |
| Aircraft Identification, SPI, Emergency Status | As for SSR [AMC20-13]. |

**Table 3:** Other Minimum ADS-B Surveillance Data Requirements

| **Parameter** | **Loss** | **Corruption** | **Note** |
|---|---|---|---|
| Barometric Altitude | Minor | Minor | As for SSR [AMC20-13]. |
| Aircraft Identification | Minor | Minor | As for SSR.[AMC20-13] |

**Table 4:** Failure Condition Categories

**Appendix 4.1: Summary of ADS-B-NRA Air-to-ground Interoperability Requirements** p. 27-28

comment *23* comment by: *Boeing*

Appendix 4.1, Table 5, Mandatory ADS-B-NRA Parameters -- Rows concerning Geometric Altitude and Emergency Status

We recommend adding a note indicating that Geometric Altitude and Emergency Status are optional for existing equipment.

Justification:
The current ES parameter list in DO-181C does not include the geometric altitude (it includes only the barometric altitude) or the Emergency Status register (6.1). Although there is a waiver in Sect. 8.8.2 for DO-260 systems for this requirement, we suggest there still should be a note with Table 5.

response

*Partially Accepted*

The purpose of the Appendix is to summarise the target ED-126 requirements as the key AMC reference, which is clearly stated in para 8.1.

The actual certification material resides in the Main Body of the document and therefore is the correct place to deal with permissible deviations from the target requirements.

Remark:
In order to fully stay in line with the target ED-126 terminology, "Geometric Altitude" is removed from the table 5.

resulting text

**Appendix 4.1: Summary of ADS-B-NRA Air-to-ground Interoperability Requirements**

The minimum set of parameters that **should** be provided to support the ADS-B-NRA application are summarised in the following table extracted from ED-126:[1]

| Parameter | | BDS register | Version 0 | | Version 1 |
|---|---|---|---|---|---|
| | | | ICAO Annex 10 Amendment 79, VOL III, App to chap 5 | DO-260/ED-102 | DO-260A |
| Aircraft identification | | 0.8 | §2.3.4 | §2.2.3.2.5 | §2.2.3.2.5 |
| SPI[2] | | 0.5 | §2.3.2.6 | §2.2.3.2.3.2 | §2.2.3.2.3.2 |
| Emergency indicator | | 0.5 | §2.3.2.6 | §2.2.3.2.3.2 | §2.2.3.2.3.2 |
| Barometric altitude | | 0.5 | §2.3.2.4 | §2.2.3.2.3.4 | §2.2.3.2.3.4 |
| Quality indicator (NUC/NIC) | | 0.5 | §2.3.1 | §2.2.3.2.3.1 | §2.2.3.2.3.1 |
| Airborne Position | Latitude | 0.5 | §2.3.2.3 | §2.2.3.2.3.7 | §2.2.3.2.3.7 |
| | Longitude | 0.5 | §2.3.2.3 | §2.2.3.2.3.8 | §2.2.3.2.3.8 |
| Emergency status[3] [4] | | 6.1 | Table 2-97 | §2.2.3.2.7.9 | §2.2.3.2.7.8 |
| Quality indicator (NACp) | | 6.5 | No definition | No definition | §2.2.3.2.7.2.7 |
| Quality indicator (SIL) | | 6.5 | No definition | No definition | §2.2.3.2.3.1.1 |
| Version Indicator[5] | | 6.5 | No definition | No definition | §A.1.4.10.5 |

**Table 5:** Mandatory ADS-B-NRA Parameters

comment

*64* comment by: *Roland Mallwitz*

Table 5, Table 6

The appendix to chapter 5 Annex 10 Vol III is no longer available . Reference can be made to ICAO Doc 9871, as the material has been moved to this doc and updated to cover both versions.

response *Noted*

Doc 9871 has not been published; therefore the currently used reference in ED-126 is kept.

comment *99* comment by: *Certification Office*

Appendix 4.1, Table 6

The paragraph preceding the table is not adequate, as the table is just for optional parameters.

response *Not accepted*

"Should" is used in order to express that this table provides optional parameters.

**Appendix 4.2: Guidance on Encoding of Positional Quality Indicators** p. 29-30

comment *24* comment by: *Boeing*

Appendix 4.2, Guidance on Encoding of Positional Quality Indicators -- Paragraph following the 4th bullet item

We suggest changing the *"SIL=3"* requirement to *"SIL>=2."* The SIL encoding for source positioning equipment reflects the certified hazard level of the equipment, and must be Major level with appropriate failure probability to qualify for ADS-B use.

Justification:
The SIL value should be interpreted as the certified integrity of the source positioning equipment. Few, if any, GNSS sources are currently certified to Severe Major as installed in air transport aircraft, which is indicated by a SIL=3 value. Typically, source data such as TSO-C129a GPS units are certified to SIL=2 levels (Major hazard failure category). As Note 2 in the text indicates, the safety analysis for the NRA document indicated that a Major hazard level was appropriate for GPS source positioning equipment and, thus, SIL=2 is the minimum requirement for NRA operations.

response *Accepted*

Changed consistently with ED-126 to read SIL ≥2.

comment *71* comment by: *AIRBUS*

Appendix 4.2 – Second paragraph "Minimum acceptable NUC and NIC/NACp values […] conversion table below"

Replace reference to "Table 2 in Appendix 4" by reference to "Table 2 in Appendix 3".

| | |
|---|---|
| | Justification:<br>There is no Table 2 in Appendix 4. |
| response | *Accepted* |

| | |
|---|---|
| comment | *100* comment by: *Certification Office*<br>Paragraph 4<br>The paragraph makes reference to Table 2 of Appendix 4, but it does not exist. |
| response | *Accepted* |

resulting text

**Appendix 4.2: Guidance on Encoding of Positional Quality Indicators**

In order to be able to check the compliance of the actually transmitted ADS-B data with the required quality on the recipient side, ADS-B message transmissions contain "Quality Indicators". These are expressed for ED-102/DO-260 and DO-260A compliant ADS-B transmit systems as follows:

☐ ED-102/DO-260: Navigation Uncertainty Category (NUC), a combined expression of (accuracy and) integrity requirements through a single parameter;

☐ DO-260A: Navigation Accuracy Category (NACp) to express the position accuracy (as a 95 percentile), Navigation Integrity Category (NIC) to express the integrity containment radius and Surveillance Integrity Level (SIL) to specify the probability of the true position lying outside that containment radius without alerting.

Minimum acceptable NUC and NIC/NACp values in support of 5 NM ADS-B-NRA separation services, based on the requirements summarised in Table 2 of Appendix 4, are as follows in line with the "NIC/NACp to NUC" conversion table below.

NUC values (encoding based on HPL, with the accuracy requirements met by GNSS systems by design and in line with the related NACp values in below conversion table):

☐ 5 NM separation: NUC = 4;

The corresponding NIC/NACp values are as follows:

☐ 5 NM separation: NIC = 4, NACp = 5,

The SIL value is established to SIL>=2 in line with the combination of the position source failure and position integrity alert failure requirements, as summarised in Table 2 of Appendix 4.

*Note 1: In case the SIL value is not output by the position data sources, it is recommended that the ADS-B transmit system provides for the static setting of SIL as part of the installation procedure and as demonstrated for the applicable position data source configuration.*

*Note 2: ED-126 provides, based on its reference collision risk analysis only, arguments for an equally appropriate encoding of a SIL=2 as a matter of expressing the system integrity as well. As for the presentation of the values presented in this document, it is at the discretion of the ATSP to decide upon the appropriate threshold values required in support of the separation services in its airspace.*