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AMENDMENT No. 85

TO THE

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME I

(RADIO NAVIGATION AIDS)

The amendment to Annex 10, Volume I, contained in this document was adopted by the Council of ICAO on **26 February 2010**. Such parts of this amendment as have not been disapproved by more than half of the total number of Contracting States on or before **12 July 2010** will become effective on that date and will become applicable on **18 November 2010** as specified in the Resolution of Adoption. (State letter AN 7/1.1.45 – 10/28 refers.)

FEBRUARY 2010

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENT 85 TO THE INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

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 26 February 2010 Amendment 85 to the International Standards and Recommended Practices contained in the document entitled *International Standards and Recommended Practices, Aeronautical Telecommunications* which for convenience is designated Annex 10 to the Convention;

2. *Prescribes* 12 July 2010 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 18 November 2010;

4. *Requests the Secretary General*:

   a) to notify each Contracting State immediately of the above action and immediately after 12 July 2010 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 18 November 2010 between its national regulations or practices and the provisions of the Standards in the Annex as hereby amended, such notification to be made before 18 October 2010, and thereafter to notify the Organization of any further differences that arise;

      2) to notify the Organization before 18 October 2010 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, when the notification of such differences is important for the safety of air navigation, 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 I

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:

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2.	New text to be inserted is highlighted with grey shading.	new text to be inserted
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TEXT OF AMENDMENT 85 TO THE INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

ANNEX 10 — *AERONAUTICAL TELECOMMUNICATIONS*

VOLUME I
(RADIO NAVIGATION AIDS)

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CHAPTER 3. SPECIFICATIONS FOR RADIO NAVIGATION AIDS

3.1 Specification for ILS

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3.1.3.3 *Coverage*

Note.— Guidance material on localizer coverage is given in 2.1.10 and Figures C-7A, C-7B, C-8A and C-8B of Attachment C.

3.1.3.3.1 The localizer shall provide signals sufficient to allow satisfactory operation of a typical aircraft installation within the localizer and glide path coverage sectors. The localizer coverage sector shall extend from the centre of the localizer antenna system to distances of:

46.3 km (25 NM) within plus or minus 10 degrees from the front course line;

31.5 km (17 NM) between 10 degrees and 35 degrees from the front course line;

18.5 km (10 NM) outside of plus or minus 35 degrees from the front course line if coverage is provided;

except that, where topographical features dictate or operational requirements permit, the limits may be reduced down to 33.3 km (18 NM) within the plus or minus 10-degree sector and 18.5 km (10 NM) within the remainder of the coverage when alternative navigational ~~facilities~~ means provide satisfactory coverage within the intermediate approach area. The localizer signals shall be receivable at the distances specified at and above a height of 600 m (2 000 ft) above the elevation of the threshold, or 300 m (1 000 ft) above the elevation of the highest point within the intermediate and final approach areas, whichever is the higher, except that, where needed to protect ILS performance and if operational requirements permit, the lower limit of coverage at angles beyond 15 degrees from the front course line shall be raised linearly from its height at 15 degrees to as high as 1 350 m (4 500 ft) above the elevation of the threshold at 35 degrees from the front course line. Such signals shall be receivable, to the distances specified, up to a surface extending outward from the localizer antenna and inclined at 7 degrees above the horizontal.

Note.— Where intervening obstacles penetrate the lower surface, it is intended that guidance need not be provided at less than line-of-sight heights ~~Guidance material on localizer coverage is given in 2.1.11 of Attachment C~~.

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3.7 Requirements for the Global Navigation Satellite System (GNSS)

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3.7.3.2 *GLONASS Channel of Standard Accuracy (CSA) (L1)*

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3.7.3.2.1.1 *Positioning accuracy*. The GLONASS CSA position errors shall not exceed the following limits:

	Global average 95% of the time	Worst site 95% of the time
Horizontal position error	~~19~~ 5 m (~~62~~ 17 ft)	~~44~~ 12 m (~~146~~ 40 ft)
Vertical position error	~~29~~ 9 m (~~96~~ 29 ft)	~~93~~ 25 m (~~308~~ 97 ft)

3.7.3.2.1.2 *Time transfer accuracy*. The GLONASS CSA time transfer errors shall not exceed 700 nanoseconds 95 per cent of the time.

3.7.3.2.1.3 *Range domain accuracy*. The range domain error shall not exceed the following limits:

a) range error of any satellite — ~~30~~ 18 m (~~98.43~~59.7 ft);

b) range rate error of any satellite — ~~0.04~~0.02 m (~~0.12~~0.07 ft) per second;

c) range acceleration error of any satellite — ~~0.013~~0.007 m (~~0.039~~0.023 ft) per second squared;

d) root-mean-square range error over all satellites — ~~7~~ 6 m (~~22.97~~19.9 ft).

3.7.3.2.2 *Availability*. The GLONASS CSA availability shall be as follows:

a) ≥99 per cent horizontal service availability, average location (~~44~~ 12 m, 95 per cent threshold);

b) ≥99 per cent vertical service availability, average location (~~93~~ 25 m, 95 per cent threshold);

c) ≥90 per cent horizontal service availability, worst-case location (~~44~~ 12 m, 95 per cent threshold);

d) ≥90 per cent vertical service availability, worst-case location (~~93~~ 25 m, 95 per cent threshold).

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Table 3.7.2.4-1 Signal-in-space performance requirements

Typical operation	Accuracy horizontal 95% (Notes 1 and 3)	Accuracy vertical 95% (Notes 1 and 3)	Integrity (Note 2)	Time-to-alert (Note 3)	Continuity (Note 4)	Availability (Note 5)
En-route	3.7 km (2.0 NM)	N/A	$1 - 1 \times 10^{-7}$/h	5 min	$1 - 1 \times 10^{-4}$/h to $1 - 1 \times 10^{-8}$/h	0.99 to 0.99999
En-route, Terminal	0.74 km (0.4 NM)	N/A	$1 - 1 \times 10^{-7}$/h	15 s	$1 - 1 \times 10^{-4}$/h to $1 - 1 \times 10^{-8}$/h	0.99 to 0.99999
Initial approach, Intermediate approach, Non-precision approach (NPA), Departure	220 m (720 ft)	N/A	$1 - 1 \times 10^{-7}$/h	10 s	$1 - 1 \times 10^{-4}$/h to $1 - 1 \times 10^{-8}$/h	0.99 to 0.99999
Approach operations with vertical guidance (APV-I)	16.0 m (52 ft)	20 m (66 ft)	$1 - 2 \times 10^{-7}$ in any approach	10 s	$1 - 8 \times 10^{-6}$ per 15 s	0.99 to 0.99999
Approach operations with vertical guidance (APV-II)	16.0 m (52 ft)	8.0 m (26 ft)	$1 - 2 \times 10^{-7}$ in any approach	6 s	$1 - 8 \times 10^{-6}$ per 15 s	0.99 to 0.99999
Category I precision approach (Note 7)	16.0 m (52 ft)	6.0 m to 4.0 m (20 ft to 13 ft) (Note 6)	$1 - 2 \times 10^{-7}$ in any approach	6 s	$1 - 8 \times 10^{-6}$ per 15 s	0.99 to 0.99999

NOTES.—

1. The 95th percentile values for GNSS position errors are those required for the intended operation at the lowest height above threshold (HAT), if applicable. Detailed requirements are specified in Appendix B and guidance material is given in Attachment D, 3.2.
2. The definition of the integrity requirement includes an alert limit against which the requirement can be assessed. For Category I precision approach, a vertical alert limit (VAL) greater than 10 m for a specific system design may only be used if a system-specific safety analysis has been completed. Further guidance on the alert limits is provided in Attachment D, 3.3.6 to 3.3.10. These alert limits are:
   ~~A range of vertical limits for Category I precision approach relates to the range of vertical accuracy requirements.~~

Typical operation	Horizontal alert limit	Vertical alert limit
En-route (oceanic/continental low density)	7.4 km (4 NM)	N/A
En-route (continental)	3.7 km (2 NM)	N/A
En-route, Terminal	1.85 km (1 NM)	N/A
NPA	556 m (0.3 NM)	N/A
APV-I	40 m (130 ft)	50 m (164 ft)
APV- II	40.0 m (130 ft)	20.0 m (66 ft)
Category I precision approach	40.0 m (130 ft)	~~15.0~~35.0 m to 10.0 m (~~50~~ 115 ft to 33 ft)

3. The accuracy and time-to-alert requirements include the nominal performance of a fault-free receiver.
4. Ranges of values are given for the continuity requirement for en-route, terminal, initial approach, NPA and departure operations, as this requirement is dependent upon several factors including the intended operation, traffic density, complexity of airspace and availability of alternative navigation aids. The lower value given is the minimum requirement for areas with low traffic density and airspace complexity. The higher value given is appropriate for areas with high traffic density and airspace complexity (see Attachment D, 3.4.2). Continuity requirements for APV and Category I operations apply to the average risk (over time) of loss of service, normalized to a 15-second exposure time (see Attachment D, 3.4.3).
5. A range of values is given for the availability requirements as these requirements are dependent upon the operational need which is based upon several factors including the frequency of operations, weather environments, the size and duration of the outages, availability of alternate navigation aids, radar coverage, traffic density and reversionary operational procedures. The lower values given are the minimum availabilities for which a system is

considered to be practical but are not adequate to replace non-GNSS navigation aids. For en-route navigation, the higher values given are adequate for GNSS to be the only navigation aid provided in an area. For approach and departure, the higher values given are based upon the availability requirements at airports with a large amount of traffic assuming that operations to or from multiple runways are affected but reversionary operational procedures ensure the safety of the operation (see Attachment D, 3.5).

6. A range of values is specified for Category I precision approach. The 4.0 m (13 feet) requirement is based upon ILS specifications and represents a conservative derivation from these specifications (see Attachment D, 3.2.7).
7. GNSS performance requirements for Category II and III precision approach operations are under review and will be included at a later date.
8. The terms APV-I and APV-II refer to two levels of GNSS approach and landing operations with vertical guidance (APV) and these terms are not necessarily intended to be used operationally.

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APPENDIX B. TECHNICAL SPECIFICATIONS FOR THE GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

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3.2 Global navigation satellite system (GLONASS) channel of standard accuracy (CSA) (L1)

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3.2.5 COORDINATE SYSTEM

3.2.5.1 *PZ-90 (Parameters of common terrestrial ellipsoid and gravitational field of the earth 1990).* The GLONASS broadcast ephemeris shall describe a position of transmitting antenna phase centre of a given satellite in the PZ-90 earth-centred earth-fixed reference frame.

