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Ref.: AN 7/1.3.105-20/42

8 April 2020

**Subject:** Proposals for the amendment of Annex 10,  
Volume IV regarding airborne collision avoidance  
system X (ACAS X)

**Action required:** Comments to reach Montréal  
by 8 October 2020

Sir/Madam,

1. I have the honour to inform you that the Air Navigation Commission, at the seventh meeting of its 213th Session held on 5 March 2020, considered proposals developed by the third meeting of the Surveillance Panel (SP/3) for the amendment of Standards and Recommended Practices (SARPs) in Annex 10 — *Aeronautical Telecommunications, Volume IV — Surveillance and Collision Avoidance Systems* concerning introduction of newly developed provisions for airborne collision avoidance system X (ACAS X). The Commission authorized their transmission to Member States and appropriate international organizations for comments.
2. The background of the aforementioned proposals is explained in Attachment A. The proposals for amendment to Annex 10, Volume IV are contained in Attachment B. A rationale box providing more information has been included immediately following each proposal.
3. May I request that any comments you wish to make on the amendment proposals be dispatched to reach me not later than 8 October 2020. To facilitate the processing of replies with substantive comments, I invite you to submit an electronic version in Word format to [icaohq@icao.int](mailto:icaohq@icao.int). The Air Navigation Commission has asked me to specifically indicate that comments received after the due date may not be considered by the Commission and the Council. In this connection, should you anticipate a delay in the receipt of your reply, please let me know in advance of the due date.
4. For your information, the proposed amendment to Annex 10, Volume IV is envisaged for applicability on 3 November 2022. Any comments you may have thereon would be appreciated.
5. The subsequent work of the Air Navigation Commission and the Council would be greatly facilitated by specific statements on the acceptability or otherwise of the proposals. Please note

that for the review of your comments by the Air Navigation Commission and the Council, replies are normally classified as “agreement with or without comments”, “disagreement with or without comments” or “no indication of position”. If in your reply the expressions “no objections” or “no comments” are used, they will be taken to mean “agreement without comment” and “no indication of position”, respectively. In order to facilitate proper classification of your response, a form has been included in Attachment C which may be completed and returned together with your comments, if any, on the proposals in Attachment B.

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

Fang Liu  
Secretary General

**Enclosures:**

- A — Background information
- B — Proposed amendment to Annex 10, Volume IV
- C — Response form

**BACKGROUND INFORMATION**

**1. INTRODUCTION OF THE NEWLY DEVELOPED ACAS X**

1.1 Attachment B (Initial Proposal 1) contains the provisions for the newly developed airborne collision avoidance system X (ACAS X). The deployment of ACAS X aims to improve safety, reduce unnecessary alerts, accommodate new procedures such as those supporting 4D trajectory based operations (TBO) and enable the use of other surveillance sources, which are required to support new aircraft types such as remotely piloted aircraft.

1.2 This proposal includes the provisions for ACAS Xa — active surveillance and Xo — operation specific. ACAS Xa is developed for large commercial aircraft. ACAS Xo is a specific variation of ACAS X that adds special modes to ACAS Xa, which provides the capability to apply conflict detection and resolution logic specific to a particular operational environment.

1.3 The ACAS X provisions proposed in this amendment are based on the outcome of extensive evaluations. Using the safety simulation employed in ACAS II (specifically TCAS v7.1) studies, the evaluation outcome indicated that deployment of ACAS Xa would reduce the probability of a Near Mid-Air Collision (NMAC) by about 20 per cent, while also reducing the number of unnecessary alerts and resolution advisory (RA) reversals.

1.4 These technical provisions fulfil the ACAS II requirements and will make ACAS X an alternative to, while maintaining full interoperability with, existing ACAS II systems, i.e. TCAS version 7.1. No consequential amendments to Annex 6 — *Operation of Aircraft* or the *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS, Doc 8168) are envisaged, since ACAS X works with the same hardware and displays traffic advisories (TAs) and resolution advisories (RAs) in the same manner as existing ACAS systems. Furthermore, additional cost estimated for implementing this proposal can be minimal for States, since this amendment just will give an additional option of implementation of ACAS II, while maintaining or improving the level of safety.

**2. A PROVISION TO REDUCE FALSE ACAS ALERTS**

2.1 Attachment B (Initial Proposal 2) contains a provision to reduce the occurrences of false ACAS alerts on aircraft equipped with current ACAS (TCAS version 7.1) with hybrid surveillance capability. These false alerts occur when hybrid surveillance transitions from passive surveillance mode to active surveillance mode. Analysis has revealed that the use of passive automatic dependent surveillance — broadcast (ADS-B) position data in the threat detection logic sometimes leads to such false RAs which are due to jumps in the ADS-B position data of the intruding aircraft. These jumps occur because of variations in the processing delays within the avionics.

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**ATTACHMENT B** to State letter AN 7/1.3.105-20/42

**PROPOSED AMENDMENT TO ANNEX 10, VOLUME IV**

**NOTES ON THE PRESENTATION OF THE PROPOSED AMENDMENT**

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:

~~Text to be deleted is shown with a line through it.~~

Text to be deleted

New text to be inserted is highlighted with grey shading.

New text to be inserted

~~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 PROPOSED AMENDMENT TO THE  
INTERNATIONAL STANDARDS  
AND RECOMMENDED PRACTICES  
AERONAUTICAL TELECOMMUNICATIONS  
VOLUME IV — SURVEILLANCE AND COLLISION AVOIDANCE SYSTEMS  
ANNEX 10  
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION**

<b>INITIAL PROPOSAL 1</b>
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**CHAPTER 1. DEFINITIONS**

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*Airborne collision avoidance system (ACAS).* An aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground-based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR transponders.

*Note.— SSR transponders referred to above are those operating in Mode C or Mode S. ACAS may also use automatic dependent surveillance — broadcast (ADS-B) signals received from other aircraft to improve its performance.*

...

<b>Origin</b>	<b>Rationale:</b>
SP/3	Use of ADS-B signals — Instead of solely relying on active surveillance of the transponder, ACAS X can use ADS-B information as an additional data source to track intruders and improve its performance.

**CHAPTER 4. AIRBORNE COLLISION AVOIDANCE SYSTEM**

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~~*Note 1.— Guidance material relating to the airborne collision avoidance system is contained in the Airborne Collision Avoidance System (ACAS) Manual (Doc 9863).*~~

~~*Note 2.— Non-SI alternative units are used as permitted by Annex 5, Chapter 3, 3.2.2. In limited cases, to ensure consistency at the level of the logic calculations, units such as ft/s, NM/s and kt/s are*~~

*used.*

*Note 3.— The system that is compliant with Chapter 4 in its entirety is the one that incorporates the traffic alert and collision avoidance systems (TCAS) Version 7.1 and therefore meets the RTCA/DO-185B or EUROCAE/ED-143 specification.*

*Note 4.— Equipment complying with RTCA/DO-185A standards (also known as TCAS Version 7.0) is not compliant with Chapter 4 in its entirety.*

*Introductory Note.— This chapter contains SARPs on ACAS I, ACAS II and ACAS III. The focus is especially on ACAS II which provides vertical resolution advisories (RAs) in addition to traffic advisories (TAs), and the related provisions are detailed in the following sections:*

- 4.3 GENERAL PROVISIONS RELATING TO ACAS II AND ACAS III
- 4.4 PERFORMANCE OF THE ACAS II COLLISION AVOIDANCE LOGIC and
- 4.5 ACAS USE OF EXTENDED SQUITTER

*ACAS X is an ACAS II compliant system. The provisions for ACAS X compliant systems in this chapter cover ACAS Xa (a stands for active surveillance, which is its main surveillance source) and ACAS Xo (o stands for operation specific). ACAS Xa is developed for large commercial aircraft. ACAS Xo is a specific variation of ACAS X that adds special modes to ACAS Xa.*

*Although ACAS X is an acceptable alternative to, and interoperable with, existing ACAS II, i.e. TCAS Version 7.1 compliant systems, it is different from existing ACAS II mainly in two areas: the collision avoidance logic and the sources of surveillance data. With these differences, technical requirements which are specific to either ACAS X or TCAS version 7.1 are identified as “For ACAS X compliant systems” or “For TCAS 7.1 compliant systems”.*

*Guidance material related to both TCAS 7.1 compliant systems and ACAS X compliant systems are contained in the Airborne Collision Avoidance System (ACAS) Manual (Doc 9863).*

*It is to be noted that hybrid and extended hybrid surveillance provisions contained in section 4.5 describe functionalities which are optional for TCAS version 7.1 compliant systems. However, their use is encouraged in order to minimize the risk of ACAS RF spectrum congestion, as proper and efficient utilization of available bandwidth and capacity at 1 030 MHz and 1 090 MHz is a key element to ensure the safe operation of not only ACAS but also several surveillance systems such as secondary surveillance radar (SSR) and automatic dependent surveillance broadcast (ADS-B). These functionalities are included in ACAS X compliant systems.*

*Non-SI alternative units are used as permitted by Annex 5, Chapter 3, 3.2.2. In limited cases, to ensure consistency at the level of the logic calculations, units such as ft/s, NM/s and kt/s are used.*

*For more details of TCAS Version 7.1 compliant systems, refer to the RTCA/DO-185B or EUROCAE/ED-143 specifications, i.e. equipment that incorporates the traffic alert and collision avoidance systems (TCAS) Version 7.1. For ACAS X compliant systems, refer to the RTCA/DO-385 or EUROCAE/ED-256 specifications, i.e. equipment that incorporates the airborne collision avoidance system X (ACAS X). Equipment meeting the ACAS X or TCAS Version 7.1 specifications listed above are compliant with the ACAS II requirements listed in Chapter 4. Equipment meeting the RTCA/DO-185A specifications (also known as TCAS Version 7.0) are not compliant with the ACAS II requirements listed in Chapter 4.*

...

