



International  
Civil Aviation  
Organization

Organisation  
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de Aviación Civil  
Internacional

Международная  
организация  
гражданской  
авиации

منظمة الطيران  
المدني الدولي

国际民用  
航空组织

Tel.: +1 514-954-8219 ext. 6710

Ref.: AN 7/66.2.1-18/29

27 March 2018

**Subject:** Adoption of Amendment 90 to Annex 10,  
Volume IV

**Action required:** a) Notify any disapproval before  
16 July 2018; b) Notify any differences and compliance  
before 8 October 2018; c) Consider the use of the  
Electronic Filing of Differences (EFOD) System for  
notification of differences and compliance

Sir/Madam,

1. I have the honour to inform you that Amendment 90 to the *International Standards and Recommended Practices, Aeronautical Telecommunications — Surveillance and Collision Avoidance Systems* (Annex 10, Volume IV to the Convention on International Civil Aviation) was adopted by the Council at the fifth meeting of its 213th Session on 7 March 2018. Copies of the Amendment and the Resolution of Adoption are available as attachments to the electronic version of this State letter on the ICAO-NET (<http://portal.icao.int>) where you can access all other relevant documentation.

2. When adopting the amendment, the Council prescribed 16 July 2018 as the date on which it will become effective, except for any part concerning which a majority of Contracting States have registered their disapproval before that date. In addition, the Council resolved that Amendment 90, to the extent it becomes effective, will become applicable on 8 November 2018.

3. Amendment 90 arises from:

- a. recommendations developed by the first meeting of the Surveillance Panel (SP/1) regarding surveillance and airborne collision avoidance systems (ACAS); and
- b. recommendations developed by the second meeting of the Surveillance Panel (SP/2) regarding secondary surveillance radar (SSR) and wide area multilateration (WAM).

4. The amendment concerning surveillance and airborne collision avoidance systems (ACAS) includes a number of provisions based on operational experience related to SSR, extended

squitter and ACAS as well as provisions for emerging technologies such as extended hybrid surveillance functionality for ACAS.

5. The amendments concerning secondary surveillance radar (SSR) and wide area multilateration (WAM) provide clarification on WAM and a technical provision on the utilization of the X pulse under specific circumstances. The provision relating to X pulse is aimed at ensuring interoperability of civil and military SSR systems in order to avoid safety impacts on aeronautical surveillance system operation.

6. The subjects are given in the amendment to the Foreword of Annex 10, a copy of which is in Attachment A.

7. In conformity with the Resolution of Adoption, may I request:

- a) that before 16 July 2018 you inform me if there is any part of the adopted Standards and Recommended Practices (SARPs) amendments in Amendment 90 concerning which your Government wishes to register disapproval, using the form in Attachment B for this purpose. Please note that only statements of disapproval need be registered and if you do not reply it will be assumed that you do not disapprove of the amendment;
- b) that before 8 October 2018 you inform me of the following, using the Electronic Filing of Differences (EFOD) System or the form in Attachment C for this purpose:
  - 1) any differences that will exist on 8 November 2018 between the national regulations or practices of your Government and the provisions of the whole of Annex 10, Volume IV, as amended by all amendments up to and including Amendment 90, and thereafter of any further differences that may arise; and
  - 2) the date or dates by which your Government will have complied with the provisions of the whole of Annex 10, Volume IV as amended by all amendments up to and including Amendment 90.

8. With reference to the request in paragraph 7 a) above, it should be noted that a registration of disapproval of Amendment 90 or any part of it in accordance with Article 90 of the Convention does not constitute a notification of differences under Article 38 of the Convention. To comply with the latter provision, a separate statement is necessary if any differences do exist, as requested in paragraph 7 b) 1). It is recalled in this respect that international Standards in Annexes have a conditional binding force, to the extent that the State or States concerned have not notified any difference thereto under Article 38 of the Convention.

9. With reference to the request in paragraph 7 b) above, it should be also noted that the ICAO Assembly, at its 38th Session (24 September to 4 October 2013), resolved that Member States should be encouraged to use the EFOD System when notifying differences (Resolution A38-11 refers). The EFOD System is currently available on the Universal Safety Oversight Audit Programme (USOAP) restricted website (<http://www.icao.int/usoap>) which is accessible by all Member States. You are invited to consider using this for notification of compliance and differences.

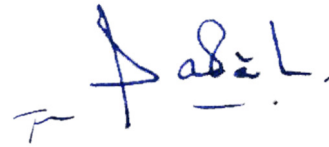
10. Guidance on the determination and reporting of differences is given in the Note on the Notification of Differences in Attachment D. Please note that a detailed repetition of previously notified differences, if they continue to apply, may be avoided by stating the current validity of such differences.

11. I would appreciate it if you would also send a copy of your notifications, referred to in paragraph 7 b) above, to the ICAO Regional Office accredited to your Government.

12. At the fifth meeting of its 204th Session, the Council requested that States, when being advised of the adoption of an Annex amendment, be provided with information on implementation and available guidance material, as well as an impact assessment. This is presented for your information in Attachments E and F, respectively.

13. As soon as practicable after the amendment becomes effective, on 16 July 2018, replacement pages incorporating Amendment 90 will be forwarded to you.

Accept, Sir/Madam, the assurances of my highest consideration.

A handwritten signature in blue ink, appearing to read 'Fang Liu', with a horizontal line underneath.