3.2.5.2 *Conversion between PZ-90 and WGS-84.* The following conversion parameters shall be used to obtain position coordinates in WGS-84 from position coordinates in PZ-90 (Version 2):

$$\cancel{\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{WGS-84} = \begin{bmatrix} -1.1 \\ -0.3 \\ -0.9 \end{bmatrix} + (1-0.12\times10^{-6}) \begin{bmatrix} 1 & -0.82\times10^{-6} & 0 \\ +0.82\times10^{-6} & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{PZ-90}}$$

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{WGS-84} = \begin{bmatrix} -0.36 \\ +0.08 \\ +0.18 \end{bmatrix} + \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{PZ-90}$$

Note.— X, Y and Z are expressed in metres.

3.2.5.2.1 The conversion error shall not exceed ~~1.5~~ 0.1 metres (1 sigma) along each coordinate axis.

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ATTACHMENT C. INFORMATION AND MATERIAL FOR GUIDANCE IN THE APPLICATION OF THE STANDARDS AND RECOMMENDED PRACTICES FOR ILS, VOR, PAR, 75 MHz MARKER BEACONS (EN-ROUTE), NDB AND DME

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2. Material concerning ILS installations

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Editorial Note.— Replace entire section 2.1.10
with the following text and figures.

2.1.10 *Reducing localizer bends and areas with insufficient difference in depth of modulation (DDM)*

2.1.10.1 *Introduction.* Owing to site effects at certain locations, it is not always possible to produce with simple standard ILS installations localizer courses that are sufficiently free from troublesome bends or irregularities. If this is the case, it is highly preferable to use two radio frequency carriers to provide the standard coverage and signal characteristics. Additional guidance on two radio frequency carrier coverage is provided in 2.7. If standard coverage requirements still cannot be met, reducing radiation in the direction of objects and accepting an increase of the lower vertical coverage boundaries as permitted in Chapter 3, 3.1.3.3.1 may be employed.

2.1.10.2 *Reducing standard localizer coverage.* When using the coverage reduction option defined in 3.1.3.3.1, care needs to be taken to ensure that the reduced coverage volume is consistent with the minimum altitudes published for the instrument approach procedure. Additionally, normal vectoring operations should not be terminated and a clearance to intercept the localizer should not be issued until within the promulgated coverage area. This is sometimes referred to as the operational service volume.

2.1.10.2.1 *Operational considerations from an air traffic management perspective.* Instrument approach procedures must be designed to take into account any reduction in localizer coverage permitted by the Standard in Chapter 3, 3.1.3.3.1. This can be done either by ensuring that the procedure remains within localizer coverage or by providing alternative means to navigate. Consequently, a significant portion (2 NM minimum) of the initial segment must be within localizer coverage. Localizer coverage needs to be available sufficiently in advance of the area where controllers usually give the approach or intercept clearance to permit pilots to verify the Morse code identification (IDENT).

2.1.10.2.2 *Operational considerations from a pilot/aircraft perspective.* For aircraft equipped with automatic flight control systems (AFCS), localizer coverage needs to be available prior to the activation of the AFCS intercept mode (manual or automatic flight) with sufficient advance to permit checking the IDENT signal. When flying manually or when using an AFCS, pilots normally check the IDENT of the ILS facility and then wait to arm the mode enabling localizer intercept turn initiation and capture until after receiving the approach or intercept clearance. Ideally, additional aids (if included in the approach procedure) should permit a determination of the relationship between the aircraft position and the localizer front course line by the pilot.

End of new text.

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2.5 Diagrams (Figures C-6 to C-12 illustrate certain of the Standards contained in Chapter 3)

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Editorial Note.— Insert the following figure after Figure C-7 and *renumber* Figure C-7 as Figure C-7A.

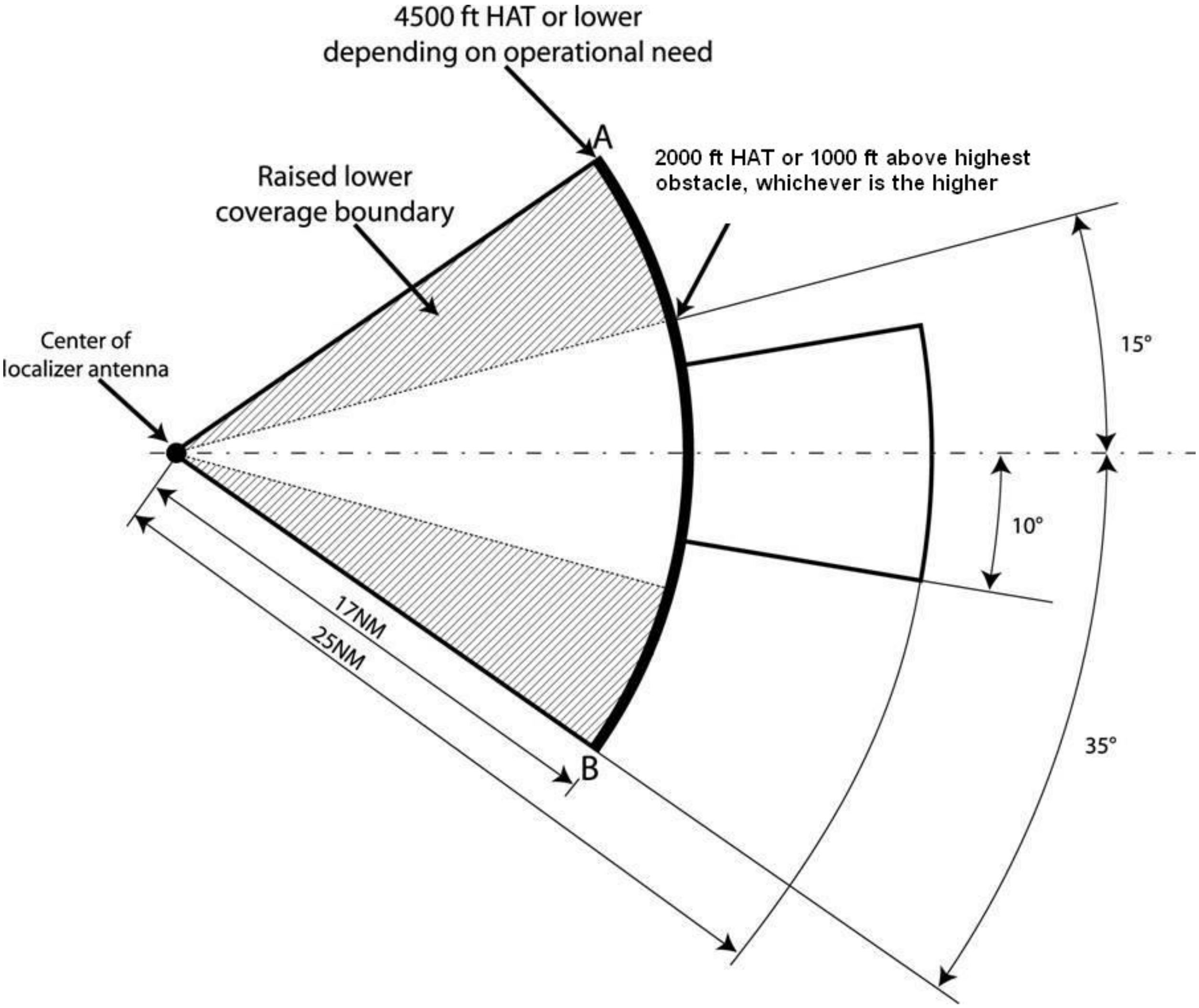

Figure C-7B. Reduced localizer coverage with respect to azimuth

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Editorial Note.— Insert the following figure after Figure C-8 and *renumber* Figure C-8 as Figure C-8A.

View from approach side of arc AB:

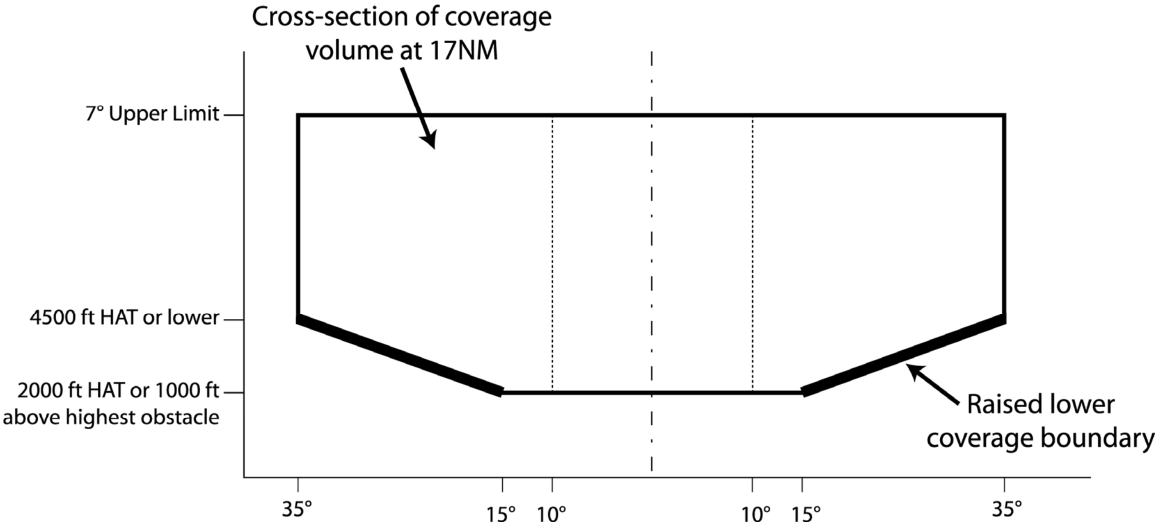

Figure C-8B. Reduced localizer coverage with respect to elevation

ATTACHMENT D. INFORMATION AND MATERIAL FOR GUIDANCE IN THE APPLICATION OF THE GNSS STANDARDS AND RECOMMENDED PRACTICES

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3.2 Accuracy

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3.2.7 A range of vertical accuracy values is specified for Category I precision approach operations which bounds the different values that may support an equivalent operation to ILS. A number of values have been derived by different groups, using different interpretations of the ILS standards. The lowest value from these derivations was adopted as a conservative value for GNSS; this is the minimum value given for the range. Because this value is conservative, and because GNSS error characteristics are different from ILS, it may be possible to achieve Category I operations using larger values of accuracy ~~and alert limits~~ within the range. The larger values would result in increased availability for the operation. The maximum value in the range has been proposed as a suitable value, subject to validation.