<p><b>Origin</b></p> <p>SP/3</p>	<p><b>Rationale:</b></p> <p>ACAS X fulfils and improves ACAS II performance.</p> <p>An addition of introductory Note is proposed to provide a summary of Chapter 4, to cover points referred by all existing notes and to clarify the following:</p> <ul style="list-style-type: none"> <li>a) ACAS X technical provisions introduced in this amendment also fulfil ACAS II requirements. Hence, ACAS X becomes an alternative to, and fully interoperable with, TCAS version 7.1;</li> <li>b) although this proposal ensures that ACAS X is interoperable with the existing ACAS II, ACAS X is different mainly in two areas: collision avoidance logic and the sources of surveillance data. With these differences, technical requirements which are specific to either ACAS X or TCAS version 7.1 are identified as “For TCAS 7.1 compliant systems” or “For ACAS X compliant systems”; and</li> <li>c) Hybrid and extended hybrid surveillance provisions contained are optional for TCAS version 7.1 compliant systems.</li> </ul>
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**4.1 DEFINITIONS RELATING TO  
AIRBORNE COLLISION AVOIDANCE SYSTEM**

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***Intruder.*** An ~~SSR transponder-equipped aircraft within the surveillance range of ACAS~~ for which ACAS has an established track.

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***Sensitivity level (S).*** An integer defining a set of parameters used by the traffic advisory (TA) and collision avoidance algorithms to control the warning time provided by the potential threat and threat detection logic, as well as the values of parameters relevant to the RA selection logic.

*Note.— For TA and RA selection, sensitivity level is not used in ACAS X compliant systems.*

...

<b>Origin</b>	<b>Rationale:</b>
SP/3	Sensitivity Level — ACAS X uses value of sensitivity levels only to provide other parts of the software with the information of current selection of the modes, i.e., automatic, standby, TA only or TA/RA mode.

**Track.** A sequence of ~~at least three~~ measurements representing positions that could reasonably have been occupied by an aircraft.

<b>Origin</b>	<b>Rationale:</b>
SP/3	The proposed amendment is to reflect ACAS X and apply the definition to all ACAS II systems. Although the current definition is correct for existing ACAS II systems, ACAS X track can be established with two measurements. Since the definition should be general and apply to all ACAS II systems, deletion of the specific number of measurement is proposed.

...

#### 4.3.2 Surveillance performance requirements

4.3.2.1 *General surveillance requirements.* ACAS shall interrogate SSR Mode A/C and Mode S transponders in other aircraft and detect the transponder replies. ACAS shall measure the range and relative bearing of responding aircraft. For ACAS X compliant systems, in addition to information from other sources described above, ACAS shall be able to receive other aircraft's ADS-B position, velocity and status information. Using these measurements and information conveyed by transponder replies and for ACAS X compliant systems also by ADS-B messages, ACAS shall estimate the relative positions of each responding aircraft. ACAS shall include provisions for achieving such position determination in the presence of ground reflections, interference and variations in signal strength.

<b>Origin</b>	<b>Rationale:</b>
SP/3	Use of ADS-B signals — Refer to the rationale described in the ACAS definition of Chapter 1.

...

4.3.2.1.2 *False track probability.* The probability that an established Mode A/C track does not correspond in range and altitude, if reported, to an actual aircraft shall be less than  $10^{-2}$  1.2 per cent. For an established Mode S track this probability shall be less than  $10^{-6}$  0.1 per cent. These limits shall not be exceeded in any traffic environment.

<b>Origin</b>	<b>Rationale:</b>
SP/3	Corrections of existing SARPs — An extensive review has been performed on the requirements described in Chapter 4 while developing the ACAS X provisions. This review has identified incorrect figures for

	false track probability used by existing systems.
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### 4.3.3 Traffic advisories (TAs)

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#### 4.3.3.2 PROXIMATE TRAFFIC DISPLAY

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4.3.3.2.2 **Recommendation.**— *While any RA and/or TA are displayed, visual acquisition of the threats and/or potential threat should not be adversely affected by the display of proximate traffic or other data (e.g. contents of received ADS-B messages) unrelated to collision avoidance.*

Origin	Rationale:
SP/3	Use of ADS-B signals — ADS-B messages were previously indicated as a specific example of data that could possibly adversely affect the display; ACAS X on the contrary, uses ADS-B messages to improve its performance, hence it is necessary to delete that specific example.

4.3.3.3 *TAs as RA precursors.* The criteria for TAs shall be such that they are satisfied before those for an RA.

*Note. — Ideally, RAs would always be preceded by a TA but this is not always possible, e.g. the RA criteria might be already satisfied when a track is first established, or a sudden and sharp manoeuvre by the intruder could cause the TA lead time to be less than a cycle.*

#### 4.3.3.3.1 *TA warning time.*

4.3.3.3.1.1 For TCAS Version 7.1 compliant systems ~~intruders reporting altitude~~, the nominal TA warning time for intruders reporting altitude shall not be greater than (T+20 s) where T is the nominal warning time for the generation of the resolution advisory.

~~*Note. — Ideally, RAs would always be preceded by a TA but this is not always possible, e.g. the RA criteria might be already satisfied when a track is first established, or a sudden and sharp manoeuvre by the intruder could cause the TA lead time to be less than a cycle.*~~

4.3.3.3.1.2 For ACAS X compliant systems, the TA warning time shall be sufficient to allow the flight crew to take actions described in PANS-OPS and prepare for a potential resolution advisory.

*Note. — The nominal TA warning time is 20 s or less before the generation of the resolution advisory.*

<p><b>Origin</b></p> <p>SP/3</p>	<p><b>Rationale:</b></p> <p>Collision avoidance logic — The logic for ACAS X to determine warning time is different from the current logic for ACAS II, therefore, a requirement for ACAS X is proposed.</p>
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#### 4.3.4 Threat detection

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4.3.4.1.1 *Intruder characteristics.* As a minimum, the characteristics of an intruder that are used to identify a threat shall include:

- a) tracked altitude;
- b) tracked rate of change of altitude;
- c) tracked slant range;
- d) tracked rate of change of slant range; and
- e) for TCAS Version 7.1 compliant systems: sensitivity level of intruder's ACAS,  $S_i$ .

...

4.3.4.2 *Sensitivity levels.* ACAS shall be capable of operating at any of a number of sensitivity levels. These shall include:

- a)  $S = 1$ , a “standby” mode in which the interrogation of other aircraft and all advisories are inhibited;
- b)  $S = 2$ , a “TA only” mode in which RAs are inhibited; ~~and~~
- c) for TCAS Version 7.1 compliant systems:  $S = 3-7$ , further levels that enable the issue of RAs that provide the warning times indicated in Table 4-2 as well as TAs; and
- d) for ACAS X compliant systems:  $S = 3$ , a “TA/RA” mode in which RAs and TAs can be issued.

4.3.4.3 *Selection of own sensitivity level ( $S_o$ ).* The selection of own ACAS sensitivity level shall be determined by sensitivity level control (SLC) commands which shall be accepted from a number of sources as follows:

- a) SLC command generated automatically by ACAS based on altitude band or other external factors;
- b) SLC command from pilot input; and
- c) for TCAS Version 7.1 compliant systems: SLC command from Mode S ground stations.

*Note. — ACAS X compliant systems acknowledge SLC commands from ground stations so that the ground stations do not need to be modified for these commands. However, the sensitivity level value is not used in ACAS X compliant systems.*

**Table 4-2**

For TCAS Version 7.1 compliant systems:

<i>Sensitivity level</i>	2	3	4	5	6	7
Nominal warning time	no RAs	15s	20s	25s	30s	35s

4.3.4.3.1 *Permitted SLC command codes.* As a minimum, the acceptable SLC command codes shall include:

		<i>Coding</i>
for SLC based on altitude band	2-7	(for TCAS Version 7.1 compliant systems)
	2-3	(for ACAS X compliant systems)
for SLC from pilot input	0,1,2	
for SLC from Mode S ground stations	0,2-6	(for TCAS Version 7.1 compliant systems)

...