Fang Liu  
Secretary General

**Enclosures:**

- A — Amendment to the Foreword of Annex 10, Volume IV
- B — Form on notification of disapproval of all or part of Amendment 90 to Annex 10, Volume IV
- C — Form on notification of compliance with or differences from Annex 10, Volume IV
- D — Note on the Notification of Differences
- E — Implementation task list and outline of guidance material in relation to Amendment 90 to Annex 10, Volume IV
- F — Impact assessment in relation to Amendment 90 to Annex 10, Volume IV



ATTACHMENT A to State letter AN 7/66.2.1-18/29

AMENDMENT TO THE FOREWORD OF ANNEX 10, VOLUME IV

Add the following elements at the end of Table A:

<i>Amendment</i>	<i>Source(s)</i>	<i>Subject</i>	<i>Adopted/Approved Effective Applicable</i>
90	First and second meetings of the Surveillance Panel (SP/1 and SP/2)	a) airborne collision avoidance system (ACAS); and b) secondary surveillance radar (SSR) and wide area multilateration (WAM).	7 March 2018 16 July 2018 8 November 2018

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**NOTIFICATION OF DISAPPROVAL OF ALL OR PART OF  
AMENDMENT 90 TO ANNEX 10, VOLUME IV**

To: The Secretary General  
International Civil Aviation Organization  
999 Robert-Bourassa Boulevard  
Montréal, Quebec  
Canada H3C 5H7

(State) \_\_\_\_\_ hereby wishes to disapprove the following parts  
of Amendment 90 to Annex 10, Volume IV:

Signature \_\_\_\_\_

Date \_\_\_\_\_

*NOTES*

- 1) If you wish to disapprove all or part of Amendment 90 to Annex 10, Volume IV please dispatch this notification of disapproval to reach ICAO Headquarters by 16 July 2018. If it has not been received by that date it will be assumed that you do not disapprove of the amendment. **If you approve of all parts of Amendment 90, it is not necessary to return this notification of disapproval.**
- 2) This notification should not be considered a notification of compliance with or differences from Annex 10, Volume IV. Separate notifications on this are necessary. (See Attachment C.)
- 3) Please use extra sheets as required.

\_\_\_\_\_





ATTACHMENT C to State letter AN 7/66.2.1-18/29

**NOTIFICATION OF COMPLIANCE WITH OR DIFFERENCES FROM  
ANNEX 10, VOLUME IV  
(Including all amendments up to and including Amendment 90)**

To: The Secretary General  
International Civil Aviation Organization  
999 Robert-Bourassa Boulevard  
Montréal, Quebec  
Canada H3C 5H7

1. No differences will exist on \_\_\_\_\_ between the national regulations and/or practices of **(State)** \_\_\_\_\_ and the provisions of Annex 10, Volume IV, including all amendments up to and including Amendment 90.

2. The following differences will exist on \_\_\_\_\_ between the regulations and/or practices of **(State)** \_\_\_\_\_ and the provisions of Annex 10, Volume IV, including Amendment 90 (Please see Note 2) below.)

<b>a) Annex Provision</b> (Please give exact paragraph reference)	<b>b) Details of Difference</b> (Please describe the difference clearly and concisely)	<b>c) Remarks</b> (Please indicate reasons for the difference)
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(Please use extra sheets as required.)

3. By the dates indicated below, **(State)** \_\_\_\_\_ will have complied with the provisions of Annex 10, Volume IV, including all amendments up to and including Amendment 90 for which differences have been notified in 2 above.

<b>a) Annex Provision</b> (Please give exact paragraph reference)	<b>b) Date</b>	<b>c) Comments</b>
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(Please use extra sheets as required.)

Signature \_\_\_\_\_ Date \_\_\_\_\_

*NOTES*

- 1) If paragraph 1 above is applicable to your State, please complete paragraph 1 and return this form to ICAO Headquarters. If paragraph 2 is applicable to you, please complete paragraphs 2 and 3 and return the form to ICAO Headquarters.
- 2) A detailed repetition of previously notified differences, if they continue to apply, may be avoided by stating the current validity of such differences.
- 3) Guidance on the notification of differences is provided in the Note on the Notification of Differences and in the *Manual on Notification and Publication of Differences* (Doc 10055).
- 4) Please send a copy of this notification to the ICAO Regional Office accredited to your Government.

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**NOTE ON THE NOTIFICATION OF DIFFERENCES**  
*(Prepared and issued in accordance with instructions of the Council)*

1. *Introduction*

1.1 Article 38 of the Convention on International Civil Aviation (“Convention”) requires that a Contracting State notify ICAO any time it does not comply with a Standard in all respects, it does not bring its regulations or practices into full accord with any Standard, or it adopts regulations or practices differing in any particular respect from the Standard.

1.2 The Assembly and the Council, when reviewing the notification of differences by Contracting States in compliance with Article 38 of the Convention, have repeatedly noted that the timeliness and currency of such notifications is not entirely satisfactory. Therefore, this note is issued to reiterate the primary purpose of Article 38 of the Convention and to facilitate the determination and notification of differences.

1.3 The primary purpose of the notification of differences is to promote safety, regularity and efficiency in air navigation by ensuring that governmental and other agencies, including operators and service providers, concerned with international civil aviation are made aware of all national regulations and practices in so far as they differ from those prescribed in the Standards contained in Annexes to the Convention.

1.4 Contracting States are, therefore, requested to give particular attention to the notification of differences with respect to Standards in all Annexes, as described in paragraph 4 b) 1) of the Resolution of Adoption.

1.5 Although differences from Recommended Practices are not notifiable under Article 38 of the Convention, the Assembly has urged Contracting States to extend the above considerations to Recommended Practices contained in Annexes to the Convention, as well.

2. *Notification of differences from Standards and Recommended Practices (SARPs)*

2.1 Guidance to Contracting States in the notification of differences to Standards and Recommended Practices (SARPs) can only be given in very general terms. Contracting States are further reminded that compliance with SARPs generally extends beyond the issuance of national regulations and requires establishment of practical arrangements for implementation, such as the provision of facilities, personnel and equipment and effective enforcement mechanisms. Contracting States should take those elements into account when determining their compliance and differences. The following categories of differences are provided as a guide in determining whether a notifiable difference exists:

- a) ***A Contracting State’s requirement is more exacting or exceeds a SARP (Category A).*** This category applies when the national regulation and practices are more demanding than the corresponding SARP, or impose an obligation within the scope of the Annex which is not covered by the SARP. This is of particular importance where a Contracting State requires a higher standard which affects the operation of aircraft of other Contracting States in and above its territory;

- b) *A Contracting State's requirement is different in character or the Contracting State has established other means of compliance (Category B)\**. This category applies, in particular, when the national regulation and practices are different in character from the corresponding SARP, or when the national regulation and practices differ in principle, type or system from the corresponding SARP, without necessarily imposing an additional obligation; and
- c) *A Contracting State's requirement is less protective, partially implemented or not implemented (Category C)*. This category applies when the national regulation and practices are less protective than the corresponding SARP; when no national regulation has been promulgated to address the corresponding SARP, in whole or in part; or when the Contracting State has not brought its practices into full accord with the corresponding SARP.