~~3.2.8 Specific alert limits have been defined for each augmentation system. For GBAS, technical provision has been made to broadcast the alert limit to aircraft. GBAS standards require the alert limit of 10 m. For SBAS, technical provisions have been made to standardize the alert limit through an updateable database (see *Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System (GPS/WAAS) Airborne Equipment* (RTCA/DO-229C)).~~

Editorial Note.— Renumber the following paragraphs.

. . .

3.3 Integrity and time-to-alert

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3.3.5 For APV and precision approach operations, integrity requirements for GNSS signal-in-space requirements of Chapter 3, Table 3.7.2.4-1, were selected to be consistent with ILS requirements.

Editorial Note.— Insert the following new paragraphs and *renumber* current paragraphs 3.3.6 to 3.3.10.

3.3.6 Alert limits for typical operations are provided in Note 2 to Table 3.7.2.4-1. A range of alert limits is specified for precision approach operations, reflecting potential differences in system design that may affect the operation. In ILS, monitor thresholds for key signal parameters are standardized, and the monitors themselves have very low measurement noise on the parameter that is being monitored. With differential GNSS, some system monitors have comparably large measurement uncertainty whose impact must be considered on the intended operation. In all cases, the effect of the alert limit is to restrict the satellite-user geometry to one where the monitor performance (typically in the pseudorange domain) is acceptable when translated into the position domain.

3.3.7 The smallest precision approach vertical alert limit (VAL) value (10 m) was derived based on the monitor performance of ILS as it could affect the glideslope at a nominal decision altitude of 200 ft above the runway threshold. By applying this alert limit, the GNSS error under faulted conditions can be directly compared to ILS error under faulted conditions, such that the GNSS errors are less than or equal to ILS errors. For those fault conditions with comparably large monitor noise in GNSS, this results in monitor thresholds that are more stringent than ILS.

3.3.8 The largest precision approach vertical alert limit value (35 m) was derived to ensure obstacle clearance equivalent to ILS for those error conditions which can be modelled as a bias during the final approach, taking into account that the aircraft decision altitude is independently derived from barometric pressure. An assessment has been conducted of the worst-case effect of a latent bias error equal to the alert limit of 35 m, concluding that adequate obstacle clearance protection is provided on the approach and missed approach (considering the decision altitude would be reached early or late, using an independent barometric altimeter). It is important to recognize that this assessment only addressed obstacle clearance and is limited to those error conditions which can be modelled as bias errors. Analysis has shown 35 m bias high and low conditions can be tolerated up to the approach speed category (category A through D) glide path angle limits in ICAO Doc 8168 without impinging on the ILS obstacle clearance surfaces.

3.3.9 Since the analysis of a 35 m VAL is limited in scope, a system-level safety analysis should be completed before using any value greater than 10 m for a specific system design. The safety analysis should consider obstacle clearance criteria and risk of collision due to navigation error, and the risk of unsafe landing due to navigation error, given the system design characteristics and operational environment (such as the type of aircraft conducting the approach and the supporting airport infrastructure). With respect to the collision risk, it is sufficient to confirm that the assumptions identified in 3.3.8 are valid for the use of a 35 m VAL. With respect to an unsafe landing, the principal mitigation for a navigation error is pilot intervention during the visual segment. Limited operational trials, in conjunction with operational expertise, have indicated that navigation errors of less than 15 m consistently result in acceptable touchdown performance. For errors larger than 15 m, there can be a significant increase in the flight crew workload and potentially a significant reduction in the safety margin, particularly for errors that shift the point where the aircraft reaches the decision altitude closer to the runway threshold where the flight crew may attempt to land with an unusually high rate of descent. The hazard severity of this event is major (see Doc 9859, *Safety Management Manual*). One acceptable means to manage the risks in the visual segment is for the system to comply with the following criteria:

a) the fault-free accuracy is equivalent to ILS. This includes system 95 per cent vertical NSE less than 4 m, and fault-free system vertical NSE exceeding 10 m with a probability less than 10^{-7} for each location where the operation is to be approved. This assessment is performed over all environmental and operational conditions under which the service is declared available;

b) under system failure conditions, the system design is such that the probability of an error greater than 15 m is lower than 10^{-5}, so that the likelihood of occurrence is remote. The fault conditions to be taken into account are the ones affecting either the core constellations or the GNSS augmentation under consideration. This probability is to be understood as the combination of the occurrence probability of a given failure with the probability of detection for applicable monitor(s). Typically, the probability of a single fault is large enough that a monitor is required to satisfy this condition.

3.3.10 For GBAS, technical provision has been made to broadcast the alert limit to aircraft. GBAS standards require the alert limit of 10 m. For SBAS, technical provisions have been made to specify the alert limit through an updateable database (see Attachment C).

End of new text.

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4.2 GLONASS

. . .

4.2.2 *Accuracy*. Accuracy is measured with a representative receiver and a measurement interval of 24 hours for any point within the coverage area. The positioning and timing accuracy are for the signal-in-space (SIS) only and do not include such error sources as: ionosphere, troposphere, interference, receiver noise or multipath. The accuracy is derived based on the worst two of 24 satellites being removed from the constellation and a ~~7~~6-metre constellation RMS SIS user range error (URE).

4.2.3 *Range domain accuracy*. Range domain accuracy is conditioned by the satellite indicating a healthy status and transmitting standard accuracy code and does not account for satellite failures outside of the normal operating characteristics. Range domain accuracy limits can be exceeded during satellite failures or anomalies while uploading data to the satellite. Exceeding the range error limit constitutes a major service failure as described in 4.2.6. The range rate error limit is the maximum for any satellite measured over any 3-second interval for any point within the coverage area. The range acceleration error limit is the maximum for any satellite measured over any 3-second interval for any point within the coverage area. The root-mean-square range error accuracy is the average of the RMS URE of all satellites over any 24-hour interval for any point within the coverage area. Under nominal conditions, all satellites are maintained to the same standards, so it is appropriate for availability modelling purposes to assume that all satellites have a ~~7~~6-metre RMS SIS URE. The standards are restricted to range domain errors allocated to space and control segments.

4.2.4 *Availability*. Availability is the percentage of time over any 24-hour interval that the predicted 95 per cent positioning error (due to space and control segment errors) is less than its threshold, for any point within the coverage area. It is based on a ~~44~~12-metre horizontal 95 per cent threshold and a ~~93~~25-metre vertical 95 per cent threshold, using a representative receiver and operating within the coverage area over any 24-hour interval. The service availability assumes the worst combination of two satellites out of service.

. . .

4.2.6 *Major service failure*. A major service failure is defined as a condition over a time interval during which a healthy GLONASS satellite's ranging signal error (excluding atmospheric and receiver errors) exceeds the range error limit of ~~30~~ 18 m (as defined in Chapter 3, 3.7.3.2.1.3 a)) and/or failures in radio frequency characteristics of the CSA ranging signal, navigation message structure or navigation message contents that deteriorate the CSA receiver's ranging signal reception or processing capabilities.

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— END —

AMENDMENT No. 85

TO THE

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME III
COMMUNICATION SYSTEMS
(Part I — Digital Data Communication Systems
Part II — Voice Communication Systems)

The amendment to Annex 10, Volume I, contained in this document was adopted by the Council of ICAO on **26 February 2010**. Such parts of this amendment as have not been disapproved by more than half of the total number of Contracting States on or before **12 July 2010** will become effective on that date and will become applicable on **18 November 2010** as specified in the Resolution of Adoption. (State letter AN 7/1.1.45 – 10/28 refers.)

FEBRUARY 2010

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENT 85 TO THE INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

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 26 February 2010 Amendment 85 to the International Standards and Recommended Practices contained in the document entitled *International Standards and Recommended Practices, Aeronautical Telecommunications* which for convenience is designated Annex 10 to the Convention;

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      1) to notify the Organization (in accordance with the obligation imposed by Article 38 of the Convention) of the differences that will exist on 18 November 2010 between its national regulations or practices and the provisions of the Standards in the Annex as hereby amended, such notification to be made before 18 October 2010, and thereafter to notify the Organization of any further differences that arise;

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NOTES ON THE PRESENTATION OF THE AMENDMENT TO ANNEX 10, VOLUME III

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TEXT OF AMENDMENT 85 TO THE INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

ANNEX 10 — *AERONAUTICAL TELECOMMUNICATIONS*

VOLUME III

(COMMUNICATION SYSTEMS)

PART I — DIGITAL DATA COMMUNICATION SYSTEMS

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APPENDIX TO CHAPTER 9 A WORLDWIDE SCHEME FOR THE ALLOCATION, ASSIGNMENT AND APPLICATION OF AIRCRAFT ADDRESSES

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5. ASSIGNMENT OF AIRCRAFT ADDRESSES

5.1 ~~When required for use by suitably equipped aircraft entered on a national or international register,~~ An individual aircraft address ~~addresses within each block~~ shall be assigned to all suitably equipped aircraft entered on a national or international register by the State of Registry or common mark registering authority using its allocated block of addresses (Table 9-1).

Note.— For an aircraft delivery, the aircraft operator is expected to inform the airframe manufacturer of an address assignment. The airframe manufacturer or other organization responsible for a delivery flight is expected to ensure installation of a correctly assigned address supplied by the State of Registry or common mark registering authority. Exceptionally, a temporary address may be supplied under the arrangements detailed in paragraph 7.