4.3.4.3.4 *Mode S ground station SLC command.*

4.3.4.3.4.1 For TCAS Version 7.1 compliant systems: For SLC commands transmitted via Mode S ground stations (4.3.8.4.2.1.1), the value 0 shall indicate that the station concerned is not issuing an SLC command and that sensitivity level selection shall be based on the other commands, including non-0 commands from other Mode S ground stations. ACAS shall not process an uplinked SLC value of 1.

4.3.4.3.4.2 For ACAS X compliant systems: ACAS shall receive any SLC commands from Mode S ground stations but shall not use their sensitivity level values.

4.3.4.3.4.3 *ATS selection of SLC command code.* ATS authorities shall ensure that procedures are in place to inform pilots of any ATS selected SLC command code other than 0 (4.3.4.3.1).

...

4.3.4.4 *Selection of parameter values for RA generation.* For TCAS Version 7.1 compliant systems: When the sensitivity level of own ACAS is 3 or greater, the parameter values used for RA generation that depend on sensitivity level shall be based on the greater of the sensitivity level of own ACAS,  $S_o$ , and the sensitivity level of the intruder's ACAS,  $S_i$ .

4.3.4.5 *Selection of parameter values for TA generation.* For TCAS Version 7.1 compliant systems:

The parameter values used for TA generation that depend on sensitivity level shall be selected on the same basis as those for RAs (4.3.4.4) except when an SLC command with a value of 2 (“TA only” mode) has been received from either the pilot or a Mode S ground station. In this case, the parameter values for TA generation shall retain the values they would have had in the absence of the SLC command from the pilot or Mode S ground station.

<b>Origin</b>	<b>Rationale:</b>
SP/3	<p><b>Sensitivity Level:</b></p> <p>Existing airborne collision avoidance logic uses sensitivity level to control the time or thresholds for TA and RA issuance and to determine the protected airspace around each ACAS equipped aircraft.</p> <p>However, since the ACAS X alerting logic is different from the existing one and is based upon a numeric lookup table optimized in accordance to a probabilistic model of the airspace and a set of safety and operational considerations, ACAS X does not use sensitivity level for this purpose, instead, it uses sensitivity levels only to provide mode selection and to transmit its own sensitivity level to other aircraft within the range ACAS X from 1 to 3.</p> <p>ACAS X compliant systems acknowledge SLC commands from ground stations and, therefore, ground stations do not need to be modified for this command. However, the sensitivity level information of the message is not used in ACAS X compliant systems and no further action is taken.</p>

**4.3.4.6 Validation of ADS-B tracks for RA generation.** For ACAS X compliant systems: If ADS-B tracks fail validation via active interrogation and reply, ACAS shall revert back to using active surveillance for threat resolution logic.

*Note.— Only validated ADS-B is used in the generation of RAs.*

<b>Origin</b>	<b>Rationale:</b>
SP/3	Use of ADS-B signals — ACAS X can use ADS-B signals as an additional data source to track intruders.

**4.3.4.7 Designation of aircraft for do not alert (DNA).** For ACAS X compliant systems with Xo functionality: If an intruder aircraft is designated as do not alert (DNA), no alerts for the intruder aircraft shall be issued to the flight crew of the own aircraft.

*Note. — ACAS Xo provides additional modes with modified threat detection criteria in respect of designated intruders. For more details on ACAS Xo, refer to RTCA/DO-385 or EUROCAE/ED-256.*

Origin	Rationale:
SP/3	ACAS Xo functionally — It is important to note that provisions related to ACAS Xo in this amendment are limited to only accommodating future operation of ACAS Xo. ACAS Xo is a specific variation of ACAS X intended to add special modes to ACAS Xa. Through implementation of those modes, ACAS Xo will provide capability to apply operationally specific conflict detection and resolution logic. The expert group is working on an amendment to Doc 9863, which will provide information specific to the future operation of ACAS Xo.

### 4.3.5 Resolution advisories (RAs)

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#### 4.3.5.1.2 RA cancellation.

4.3.5.1.2.1 For TCAS 7.1 compliant systems: Once an RA has been generated against a threat or threats it shall be maintained or modified until tests that are less stringent than those for threat detection indicate on two consecutive cycles that the RA may be cancelled, at which time it shall be cancelled.

4.3.5.1.2.2 For ACAS X compliant systems: Once an RA has been generated against a threat or threats it shall be maintained until the intruder or intruders of the RA cease to be a threat.

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Origin	Rationale:
SP/3	Separate requirement for ACAS X — In order to reflect different approach to RA cancellation performed by TCAS 7.1 and ACAS X, the addition of a specific ACAS X provision is required.

4.3.5.3.1 New ACAS installations after 1 January 2014 shall monitor own aircraft's vertical rate to verify compliance with the RA sense. If non-compliance is detected, ACAS shall stop assuming compliance, and instead shall assume the observed vertical rate.

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*Note 3.— Compliance with this requirement can be achieved through the implementation of traffic alert and collision avoidance system (TCAS) Version 7.1 as specified in RTCA/DO-185B, ~~or~~ EUROCAE/ED-143 or airborne collision avoidance system X (ACAS Xa — active surveillance and Xo — operation specific) as specified in RTCA/DO-385 or EUROCAE/ED-256.*

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4.3.5.4.2 ACAS shall not operate in TA only mode sensitivity levels 3-7 when own aircraft is below

300 m (1 000 ft) AGL nominal value with hysteresis applied.

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Origin	Rationale:
SP/3	Sensitivity Level — Refer to the rationale described under paragraph 4.3.4.5.

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4.3.5.5.2 *Sense reversals due to inadequate predicted separation.* ACAS shall initiate not more than one reversal per threat per encounter due to inadequate predicted separation.

*Note 1.— For TCAS Version 7.1 compliant systems: The aircraft with the lower 24-bit aircraft address can initiate this type of reversal at any time during the encounter; the aircraft with the higher 24-bit aircraft address performs this type of reversal only to comply with an RAC received from the aircraft with a lower 24-bit aircraft address.*

*Note 2.— For ACAS X compliant systems: In a coordinated encounter as described in section 4.3.6.1, the aircraft with the lower 24-bit aircraft address can initiate this type of reversal at any time during the encounter; the aircraft with the higher 24-bit aircraft address can initiate this type of reversal only before it has received an RAC from the threat or after receiving cancellation of any remaining RAC from the threat.*

...

Origin	Rationale:
SP/3	An additional requirement for sense reversals is proposed. Due to differences between the ACAS X and TCAS version 7.1 coordination mechanism, the number of maximum reversals in an encounter is different. To reflect those differences, the addition of Notes 1 and 2 is also proposed.

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4.3.5.9 *Encoding of ARA subfield.* On each cycle of an RA, the RA sense, strength and attributes shall be encoded in the active RA (ARA) subfield (4.3.8.4.2.2.1.1). ~~If the ARA subfield has not been refreshed for an interval of 6 s, it shall be set to 0, along with the MTE subfield in the same message (4.3.8.4.2.2.1.3).~~

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Origin	Rationale:
SP/3	Corrections of existing SARPs — When developing ACAS X provisions, an extensive review was performed of the provisions contained in Chapter 4. This work identified an incorrect statement relating to encoding

	of ARA subfield.
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**4.3.6 Coordination and communication**

**4.3.6.1 PROVISIONS FOR COORDINATION WITH ACAS-EQUIPPED THREATS**

*Note 1.— The provisions in this section apply to aircraft that coordinate with ACAS equipped aircraft via 1 030/1 090 MHz discrete Mode S interrogations/replies.*

*Note 2.— ACAS equipment not capable of utilizing 1 030/1 090 MHz discrete Mode S interrogations/replies and that will use ADS-B to convey the applicable coordination scheme is under development. ACAS X-compliant systems incorporate the ability to coordinate with threats using such ACAS equipment. For more details, refer to Section 2.2.3.9.3.1 of RTCA/DO-385 or EUROCAE/ED-256.*

...

4.3.6.1.4 *Resolution message processing.* Resolution messages shall be processed in the order in which they are received and with delay limited to that required to prevent possible concurrent access to stored data and delays due to the processing of previously received resolution messages. Resolution messages that are being delayed shall be temporarily queued to prevent possible loss of messages. Processing a resolution message shall include decoding the message and updating the appropriate data structures with the information extracted from the message.

*Note 1.— For TCAS Version 7.1 compliant systems: According to 4.3.6.1.2, resolution message processing must not access any data whose usage is not protected by the coordination lock state.*

*Note 2.— For ACAS X compliant systems: Simultaneous data access may exist because incoming resolution messages are received asynchronously to ACAS X processing, effectively interrupting this processing. Simultaneous reading and writing by concurrent processes are to be prevented.*

<b>Origin</b>	<b>Rationale:</b>
SP/3	To clarify provisions, the addition of notes is proposed.