These categories do not apply to Not Applicable SARP. Please see the paragraph below.

2.2 **Not Applicable SARP.** When a Contracting State deems a SARP concerning aircraft, operations, equipment, personnel, or air navigation facilities or services to be not applicable to the existing aviation activities of the State, notification of a difference is not required. For example, a Contracting State that is not a State of Design or Manufacture and that does not have any national regulations on the subject, would not be required to notify differences from Annex 8 provisions related to the design and construction of an aircraft.

2.3 **Differences from appendices, tables and figures.** The material comprising a SARP includes not only the SARP itself, but also the appendices, tables and figures associated with the SARP. Therefore, differences from appendices, tables and figures are notifiable under Article 38. In order to file a difference against an appendix, table or figure, States should file a difference against the SARP that makes reference to the appendix, table or figure.

2.4 **Differences from definitions.** Contracting States should notify differences from definitions. The definition of a term used in a SARP does not have independent status but is an essential part of each SARP in which the term is used. Therefore, a difference from the definition of the term may result in there being a difference from any SARP in which the term is used. To this end, Contracting States should take into consideration differences from definitions when determining compliance or differences to SARPs in which the terms are used.

2.5 The notification of differences should be not only to the latest amendment but to the whole Annex, including the amendment. In other words, Contracting States that have already notified differences are requested to provide regular updates of the differences previously notified until the difference no longer exists.

2.6 Further guidance on the identification and notification of differences, examples of well-defined differences and examples of model processes and procedures for management of the notification of differences can be found in the *Manual on Notification and Publication of Differences* (Doc 10055).

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\* The expression "different in character or other means of compliance" in b) would be applied to a national regulation and practice which achieve, by other means, the same objective as that of the corresponding SARPs or for other substantive reasons so cannot be classified under a) or c).

3. *Form of notification of differences*

3.1 Differences can be notified:

- a) by sending to ICAO Headquarters a form on notification of compliance or differences; or
- b) through the Electronic Filing of Differences (EFOD) System at [www.icao.int/usoap](http://www.icao.int/usoap).

3.2 When notifying differences, the following information should be provided:

- a) the number of the paragraph or subparagraph which contains the SARP to which the difference relates\*;
- b) the reasons why the State does not comply with the SARP, or considers it necessary to adopt different regulations or practices;
- c) a clear and concise description of the difference; and
- d) intentions for future compliance and any date by which your Government plans to confirm compliance with and remove its difference from the SARP for which the difference has been notified.

3.3 The differences notified will be made available to other Contracting States, normally in the terms used by the Contracting State when making the notification. In the interest of making the information as useful as possible, Contracting States are requested to ensure that:

- a) statements be as clear and concise as possible and be confined to essential points;
- b) the provision of extracts from national regulations not be considered as sufficient to satisfy the obligation to notify differences; and
- c) general comments, unclear acronyms and references be avoided.

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\* This applies only when the notification is made under 3.1 a).



ATTACHMENT E to State letter AN 7/66.2.1-18/29

**IMPLEMENTATION TASK LIST AND OUTLINE OF GUIDANCE MATERIAL  
IN RELATION TO AMENDMENT 90 TO ANNEX 10, VOLUME IV**

**1. IMPLEMENTATION TASK LIST**

1.1 Essential steps to be followed by a State in order to implement the proposed amendment to Annex 10, Volume IV:

- a) identification of the rule-making process necessary to transpose the modified ICAO provisions into the national regulations;
- b) establishment of a national implementation plan that takes into account the modified ICAO provisions;
- c) drafting of the modification(s) to the national regulations and means of compliance;
- d) official adoption of the national regulations and means of compliance;
- e) filing of State differences with ICAO, if necessary; and
- f) publication of significant differences in the AIP.

**2. STANDARDIZATION PROCESS**

- 2.1 Effective date: 16 July 2018
- 2.2 Applicability date: 8 November 2018
- 2.3 Embedded applicability date(s): N/A

**3. SUPPORTING DOCUMENTATION**

**3.1 ICAO documentation**

<b>Title</b>	<b>Type (PANS/TI/Manual/Circ)</b>	<b>Publication date</b>
Amendment 1 to the <i>Airborne Collision Avoidance System (ACAS) Manual</i> (Doc 9863)	Manual	2017
Amendment 1 to the <i>Manual on Technical Provisions for Mode S Services and Extended Squitter</i> (Doc 9871)	Manual	2017
<i>Aeronautical Surveillance Manual</i> (Doc 9924), 2nd edition	Manual	2017

<b>Title</b>	<b>Type (PANS/TI/Manual/Circ)</b>	<b>Publication date</b>
<i>Manual on Airborne Surveillance Applications</i> (Doc 9994), 1st edition	Manual	2014
<i>Airworthiness Manual</i> (Doc 9760), 3rd edition	Manual	2014

### 3.2 External documentation

<b>Title</b>	<b>External organization</b>	<b>Publication date</b>
ED-117A – MOPS for Mode S Multilateration Systems for Use in A-SMGCS	EUROCAE	2016
ED-142 – Technical Specifications for Wide Area Multilateration System (WAM)	EUROCAE	2010
DO-300A Change 1/EUROCAE ED-221A – Minimum Operational Performance Standards (MOPS) for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance.	RTCA/EUROCAE	2015

## 4. IMPLEMENTATION ASSISTANCE TASKS

<b>Type</b>	<b>Global</b>	<b>Regional</b>
Manufacturer-specific training		As required based on individual State needs

## 5. UNIVERSAL SAFETY OVERSIGHT AUDIT PROGRAMME (USOAP)

5.1 No changes are envisaged in the protocol questions (PQs).

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**IMPACT ASSESSMENT IN RELATION TO AMENDMENT 90 TO ANNEX 10, VOLUME IV**

**1. INTRODUCTION**

- 1.1 Amendment 90 to Annex 10, Volume IV addresses:
- a) secondary surveillance radar (SSR);
  - b) ADS-B and extended squitter;
  - c) airborne collision avoidance systems (ACAS); and
  - d) wide area multilateration (WAM).