5.2 Aircraft addresses shall be assigned to aircraft in accordance with the following principles:

a) at any one time, no address shall be assigned to more than one aircraft with the exception of aerodrome surface vehicles on surface movement areas. If such exceptions are applied by the State of Registry, the vehicles which have been allocated the same address shall not operate on aerodromes separated by less than 1 000 km;

b) only one address shall be assigned to an aircraft, irrespective of the composition of equipment on board. In the case when a removable transponder is shared by several light aviation aircraft such as balloons or gliders, it shall be possible to assign a unique address to the removable transponder. The registers 08_{16}, 20_{16}, 21_{16}, 22_{16} and 25_{16} of the removable transponder shall be correctly updated each time the removable transponder is installed in any aircraft;

c) the address shall not be changed except under exceptional circumstances and shall not be changed during flight;

d) when an aircraft changes its State of Registry, the new registering State shall assign the aircraft a new address from its own allocation address block, and the old aircraft address shall be returned to the allocation address block of the State that previously registered the aircraft. ~~the previously assigned address shall be relinquished and a new address shall be assigned by the new registering authority~~;

e) the address shall serve only a technical role for addressing and identification of aircraft and shall not be used to convey any specific information; and

f) the addresses composed of 24 ZEROS or 24 ONES shall not be assigned to aircraft.

5.2.1 **Recommendation.—** *Any method used to assign aircraft addresses should ensure efficient use of the entire address block that is allocated to that State.*

. . .

Table 9-1. Allocation of aircraft addresses to States

After the row for Mongolia, *insert* the following new row:

Montenegro	*					0101 00 0 10 110 00 – – – – – – – – – –

Delete the row labelled Yugoslavia

~~Yugoslavia~~			~~*~~			~~0 1 0 0 1 1 0 0 0 – – – – – – – – – – – –~~ ~~– –~~

After the row for Senegal, *insert* the following new row:

Serbia			*			0 1 0 0 1 1 0 0 0 – – – – – – – – – – – – – – –

— END —

AMENDMENT No. 85

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 I, contained in this document was adopted by the Council of ICAO on **26 February 2010**. Such parts of this amendment as have not been disapproved by more than half of the total number of Contracting States on or before **12 July 2010** will become effective on that date and will become applicable on **18 November 2010** as specified in the Resolution of Adoption. (State letter AN 7/1.1.45-10/28 refers.)

FEBRUARY 2010

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENT 85 TO THE INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

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 26 February 2010 Amendment 85 to the International Standards and Recommended Practices contained in the document entitled *International Standards and Recommended Practices, Aeronautical Telecommunications* which for convenience is designated Annex 10 to the Convention;

2. *Prescribes* 12 July 2010 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 18 November 2010;

4. *Requests the Secretary General*:

   a) to notify each Contracting State immediately of the above action and immediately after 12 July 2010 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 18 November 2010 between its national regulations or practices and the provisions of the Standards in the Annex as hereby amended, such notification to be made before 18 October 2010, and thereafter to notify the Organization of any further differences that arise;

      2) to notify the Organization before 18 October 2010 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, when the notification of such differences is important for the safety of air navigation, following the procedure specified in subparagraph b) above with respect to differences from Standards.

— — — — — — — —

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

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:

1.	~~Text to be deleted is shown with a line through it~~.	text to be deleted
2.	New text to be inserted is highlighted with grey shading.	new text to be inserted
3.	~~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 85 TO THE INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

ANNEX 10 — *AERONAUTICAL TELECOMMUNICATIONS*

VOLUME IV
(SURVEILLANCE AND COLLISION AVOIDANCE SYSTEMS)

. . .

CHAPTER 2. GENERAL

2.1 SECONDARY SURVEILLANCE RADAR (SSR)

. . .

2.1.5.1.7 *SI capability* — Transponders with the ability to process SI codes shall have the capabilities of 2.1.5.1.1, 2.1.5.1.2, 2.1.5.1.3, 2.1.5.1.4 or 2.1.5.1.5 and also those prescribed for SI code operation (3.1.2.3.2.1.4, 3.1.2.5.2.1, 3.1.2.6.1.3, 3.1.2.6.1.4.1, 3.1.2.6.9.1.1 and 3.1.2.6.9.2). Transponders with this capability shall be designated with a suffix “s”.

. . .

CHAPTER 3. SURVEILLANCE SYSTEMS

3.1 SECONDARY SURVEILLANCE RADAR (SSR) SYSTEM CHARACTERISTICS

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3.1.1.6 REPLY TRANSMISSION CHARACTERISTICS (SIGNAL-IN-SPACE)

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3.1.1.6.2 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:

Pulses	*Position (microseconds)*
C_1	1.45
A_1	2.90
C_2	4.35
A_2	5.80
C_4	7.25
A_4	8.70
X	10.15
B_1	11.60
D_1	13.05
B_2	14.50
D_2	15.95
B_4	17.40
D_4	18.85

Note.— The Standard relating to the use of these pulses is given in 2.1.4.1. However, the position of the "X" pulse is not used in replies to Mode A or Mode C interrogations and is specified only as a technical standard to safeguard possible future ~~use~~ 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.

. . .

3.1.1.7.4.1 The transponder shall be suppressed when the received amplitude of P_2 is equal to, or in excess of, the received amplitude of P_1 and spaced 2.0 plus or minus 0.15 microseconds. The detection of P_3 is not required as a prerequisite for initiation of suppression action.

. . .

3.1.1.7.4.3 Suppression in presence of S_1 pulse

Note.— The S1 pulse is used in a technique employed by ACAS known as "whisper-shout" to facilitate ACAS surveillance of Mode A/C aircraft in higher traffic densities. The whisper-shout technique is explained in the Airborne Collision Avoidance System (ACAS) Manual (Doc 9863).

When an S_1 pulse is detected 2.0 plus or minus 0.15 microseconds before the P_1 of a Mode A or Mode C interrogation:

a) with S_1 and P_1 above MTL, the transponder shall be suppressed as specified in 3.1.1.7.4.1;

b) with P_1 at MTL and S_1 at MTL, the transponder shall be suppressed and shall reply to no more than 10 per cent of Mode A/C interrogations;

c) with P_1 at MTL and S_1 at MTL -3 dB, the transponder shall reply to Mode A/C interrogations at least 70 per cent of the time; and

d) with P_1 at MTL and S_1 at MTL -6 dB, the transponder shall reply to Mode A/C interrogations at least 90 per cent of the time.

Note 1.— The suppression action is because of the detection of S_1 and P_1 and does not require detection of a P_2 or P_3 pulse.

Note 2.— S_1 has a lower amplitude than P_1. Certain ACAS use this mechanism to improve target detection (4.3.7.1).

Note 3.— These requirements also apply to a Mode A/C only capable transponder when an S_1 precedes an intermode interrogation (2.1.2.1).

. . .

3.1.1.7.9 *REPLY RATE*

3.1.1.7.9.1 ~~The transponder shall be capable of at least 1 200 replies per second for a 15-pulse coded reply, except that, for transponder installations used solely below 4 500 m (15 000 ft), or below a lesser altitude established by the appropriate authority or by regional air navigation agreement, transponders capable of at least 1 000 replies per second for a 15-pulse coded reply shall be permitted.~~ All transponders shall be capable of continuously generating at least 500 replies per second for a 15-pulse coded reply. Transponder installations used solely below 4 500 m (15 000 ft), or below a lesser altitude established by the appropriate authority or by regional air navigation agreement, and in aircraft with a maximum cruising true airspeed not exceeding 175 kt (324 km/h) shall be capable of generating at least 1 000 15-pulse coded replies per second for a duration of 100 milliseconds. Transponder installations operated above 4 500 m (15 000 ft) or in aircraft with a maximum cruising true airspeed in excess of 175 kt (324 km/h), shall be capable of generating at least 1 200 15-pulse coded replies per second for a duration of 100 milliseconds.

Note.— A 15-pulse reply includes 2 framing pulses, 12 information pulses, and the SPI pulse.

3.1.1.7.9.2 *Reply rate limit control.* To protect the system from the effects of transponder over-interrogation by preventing response to weaker signals when a predetermined reply rate has been reached, a sensitivity reduction type reply limit control shall be incorporated in the equipment. The range of this control shall permit adjustment, as a minimum, to any value between 500 and 2 000 replies per second, or to the maximum reply rate capability if less than 2 000 replies per second, without regard to the number of pulses in each reply. Sensitivity reduction in excess of 3 dB shall not take effect until 90 per cent of the selected value is exceeded. Sensitivity reduction shall be at least 30 dB for rates in excess of 150 per cent of the selected value.

~~3.1.1.7.9.3 **Recommendation.**— *The reply rate limit should be set at 1 200 replies per second, or the maximum value below 1 200 replies per second of which the transponder is capable.*~~

. . .

3.1.2.1.5.1 *Intermode interrogation*

. . .

3.1.2.1.5.1.2 *Mode A/C-only all-call interrogation.* This interrogation shall be identical to that of the Mode A/C/S all-call interrogation except that the short P_4 pulse shall be used.

Note.— The Mode A/C-only all-call interrogation elicits a Mode A or Mode C reply from a Mode A/C transponder. A Mode S transponder recognizes the short P_4 pulse and does not reply to this interrogation.

. . .

3.1.2.4.2 *SUPPRESSION*

. . .

3.1.2.4.2.2 *Suppression pairs.* The two-pulse Mode A/C suppression pair defined in 3.1.1.7.4.1 shall initiate suppression in a Mode S transponder regardless of the position of the pulse pair in a group of pulses, provided the transponder is not already suppressed or in a transaction cycle.

. . .

3.1.2.4.2.3 Suppression in presence of S_1 pulse shall be as defined in 3.1.1.7.4.3.

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3.1.2.5.2 *MODE S-ONLY ALL-CALL TRANSACTIONS*

. . .

3.1.2.5.2.1.2.2 *The use of multiple interrogator codes by one interrogator.* An interrogator shall not interleave Mode S-only all-call interrogations using different interrogator codes.

Note.— An explanation of RF interference issues, sector size and impact on data link transactions is presented in the ~~Manual of the Secondary Surveillance Radar (SSR) Systems~~ ~~*(Doc 9684)*~~ Aeronautical Surveillance Manual *(Doc 9924).*

. . .

3.1.2.5.2.2.1 *CA: Capability.* This 3-bit (6-8) downlink field shall convey information on the transponder level, the additional information below, and shall be used in formats DF = 11 and DF = 17.