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4.3.6.2.2 *Sensitivity level control (SLC) command.* For TCAS Version 7.1 compliant systems: ACAS shall store SLC commands from Mode S ground stations. An SLC command received from a Mode S ground station shall remain effective until replaced by an SLC command from the same ground station as indicated by the site number contained in the IIS subfield of the interrogation. If an existing stored command from a Mode S ground station is not refreshed within 4 minutes, or if the SLC command received has the value 15 (4.3.8.4.2.1.1), the stored SLC command for that Mode S ground station shall be set to 0.

*Note.— ACAS X compliant systems do not use the sensitivity level value obtained from an SLC command to modify the sensitivity level value of own aircraft.*

**4.3.6.3 PROVISIONS FOR DATA TRANSFER BETWEEN ACAS AND ITS MODE S TRANSPONDER**

4.3.6.3.1 Data transfer from ACAS to its Mode S transponder:

- a) ACAS shall transfer RA information to its Mode S transponder for transmission in an RA report (4.3.8.4.2.2.1) and in a coordination reply (4.3.8.4.2.4.2);
- b) ACAS shall transfer current sensitivity level to its Mode S transponder for transmission in a sensitivity level report (4.3.8.4.2.5); and
- c) ACAS shall transfer capability information to its Mode S transponder for transmission in a data link capability report (4.3.8.4.2.2.2).

*Note.— For ACAS X compliant systems: ACAS will not transfer a sensitivity level value greater than 3 as part of the capability information to its Mode S transponder.*

4.3.6.3.2 Data transfer from Mode S transponder to its ACAS:

- a) ACAS shall receive from its Mode S transponder sensitivity level control commands (4.3.8.4.2.1.1) transmitted by Mode S ground stations;

*Note.— For ACAS X compliant systems: It is necessary to receive SLC commands from the transponder to be compliant with the interface protocols between the Mode S transponder and the ACAS unit; however, the sensitivity level values are not used (refer to 4.3.4.3.4).*

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Origin	Rationale:
SP/3	Sensitivity Level — Refer to the rationale described under paragraph 4.3.4.5.

**4.3.7 ACAS protocols**

4.3.7.1 SURVEILLANCE PROTOCOLS

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**4.3.7.1.3 SURVEILLANCE OF ADS-B MESSAGES FROM INTRUDER AIRCRAFT FOR ACAS X COMPLIANT SYSTEMS:**

4.3.7.1.3.1 *Detection.* ACAS shall monitor 1 090 MHz extended squitter.

4.3.7.1.3.2 ACAS shall receive and use 1 090 MHz extended squitter messages which include information on ADS-B airborne and surface position, airborne velocity, target state and status, and aircraft operational status.

<p><b>Origin</b></p> <p>SP/3</p>	<p><b>Rationale:</b></p> <p>Use of ADS-B signals — Refer to the rationale described in ACAS definition in Chapter 1.</p> <p>Also, addition of a note is proposed to indicate the use of hybrid and extended hybrid surveillance is an integral part of ACAS X compliant systems.</p>
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4.3.7.2 AIR-AIR COORDINATION PROTOCOLS

*Note 1.— The provisions in this section apply to aircraft that coordinate with ACAS equipped aircraft via 1 030/1 090 MHz discrete Mode S interrogations/replies.*

*Note 2.— ACAS equipment not capable of utilizing 1 030/1 090 MHz discrete Mode S interrogations/replies and that will use ADS-B to convey the applicable coordination scheme is under development. ACAS X compliant systems incorporate the ability to coordinate with threats using such ACAS equipment. For more details, refer to Section 2.2.3.9.3.1 of RTCA/DO-385 or EUROCAE/ED-256.*

...

<p><b>Origin</b></p> <p>SP/3</p>	<p><b>Rationale:</b></p> <p>To clarify that the provisions in this section only apply to air-air coordination via 1 030/1 090 MHz interrogations and replies, the addition of notes is proposed.</p>
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4.3.7.3 PROTOCOLS FOR ACAS COMMUNICATION WITH GROUND STATIONS

4.3.7.3.1 *RA reports to Mode S ground stations.* These protocols are described in 4.3.11.4.1.

4.3.7.3.2 *RA broadcasts.* RA broadcasts shall be transmitted at full power from the bottom antenna at jittered ~~nominally 8 s intervals for the period that the RA is indicated~~ intervals. The RA broadcast shall include the MU field as specified in 4.3.8.4.2.3.4. The RA broadcast shall describe the ~~most recent current RA that existed during the preceding 8 s period~~ **most recent current** RA. Installations using directional antennas shall operate such that complete circular coverage is provided ~~nominally every 8 s and the same RA sense and strength is broadcast in each direction~~.

*Note. — The nominal jittered interval of RA broadcasts is every 8 s for the majority of ACAS legacy systems and 1 s for ACAS X compliant systems.*

<p><b>Origin</b></p> <p>SP/3</p>	<p><b>Rationale:</b></p> <p>The amendment is proposed to reflect the different nominal jittered interval of RA broadcasts used by ACAS X and legacy ACAS systems. Indeed, there have been two nominal values published for TCAS II version 7.1. Considering those variations, which are not appropriate to</p>
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	connect with legal requirements as a specific value, the addition of a Note to explain nominal jittered interval to cover all ACAS II systems is proposed.
--	--

4.3.7.3.3 *Data link capability report.* These protocols are described in 4.3.11.4.2.

4.3.7.3.4 *ACAS sensitivity level control.*

4.3.7.3.4.1 For TCAS Version 7.1 compliant systems: ACAS shall act upon an SLC command if and only if TMS (Chapter 3, 3.1.2.6.1.4.1) has the value 0 and DI is either 1 or 7 in the same interrogation.

4.3.7.3.4.2 For ACAS X compliant systems: ACAS shall receive any SLC commands from Mode S ground stations but shall not use their sensitivity level values.

### 4.3.8 Signal formats

...

#### 4.3.8.2 RELATIONSHIP BETWEEN ACAS AND MODE S SIGNAL FORMATS

*Note.— ACAS uses Mode S transmissions for surveillance and communications. ACAS air-air communication functions permit RA decisions to be coordinated with ACAS-equipped threats. ACAS air-ground communication functions permit the reporting of RAs to ground stations ~~and the uplinking of commands to ACAS-equipped aircraft to control parameters of the collision avoidance algorithms.~~*

...

Origin	Rationale:
SP/3	<p>Sensitivity Level — Refer to the rationale described under paragraph 4.3.4.5.</p> <p>Deletion of some texts from the note under 4.3.8.2 is also related to sensitivity level. In order to make the note applicable to both TCAS Version 7.1 compliant systems and ACAS X compliant systems, deletion of texts is required, since ACAS X compliant systems just acknowledge SLC commands from ground stations but do not use them to control parameters of the collision avoidance algorithms.</p>

## 4.3.8.4 FIELD DESCRIPTION

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4.3.8.4.1 *FIELDS AND SUBFIELDS INTRODUCED IN CHAPTER 3, 3.1.2*

...

4.3.8.4.1.2 *RI (air-air reply information)*. The significance of the coding in the RI field shall be as follows:

*Coding*

0	No operating ACAS
1	Not assigned
2	ACAS with resolution capability inhibited
3	ACAS with vertical-only resolution capability and capability to utilize 1 030/1 090 MHz discrete Mode S interrogations/replies for coordination
4	ACAS with vertical and horizontal resolution capability and capability to utilize 1 030/1 090 MHz discrete Mode S interrogations/replies for coordination
5-6	Reserved for passive ACAS
5-7	Not assigned
8-15	See Chapter 3, 3.1.2.8.2.2

...

4.3.8.4.2 *ACAS FIELDS AND SUBFIELDS*

*Note.*— *The following paragraphs describe the location and coding of those fields and subfields that are not defined in Chapter 3, 3.1.2 but are used by aircraft equipped with ACAS.*

4.3.8.4.2.1 *For TCAS Version 7.1 compliant systems: Subfield in MA*

...

4.3.8.4.2.1.3 *SLC (ACAS sensitivity level control (SLC) command)*. This 4-bit (41-44) subfield shall denote a sensitivity level command for own ACAS.

...

*Note 1.*— *Structure of MA for a sensitivity level control command:*

...

*Note 2.*— *ACAS X compliant systems receive SLC commands but their sensitivity level values are not used.*

<b>Origin</b>	<b>Rationale:</b>
SP/3	Sensitivity Level — Refer to the rationale described under paragraph 4.3.4.5.

4.3.8.4.2.2 *Subfields in MB*

*Note.— 4.3.8.4.2.2.1 is applicable to TCAS Version 7.1 compliant systems, while 4.3.8.4.2.2.2 is applicable to ACAS X compliant systems. 4.3.8.4.2.2.3 is applicable to both TCAS Version 7.1 and ACAS X compliant systems.*

4.3.8.4.2.2.1 *For TCAS Version 7.1 compliant systems: Subfields in MB for an RA report.* When BDS1=3 and BDS2=0, the subfields indicated below shall be contained in MB.