**2. IMPACT ASSESSMENT**

**2.1 Amendment concerning surveillance and airborne collision avoidance systems (ACAS)**

2.1.1 *Safety impact:* The new provisions included in this amendment will have a positive impact on safety by dealing with issues based on operational experience and introducing new technologies to improve safety.

2.1.2 *Financial impact:* Introducing ADS-B OUT equipage on surface vehicles will have some cost implications for those States that decide to implement the provisions. The other proposed amendments reflect current practices and will not have a significant financial impact.

2.1.3 *Security impact:* No direct impact on security is expected as a result of this amendment.

2.1.4 *Environmental impact:* No direct impact on the environment is expected as a result of this amendment.

2.1.5 *Efficiency impact:* The new provisions included in this amendment will have a positive impact on efficiency by addressing issues arising from operational experiences. For example, downlinking of accurate aircraft identification will reduce ATC controller workload through automatic notification of aircraft ID change.

2.1.6 *Expected implementation time:* The amendment includes many provisions and, depending on each provision, different implementation times are expected. Many of the provisions are based on operational experience and can be implemented within a short time frame but provisions concerning new technologies would be implemented over a longer period since the change would be applied on a voluntary basis.

**2.2 Amendment concerning secondary surveillance radar (SSR) and wide area multilateration (WAM)**

2.2.1 *Safety impact:* The new provisions concerning WAM and X-pulse will have a positive impact on safety by clarifying WAM and by providing guidance on appropriate use of X pulse in SSR Mode A reply.

2.2.2 *Financial impact:* The proposed amendments reflect current practices in most States. No significant financial impact is expected as a result of this amendment.

2.2.3 *Security impact:* No direct impact on security is expected as a result of this amendment.

2.2.4 *Environmental impact:* No direct impact on the environment is expected as a result of this amendment.

2.2.5 *Efficiency impact:* No direct impact on efficiency is expected as a result of this amendment.

2.2.6 *Expected implementation time:* The amendments could be implemented within a short time frame (one to two years).

— END —

**AMENDMENT No. 90**

**TO THE**

**INTERNATIONAL STANDARDS  
AND RECOMMENDED PRACTICES**

**AERONAUTICAL  
TELECOMMUNICATIONS**

**ANNEX 10**

**TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION**

**VOLUME IV  
(SURVEILLANCE AND COLLISION AVOIDANCE SYSTEMS)**

The amendment to Annex 10, Volume IV, contained in this document was adopted by the Council of ICAO on **7 March 2018**. Such parts of this amendment as have not been disapproved by more than half of the total number of Contracting States on or before **16 July 2018** will become effective on that date and will become applicable on **8 November 2018** as specified in the Resolution of Adoption. (State letters AN 7/66.2.1-18/29.)

**MARCH 2018**

**INTERNATIONAL CIVIL AVIATION ORGANIZATION**



**AMENDMENT 90 TO THE INTERNATIONAL STANDARDS  
AND RECOMMENDED PRACTICES**

**ANNEX 10— AERONAUTICAL TELECOMMUNICATIONS,  
VOLUME IV — SURVEILLANCE AND COLLISION AVOIDANCE SYSTEMS**

**RESOLUTION OF ADOPTION**

*The Council*

Acting in accordance with the Convention on International Civil Aviation, and particularly with the provisions of Articles 37, 54 and 90 thereof,

1. *Hereby adopts* on 7 March 2018 Amendment 90 to the International Standards and Recommended Practices contained in the document entitled *Aeronautical Telecommunications — Surveillance and Collision Avoidance Systems* which for convenience is designated Annex 10, Volume IV to the Convention;
2. *Prescribes* 16 July 2018 as the date upon which the said amendment shall become effective, except for any part thereof in respect of which a majority of the Contracting States have registered their disapproval with the Council before that date;
3. *Resolves* that the said amendment or such parts thereof as have become effective shall become applicable on 8 November 2018;
4. *Requests the Secretary General:*
  - a) to notify each Contracting State immediately of the above action and immediately after 16 July 2018 of those parts of the amendment which have become effective;
  - b) to request each Contracting State:
    - 1) to notify the Organization (in accordance with the obligation imposed by Article 38 of the Convention) of the differences that will exist on 8 November 2018 between its national regulations or practices and the provisions of the Standards in the Annex as hereby amended, such notification to be made before 8 October 2018, and thereafter to notify the Organization of any further differences that arise;
    - 2) to notify the Organization before 8 October 2018 of the date or dates by which it will have complied with the provisions of the Standards in the Annex as hereby amended;
  - c) to invite each Contracting State to notify additionally any differences between its own practices and those established by the Recommended Practices following the procedure specified in subparagraph b) above with respect to differences from Standards.

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**NOTES ON THE PRESENTATION OF THE AMENDMENT TO ANNEX 10, VOLUME IV**

1. The text of the amendment is arranged to show deleted text with a line through it and new text highlighted with grey shading, as shown below:

- a) ~~Text to be deleted is shown with a line through it.~~ text to be deleted
- b) **New text to be inserted is highlighted with grey shading.** new text to be inserted
- c) ~~Text to be deleted is shown with a line through it followed by~~  
**the replacement text which is highlighted with grey shading.** new text to replace  
existing text

**TEXT OF AMENDMENT 90 TO THE  
INTERNATIONAL STANDARDS  
AND RECOMMENDED PRACTICES  
AERONAUTICAL TELECOMMUNICATIONS  
ANNEX 10  
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION  
VOLUME IV  
(SURVEILLANCE AND COLLISION AVOIDANCE SYSTEMS)**

**CHAPTER 1. DEFINITIONS**

...

***Transponder occupancy.*** A state of unavailability of the transponder from the time it detects an incoming signal that appears to cause some action or from the time of a self-initiated transmission, to the time that it is capable of replying to another interrogation.