Coding

0	signifies Level 1 transponder (surveillance only), and no ability to set CA code 7 and either airborne or on the ground
1	reserved
2	reserved
3	reserved
4	signifies Level 2 or above transponder and ability to set CA code 7 and on the ground
5	signifies Level 2 or above transponder and ability to set CA code 7 and airborne
6	signifies Level 2 or above transponder and ability to set CA code 7 and either airborne or on the ground
7	signifies the DR field is not equal to 0 or the FS field equals 2, 3, 4 or 5, and either airborne or on the ground

When the conditions for CA code 7 are not satisfied, aircraft with Level 2 or above transponders:

a) ~~in installations~~ that do not have automatic means to set the on-the-ground condition shall use CA code 6;~~.~~

b) ~~Aircraft~~ with automatic on-the-ground determination shall use CA code 4 when on the ground and 5 when airborne;~~.~~ and

c) with or without automatic on-the-ground determination shall use CA = 4 when commanded to set and report the on-the-ground status via the TCS subfield (3.1.2.6.1.4.1 f).

Data link capability reports (3.1.2.6.10.2.2) shall be available from aircraft installations that set CA code 4, 5, 6 or 7.

. . .

3.1.2.6.1.4.1 *Subfields in SD.* The SD field shall contain information as follows:

. . .

f) If DI = 2:

TCS, the 3-bit (21-23) type control subfield in SD shall control the ~~position type used~~ on-the-ground status reported by the transponder. The following codes have been assigned:

0	signifies no ~~position type~~ on-the-ground status command
1	signifies ~~use surface position type~~ set and report the on-the-ground status for the next 15 seconds
2	signifies set and report the on-the-ground status ~~use surface position type~~ for the next 60 seconds
3	signifies cancel the on-the-ground ~~surface type~~ command
4-7	not assigned.

The transponder shall be able to accept a new command to set or cancel the on-the-ground status even though a prior command has not as yet timed out.

Note.— Cancellation of the on-the-ground status command signifies that the determination of the vertical status reverts to the aircraft technique for this purpose. It does not signify a command to change to the vertical status.

. . .

3.1.2.6.10 *BASIC DATA PROTOCOLS*

. . .

3.1.2.6.10.1.1.2 *Temporary alert condition.* The alert condition shall be temporary and shall cancel itself after T_C seconds if the Mode A identity code is changed to a value other than those listed in 3.1.2.6.10.1.1.1. The T_C shall be retriggered and continued for T_C seconds after any change has been accepted by the transponder function.

Note 1.— This retriggering is performed to ensure that the ground interrogator obtains the desired Mode A identity code before the alert condition is cleared.

Note 2.— The value of T_C is given in 3.1.2.10.3.9.

. . .

3.1.2.6.10.1.2 *Ground report.* The on-the-ground status of the aircraft shall be reported in the CA field (3.1.2.5.2.2.1), the FS field (3.1.2.6.5.1), and the VS field (3.1.2.8.2.1). If an automatic indication of the on-the-ground condition (e.g. from a weight on wheels or strut switch) is available at the transponder data interface, it shall be used as the basis for the reporting of on-the-ground status except as specified in 3.1.2.6.10.3.1 and 3.1.2.8.6.7. If such indication is not available at the transponder data interface (3.1.2.10.5.1.3), the FS and VS codes shall indicate that the aircraft is airborne and the CA field shall indicate that the aircraft is either airborne or on the ground (CA = 6) except as indicated in 3.1.2.8.6.7.

. . .

3.1.2.6.10.2.2.2 *Updating of the data link capability report.* The transponder shall, at intervals not exceeding four seconds, compare the current data link capability status (bits 41-88 in the data link capability report) with that last reported and shall, if a difference is noted, initiate a revised data link capability report by Comm-B broadcast (3.1.2.6.11.4) for BDS1 = 1 (33-36) and BDS 2 = 0 (37-40). The transponder shall initiate, generate and ~~transmit~~ announce the revised capability report even if the aircraft data link capability is degraded or lost. The transponder shall ensure that ~~set~~ the BDS code is set for the data link capability report in all cases, including a loss of the interface.

Note.— The setting of the BDS code by the transponder ensures that a broadcast change of capability report will contain the BDS code for all cases of data link failure (e.g. the loss of the transponder data link interface).

. . .

3.1.2.6.10.3.1 Aircraft with an automatic means for determining the on-the-ground state ~~condition that are equipped to format extended squitter messages~~ on which transponders have access to at least one of the parameters, ground speed, radio altitude or airspeed, shall perform the following validation check:

If the automatically determined air/ground status is not available or is “airborne”, no validation shall be performed. If the automatically determined air/ground status is available and “on-the-ground” condition is being reported or if the on-the-ground status has been commanded via the TCS subfield (3.1.2.6.1.4.1 f)), the air/ground status shall be overridden and changed to “airborne” if: ~~the conditions given for the vehicle category in Table 3-7 are satisfied.~~

Ground Speed > 100 knots OR Airspeed > 100 knots OR Radio Altitude > 50 feet

~~*Note.— While this test is only required for aircraft that are equipped to format extended squitter messages, this feature is desirable for all aircraft.*~~

. . .

3.1.2.8.2 *SHORT AIR-AIR SURVEILLANCE, DOWNLINK FORMAT 0*

1	6	7		9		14		20	33
DF	VS	CC		SL		RI		AC	AP
5				11		17		32	56

This reply shall be sent in response to an interrogation with UF equals 0 and RL equals 0. The format of this reply shall consist of these fields:

Field	*Reference*
DF downlink format	3.1.2.3.2.1.2
VS vertical status	3.1.2.8.2.1
CC cross-link capability	3.1.2.8.2.3
spare — 1 bits ~~6 bits~~	
SL sensitivity level, ACAS	4.3.8.4.2.5
spare — 2 bits	
RI reply information	3.1.2.8.2.2
spare — 2 bits	
AC altitude code	3.1.2.6.5.4
AP address/parity	3.1.2.3.2.1.3

. . .

3.1.2.8.3 *LONG AIR-AIR SURVEILLANCE, DOWNLINK FORMAT 16*

1	6		9		14	20	33	89
DF	VS		SL		RI	AC	MV	AP
5			11		17	32	88	112

This reply shall be sent in response to an interrogation with UF equals 0 and RL equals 1. The format of this reply shall consist of these fields:

Field	*Reference*
DF downlink format	3.1.2.3.2.1.2
VS vertical status	3.1.2.8.2.1
spare — 2 bits ~~7 bits~~	
SL sensitivity level, ACAS	4.3.8.4.2.5
spare — 2 bits	
RI reply information	3.1.2.8.2.2
spare — 2 bits	
AC altitude code	3.1.2.6.5.4
MV message, ACAS	3.1.2.8.3.1
AP address/parity	3.1.2.3.2.1.3

. . .

3.1.2.8.4 *AIR-AIR TRANSACTION PROTOCOL*

Note.— Interrogation-reply coordination for the air-air formats follows the protocol outlined in Table 3-5 (3.1.2.4.1.3.2.2).

The most significant bit (bit 14) of the RI field of an air-air reply shall replicate the value of the AQ field (bit 14) received in an interrogation with UF equals 0.

If AQ equals 0 in the interrogation, the RI field of the reply shall contain the value 0 (no operating ACAS) or ACAS information as indicated in 3.1.2.8.2.2 and 4.3.8.4.1.2.

If AQ equals 1 in the interrogation, the RI field of the reply shall contain the maximum cruising true airspeed capability of the aircraft as defined in 3.1.2.8.2.2.

In response to a UF = 0 with RL = 1 and DS ≠ 0, the transponder shall reply with a DF = 16 reply in which the MV field shall contain the contents of the GICB register designated by the DS value. In response to a UF = 0 with RL = 1 and DS = 0, the transponder shall reply with a DF = 16 with an MV field of all zeros. Receipt of a UF = 0 with DS ≠ 0 but RL = 0 shall have no associated ACAS cross-link action, and the transponder shall reply as specified in 3.1.2.8.2.2.

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3.1.2.8.6 *EXTENDED SQUITTER, DOWNLINK FORMAT 17*

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

a) Version 0 ES message formats and related requirements are suitable for early implementation of extended squitter applications. Surveillance quality is reported by navigation uncertainty category (NUC), which can be an indication of either the accuracy or integrity of the navigation data used by ADS-B. However, there is no indication as to which of these, integrity or accuracy, the NUC value is providing an indication of.

b) Version 1 ES message formats and related requirements apply to more advanced ADS-B applications. Surveillance accuracy and integrity are reported separately as navigation accuracy category (NAC), navigation integrity category (NIC) and surveillance integrity level (SIL). Version 1 ES formats also include provisions for enhanced reporting of status information.

Note 1.— The formats and update rates of each register are specified in the Technical Provisions for Mode S Services and Extended Squitter *(Doc 9871).*

Note 2.— The formats for the two versions are interoperable. An extended squitter receiver can recognize and decode both version 0 and version 1 message formats.

Note 3.— Guidance material on transponder register formats and data sources is included in the ~~Manual on Mode S Specific Services~~ ~~*(Doc 9688)*~~ Technical Provisions for Mode S Services and Extended Squitter *(Doc 9871)*.

. . .

3.1.2.8.6.4.6 *Event-driven squitter rate.* The event-driven squitter shall be transmitted once, each time that GICB register 0A {HEX} is loaded, while observing the delay conditions specified in 3.1.2.8.6.4.7. The maximum transmission rate for the event-driven squitter shall be limited by the transponder to twice per second. If a message is inserted in the event-driven register and cannot be transmitted due to rate limiting, it shall be held and transmitted when the rate limiting condition has cleared. If a new message is received before transmission is permitted, it shall overwrite the earlier message.

Note.— The squitter transmission rate and the duration of squitter transmissions is application-dependent. Choices made for each application must take into account interference considerations ~~(Manual of the Secondary Surveillance Radar (SSR) Systems~~ ~~*(Doc 9684), Chapter 8 refer)*~~ *as shown in the* Aeronautical Surveillance Manual *(Doc 9924).*

. . .

3.1.2.8.6.7 *Airborne/surface state determination.* Aircraft with an automatic means of determining on-the-ground conditions shall use this input to select whether to report the airborne or surface message types. Aircraft without such means shall report the airborne type messages, except as specified in

Table ~~3-8~~3-7. Use of this table shall only be applicable to aircraft that are equipped to provide data for radio altitude AND, as a minimum, airspeed OR ground speed. Otherwise, aircraft in the specified categories that are only equipped to provide data for airspeed and ground speed shall broadcast the surface format if:

airspeed <50 knots AND ground speed <50 knots.

Aircraft with or without such automatic on-the-ground determination shall set and report the on-the-ground status ~~use position message types~~ (and therefore broadcast the surface type format) as commanded by control codes in TCS (3.1.2.6.1.4.1 f)). After time-out of the TCS commands, control of airborne/surface determination shall revert to the means described above.