...

*Note 1.— When ARA bit 41 = 0 and MTE = 0, no vertical RA has been generated.*

*Note 2.— An RA is considered crossing if own aircraft is expected to cross the altitude of the intruder before closest approach, e.g. pass above a threat currently above own aircraft. An RA is considered crossing regardless of whether the word “crossing” is included in the aural annunciation.*

...

4.3.8.4.2.2.2 *For ACAS X compliant systems: Subfields in MB for an RA report.* When BDS1=3 and BDS2=0, the subfields indicated below shall be contained in MB.

4.3.8.4.2.2.2.1 *ARA (active RAs).* This 10-bit (41-50) subfield shall indicate the currently active RA if any generated by own ACAS X unit against one or more threat aircraft.

The ARA subfield is further divided into:

- a) *AVRA (vertical RA).* This 7-bit (41-47) subfield contains the vertical component of the ARA as defined below; and
- b) *AHRA (horizontal RA).* This 3-bit (48-50) subfield contains the horizontal component of the ARA. For ACAS X compliant systems, AHRA=0.

Bits 41-50 shall have the following meanings:

<i>Bit</i>	<i>Coding</i>	
41	0	Different vertical senses have been generated in a multi-threat encounter (when MTE = 1); or no RA has been generated (when MTE=0)
	1	The same vertical sense has been generated in a single or multi-threat encounter
42	0	RA is not crossing
	1	RA is crossing

43	0	Upward sense RA has been generated (i.e. own aircraft intent is to pass above the threat)
	1	Downward sense RA has been generated (i.e. own aircraft intent is to pass below the threat)
44		Strength bit 1
45		Strength bit 2
46		Strength bit 3
47		Strength bit 4
48-50	0	AHRA

*Note.* —An RA is considered crossing if own aircraft is expected to cross the altitude of the intruder before closest approach, e.g., pass above a threat currently above own aircraft. An RA is considered crossing regardless of whether the word “crossing” is included in the aural annunciation.

The strength bits indicated in bits 44 - 47 shall have the following meaning:

<i>Strength bits</i>				
1	2	3	4	
0	0	0	0	0 Clear of conflict
0	0	0	1	1 Monitor vertical speed
0	0	1	0	2 Level-off; weakening of positive RA
0	0	1	1	3 Level-off; corrective when climbing/descending
0	1	0	0	4 Climb/descend at 1500 ft/min
0	1	0	1	5 Reversal to climb/descend
0	1	1	0	6 Increase climb/descend
0	1	1	1	7 Maintain rate; at current rate > 1500 ft/min
1	0	0	0	8 Reversal to maintain
1	0	0	1	9 Level-off; reversal to corrective negative RA
1	0	1	0	10 Monitor vertical speed; following descend RA, descend inhibited
1	0	1	1	11 Monitor vertical speed; reversal to preventive negative RA
1	1	0	0	12 Unallocated
1	1	0	1	13 Unallocated
1	1	1	0	14 Preventive multi-threat level off (MTLO) while level
1	1	1	1	15 Corrective MTLO while climbing/descending

*Note.* —For MTLO own aircraft with -500 ft/min to +500 ft/min is “level”; own aircraft with vertical rate > 500 ft/min is “climbing” and own aircraft with vertical rate < -500 ft/min is “descending”

4.3.8.4.2.2.2.2 *LDI (low-level descend inhibit).* This 2-bit (51-52) subfield is derived from the own aircraft radar altimeter value and shall indicate whether own aircraft is in a region where low level descend inhibits may be applied. The coding shall have the following meanings:

<i>Bits 51-52 Coding</i>	
0	No descend inhibit
1	Increase descend RAs inhibited
2	Both increase descend RAs and descend RAs inhibited
3	All RAs are inhibited

4.3.8.4.2.2.2.3 *RMF (RA message format)*. This 2-bit (53-54) subfield indicates the collision avoidance (CA) system used to generate bits 41-88 of the RF message. The coding shall have the following meanings:

*Bits 53-54*

*Coding*

0	All TCAS II versions
1	ACAS X compliant system
2	Reserved for ACAS III
3	Unallocated

4.3.8.4.2.2.2.4 *RAC (RACs record)*. This 4-bit (55-58) subfield shall indicate all the currently active RACs, if any, received from other ACAS aircraft. The bits in RAC shall have the following meanings:

<i>Bit</i>	<i>Resolution advisory complement</i>
55	Do not pass below
56	Do not pass above
57	Reserved for horizontal coordination
58	Reserved for horizontal coordination

A bit set to 1 shall indicate that the associated RAC is active. A bit set to 0 shall indicate that the associated RAC is inactive.

4.3.8.4.2.2.2.5 *RAT (RA terminated indicator)*. This 1-bit (59) subfield shall indicate when an RA previously generated by ACAS has ceased being generated.

*Coding*

0	ACAS is currently generating the RA indicated in the ARA subfield
1	The RA indicated by the ARA subfield has been terminated (4.3.11.4.1)

*Note 1.* — After an RA has been terminated by ACAS, it is still required to be reported by the Mode S transponder for  $18 \pm 1$  s (4.3.11.4.1). The RA terminated indicator may be used, for example, to permit timely removal of an RA indication from an air traffic controller's display, or for assessments of RA duration within a particular airspace.

*Note 2.* — RAs may terminate for a number of reasons: normally, when the conflict has been resolved and the threat is diverging in range; or when the threat's Mode S transponder for any reason ceases to report altitude during the conflict. The RA terminated indicator is used to show that the RA has been removed in each of these cases.

4.3.8.4.2.2.2.6 *MTE (multiple threat encounter)*. This 1-bit (60) subfield shall indicate whether two or more simultaneous threats are currently being processed by the ACAS threat resolution logic.

*Coding*

0	One threat is being processed by the resolution logic (when ARA bit 41 = 1); or no threat is being processed by the resolution logic (when ARA bit 41 = 0)
1	Two or more simultaneous threats are being processed by the resolution logic

4.3.8.4.2.2.2.7 *CNT (continuation bit)*. This 1-bit subfield (61) shall indicate whether a follow-on

RF message is being generated to report additional information.

*Coding*

0	No follow-on RF message exists
1	A follow-on RF message exists

4.3.8.4.2.2.2.8 *TTI (threat type indicator subfield)*. This 1-bit subfield (62) shall define the type of identity data contained in the TID subfield.

*Coding*

0	TID contains altitude, range and bearing data
1	TID contains a 24-bit aircraft address

4.3.8.4.2.2.2.9 *TID (threat identity data subfield)*. This 24-bit subfield (63-86) shall contain the 24-bit aircraft address of the threat or the altitude, range, and bearing if the threat is not Mode S equipped. If two or more threats are simultaneously processed by the ACAS resolution logic, TID shall contain the identity or position data for the most recently declared threat. If TTI = 1, TID shall contain in bits 63-86 the aircraft address of the threat. If TTI = 0, TID shall contain the following three subfields (refer to 4.3.8.4.2.2.2.8).

4.3.8.4.2.2.2.9.1 *TIDA (threat identity data altitude subfield)*. This 11-bit subfield (63-73) shall contain the most recent threat altitude estimated by ACAS, expressed in binary to a resolution of 100 ft as follows.

*Coding*

0	No data
1	Alt < -950 ft
2	-950 ft ≤ Alt < -850 ft
3	-850 ft ≤ Alt < -750 ft
4....	

4.3.8.4.2.2.2.9.2 *TIDR (threat identity data range subfield)*. This 7-bit subfield (74-80) shall contain the most recent threat range estimated by ACAS.

*Coding (n)*

<i>n</i>	<i>Estimated range (NM)</i>
0	No range estimate available
1	Less than 0.05
2-126	$(n-1)/10 \pm 0.05$
127	Greater than 12.55

4.3.8.4.2.2.2.9.3 *TIDB (threat identity data bearing subfield)*. This 6-bit subfield (81-86) shall contain the most recent estimated bearing of the threat aircraft, relative to the ACAS aircraft heading.