*Note.— Signals from various systems that contribute to transponder occupancy are described in the Aeronautical Surveillance Manual (Doc 9924), Appendix M.*

...

**CHAPTER 2. GENERAL**

**2.1 SECONDARY SURVEILLANCE RADAR (SSR)**

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**2.1.7 Transponder occupancy**

*Note.— See Appendix M of the Aeronautical Surveillance Manual (Doc 9924) for guidance on consistent modelling of transponder occupancy.*

...

**CHAPTER 3. SURVEILLANCE SYSTEMS**

**3.1 SECONDARY SURVEILLANCE RADAR (SSR)  
SYSTEM CHARACTERISTICS**

...

**3.1.1 Systems having only Mode A and Mode C capabilities**



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### 3.1.1.6 REPLY TRANSMISSION CHARACTERISTICS (SIGNALS-IN-SPACE)

...

#### 3.1.1.6.2 INFORMATION PULSES

3.1.1.6.2.1 ~~Information pulses.~~ Information pulses shall be spaced in increments of 1.45 microseconds from the first framing pulse. The designation and position of these information pulses shall be as follows:

...

*Note.— The Standard relating to the use of these pulses is given in 2.1.4.1. However, the position of Information on the "X" pulse is not used in replies to Mode A or Mode C interrogations and is contained in the Aeronautical Surveillance Manual (Doc 9924) specified only as a technical standard to safeguard possible future expansion of the system. It has nevertheless been decided that such expansion should be achieved using Mode S. The presence of a pulse in the X pulse position is used in some States to invalidate replies.*

3.1.1.6.2.2 The position of the X pulse shall not be used in replies to Mode A or Mode C interrogations if the safe operation of surveillance systems cannot be maintained.

3.1.1.6.2.3 **Recommendation.**— *Utilization of the X pulse for special applications should be carried out in conformance with a procedure established by the State to ensure compatibility of all systems.*

...

## 3.1.2 Systems having Mode S capabilities

...

### 3.1.2.5 INTERMODE AND MODE S ALL-CALL TRANSACTIONS

...

3.1.2.5.2.1.4.2 **Recommendation.**— *Passive acquisition without using all-call interrogations should be used in the place of lockout override.*

*Note.— The Aeronautical Surveillance Manual (Doc 9924) provides guidance on different passive acquisition methods.*

3.1.2.5.2.1.4.3 *Field content for a selectively addressed interrogation used by an interrogator without an assigned interrogator code.* An interrogator that has not been assigned with a unique discrete interrogator code and is authorized to transmit shall use the II code 0 to perform the selective interrogations. In this case, selectively addressed interrogations used in connection with acquisition using lockout override shall have interrogation field contents restricted as follows:

UF = 4, 5, 20 or 21

PC	=	0
RR	<del>≠</del>	<del>16 if RRS = 0</del>
DI	=	7
IIS	=	0
LOS	=	0 except as specified in 3.1.2.5.2.1.5
TMS	=	0

3.1.2.5.2.1.4.4 An interrogator that has not been assigned with a unique discrete interrogator code and is authorized to transmit using II code 0 shall not attempt to extract air-initiated Comm-B message announced by DR = 1 or 3.

*Note.— These restrictions permit surveillance transaction, ~~and~~ GICB transaction and Comm-B broadcast extraction, but prevent the interrogation from making any changes to transponder multisite lockout or communications protocol states.*

...

### 3.1.2.6 ADDRESSED SURVEILLANCE AND STANDARD LENGTH COMMUNICATION TRANSACTIONS

...

3.1.2.6.1.2 *RR: Reply request.* This 5-bit, (9-13) uplink field shall command the length and content of a requested reply.

The last four bits of the 5-bit RR code, transformed into their decimal equivalent, shall designate the BDS1 code (3.1.2.6.11.2 or 3.1.2.6.11.3) of the requested Comm-B message if the most significant bit (MSB) of the RR code is 1 (RR is equal to or greater than 16).

#### *Coding*

RR = 0-15 shall be used to request a reply with surveillance format (DF = 4 or 5);

RR = 16-31 shall be used to request a reply with Comm-B format (DF = 20 or 21);

RR = 16 shall be used to request transmission of an air-initiated Comm-B message according to 3.1.2.6.11.3 or to request the extraction of a Comm-B broadcast message according to 3.1.2.6.11.4;

RR = 17 shall be used to request a data link capability report according to 3.1.2.6.10.2.2;

RR = 18 shall be used to request aircraft identification according to 3.1.2.9;

19-31 are not assigned in section 3.1.

*Note.— Codes 19-31 are reserved for applications such as data link communications, airborne collision avoidance systems (ACAS), etc.*

...

#### 3.1.2.6.11 STANDARD LENGTH COMMUNICATIONS PROTOCOLS

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##### 3.1.2.6.11.4 *Comm-B broadcast*

...

3.1.2.6.11.4.1 *Initiation*—~~A Comm-B broadcast cycle shall not be initiated when an air-initiated Comm-B is waiting to be transmitted. A Comm-B broadcast cycle shall begin with:~~

3.1.2.6.11.4.1.1 A Comm-B broadcast cycle shall begin with:

- a) ~~the insertion of DR code 4 or 5, (3.1.2.6.5.2) into replies with DF 4, 5, 20 or 21; and loading of the broadcast message into the Comm-B buffer;~~
- b) the starting of the B-timer ~~for the current Comm-B message; and~~

*Note.*— *If there is more than one Comm-B message waiting for transmission, the timer is only started once the message becomes the current Comm-B broadcast.*

- c) the selection of DR code 4 or 5, (3.1.2.6.5.2) for insertion into future replies with DF 4, 5, 20 or 21 when ACAS information is not available, or DR code 6 or 7 when ACAS information is available.

3.1.2.6.11.4.1.2 The DR field shall be changed to the next value each time a new Comm-B broadcast message is initiated by the transponder.

