242A-WP-9-01a
25 October 2001

RTCA SC- 186/WG-6 (Working Group On DO-242A MASPS)

Meeting #9, Arlington VA

Draft Text for DO-242A
Revised SV, MS, and OC Report Contents

Presented by James Maynard

SUMMARY
This paper offers draft text for DO-242A. A summary of the changes from the previous draft (working paper 242A-WP-8-01) is given on the following page.

I have made the following changes in accordance with discussions at meeting #8, as reflected in the minutes of that meeting:

- In §2.1.2.1.3, I added two more notes. One states that weights for determining participant categories are maximum gross weights, not operating weights. The second note is a copy of Note 2 following Table 2-16 in DO-260. For backward compatibility reasons with DO-260, I did not "split the ICAO categories into 3 categories that would more directly map into the US coding."
- In §2.1.2.3.1, I deleted the Capability Class (CC) codes for "aircraft is capable of transmitting" this or that, and added an OM (rather than a CC) code for "aircraft is transmitting its Aircraft Size Code." Also, I added brief paragraphs to describe each of the CC codes listed.
- I moved the NIC code from the MS (§3.4.3.2) report to the SV report (§3.4.3.1). The NAC and SIL codes were kept in the MS report.
- I added Barometric Altitude Integrity codes to the MS report (§3.4.3.2) and described them in §1.1.1.1.
- I deleted descriptions of the OC-RFI report.

I have made addition organizational and editorial changes as follows:

- Deleted from this draft any text that doesn't directly relate to the organization of report elements into various reports.
- Moved the description of TOA from section 2.1.1 (General Performance Requirements) to section 2.1.2 (Information Transfer Requirements). Thus the TOA description is renumbered from §2.1.1.4 to §2.1.2.1.
- Added §2.1.2.10 to describe OM codes, and inserted the TCAS/ACAS resolution advisory active flag as the first of those OM codes.

The following additional changes were made in accordance with discussions during the first two days of meeting #9:

- Added "TCR cycle number" and "TCR+0 just transitioned" flag to the OM codes in the MS report.
- Revised the TSR and TCR definitions to follow the current draft Intent white paper, as revised during meeting #9.

Table of Contents

Appendices

Table of Figures

Table of Tables

1 Purpose and Scope

2 Operational Requirements

2.1 General Requirements

2.1.1 General Performance

2.1.2 Information Transfer Requirements

The ADS-B system shall (R2.4) be capable of transmitting messages and issuing reports containing the information specified in the following subsections. This MASPS does not specify a particular message structure or encoding technique. The information specified in the following subsections can be sent in one or more messages in order to meet the report update requirements specified in Section 3.

2.1.2.1 Time of Applicability (TOA)

The time of applicability (TOA) of ADS-B reports indicates the time at which the reported values were valid. Time of applicability shall (R2.3) be provided in all reports. Requirements on the accuracy of the time of applicability are addressed in Section 3.

~~2.1.2.1.1~~2.1.2.2 Call Sign

ADS-B shall (R2.7) be able to convey an aircraft call sign of up to ~~7~~ 8 alphanumeric characters in length ~~[6]~~. For aircraft/vehicles not receiving ATS services and military aircraft the call sign is not required.

~~2.1.2.1.2~~2.1.2.3 Address and Address Qualifier

The ADS-B system design shall (R2.8) include a means (e.g., an address) to 1, correlate all ADS-B messages transmitted from the A/V and 2, differentiate it from other A/Vs in the operational domain.

Those aircraft requesting ATC services will be required in some jurisdictions to use the same 24 bit address for all CNS systems. Aircraft with Mode-S transponders using an ICAO 24 bit address shall (R2.9) use the same 24 bit address for ADS-B. All aircraft/vehicle addresses shall (R2.10) be unique within the operational domain(s) applicable.

The ADS-B system design shall (R2.6) accommodate a means to ensure anonymity whenever pilots elect to operate under flight rules permitting an anonymous mode. (Most non-IFR flight operations do not require one to fully disclose either the A/V call sign or address. This feature is provided to encourage voluntary equipage and operation of ADS-B by ensuring that ADS-B messages will not be traceable to an aircraft if the operator requires anonymity.) Associated with the address there shall (R2.xx) be an address qualifier code to indicate whether the address is an ICAP 24-bit aircraft address or some other kind of address.

Notes:

1. *For example, all surface vehicles for a given airport need to have unique addresses only within range of the airport; vehicle addresses may be reused at other airports.*
2. *Correlation of ADS-B messages with transponder codes will facilitate the integration of radar and ADS-B information on the same A/V during transition.*
3. *A participant's address and address qualifier are included as parts of all reports about that participant: State Vector (SV) reports, Mode Status (MS) reports, and the various types of On Condition (OC) reports.*

~~2.1.2.1.2.1~~2.1.2.3.1 Participant Address

The Participant Address field is a required field in all ADS-B reports. This 24-bit field contains either the ICAO 24-bit address assigned to the particular aircraft about which the report is concerned, or another kind of address, as determined by the Address Qualifier field.