~~*Note 1.— Use of this technique may result in the surface position format being transmitted when the air-ground status in the CA fields indicates "airborne or on the ground".*~~

Note ~~2~~.— Extended squitter ground stations determine aircraft airborne or ~~surfaces~~ on-the-ground status by monitoring aircraft position, altitude and ground speed. Aircraft determined to be on the ground that are not reporting the ~~surface~~ on-the-ground status ~~position message type~~ will be commanded to set and report the ~~surface format~~ on-the-ground status via TCS (3.1.2.6.1.4.1 f)). The normal return to aircraft control of the vertical ~~the airborne position message type~~ status is via a ground command to cancel ~~report~~ the ~~airborne message type~~ on-the-ground status. To guard against loss of communications after take-off, commands to set and report the ~~surface position message type~~ on-the-ground status automatically time-out.

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3.1.2.8.7.3.3.5 *Airborne/surface state determination.* Aircraft with an automatic means of determining the on-the-ground ~~condition~~ state shall use this input to select whether to report the airborne or surface message types except as specified in 3.1.2.6.10.3.1 and 3.1.2.8.6.7. Aircraft without such means shall report the airborne type message, except as specified in 3.1.2.8.6.7

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3.1.2.8.9 *EXTENDED SQUITTER MAXIMUM TRANSMISSION RATE*

3.1.2.8.9.1 The maximum total number of extended squitters (DF = 17, 18 ~~or~~ and 19) emitted by any extended squitter installation shall not exceed 6.2 per second, except as specified in 3.1.2.8.9.2.

3.1.2.8.9.2 For installations capable of emitting DF = 19 squitters and in accordance with 3.1.2.8.8, transmission rates for lower power DF = 19 squitters shall be limited to a peak of forty DF = 19 squitters per second, and thirty DF = 19 squitters per second averaged over 10 seconds, provided that the maximum total squitter power-rate product for the sum of full power DF = 17 squitters, full power DF = 18 squitters, full power DF = 19 squitters, and lower power DF = 19 squitters, is maintained at or below a level equivalent to the power sum of 6.2 full power squitters per second averaged over 10 seconds.

3.1.2.8.9.3 States shall ensure that the use of low power and higher rate DF = 19 operation (as per 3.1.2.8.9.2) is compliant with the following requirements:

a) it is limited to formation or element lead aircraft engaged in formation flight, directing the messages toward wing and other lead aircraft through a directional antenna with a beamwidth of no more than 90 degrees; and

b) the type of information contained in the DF = 19 message is limited to the same type of information in the DF = 17 message, that is, information for the sole purpose of safety-of-flight.

Note.— This low-power, higher squitter rate capability is intended for limited use by State aircraft in coordination with appropriate regulatory bodies.

3.1.2.8.9.4 All UF = 19 airborne interrogations shall be included in the interference control provisions of 4.3.2.2.2.2.

3.1.2.9 AIRCRAFT IDENTIFICATION PROTOCOL

. . .

3.1.2.9.1.4 *Change of aircraft identification.* If the aircraft identification reported in the AIS subfield is changed in flight, the transponder shall report the new identification to the ground by use of the Comm-B broadcast message protocol of 3.1.2.6.11.4 for BDS1 = 2 (33 - 36) and BDS2 = 0 (37 - 40). The transponder shall initiate, generate and announce the revised aircraft identification even if the interface providing flight identification is lost. The transponder shall ensure that the BDS code is set for the aircraft identification report in all cases, including a loss of the interface. In this latter case, bits 41 - 88 shall contain all ZEROs.

Note.— The setting of the BDS code by the transponder ensures that a broadcast change of aircraft identification will contain the BDS code for all cases of flight identification failure (e.g. the loss of the interface providing flight identification).

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 certified after 1 January 2011, the spurious Mode A/C reply ratio generated by 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.— 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.

. . .

3.1.2.10.3.10.3 *Inhibition of squitter transmissions.* It shall not be possible to inhibit extended squitter transmissions except as specified in 3.1.2.8.6 or acquisition squitter transmissions except as specified in 3.1.2.8.5 regardless of whether the aircraft is airborne or on the ground.

Note.— For additional information on squitter inhibition see the ~~Manual of the Secondary Surveillance Radar (SSR) Systems~~ ~~*(Doc 9684)*~~ Aeronautical Surveillance Manual (*Doc 9924*).

. . .

Table 3-1. Pulse shapes — Mode S and intermode interrogations

			(Rise time)		*(Decay time)*	
Pulse	*Duration*	*Duration Tolerance*	*Min.*	*Max.*	*Min.*	*Max*
P_1, P_2, P_3, P_5	0.8	±0.1	0.05	0.1	0.05	0.2
P_4 (short)	0.8	±0.1	0.05	0.1	0.05	0.2
P_4 (long)	1.6	±0.1	0.05	0.1	0.05	0.2
P_6 (short)	16.25	±0.25	0.05	0.1	0.05	0.2
P_6 (long)	30.25	±0.25	0.05	0.1	0.05	0.2
S_1	0.8	±0.1	0.05	0.1	0.05	0.2

. . .

Table 3-3. Field definitions

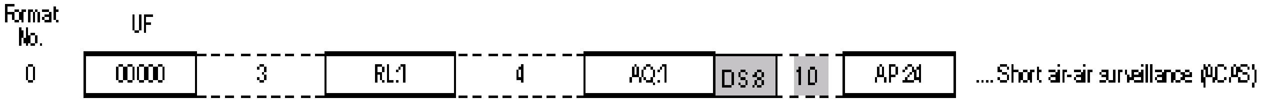
Field		*Format*		*Reference*
Designator	*Function*	*UF*	*DF*	
…				
SD	…	…	…	…
SL	Sensitivity Level (ACAS)		0, 16	4.3.8.4.2.5
UF				
…				

. . .

Delete Table 3.7 in its entirety and *renumber*
Tables 3-8 through 3-12

. . .

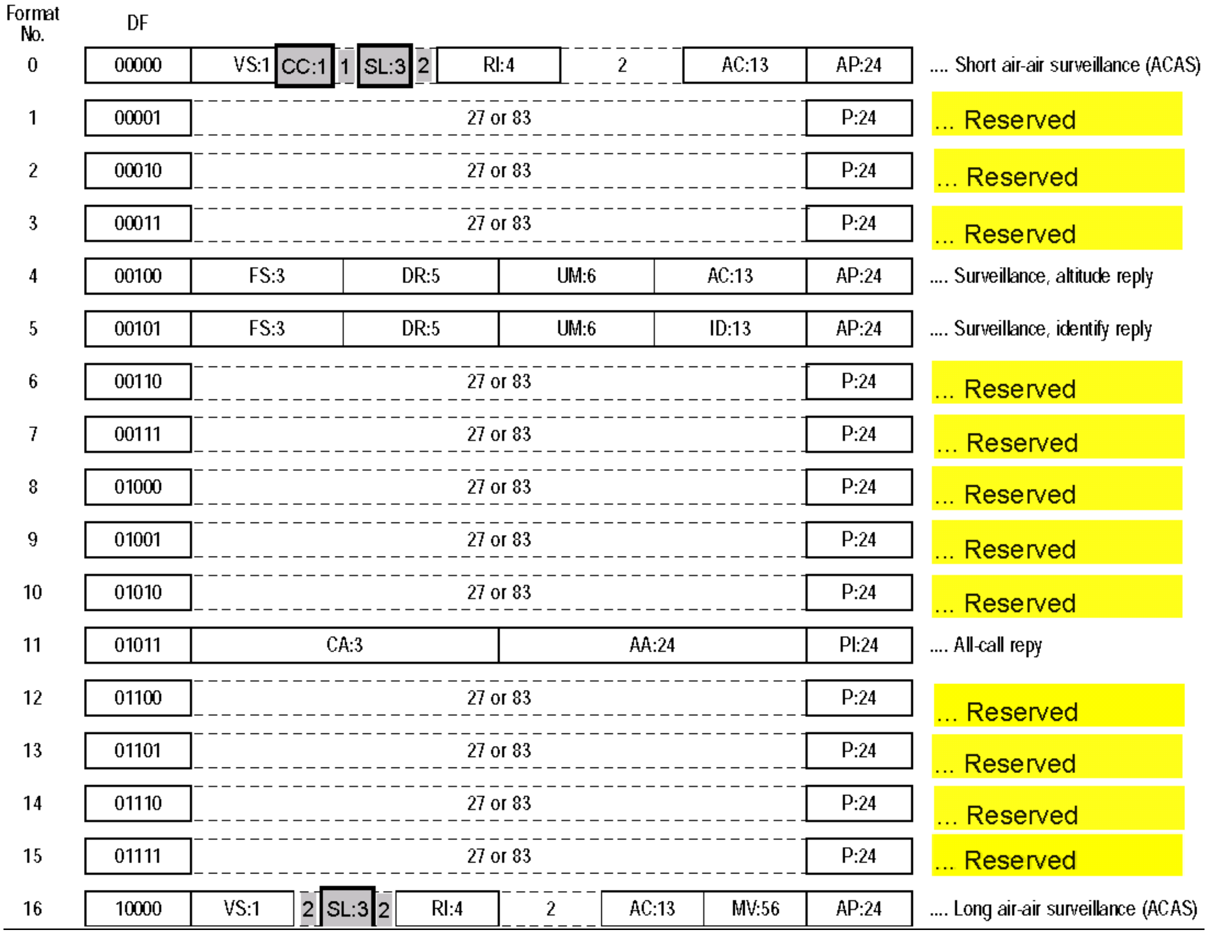
Figure 3-7. Summary of Mode S interrogation or uplink formats



Format No.	UF								
0	00000	3	RL:1	4	AQ:1	DS:8	10	AP:24	....Short air-air surveillance (ACAS)

. . .