*Coding (n)*

<i>n</i>	<i>Estimated bearing (degrees)</i>
0	No bearing estimate available
1-60	Between $6(n-1)$ and $6n$
61-63	<i>Not assigned</i>

4.3.8.4.2.2.2.10 *DSI (designation indicator)*. This 1-bit subfield (87) shall be coded as follows:

**Coding**

- 0 The threat defined in TID is not designated for Xo or the designation is not applied
- 1 The threat defined in TID is designated for Xo, and the designation is applied

4.3.8.4.2.2.11 *SPI (suppression indicator)*. This 1-bit subfield (88) shall be coded as follows:

For single-threat encounters:

**Coding**

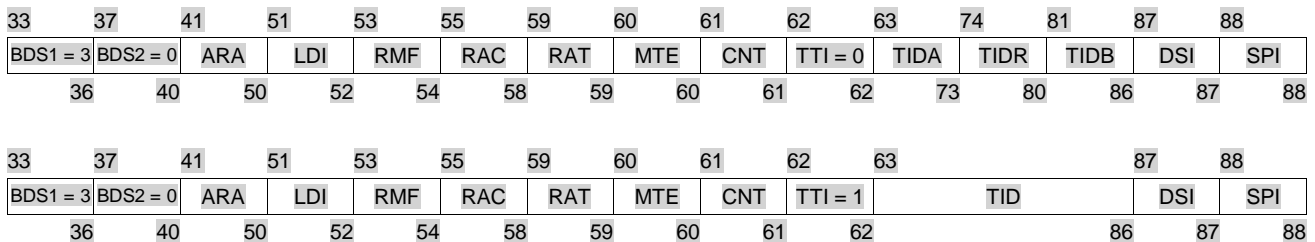
- 0 The RA is not suppressed
- 1 The RA is suppressed (not announced to the flight crew)

For multi-threat encounters, suppression does not apply, so the SPI subfield shall indicate the following designations:

**Coding**

- 0 No threat other than the one defined in TID is designated for Xo
- 1 Another threat is designated for Xo, and the designation is applied

*Note.— For ACAS X compliant systems: Subfields in MB for an RA report.*



4.3.8.4.2.2.32 *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>	
43-46	0000	TCAS Version 7.1 compliant and other systems defined by bits 71 and 72
	0001	ACAS Xa (RTCA/DO-385 and EUROCAE/ED-256)
	0010 to	
	1111	Reserved for ACAS III
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 and EUROCAE/ED-143

1 1 **All later systems Reserved for future versions** (see Note 3 and 4.3.8.4.2.8)

*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 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>.*

...

Origin	Rationale:
SP/3	<p>ACAS X subfield changes.</p> <p>Format change of subfield in Message, Comm-B (MB) for RA report is required to accommodate ACAS X. As indicated in the note under 4.3.8.4.2.2, 4.3.8.4.2.2.1 is applicable to TCAS 7.1 compliant systems while 4.3.8.4.2.2.2 is applicable to ACAS X compliant systems. 4.3.8.4.2.2.3 is applicable to both TCAS 7.1 and ACAS X compliant systems.</p>

4.3.8.4.2.3.2.1 *MTB (multiple threat bit).* This 1-bit (42) subfield shall indicate the presence or absence of multiple threats.

*Coding*

- 0 Interrogating ACAS has **not more than** one threat
- 1 Interrogating ACAS has **more than** one threat

...

**4.3.8.4.2.3.4 Subfields in MU for an RA broadcast (RA broadcast interrogation message)**

*Note. — 4.3.8.4.2.3.4.1 is only applicable to TCAS Version 7.1 compliant systems, while 4.3.8.4.2.3.4.2 is only applicable to ACAS X compliant systems.*

**4.3.8.4.2.3.4.1 For TCAS Version 7.1 compliant systems: Subfields in MU for an RA broadcast (RA broadcast interrogation message).** When UDS1 = 3 and UDS2 = 1, the following subfields shall be contained in MU:

4.3.8.4.2.3.4.1.1 *ARA (active RAs).* This 14-bit (41-54) subfield shall be coded as defined in 4.3.8.4.2.2.1.1.

4.3.8.4.2.3.4.1.2 *RAC (RACs record).* This 4-bit (55-58) subfield shall be coded as defined in 4.3.8.4.2.2.1.2.

4.3.8.4.2.3.4.1.3 *RAT (RA terminated indicator)*. This 1-bit (59) subfield shall be coded as defined in 4.3.8.4.2.2.1.3.

4.3.8.4.2.3.4.1.4 *MTE (multiple threat encounter)*. This 1-bit (60) subfield shall be coded as defined in 4.3.8.4.2.2.1.4.

4.3.8.4.2.3.4.1.5 *AID (Mode A identity code)*. This 13-bit (63-75) subfield shall denote the Mode A identity code of the reporting aircraft.

...

4.3.8.4.2.3.4.1.6 *CAC (Mode C altitude code)*. This 13-bit (76-88) subfield shall denote the Mode C altitude code of the reporting aircraft.

...

4.3.8.4.2.3.4.2 *For ACAS X compliant systems: Subfields in MU for an RA broadcast (RA broadcast interrogation message)*. When  $UDS1 = 3$  and  $UDS2 = 1$ , the following subfields shall be contained in MU:

4.3.8.4.2.3.4.2.1 *ARA (active RAs)*. This 10-bit (41-50) subfield shall be coded as defined in 4.3.8.4.2.2.2.1.

4.3.8.4.2.3.4.2.2 *LDI (low-level descend inhibit)*. This 2-bit (51-52) subfield shall be coded as defined in 4.3.8.4.2.2.2.2.

4.3.8.4.2.3.4.2.3 *RMF (RA message format)*. This 2-bit (53-54) subfield shall be coded as defined in 4.3.8.4.2.2.2.3.

4.3.8.4.2.3.4.2.4 *RAC (RACs record)*. This 4-bit (55-58) subfield shall be coded as defined in 4.3.8.4.2.2.2.4.

4.3.8.4.2.3.4.2.5 *RAT (RA terminated indicator)*. This 1-bit (59) subfield shall be coded as defined in 4.3.8.4.2.2.2.5.

4.3.8.4.2.3.4.2.6 *MTE (multiple threat encounter)*. This 1-bit (60) subfield shall be coded as defined in 4.3.8.4.2.2.2.6.

4.3.8.4.2.3.4.2.7 *SPI (Suppression indicator)*. This 1-bit (61) subfield shall be coded as defined in 4.3.8.4.2.2.2.11.

4.3.8.4.2.3.4.2.8 *AID (Mode A identity code)*. This 13-bit (63-75) subfield shall denote the Mode A identity code of the reporting aircraft.

*Coding*

Bit	63	64	65	66	67	68	69	70	71	72	73	74	75
Mode A code bit	A <sub>4</sub>	A <sub>2</sub>	A <sub>1</sub>	B <sub>4</sub>	B <sub>2</sub>	B <sub>1</sub>	0	C <sub>4</sub>	C <sub>2</sub>	C <sub>1</sub>	D <sub>4</sub>	D <sub>2</sub>	D <sub>1</sub>

4.3.8.4.2.3.4.2.9 *CAC (Mode C altitude code)*. This 13-bit (76-88) subfield shall denote the Mode C altitude code of the reporting aircraft.

Coding		76	77	78	79	80	81	82	83	84	85	86	87	88
Bit														
Mode C code bit		C <sub>1</sub>	A <sub>1</sub>	C <sub>2</sub>	A <sub>2</sub>	C <sub>4</sub>	A <sub>4</sub>	0	B <sub>1</sub>	D <sub>1</sub>	B <sub>2</sub>	D <sub>2</sub>	B <sub>4</sub>	D <sub>4</sub>

Note. — Structure of MU for an RA broadcast:

33	37	41	51	53	55	59	60	61	62	63	76
UDS1 = 3	UDS2 = 1	ARA	LDI	RMF	RAC	RAT	MTE	SPI	-1-	AID	CAC
36	40	50	52	54	58	59	60	61	62	75	88

<p><b>Origin</b> SP/3</p>	<p><b>Rationale:</b></p> <p>ACAS X subfield changes.</p> <p>Format change of subfield in MU (uplink Message, ACAS) for an RA broadcast is required to accommodate ACAS X. As indicated in the note under 4.3.8.4.2.3.4, 4.3.8.4.2.3.4.1 is only applicable to TCAS 7.1 compliant systems, while 4.3.8.4.2.3.4.2 is only applicable to ACAS X compliant systems.</p>
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4.3.8.4.2.4.2 Subfields in MV for a coordination reply

Note. — 4.3.8.4.2.4.2.1 is only applicable to TCAS Version 7.1 compliant systems, while 4.3.8.4.2.4.2.2 is only applicable to ACAS X compliant systems.

4.3.8.4.2.4.2.1 For TCAS Version 7.1 compliant systems: Subfields in MV for a coordination reply. When VDS1 = 3 and VDS2 = 0, the following subfields shall be contained in MV:

4.3.8.4.2.4.2.1.1 ARA (active RAs). This 14-bit (41-54) subfield shall be coded as defined in 4.3.8.4.2.2.1.1.

4.3.8.4.2.4.2.1.2 RAC (RACs record). This 4-bit (55-58) subfield shall be coded as defined in 4.3.8.4.2.2.1.2.

4.3.8.4.2.4.2.1.3 RAT (RA terminated indicator). This 1-bit (59) subfield shall be coded as defined in 4.3.8.4.2.2.1.3.

4.3.8.4.2.4.2.1.4 MTE (multiple threat encounter). This 1-bit (60) subfield shall be coded as defined in 4.3.8.4.2.2.1.4.

...