~~2.1.2.1.2.2~~2.1.2.3.2 Address Qualifier

The Address Qualifier field is a required field in all ADS-B reports. This field consists of one or more bits and describes whether or not the Address field contains the 24-bit ICAO address of a particular aircraft, or another kind of address. ~~The number of bits in the Address Qualifier field and the encoding of those bits are expected to be defined in lower-level documents, such as the MOPS (Minimum Operational Performance Specification) for a particular data link.~~

Note: The particular encoding used for the Address Qualifier is not specified in this MASPS, but is left for specification in lower level documents, such as the MOPS for a particular ADS-B data link. Experience in developing the MOPS for several proposed ADS-B data links suggests that 4 bits is sufficient for the Address Qualifier field.

~~2.1.2.1.3~~2.1.2.4 Participant Category

Participant category (Aircraft/vehicle category) shall (R2.11) be one of the following:

- Light aircraft (ICAO) - 7,000 kg (15,500 lbs) or less
- Small aircraft – 7,000 kg to 34,000 kg (15,500 lbs to 75,000 lbs)
- Large aircraft – 34,000 kg to 136,000 kg (75,000 lbs to 300,00 lbs)
- High vortex large (aircraft such as B-757)
- Heavy aircraft (ICAO) - 136,000 kg (300,000 lbs) or more
- Highly maneuverable (> 5g acceleration capability) and high speed (> 400 knots cruise)
- Rotorcraft
- Glider/Sailplane
- Lighter-than-air
- Unmanned Aerial vehicle
- Space/Transatmospheric vehicle
- Ultralight / Hang glider / Paraglider
- Parachutist/Skydiver
- Surface Vehicle - emergency vehicle
- Surface Vehicle - service vehicle
- Point obstacle (includes tethered balloons)
- Cluster obstacle
- Line obstacle

Note 1: ICAO Medium aircraft – 7,000 to 136,000 kg (15,500 to 300,000 lbs) can be represented as either small or large aircraft as defined above.

Note 2: Obstacles can be either fixed or movable. Movable obstacles would require a position source.

Note 3: A participant's category is reported in the Mode Status (MS) report (section 3.4.3.2 below).

Note 4: Weights given for determining participant categories are maximum gross weights, not operating weights.

Note 5: The following category code assignments should be considered for aircraft operating in the United States national air space (NAS).

Light : Less than 7,000 kg (15,500 lb)
Small: ³ 15,500 and < 41,000 lb
Large: ³ 41,000 lb and < 255,000 lb and not in "High Vortex Large" category
High Vortex Large: Certain other aircraft, including B-757
Heavy: ³ 255,000 lb

~~2.1.2.1.4~~2.1.2.5 Aircraft Size Code

The aircraft size code describes the amount of space that an aircraft occupies. The aircraft size code is not required to be transmitted by all ADS-B participants all of the time. However, it *is* required to be transmitted by aircraft above a certain size, at least while those aircraft are in the airport surface movement area.

The aircraft size code shall (R2.xx) be as described in Table 2.1.2.5. The aircraft size code is a four-bit code, in which the 3 most significant bits (the length code) classify the aircraft into one of eight length categories, and the least significant bit (the width code) classifies the aircraft into a "narrow" or "wide" subcategory.

Each aircraft shall (R2.xx) be assigned the smallest length and width codes for which its overall length and wingspan qualify it. For example, consider a powered glider with overall length of 25 m and wingspan of 50 m. Normally, an aircraft of that length would be in length category 0. But since the wingspan exceeds 33 m, it will not fit within even the "wide" subcategory of length category 0. Such an aircraft would be assigned length category 3 and width category 1, meaning "length less than 54 m and wingspan less than 52 m."

Each aircraft ADS-B participant for which the length code is ~~3~~ 1 or more (length greater than or equal to ~~39~~ 30 m or wingspan greater than ~~48~~ 33 m) shall (R2.xx) transmit its aircraft size code while it is on the surface. For this purpose, the determination of when an aircraft is on the surface shall be as described in section TBD.

Table 2.1.2.5: Aircraft Size Codes.