*Note.*— *The change of the DR value is used by the interrogator to detect that a new Comm-B broadcast message is announced and to extract the new Comm-B message.*

3.1.2.6.11.4.1.3 A Comm-B broadcast cycle shall not be initiated when an air-initiated Comm-B message is waiting to be transmitted.

3.1.2.6.11.4.1.4 A new Comm-B broadcast cycle shall not interrupt a current Comm-B broadcast cycle.

3.1.2.6.11.4.2 *Extraction.* To extract the broadcast message, an interrogator shall transmit RR equals 16 and DI not equal to 3 or 7 or RR equals 16 and DI equals 3 or 7 with RRS equals 0 in a subsequent interrogation.

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3.1.2.6.11.4.6 *Management of Comm-B messages waiting for transmission.* If the content of a waiting Comm-B broadcast message is updated, only the most recent value for each downlink broadcast identifier shall be retained and broadcast once the current Comm-B broadcast is finished.

*Note.*— *Downlink broadcast identifiers are defined in the Manual on Technical Provisions for Mode S Services and Extended Squitter (Doc 9871).*

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### 3.1.2.10 ESSENTIAL SYSTEM CHARACTERISTICS OF THE SSR MODE S TRANSPONDER

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#### 3.1.2.10.1.1.5 *Spurious response*

3.1.2.10.1.1.5.1 **Recommendation.**— *The response to signals not within the receiver pass band should be at least 60 dB below normal sensitivity.*

3.1.2.10.1.1.5.2 For ~~equipment~~ transponder designs first certified on or after 1 January 2011, the

spurious Mode A/C reply ratio generated by resulting from low level Mode S interrogations shall be no more than:

- a) an average of 1 per cent in the input interrogation signal range between –81 dBm and the Mode S MTL; and
- b) a maximum of 3 per cent at any given level in the input interrogation signal range between –81 dBm and the Mode S MTL.

*Note 1.— Failure to detect a low level Mode S interrogation can also result in the transponder decoding a three-pulse Mode A/C/S all-call interrogation. This would result in the transponder responding with a Mode S all-call (DF = 11) reply. The above requirement will also control these DF = 11 replies since it places a limit on the probability of failing to correctly detect the Mode S interrogation.*

*Note 2.— More information about issuing a type certificate for aircraft and separate design approval can be found in the Airworthiness Manual (Doc 9760).*

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### 3.1.2.10.3 SPECIAL CHARACTERISTICS

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#### 3.1.2.10.3.7 Minimum reply rate capability, Modes A, C and S

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3.1.2.10.3.7.3 *Minimum reply rate capability, Mode S.* A transponder capable of transmitting only short Mode S replies shall be able to generate replies at the following rates:

- 50 Mode S replies in any 1-second interval
- 18 Mode S replies in a 100-millisecond interval
- 8 Mode S replies in a 25-millisecond interval
- 4 Mode S replies in a 1.6-millisecond interval

In addition to any downlink ELM transmissions, a level 2, 3 or 4 transponder shall be able to generate as long replies at least:

- 16 of 50 Mode S replies in any 1-second interval
- 6 of 18 Mode S replies in a 100-millisecond interval
- 4 of 8 Mode S replies in a 25-millisecond interval
- 2 of 4 Mode S replies in a 1.6-millisecond interval

Transponders used in conjunction with ACAS shall be able to generate as long replies at least:

- 60 Mode S replies in any 1-second interval
- 6 of 18 Mode S replies in a 100-millisecond interval
- 4 of 8 Mode S replies in a 25-millisecond interval
- 2 of 4 Mode S replies in a 1.6-millisecond interval

In addition to downlink ELM transmissions, a level 5 transponder shall be able to generate as long replies at least:

- 24 of 50 Mode S replies in any 1-second interval
- 9 of 18 Mode S replies in a 100-millisecond interval
- 6 of 8 Mode S replies in a 25-millisecond interval
- 2 of 4 Mode S replies in a 1.6-millisecond interval

~~In addition, a transponder within an ACAS installation shall be able to generate as ACAS coordination replies at least 3 of 50 Mode S replies in any 1-second interval.~~

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### 3.1.2.11 ESSENTIAL SYSTEM CHARACTERISTICS OF THE GROUND INTERROGATOR

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#### 3.1.2.11.1 All-call interrogation repetition rate

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3.1.2.11.1.1.2 *Maximum number of Mode S all-call replies triggered by an interrogator.* For aircraft that are not locked out, a Mode S interrogator shall not trigger, on average, more than 6 Mode S all-call replies per period of 200 ms and no more than 26 Mode S all-call replies counted over a period of 18 seconds.

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## CHAPTER 4. AIRBORNE COLLISION AVOIDANCE SYSTEM

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### 4.3 GENERAL PROVISIONS RELATING TO ACAS II AND ACAS III

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#### 4.3.8 Signal formats

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4.3.8.4.2.2.2 *Subfields in MB for the data link capability report.* When BDS1 = 1 and BDS2 = 0, the following bit patterns shall be provided to the transponder for its data link capability report:

<i>Bit</i>	<i>Coding</i>	
48	0	ACAS failed or on standby
	1	ACAS operating
69	0	Hybrid surveillance not operational
	1	Hybrid surveillance fitted and operational
70	0	ACAS generating TAs only
	1	ACAS generating TAs and RAs
Bit 72	Bit 71	ACAS version
0	0	RTCA/DO-185 (pre-ACAS)
0	1	RTCA/DO-185A
1	0	RTCA/DO-185B & EUROCAE ED 143
1	1	Reserved for future versions (see <i>Note 3</i> )

*Note 1.— A summary of the MB subfields for the data link capability report structure is described in Chapter 3, 3.1.2.6.10.2.2.*

*Note 2.— The use of hybrid surveillance to limit ACAS active interrogations is described in 4.5.1. The ability only to support decoding of DF = 17 extended squitter messages is not sufficient to set bit ~~72~~ 69.*

*Note 3.— Future versions of ACAS will be identified using part numbers and software version numbers specified in registers E5<sub>16</sub> and E6<sub>16</sub>.*

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#### **4.3.11 Requirements for a Mode S transponder used in conjunction with ACAS**