4.3.8.4.2.4.2.2 For ACAS X compliant systems: Subfields in MV for a coordination reply. When VDS1 = 3 and VDS2 = 0, the following subfields shall be contained in MV:

4.3.8.4.2.4.2.2.1 ARA (active RAs). This 10-bit (41-50) subfield shall be coded as defined in 4.3.8.4.2.2.1.1.

4.3.8.4.2.4.2.2.2 *LDI (low-level descend inhibit)*. This 2-bit (51-52) subfield shall be coded as defined in 4.3.8.4.2.2.2.2.

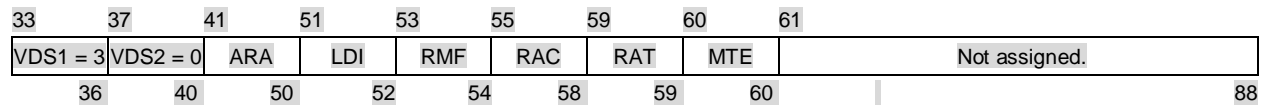
4.3.8.4.2.4.2.2.3 *RMF (RA message format)*. This 2-bit (53-54) subfield shall be coded as defined in 4.3.8.4.2.2.2.3.

4.3.8.4.2.4.2.2.4 *RAC (RACs record)*. This 4-bit (55-58) subfield shall be coded as defined in 4.3.8.4.2.2.2.4.

4.3.8.4.2.4.2.2.5 *RAT (RA terminated indicator)*. This 1-bit (59) subfield shall be coded as defined in 4.3.8.4.2.2.2.5.

4.3.8.4.2.4.2.2.6 *MTE (multiple threat encounter)*. This 1-bit (60) subfield shall be coded as defined in 4.3.8.4.2.2.2.6.

*Note.* — *Structure of MV for a coordination reply:*



<b>Origin</b>  SP/3	<b>Rationale:</b>  ACAS X subfield changes.  Format change of subfield in MV (downlink Message, ACAS) for a coordination reply is required to accommodate ACAS X. As indicated in the note under 4.3.8.4.2.4.2, 4.3.8.4.2.4.2.1 is only applicable to TCAS 7.1 compliant systems, while 4.3.8.4.2.4.2.2 is only applicable to ACAS X compliant systems.
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4.3.8.4.2.5 *SL (sensitivity level report)*. This 3-bit (9-11) downlink field shall be included in both short and long air-air reply formats (DF = 0 and 16). This field shall denote the sensitivity level at which ACAS is currently operating.

*Coding*

- 0 ACAS inoperative
- 1 ACAS is operating at sensitivity level 1
- 2 ACAS is operating at sensitivity level 2
- 3 ACAS is operating at sensitivity level 3
- 4 ACAS is operating at sensitivity level 4
- 5 ACAS is operating at sensitivity level 5
- 6 ACAS is operating at sensitivity level 6
- 7 ACAS is operating at sensitivity level 7

*Note.* — *For ACAS X compliant systems: ACAS will not transmit an SL code greater than 3.*

...

4.3.8.4.2.7 For ACAS X compliant systems: Extended squitter ME field for use in air-to-air coordination. This 56-bit (33-88) field shall be used for air-to-air coordination involving ADS-B only equipped intruders (intruders that cannot receive a discrete 1 030 MHz resolution message).

*Note.* — ADS-B messages with TYPE code = 28 (ADS-B operational coordination message, refer to 4.3.8.4.2.7.1) and TYPE code = 31 (ADS-B aircraft operational status message, refer to 4.3.8.4.2.7.2) are used in air-to-air coordination.

#### 4.3.8.4.2.7.1 Subfields in ME for ADS-B operational coordination message (OCM).

*Note.* — In the subfields defined below, the bit number is relative to the start of the extended squitter, where bit 33 is the start of the ME message field.

4.3.8.4.2.7.1.1 TYPE. This 5-bit (33-37) subfield that defines the type of extended squitter shall be set to 28 for the ADS-B OCM.

4.3.8.4.2.7.1.2 Subtype. This 3-bit (38-40) subfield that further defines TYPE shall be set to 3 for the ADS-B OCM.

4.3.8.4.2.7.1.3 MTB (multiple threat bit). This 1-bit (42) subfield shall indicate a multiple threat according to the codes as defined in 4.3.8.4.2.3.

4.3.8.4.2.7.1.4 CVC (cancel vertical RAC). This 2-bit (43-44) subfield shall be used by airborne ACAS X equipment to cancel a vertical resolution advisory complement sent to an ACAS equipped threat aircraft with codes as defined in 4.3.8.4.2.3.

4.3.8.4.2.7.1.5 VRC (vertical RAC). This 2-bit (45-46) subfield shall be used by airborne ACAS X equipment to send a vertical resolution advisory complement (“do not pass above” or “do not pass below”) to an ACAS equipped threat aircraft with codes as defined in 4.3.8.4.2.3.

4.3.8.4.2.7.1.6 CHC (cancel horizontal RAC). This 3-bit (47-49) subfield shall be used by ACAS X with horizontal on-board resolution equipment to cancel a horizontal resolution advisory complement sent to an ACAS equipped threat aircraft with codes as defined in 4.3.8.4.2.3. The CHC shall be set to 0 in TCAS resolution messages transmitted by ACAS X without horizontal resolution capability.

4.3.8.4.2.7.1.7 HRC (horizontal RAC). This 3-bit (50-52) subfield shall be used by ACAS X with horizontal on-board resolution equipment to send a horizontal resolution advisory complement to manoeuvre (“do not turn left” or “do not turn right”) to the ACAS equipped threat aircraft with codes as defined in 4.3.8.4.2.3. The HRC shall be set to 0 in ADS-B OCMs transmitted by ACAS X without horizontal resolution capability.

4.3.8.4.2.7.1.8 HSB (horizontal sense bits subfield). This 5-bit (53-57) subfield shall be used as a parity coding field to protect the six horizontal sense bits (47-52). The originating aircraft equipped with ACAS which is capable of 1 030/1 090 MHz transmission and that sends a coordination message shall include bits 53-57 with code as defined in 4.3.8.4.2.3 in all ADS-B OCMs sent. The receiving ACAS X aircraft shall examine HSB (bits 53-57) in the ADS-B OCMs. If the six vertical sense bits (47-52) are not in agreement with the HSB (bits 53-57), the receiving ACAS X aircraft detects there is an error in the message and shall not use the message contents.

4.3.8.4.2.7.1.9 VSB (vertical sense bits subfield). This 4-bit (58-61) subfield shall be used as a parity coding field to protect the four vertical sense bits (43-46). The originating active ACAS shall include

VSB (bits 58-61) with codes as defined in 4.3.8.4.2.3 in all operational coordination messages sent. The receiving ACAS X shall examine VSB (bits 58-61) in operational coordination messages received. If four vertical sense bits (43-46) are not in agreement with VSB (bits 58-61), the receiving ACAS X aircraft detects there is an error in the message and shall not use the message contents.

4.3.8.4.2.7.1.10 *TAA (threat identity aircraft address)*. This 24-bit (65-88) subfield shall contain the 24-bit aircraft address of the threat with codes as defined in 4.3.8.4.2.3.

*Note.* —The structure of ME for an operational coordination message is:

Position	# of bits	Subfield	Remarks
33-37	5	TYPE	= 28
38-40	3	Subtype	= 3
41	1	-	Not assigned
42	1	MTB	-
43-44	2	CVC	-
45-46	2	VRC	-
47-49	3	CHC	-
50-52	3	HRC	-
53-57	5	HSB	-
58-61	4	VSB	-
62-64	3	-	Not assigned
65-88	24	TAA	-

4.3.8.4.2.7.2 *Subfields in ME for aircraft operational status message.*

*Note.* — In the subfields defined below, the bit number is relative to the start of the extended squitter, where bit 33 is the start of the ME message field.

4.3.8.4.2.7.2.1 *TYPE*. This 5-bit (33-37) subfield that defines the type of extended squitter shall be set to 31 for the Aircraft operational status message.

4.3.8.4.2.7.2.2 *Subtype*. This 3-bit (38-40) subfield that further defines TYPE shall be set to 0 for airborne aircraft and 1 for surface aircraft. For ACAS X air-to-air coordination purposes, Subtype shall always be set to 0.

4.3.8.4.2.7.2.3 *CC (airborne capability class code)*. This 16-bit (41-56) subfield which is part of Subtype=0 messages shall be coded as defined in 4.3.8.4.2.7.2.3.1 to 4.3.8.4.2.7.2.3.4.

4.3.8.4.2.7.2.3.1 *Bit (41-42)*. This 2-bit (41-42) subfield shall be set to 0 for ACAS air-to-air coordination purposes.

4.3.8.4.2.7.2.3.2 *CA Operational (collision avoidance operational)*. This 1-bit (43) subfield shall be set to 1 to indicate that a collision avoidance system is available and operational and capable of issuing resolution advisories. When this bit is set to 1, the collision avoidance coordination capability bits shall be examined to provide detailed coordination information.