Length Code (3 MSBs)			Width (Wingspan) Code (LSB)	
dec.	**binary**	**Length Category**	**Narrow** (LSB = 0)	**Wide** (LSB = 1)
0	0 0 0	L < 30 m	W < 16.5 m	16.5 m ≤ W < 33 m
1	0 0 1	L < 38 m	W < 30.5 m	30.5 m ≤ W < 38 m
2	0 1 0	L < 46 m	W < 38 m	38 m ≤ W < 48 m
3	0 1 1	L < 54 m	W < 42 m	42 m ≤ W < 52 m
4	1 0 0	L < 62 m	W < 51.5 m	51.5 m ≤ W < 65 m
5	1 0 1	L < 70 m	W < 66.5 m	66.5 m ≤ W < 74 m
6	1 1 0	L < 78 m	W < 69.5 m	69.5 m ≤ W < 80 m
7	1 1 1	L ≥ 78 m	W < 84 m	W ≥ 84 m

The aircraft size code is reported in the MS (Mode Status) report (section 3.4.3.2).

~~2.1.2.2State Vector~~

~~The reported state vector for an A/V includes the three-dimensional position and velocity referenced to an accepted world-wide reference system.~~

~~The accuracy of the state vector information affects its utility for surveillance applications. Accuracy requirements for surveillance applications using ADS-B are based on the uncertainty in each state vector element that is required to support a given application.~~

~~*Note: The accuracy and integrity of the position and velocity elements of the state vector are communicated in the Mode Status report. See the descriptions of Navigation Integrity Category (NIC), Navigation Accuracy Categories for Position and Velocity (NAC_p and NAC_v), and Surveillance Integrity Level (SIL) in subsections 2.1.2.3.2.1 to 2.1.2.3.2.4 below.*~~

~~Factors that affect state vector accuracy include:~~

- ~~Errors in the navigational sensor system. For applications using ADS-B data, the measuring system is the aircraft/vehicle's navigation system. The error in the measured state vector will vary widely depending on the navigation source or sources used.~~
- ~~Errors in the ADS-B reporting system. Additional error may be added due to the resolution of the reported state vector element (that is, the minimum increment that can be reported).~~
- ~~Errors in the time of applicability. Because the A/V is moving, the reported state vector needs to meet latency requirements.~~
- ~~Errors introduced by processing. Errors may also be introduced through the processing of the state vector data. These may be introduced, for example, from coordinate conversions and round-off errors in representing position and time values.~~

~~Aircraft/vehicle state vector information shall (R2.12) include the following elements:~~

- ~~Three-dimensional position~~
- ~~Three-dimensional velocity~~
- ~~Time of applicability of the three-dimensional position and velocity.~~

~~All non-stationary ADS-B subsystem installations shall (R2.13) provide dynamic state vector reporting.~~

~~2.1.2.2.1~~2.1.2.6 Position

The state vector (SV) report (section 3.4.3.1) for an A/V includes the three-dimensional position referenced to an accepted world-wide reference system. Position information shall (R2.14) be transmitted in a form that can be translated, without loss of accuracy and integrity, to latitude, longitude, and barometric altitude and geometric height.

All geometric position elements shall (R2.15) be referenced to the WGS-84 ellipsoid.

~~2.1.2.2.1.1~~2.1.2.6.1 Horizontal Position

Horizontal latitude and longitude position shall (R2.16) be reported as a geometric position.

~~2.1.2.2.1.2~~2.1.2.6.2 Altitude

Both barometric pressure altitude and geometric altitude (height above the WGS-84 ellipsoid) shall (R2.17) be reported, if available. Some applications may have to compensate if only one source is available. However, when an A/V is operating on the airport surface, the altitude is not required to be reported, provided that the A/V indicates that it is on the surface.

~~2.1.2.2.1.2.1~~2.1.2.6.2.1 Pressure Altitude

Barometric pressure altitude is the reference for vertical separation within the NAS and ICAO airspace. Barometric pressure altitude shall (R2.18) be reported referenced to standard temperature and pressure.

Pressure altitude, which is currently reported by aircraft in SSR Mode C and Mode S, will also be transmitted in ADS-B messages and reported to client applications in SV reports. The pressure altitude reported (SV element 8a) shall (R3.34) be derived from the same source as the pressure altitude reported in Mode C and Mode S for aircraft with both transponder and ADS-B.

~~2.1.2.2.1.2.2~~2.1.2.6.2.2 Geometric Altitude

Geometric altitude is defined as the shortest distance from the current aircraft position to the surface of the WGS-84 ellipsoid. It is positive for positions above the WGS-84 ellipsoid surface, and negative for positions below that surface.

~~2.1.2.2.1.2.3~~2.1.2.6.2.3 Altitude Range

Altitude shall (R2.19) be provided with a range from -1,000 ft up to +100,000 ft. For fixed or movable obstacles, the altitude of the highest point should be reported.

Note: In this context, a "movable obstacle" means an obstacle that can change its position, but only very slowly, so that its horizontal velocity may be ignored.