4.3.11.1 *Transponder capabilities.* In addition to the minimum transponder capabilities defined in Chapter 3, 3.1, the Mode S transponder used in conjunction with ACAS shall have the following capabilities:

- a) ability to handle the following formats:

<i>Format No.</i>	<i>Format name</i>
UF = 16	Long air-air surveillance interrogation
DF = 16	Long air-air surveillance reply

- b) ability to receive long Mode S interrogations (UF = 16) and generate long Mode S replies (DF = 16) at a continuous rate of 16.6 ms (60 per second) as per 3.1.2.10.3.7.3;
- c) means for delivering the ACAS data content of all accepted interrogations addressed to the ACAS equipment;

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#### **4.3.11.3 COMMUNICATION OF ACAS INFORMATION TO OTHER ACAS**

4.3.11.3.1 *Surveillance reply.* The ACAS Mode S transponder shall use the short (DF = 0) or long (DF = 16) surveillance formats for replies to ACAS surveillance interrogations. The surveillance reply shall include the VS field as specified in Chapter 3, 3.1.2.8.2, the RI field as specified in Chapter 3, 3.1.2.8.2 and in 4.3.8.4.1.2, and the SL field as specified in 4.3.8.4.2.5.

4.3.11.3.2 *Coordination reply.* The ACAS Mode S transponder shall transmit a coordination reply upon receipt of a coordination interrogation from an equipped threat subject to the conditions of 4.3.11.3.2.1. The coordination reply shall use the long air-air surveillance reply format, DF = 16, with the VS field as specified in Chapter 3, 3.1.2.8.2, the RI field as specified in Chapter 3, 3.1.2.8.2 and in 4.3.8.4.1.2, the SL field as specified in 4.3.8.4.2.5 and the MV field as specified in 4.3.8.4.2.4. ~~Coordination replies shall be transmitted even if the minimum reply rate limits of the transponder (Chapter 3, 3.1.2.10.3.7.2) are exceeded.~~

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## 4.5 ACAS USE OF EXTENDED SQUITTER

### 4.5.1 ACAS hybrid surveillance using extended squitter position data

*Note.*— ~~Hybrid surveillance is the technique used by ACAS to take advantage of passive position information available via extended squitter DF = 17. Using hybrid surveillance, ACAS validates the position provided by extended squitter through direct active range measurement. An initial validation is performed at track initiation. Revalidation is performed once every 60 seconds for targets that do not meet the conditions in altitude or range. Revalidation is performed once per 10 seconds if the intruder becomes a near threat in altitude or range. Finally, regular active surveillance is performed once per second on intruders that become a near threat in both altitude and range. In this manner, passive surveillance (once validated) is used for non-threatening intruders thus lowering the ACAS interrogation rate. Active surveillance is used whenever an intruder becomes a near threat in order to preserve ACAS independence as an independent safety monitor. Surveillance protocols defined in this section are for ACAS hybrid surveillance, and surveillance protocols for ACAS not equipped for hybrid surveillance are defined in 4.3.7.1.~~

#### 4.5.1.1 DEFINITIONS

**Active surveillance.** The process of tracking an intruder by using the information gained from the replies to own ACAS interrogations.

**Extended hybrid surveillance.** The process of using qualified ADS-B airborne position messages via 1 090 MHz extended squitter without validating 1 090 extended squitter data for the track by ACAS active interrogations.

**Hybrid surveillance.** The process of using a combination of active surveillance and passive surveillance with validated data to update an ACAS track ~~to validate and monitor other aircraft being tracked principally using passive surveillance~~ in order to preserve ACAS independence.

**Initial acquisition.** ~~The process of starting the formation of a new track upon receipt of a squitter from a Mode S aircraft for which there is no track by making an active interrogation.~~

**Passive surveillance.** The process of tracking another aircraft without interrogating it, by using the other aircraft's extended squitters. ACAS uses the information obtained via 1 090 MHz extended squitter to monitor the need for active surveillance, but not for any other purpose. Passive surveillance applies to both hybrid and extended hybrid surveillance.

**Validation.** The process of verifying the relative position of an intruder using passive information via 1 090 MHz extended squitter by comparing it to the relative position obtained by ACAS active interrogation.

4.5.1.2 An ACAS equipped to receive extended squitter airborne position messages for passive surveillance of non-threatening intruders shall utilize this passive position information in the following manner.

#### 4.5.1.3 PASSIVE SURVEILLANCE

##### 4.5.1.3.1 EXTENDED HYBRID SURVEILLANCE

4.5.1.3.1.1 Systems using extended hybrid surveillance mode shall establish a track in such a way that

no interrogations are performed, i.e. acquiring the track through exclusive use of ADS-B extended squitter, when the following conditions are met:

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

4.5.1.3.1.2 The system shall not use ADS-rebroadcast (ADS-R) and TIS-B data to passively acquire an aircraft.

*Note 1.— ADS-R is described in the Technical Provisions for Mode S Services and Extended Squitter (Doc 9871).*

*Note 2.— The signal level strength cannot be applied to ADS-R and TIS-B data.*

4.5.1.3.1.3 A track maintained under extended hybrid surveillance mode shall transition to a track maintained under active surveillance mode if range and altitude of hybrid threat criteria are met.

*Note.— Information concerning range and altitude hybrid threat criteria can be found in RTCA DO-300A Change 1/EUROCAE ED-221A – Minimum Operational Performance Standards (MOPS) for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance.*

4.5.1.3.1.4 A track under extended hybrid surveillance mode shall transition to a track under hybrid surveillance mode if:

- 1) The signal indicates a high probability to be in close proximity, i.e. signal  $>$  Extended Hybrid Surveillance MTL, except when operating on the airport surface; or
- 2) Intruder data or own data quality does not meet minimum requirements.