Figure 3-8. Summary of Mode S reply or downlink formats



Format No.	DF										
0	00000	VS:1	CC:1	1	SL:3	2	RI:4	2	AC:13	AP:24	.... Short air-air surveillance (ACAS)
1	00001	27 or 83								P:24	... Reserved
2	00010	27 or 83								P:24	... Reserved
3	00011	27 or 83								P:24	... Reserved
4	00100	FS:3	DR:5	UM:6	AC:13					AP:24	.... Surveillance, altitude reply
5	00101	FS:3	DR:5	UM:6	ID:13					AP:24	.... Surveillance, identify reply
6	00110	27 or 83								P:24	... Reserved
7	00111	27 or 83								P:24	... Reserved
8	01000	27 or 83								P:24	... Reserved
9	01001	27 or 83								P:24	... Reserved
10	01010	27 or 83								P:24	... Reserved
11	01011	CA:3	AA:24							PI:24	.... All-call repy
12	01100	27 or 83								P:24	... Reserved
13	01101	27 or 83								P:24	... Reserved
14	01110	27 or 83								P:24	... Reserved
15	01111	27 or 83								P:24	... Reserved
16	10000	VS:1	2	SL:3	2	RI:4	2	AC:13	MV:56	AP:24	.... Long air-air surveillance (ACAS)

. . .

CHAPTER 4. AIRBORNE COLLISION AVOIDANCE SYSTEM

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

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.

. . .

4.2.3.3.3 *Mode A/C ACAS I interference limits.* The interrogator power shall not exceed the following limits:

	Upper limit for $\{\sum_{k=1}^{\cancel{k_1}k_t} P_a(k)\}$	
n_a	*If* $f_r \leq 240$	*If* $f_r > 240$
0	250	118
1	250	113
2	250	108
3	250	103
4	250	98
5	250	94
6	250	89
7	250	84
8	250	79
9	250	74
10	245	70
11	228	65
12	210	60
13	193	55
14	175	50
15	158	45
16	144	41
17	126	36
18	109	31
19	91	26
20	74	21
21	60	17
≥22	42	12

. . .

4.3 GENERAL PROVISIONS RELATING TO ACAS II AND ACAS III

Note 1.— The acronym ACAS is used in this section to indicate either ACAS II or ACAS III.

Note 2.— Carriage requirements for ACAS equipment are addressed in Annex 6 ~~Part I, Chapter 6~~.

Note 3.— The term "equipped threat" is used in this section to indicate a threat fitted with ACAS II or ACAS III.

. . .

4.3.2.2 INTERFERENCE CONTROL

. . .

4.3.2.2.2.2 *ACAS interference limiting inequalities.* ACAS shall adjust its interrogation rate and interrogation power such that the following three inequalities remain true, except as provided in 4.3.2.2.2.2.1.

Editorial Note.— In equations (1) and (2) below *replace* the variable listed as “i_1” to read “i_t”. In equation (3) *replace* the variable listed as “k_1” to read “k_t”.

$$\left\{ \sum_{i=1}^{i_1} \left[\frac{p(i)}{250}\right]^{\alpha} \right\} < minimum \left[\frac{280}{1+n_a}, \frac{11}{\alpha^2}\right] \qquad (1)$$

$$\left\{ \sum_{i=1}^{i_1} m(i) \right\} < 0.01 \qquad (2)$$

$$\left\{ \frac{1}{B} \sum_{k=1}^{k_1} \frac{P_a(k)}{250} \right\} < minimum \left[\frac{80}{1+n_a}, 3\right] \qquad (3)$$

The variables in these inequalities shall be defined as follows:

i_t = number of interrogations (Mode A/C and Mode S) transmitted in a 1 s interrogation cycle. This shall include all Mode S interrogations used by the ACAS functions, including those in addition to UF = 0 and UF = 19 interrogations, except as provided in 4.3.2.2.2.2.1;

Note.— UF = 19 interrogations are included in i_t *as specified in 3.1.2.8.9.3.*

. . .

i = index number for Mode A/C and Mode S interrogations, $i = 1, 2, \ldots, i_t$;

α = the minimum of α_1 calculated as 1/4 $[n_b/n_c]$ subject to the special conditions given below and α_2 calculated as $\text{Log}_{10}\,[n_a/n_b]$ / Log_{10} 25, where n_b and n_c are defined as the number of operating ACAS II and ACAS III equipped aircraft (airborne or on the ground) within 11.2 km (6 NM) and 5.6 km (3 NM) respectively, of own ACAS (based on ACAS surveillance). ACAS aircraft operating on the ground or at or below a radio altitude of 610 m (2 000 ft) AGL shall include both airborne and on-ground ACAS II and ACAS III aircraft in the value for n_b and n_c. Otherwise, ACAS shall include only airborne ACAS II and ACAS III aircraft in the value for n_b and n_c. The ~~value~~ values of α, α_1 and α_2 are ~~is~~ further constrained to a minimum of 0.5 and a maximum of 1.0.

In addition;

IF [($n_b \leq 1$) ~~OR ($n_b > 4n_c$)~~ OR ($n_b \leq 4$ AND $n_c \leq 2$ AND $n_a > 25$)] THEN $\alpha_1 = 1.0$,

. . .

4.3.2.2.2.2.1 *Transmissions during RAs.* All air-to-air coordination interrogations ~~and RA and ACAS broadcasts~~ shall be transmitted at full power and these interrogations shall be excluded from the summations of Mode S interrogations in the left-hand terms of inequalities (1) and (2) in 4.3.2.2.2.2 for the duration of the RA.

. . .

4.3.2.2.2.2.3 *Transmissions from ACAS units above 5 490 m (18 000 ft) altitude.* Each ACAS interrogator operating above a pressure-altitude of 5 490 m (18 000 ft) shall control its interrogation rate or power or both such that inequalities (1) and (3) in 4.3.2.2.2.2 remain true when n_a and ~~a~~ α are equal to 1, except as provided in 4.3.2.2.2.2.1.

. . .

4.3.3 Traffic advisories (TAs)

4.3.3.1 *TA function.* ACAS shall provide TAs to alert the flight crew to potential threats. Such TAs shall be accompanied by an indication of the approximate relative position of potential threats to facilitate visual acquisition.

4.3.3.1.1 *Display of potential threats.* If potential threats are shown on a traffic display, they shall be displayed in amber or yellow.

Note 1.— These colours are generally considered suitable for indicating a cautionary condition.

Note 2.—Additional information assisting in the visual acquisition such as vertical trend and relative altitude may be displayed as well.

Note 3.— Traffic situational awareness is improved when tracks can be supplemented by display of heading information (e.g. as extracted from received ADS-B messages).

4.3.3.2 PROXIMATE TRAFFIC DISPLAY

4.3.3.2.1 **Recommendation.—** *While any RA and/or TA are displayed, proximate traffic within 11 km (6 NM) range and, if altitude reporting, ±370 m (1 200 ft) altitude should be displayed. This proximate traffic should be distinguished (e.g. by colour or symbol type) from threats and potential threats, which should be more prominently displayed.*

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.*

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

4.3.3.3.1 *TA warning time.* For intruders reporting altitude, the nominal TA warning time 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.

. . .

4.3.5 Resolution advisories (RAs)

4.3.5.1 *RA generation.* For all threats, ACAS shall generate an RA except where it is not possible to select an RA that can be predicted to provide adequate separation either because of uncertainty in the diagnosis of the intruder's flight path or because there is a high risk that a manoeuvre by the threat will negate the RA.

4.3.5.1.1 *Display of threats*. If threats are shown on a traffic display, they shall be displayed in red.

Note.— This colour is generally considered suitable for indicating a warning condition.

4.3.5.1.2 *RA cancellation.* 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.

4.3.5.2 *RA selection.* ACAS shall generate the RA that is predicted to provide adequate separation from all threats and that has the least effect on the current flight path of the ACAS aircraft consistent with the other provisions in this chapter.

4.3.5.3 *RA effectiveness.* The RA shall not recommend or continue to recommend a manoeuvre or manoeuvre restriction that, considering the range of probable threat trajectories, is more likely to reduce separation than increase it, subject to the provisions in 4.3.5.5.1.1 and 4.3.5.6.

Note.— See also 4.3.5.8.

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.

Note 1.— This overcomes the retention of an RA sense that would work only if followed. The revised vertical rate assumption is more likely to allow the logic to select the opposite sense when it is consistent with the non-complying aircraft's vertical rate.

Note 2.— Equipment complying with RTCA/DO-185 or DO-185A standards (also known as TCAS Version 6.04A or TCAS Version 7.0) do not comply with this requirement.

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.

4.3.5.3.2 **Recommendation.—** *All ACAS should be compliant with the requirement in 4.3.5.3.1.*

4.3.5.3.3 After 1 January 2017, all ACAS units shall comply with the requirements stated in 4.3.5.3.1.

. . .

4.3.7 ACAS protocols

4.3.7.1 SURVEILLANCE PROTOCOLS

4.3.7.1.1 *Surveillance of Mode A/C transponders.* ~~ACAS shall use the Mode C-only all-call interrogation (Chapter 3, 3.1.2.1.5.1.2) for surveillance of aircraft equipped with Mode A/C transponders.~~

4.3.7.1.1.1 ACAS shall use the Mode C-only all-call interrogation (Chapter 3, 3.1.2.1.5.1.2) for surveillance of aircraft equipped with Mode A/C transponders.

4.3.7.1.1.2 Using a sequence of interrogations with increasing power, surveillance interrogations shall be preceded by an S_1-pulse (Chapter 3, 3.1.1.7.4.3) to reduce interference and improve Mode A/C target detection.

. . .

4.3.8.4 FIELD DESCRIPTION

. . .

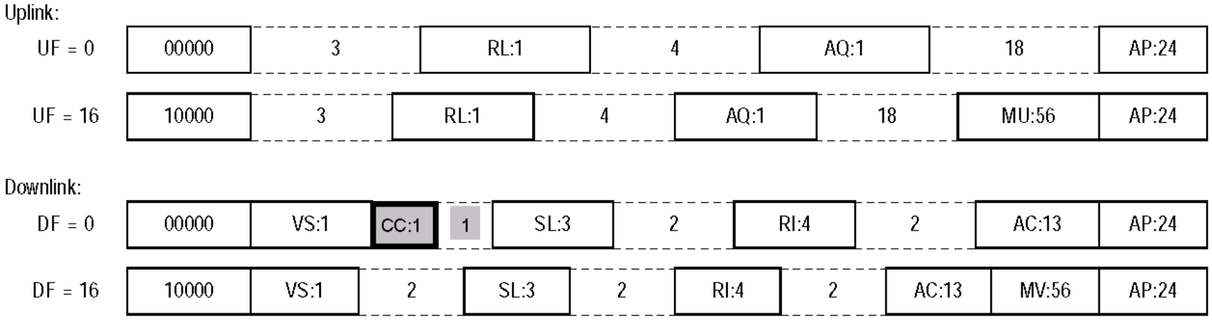


Figure 4-1. Surveillance and communication formats used by ACAS

. . .