*Note.* — For all TCAS II versions and ACAS X compliant systems, the associated Mode S transponder sets the CA Operational bit=1 when RI=3 or 4.

4.3.8.4.2.7.2.3.3 Bits (44-54) shall not be used by the ACAS X air-to-air coordination process but are reserved for future use.

4.3.8.4.2.7.2.3.4 *DAA (detect and avoid)*. This 2-bit (55-56) subfield shall be used as defined below:

00	No DAA capability or no capability of DAA system to receive CA coordination information
01	Aircraft has a DAA system capable of receiving TCAS resolution messages and ADS-B OCMs
10	Aircraft has a DAA system capable of receiving only ADS-B OCMs
11	Not defined

*Note 1. — The DAA bits indicate whether and what type of coordination information needs to be provided to the aircraft so that the DAA system of the threat aircraft can listen and provide guidance that is interoperable with ACAS. These bits are independent of the CA Coordination capability bits, as aircraft with a DAA system may or may not have an ACAS. For more details of DAA bits, refer to RTCA/DO-365.*

*Note 2. — The type of coordination message transmitted, resolution message or ADS-B OCM, depends both on the receive capability of the DAA system and on the transmit capability of the ACAS. If the DAA system can receive both the resolution message and the OCM, an ACAS with 1 030 MHz transmit capability is required to transmit the resolution message.*

4.3.8.4.2.7.2.4 *OM (airborne operational mode)*. This 16-bit (57-72) subfield which is part of Subtype=0 messages shall be coded as defined in 4.3.8.4.2.7.2.4.1 to 4.3.8.4.2.7.2.4.3.

4.3.8.4.2.7.2.4.1 *Bits (57-58)*. This 2-bit (57-58) subfield shall be set to 0 for ACAS X air-to-air coordination purposes.

4.3.8.4.2.7.2.4.2 *Bits (59-64) and Bit 72*. The bits (59-64) and bit 72 shall not be used by the ACAS X air-to-air coordination process.

4.3.8.4.2.7.2.4.3 *CCCB (collision avoidance coordination capability bits)*. This 7-bit (65-71) subfield shall be used as defined below:

Vertical and horizontal (2 bits (65-66))

00	Vertical
01	Horizontal
10	Blended
11	Reserved

Aircraft CAS Type / Capability (3 bits (67-69))

000	Active ACAS (TCAS II)
001	Active ACAS (except all TCAS II)
010	Active ACAS (except all TCAS II) with OCM transmit capability
011	Responsive ACAS
100	Passive ACAS with 1 030 MHz resolution message receive capability
101	Passive ACAS with only OCM receive capability
110 to 111	Reserved

Reserved (2 bits (70-71))

00 to 11

Intended for unmanned aircraft systems use

*Note1. — The two reserved bits marked ‘Intended for unmanned aircraft systems use’ are envisioned as a priority field to distinguish among users with different levels of capability or as directed by regulatory authorities.*

<b>Origin</b>	<b>Rationale:</b>
SP/3	<p>Air-air coordination involving ADS-B only equipped intruders.</p> <p>The addition of 4.3.8.4.2.7 is proposed for ACAS X to support the use of the extended squitter ME field for air-to-air coordination involving ADS-B only equipped intruders.</p>

4.3.8.4.2.8 *ACAS Unit Part Number and ACAS Software Part Number.* ACAS shall transmit its unit part number to transponder register E5<sub>16</sub> and shall transmit its software part number to transponder register E6<sub>16</sub>.

*Note. — The data formats for transponder registers E5<sub>16</sub> and E6<sub>16</sub> are specified in the Technical Provisions for Mode S Services and Extended Squitter (Doc 9871).*

<b>Origin</b>	<b>Rationale:</b>
SP/3	<p>The addition of the provision is proposed to identify ACAS unit part number and software part number.</p>

### 4.3.9 ACAS equipment characteristics

4.3.9.1 *Interfaces.* As a minimum, the following input data shall be provided to the ACAS:

- a) aircraft address code;
- b) air-air and ground-air Mode S transmissions received by the Mode S transponder for use by ACAS (4.3.6.3.2);
- c) own aircraft’s maximum cruising true airspeed capability (Chapter 3, 3.1.2.8.2.2);
- d) pressure-altitude; ~~and~~
- e) radio altitude;
- f) operating mode control (ACAS accepting automatic, standby, TA only and TA/RA Mode);
- g) for ACAS X compliant systems: heading;

- h) for ACAS X compliant systems: GNSS own aircraft’s position and velocity;
- i) for ACAS X compliant systems: ADS-B airborne and surface position, airborne velocity, target state and status, and aircraft operational status messages from other aircraft for use by ACAS; and
- j) for ACAS X-compliant systems with Xo special modes available: Designation information for special operation mode.

*Note.* — *Specific requirements for additional inputs for ACAS II and III are listed in the appropriate sections below.*

...

Origin	Rationale:
SP/3	The Addition of the input data listed from f) to j) is required for ACAS X operation. Also the extensive review of Chapter 4 identified the need to add f) for existing ACAS II operation as well; therefore, f) is not specific to ACAS X.

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

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##### 4.3.11.2.2 Data transfer from Mode S transponder to its ACAS:

- a) For TCAS Version 7.1 compliant systems: The Mode S transponder shall transfer to its ACAS received sensitivity level control commands (4.3.8.4.2.1.1) transmitted by Mode S stations;
- b) the Mode S transponder shall transfer to its ACAS received ACAS broadcast messages (4.3.8.4.2.3.3) transmitted by other ACASs;
- c) the Mode S transponder shall transfer to its ACAS received resolution messages (4.3.8.4.2.3.2) transmitted by other ACASs for air-air coordination purposes; and
- d) the Mode S transponder shall transfer to its ACAS own aircraft’s Mode A identity data for transmission in an RA broadcast (4.3.8.4.2.3.4.5).

...

#### 4.4 PERFORMANCE OF THE ACAS II COLLISION AVOIDANCE LOGIC

*Note 1.* — *Caution is to be observed when considering potential improvements to ~~the reference ACAS II system described in Section 3.17 of the Airborne Collision Avoidance System (ACAS) Manual (Doc 9863)~~ ACAS since changes may affect more than one aspect of the system performance. It is essential that alternative designs would not degrade the performances of other designs and that such compatibility is demonstrated with a high degree of confidence. The performance specified in Section 4.4 is based on the performance achieved by TCAS Version 7.1 compliant systems.*

*Note 2. — The performance of ACAS X compliant systems is improved compared to the performance of TCAS Version 7.1 compliant systems in all categories listed in Section 4.4.*

...

<b>Origin</b>	<b>Rationale:</b>
SP/3	Amendment to the Note and addition of Note 2 are proposed to clarify that:  a) section 4.4 was defined based on existing ACAS II performance (i.e. TCAS 7.1); and  b) the performance of ACAS X compliant systems was demonstrated to be superior to the performance of TCAS 7.1 compliant systems in all categories listed in section 4.4.

**INITIAL PROPOSAL 2**

...

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

...

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

...

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

4.5.1.6.2 Adequate protection against residual ADS-B position data shall be provided in track state computation when transitioning from passive to active surveillance, in order to avoid unnecessary advisories during such transitions.

*Note.— A suitable means of protection can be found in RTCA DO-300 Change 2 and 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, Section 2.2.6.2.*

4.5.1.6.23 A track under active surveillance shall transition to passive surveillance if it is neither a near threat, 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-300A Change 1/EUROCAE ED-221A – Minimum Operational Performance Standards (MOPS) for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance.*

<b>Origin</b>	<b>Rationale:</b>
SP/3	This proposal is to reduce the occurrences of false ACAS alerts on aircraft equipped with current ACAS (TCAS version 7.1) with hybrid surveillance capability. The use of passive ADS-B position data in the threat detection logic sometimes leads to such false RAs which are due to jumps in the ADS-B position data of the intruding aircraft. These jumps occur because of variations in the processing delays within the avionics.

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ATTACHMENT C to State letter AN 7/1.3.105-20/42

**RESPONSE FORM TO BE COMPLETED AND RETURNED TO ICAO TOGETHER  
WITH ANY COMMENTS YOU MAY HAVE ON THE PROPOSED AMENDMENT**

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

(State) \_\_\_\_\_

Please make a checkmark (✓) against one option for each amendment. If you choose options “agreement with comments” or “disagreement with comments”, **please provide your comments on separate sheets.**

	<i>Agreement without comments</i>	<i>Agreement with comments*</i>	<i>Disagreement without comments</i>	<i>Disagreement with comments</i>	<i>No position</i>
Amendment to Annex 10 — <i>Aeronautical Telecommunications, Volume IV — Surveillance and Collision Avoidance Systems</i> (Attachment B refers)					

\*“Agreement with comments” indicates that your State or organization agrees with the intent and overall thrust of the amendment proposal; the comments themselves may include, as necessary, your reservations concerning certain parts of the proposal and/or offer an alternative proposal in this regard.

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

— END —