4.5.1.3.1-2 *Validation.* To validate the position of an intruder reported by extended squitter and not meeting the criteria for extended hybrid surveillance mode, ACAS shall determine the relative range and relative bearing as computed from the position and geographical heading of own aircraft and the intruder's position as reported in the extended squitter. This derived range and relative bearing and the altitude reported in the squitter shall be compared to the range, relative bearing and altitude determined by active ACAS interrogation—of requiring a short reply from the aircraft. Differences between the derived and measured range and relative bearing and the squitter and reply altitude shall be computed and used in tests to determine whether the extended squitter data is valid. If these tests are satisfied the passive position shall be considered to be validated and the track shall be maintained on passive data unless it is a near threat as described in 4.5.1.4. If any of these validation tests fail, active surveillance shall be used to track the intruder.

*Note.— Suitable tests for validating extended squitter data information for the purposes of ACAS hybrid surveillance can be found in ~~RTCA/DO-300~~RTCA DO-300A Change 1/EUROCAE ED-221A – Minimum Operational Performance Standards (MOPS) for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance.*

4.5.1.3.23 *Supplementary active interrogations.* In order to ensure that an intruder's track is updated at least as frequently as required in the absence of extended squitter data (4.3.7.1.2.2), each time a track is updated using squitter information the time at which an active interrogation would next be required shall be calculated. An active interrogation shall be made at that time if a further squitter has not been received before the interrogation is due.

4.5.1.4 *Near threat.* An intruder shall be tracked under active surveillance if it is a near threat, as determined by separate tests on the range and altitude of the aircraft. These tests shall be such that an intruder is considered a near threat before it becomes a potential threat, and thus triggers a traffic advisory as described in 4.3.3. These tests shall be performed once per second. All near threats, potential threats and threats shall be tracked using active surveillance.

*Note.— Suitable tests for determining that an intruder is a near threat can be found in ~~RTCA/DO-300~~RTCA DO-300A Change 1/EUROCAE ED-221A – Minimum Operational Performance Standards (MOPS) for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance.*

4.5.1.5 *Revalidation and monitoring.* If an aircraft is being tracked using passive surveillance and if criteria for extended hybrid surveillance mode are not met, periodic active interrogations shall be performed to validate and monitor the extended squitter data as required in 4.5.1.3.1-2. The default rates of revalidation shall be between once per minute for a non-threat and once per 10 seconds for a near threat. The tests required in 4.5.1.3.1-2 shall be performed for each interrogation, and active surveillance shall be used to track the intruder if these revalidation tests fail.

*Note.— More information about criteria of revalidation rate can be found in RTCA DO-300A\_Change 1/EUROCAE ED-221A – Minimum Operational Performance Standards (MOPS) for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance.*

4.5.1.6 *Full active surveillance.* If the following condition is met for a track being updated via passive surveillance data:

- a)  $|a| \leq 10\,000$  ft and both;
- b)  $|a| \leq 3\,000$  ft or  $|a - 3\,000\text{ ft}| / |\dot{a}| \leq 60$  s; and

$$c) \quad r \leq 3 \text{ NM or } (r - 3 \text{ NM}) / |\dot{r}| \leq 60 \text{ s};$$

where:  $a$  = intruder altitude separation in ft

$\dot{a}$  = altitude rate estimate in ft/s

$r$  = intruder slant range in NM

$\dot{r}$  = range rate estimate in NM/s

the aircraft shall be declared an active track and shall be updated on active range measurements once per second for as long as the above condition is met.

4.5.1.6.1 All near threats, potential threats and threats shall be tracked using active surveillance.

4.5.1.6.2 A track under active surveillance shall transition to passive surveillance if it is neither a near, potential threat nor a threat. The tests used to determine it is no longer a near threat shall be similar to those used in 4.5.1.4 but with larger thresholds in order to have hysteresis which prevents the possibility of frequent transitions between active and passive surveillance.

*Note.— Suitable tests for determining that an intruder is no longer a near threat can be found in ~~RTCA/DO-300~~ RTCA DO-300A Change 1/EUROCAE ED-221A – Minimum Operational Performance Standards (MOPS) for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance.*

## CHAPTER 5. MODE S EXTENDED SQUITTER

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### 5.1 MODE S EXTENDED SQUITTER TRANSMITTING SYSTEM CHARACTERISTICS

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#### 5.1.3 ADS-B OUT requirements for surface vehicles

5.1.3.1 All surface vehicles supporting any versions of extended squitter ADS-B capability shall transmit extended squitter messages as per 5.1.1.2.

5.1.3.2 *Extended squitter version 2 required system performance.* The position source and equipment installed in surface vehicles to transmit extended squitter version 2 messages shall support the following performance characteristics:

5.1.3.2.1 The  $NAC_P$  for the navigation position data shall be greater than or equal to 9, a 95 per cent accuracy bound on horizontal position less than 30 metres.

*Note.—  $NAC_P$  is calculated based on satellite performance.*

5.1.3.2.2 The  $NAC_V$  for the navigation velocity data shall be greater than or equal to 2, a velocity error less than 3 metres per second.

5.1.3.2.3 The  $NAC_P$  and  $NAC_V$  minimum values shall be met at a minimum availability of 95 per cent.

5.1.3.2.4 The system design assurance parameter shall be equal to 1 or more, which defines the probability of a failure resulting in transmission of false or misleading information to be less than or equal to  $1 \times 10^{-3}$ .

*Note 1.— These minimum performance requirements for extended squitter version 2 transmitted position data from surface vehicles are necessary to support aircraft-based alerting applications.*

*Note 2.— Guidance material for implementation of surface vehicle ADS-B systems is contained in the Technical Provisions for Mode S Services and Extended Squitter (Doc 9871).*

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## CHAPTER 6. MULTILATERATION SYSTEMS

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*Note 2.— Detailed technical guidance for MLAT and WAM can be found in the Aeronautical Surveillance Manual (Doc 9924), Appendix L. Material contained in EUROCAE ED-117A – MOPS for Mode S Multilateration Systems for Use in A-SMGCS and ED-142 – Technical Specifications for Wide Area Multilateration System (WAM) provides ~~a good basis~~ information for planning, implementation and satisfactory operation of MLAT systems for most applications.*

### 6.1 DEFINITIONS

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**Wide area multilateration (WAM) system.** A multilateration system deployed to support en-route surveillance, terminal area surveillance and other applications such as height monitoring and precision runway monitoring (PRM).

— END —