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:

Bit	Coding
48	0 ACAS failed or on standby
	1 ACAS operating
69	0 ~~ACAS II~~ Hybrid surveillance not operational
	1 ~~ACAS III~~ Hybrid surveillance fitted and operational
70	0 ACAS generating TAs only
	1 ACAS generating TAs and RAs
~~71~~	0 ~~ACAS not fitted~~
	~~1 ACAS fitted~~
~~72~~	~~0 Hybrid surveillance not fitted~~
	~~1 Hybrid surveillance fitted~~

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	Future version (see registers $E5_{16}$ and $E6_{16}$)

. . .

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

Coding:

Bit No.	63	64	65	66	67	68	69	70	71	72	73	74	75
Mode A code bit	~~C1~~ A4	~~A1~~ A2	~~C2~~ A1	~~A2~~ B4	~~C4~~ B2	~~A4~~ B1	0	~~B1~~ C4	~~D1~~ C2	~~B2~~ C1	~~D2~~ D4	~~B4~~ D2	~~D4~~ D1

. . .

Insert new text as follows:

4.3.8.4.2.6 *CC: Cross-link capability*. This 1-bit (7) downlink field shall indicate the ability of the transponder to support the cross-link capability, i.e. decode the contents of the DS field in an interrogation with UF equals 0 and respond with the contents of the specified GICB register in the corresponding reply with DF equals 16.

Coding

0 signifies that the transponder cannot support the cross-link capability.
1 signifies that the transponder supports the cross-link capability.

End of new text.

. . .

4.5 ACAS USE OF EXTENDED SQUITTER ~~REPORTS~~

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.*

4.5.1.1 DEFINITIONS

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

~~***Active track.*** A track formed by measurements gained by active interrogation.~~

Hybrid surveillance. The process of using active surveillance 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.

~~***Initial validation***~~***Validation.*** The process of verifying the relative position of ~~a~~ an intruder ~~new track~~ using passive information by comparing it to the relative position obtained by 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 ~~contained in passive tracks~~obtained to monitor the need for active surveillance, but not for any other purpose.

~~***Passive track.*** After initial acquisition, a track maintained without active interrogation, using information contained in extended squitters.~~

4.5.1.2 An ACAS equipped to receive extended squitter airborne position ~~reports~~ 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 ~~*Initial*~~ *Validation* ~~*validation*~~. ~~At initial acquisition of an aircraft reporting~~ To validate the position of an intruder reported by extended squitter ~~information~~, 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 the aircraft. Differences between the derived and measured range and relative bearing and the squitter ~~and 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 ~~the~~ these ~~above~~ validation tests fail, ~~the track~~active surveillance shall be ~~declared an active~~used to track the intruder~~and no further use shall be made of the subsequent passive surveillance data received for this track~~.

Note.— Suitable tests for validating extended squitter data information for the purposes of ACAS hybrid surveillance can be found in RTCA/DO-300.

~~4.5.1.3.2 **Recommendation.** — *The following tests should be used to validate the position reported in the extended squitter message:*~~

~~*| slant range difference | ≤ 200 m; and*~~

~~*| bearing difference | ≤ 45 degrees; and*~~

~~*| altitude difference | ≤ 100 ft.*~~

4.5.1.3.~~3~~2 *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.

4.5.1.~~4~~5 *Revalidation and monitoring.* If ~~the following condition is met for a track being updated~~an aircraft is being tracked using passive surveillance, periodic active interrogations shall be performed to validate and monitor the extended squitter data as required in 4.5.1.3.1. The default rates of revalidation shall be once per minute for a non-threat and once per 10 seconds for a near threat. ~~data:~~

~~a) $|a| \le 10\,000$ ft and either;~~

~~b) $|a| \le 3\,000$ ft or $|a - 3\,000 \text{ ft}| / |\dot{a}| \le 60$ s; or~~

~~c) $r \le 3$ NM or $(r - 3 \text{ NM}) / |\dot{r}| \le 60$ 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~~

~~an active interrogation shall be made every 10 seconds to continuously revalidate and monitor the extended squitter data for as long as the above condition is met.~~ The tests required in 4.5.1.3.1 shall be performed for each interrogation, and active surveillance shall be used to track the intruder if~~. If any of~~ these revalidation tests fail~~, the track shall be declared an active track~~.

. . .

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

4.5.1.6 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.

. . .

Insert new text as follows:

CHAPTER 6. MULTILATERATION SYSTEMS

Note 1.— Multilateration (MLAT) systems use the time difference of arrival (TDOA) of the transmissions of a SSR transponder (or the extended squitter transmissions of a non-transponder device) between several ground receivers to determine the position of the aircraft (or ground vehicle). A multilateration system can be:

a) passive, using transponder replies to other interrogations or spontaneous squitter transmissions;

b) active, in which case the system itself interrogates aircraft in the coverage area; or

c) a combination of a) and b).

Note 2.— Material contained in EUROCAE ED-117 – 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 for planning, implementation and satisfactory operation of MLAT systems for most applications.

6.1 DEFINITIONS

Multilateration (MLAT) System. A group of equipment configured to provide position derived from the secondary surveillance radar (SSR) transponder signals (replies or squitters) primarily using time difference of arrival (TDOA) techniques. Additional information, including identification, can be extracted from the received signals.

Time Difference of Arrival (TDOA). The difference in relative time that a transponder signal from the same aircraft (or ground vehicle) is received at different receivers.

6.2 FUNCTIONAL REQUIREMENTS

6.2.1 Radio frequency characteristics, structure and data contents of signals used in 1 090 MHz MLAT systems shall conform to the provisions of Chapter 3.

6.2.2 An MLAT system used for air traffic surveillance shall be capable of determining aircraft position and identity.

Note 1.— Depending on the application, either two- or three-dimensional position of the aircraft may be required.

Note 2.— Aircraft identity may be determined from:

a) *Mode A code contained in Mode A or Mode S replies; or*

b) *Aircraft Identification contained in Mode S replies or extended squitter identity and category message.*

Note 3.— Other aircraft information can be obtained by analysing transmissions of opportunity (i.e. squitters or replies to other ground interrogations) or by direct interrogation by the MLAT system.

6.2.3 Where an MLAT system is equipped to decode additional position information contained in transmissions, it shall report such information separately from the aircraft position calculated based on TDOA.

6.3 PROTECTION OF THE RADIO FREQUENCY ENVIRONMENT

Note.— This section only applies to active MLAT systems.

6.3.1 In order to minimize system interferences the effective radiated power of active interrogators shall be reduced to the lowest value consistent with the operationally required range of each individual interrogator site.

Note.— Guidance material on power consideration is contained in the Aeronautical Surveillance Manual *(Doc 9924).*

6.3.2 An active MLAT system shall not use active interrogations to obtain information that can be obtained by passive reception within each required update period.

Note. — Transponder occupancy will be increased by the use of omnidirectional antennas. It is particularly significant for Mode S selective interrogations because of their higher transmission rate. All Mode S transponders will be occupied decoding each selective interrogation not just the addressed transponder.

6.3.3 The set of transmitters used by all active MLAT systems in any part of the airspace shall not occupy any transponder more than 2 per cent of the time.

Note. — The use of active MLAT systems may be even more restrictive in some regions.

6.3.4 Active MLAT systems shall not use Mode S All-Call interrogations.

Note. — Mode S aircraft can be acquired by the reception of acquisition squitter or extended squitter even in airspace where there are no active interrogators.

6.4 PERFORMANCE REQUIREMENTS

6.4.1 The performance characteristics of the MLAT system used for air traffic surveillance shall be such that the intended operational service(s) can be satisfactorily supported.

CHAPTER 7 — TECHNICAL REQUIREMENTS FOR AIRBORNE SURVEILLANCE APPLICATIONS

Note 1.— Airborne surveillance applications are based on aircraft receiving and using ADS-B message information transmitted by other aircraft/vehicles or ground stations. The capability of an aircraft to receive and use ADS-B/TIS-B message information is referred to as ADS-B/TIS-B IN.

Note 2.— Initial airborne surveillance applications use ADS-B messages on 1090 MHz extended squitter to provide airborne traffic situational awareness (ATSA) and are expected to include "In-trail procedures" and "Enhanced visual separation on approach".

Note 3.— Detailed description of aforementioned applications can be found in RTCA/DO-289 and DO-312.

7.1 GENERAL REQUIREMENTS

7.1.1 Traffic data functions

Note.— The aircraft transmitting ADS-B messages used by other aircraft for airborne surveillance applications is referred to as the reference aircraft.

7.1.1.1 IDENTIFYING THE REFERENCE AIRCRAFT

7.1.1.1.1 The system shall support a function to identify unambiguously each reference aircraft relevant to the application.

7.1.1.2 TRACKING THE REFERENCE AIRCRAFT

7.1.1.2.1 The system shall support a function to monitor the movements and behaviour of each reference aircraft relevant to the application.

7.1.1.3 TRAJECTORY OF THE REFERENCE AIRCRAFT

7.1.1.3.1 **Recommendation.—** *The system should support a computational function to predict the future position of a reference aircraft beyond simple extrapolation.*

Note. — It is anticipated that this function will be required for future applications.

7.1.2 Displaying traffic

Note. — Provisions contained in this section apply to cases wherein tracks generated by ACAS and by reception of ADS-B/TIS-B IN messages are shown on a single display.

7.1.2.1 The system shall display only one track for each distinct aircraft on a given display.

Note. — This is to ensure that tracks established by ACAS and ADS-B /TIS-B IN are properly correlated and mutually validated before being displayed.

7.1.2.2 Where a track generated by ADS-B/TIS-B IN and a track generated by ACAS have been determined to belong to the same aircraft, the track generated by ADS-B/TIS-B IN shall be displayed.

Note. — At close distances, it is possible that the track generated by ACAS provides better accuracy than the track generated by ADS-B/TIS-B IN. The requirement above ensures the continuity of the display.

7.1.2.3 The display of the tracks shall comply with the requirements of ACAS traffic display.

Note. — Section 4.3 addresses color coding and readability of the display.

End of new text.

. . .

— END —