~~2.1.2.2.2~~2.1.2.7 Velocity Vector

The reported state vector (SV) report (section 3.4.3.1) for an A/V includes the three-dimensional velocity referenced to an accepted world-wide reference system.
Transmitting A/Vs that are not fixed or movable obstacles shall (R2.20) provide the following information:

- Horizontal Velocity Vector

  Note: In this context, a "movable obstacle" means an obstacle that can change its position, but only very slowly, so that its horizontal velocity may be ignored.

  In addition, transmitting A/Vs that are not fixed or movable obstacles and that are not known to be on the airport surface shall (R2.xx) provide the following information:

- Vertical Rate

  ADS-B geometric velocity information shall (R2.21) be referenced to WGS-84 [7].

~~2.1.2.2.2.1~~2.1.2.7.1 Horizontal Velocity Vector

Horizontal velocity information shall (R2.xx) be transmitted in a form that can be translated, without loss of accuracy and integrity, to north-south and east-west velocity relative to the WGS-84 earth ellipsoid. Reported ranges shall (R2.22) be [0 to ±~~-~~250] knots on the surface and [0 to ±~~-~~4000] knots airborne.

~~2.1.2.2.2.2~~2.1.2.7.2 Altitude Rate

Altitude Rate shall (R2.23) be designated as climbing or descending and shall be reported up to 32,000 feet per minute (fpm). Barometric altitude rate is defined as the current rate of change of barometric altitude. Likewise, geometric altitude rate is the rate of change of geometric altitude.

The best available source of altitude rate information should be used to derive an altitude rate for broadcast. If differentially corrected GPS (WAAS, LAAS, or other) is available, geometric altitude rate as derived from the GPS source should be transmitted. If differentially corrected GPS is not available, but inertial augmented barometric altitude rate is available, inertial augmented barometric altitude rate will be the preferred source of altitude rate information. In the absence of GPS or inertial augmented barometric altitude rate sources, ADS-B derived barometric altitude rate may be transmitted. ~~A recommended Kalman filtering algorithm for deriving barometric altitude rate is provided in Appendix ??. Alternative algorithms or direct measurement sources may be used to derive barometric altitude rate if it is demonstrated that the performance of the alternative is at least as good as that of the algorithm described in Appendix ??.~~

~~2.1.2.2.3~~2.1.2.8 Heading

Heading indicates the orientation of the A/V, that is, the direction in which the nose of the aircraft is pointing. Heading is described as an angle measured clockwise from true north or magnetic north. The heading reference direction (true north or magnetic north) is conveyed in the MS report. If the heading of an A/V is available to the ADS-B transmitting subsystem on that A/V, then heading shall (R2.xx) be transmitted while that A/V is on the surface.

To promote ADS-B equipage by as many aircraft as possible, participants are not required to have a heading source available if their length code (part of the aircraft size code, section 2.1.2.5) is 2 or less. However, ADS-B participants of length code 3 or above shall (R2.xx) have a heading source available and shall (R2.xx) transmit messages to support the heading element of the SV report when those participants are on the surface.

Heading occurs not only in the SV report for participants on the airport surface, but also in the On Condition – Air Referenced Velocity (OC-ARV) report for airborne participants. If a transmitting ADS-B participant transmits messages to support OC-ARV reports, it shall (R2.xx) provide heading in those messages.

~~2.1.2.3.1~~2.1.2.9 Capability Class (CC) Codes

Capability class codes are used to indicate the capability of a participant to support engagement in specific operations. Known specific capability class codes are listed below. However, this is not an exhaustive set and provision should be made for future expansion of available class codes, including appropriate combinations thereof:

- CDTI based traffic display capability
- TCAS/ACAS installed and operational
- Service Level of the transmitting A/V

~~- Capability of transmitting Air Referenced Velocity~~

~~- Capability of transmitting Target Altitude~~

~~- Capability of transmitting Target Heading or Target Track Angle~~

~~- Capability of transmitting information to support Trajectory Change Reports for TCP, TCP+1, TCP+2, and TCP+3.~~

- Other capabilities, to be defined in later versions of this MASPS

2.1.2.9.1 CDTI

The CC code for "CDTI based traffic display capability" shall be set to ONE if the transmitting aircraft has the capability of displaying nearby traffic on a Cockpit Display of Traffic Information (CDTI). Otherwise, this CC code shall be ZERO.

2.1.2.9.2 TCAS/ACAS

The CC code for "TCAS/ACAS installed and operational" shall be set to ONE if the transmitting aircraft is fitted with a TCAS (ACAS) computer and that computer is turned on and operating ~~normally~~in a mode that can generate Resolution Advisory (RA) alerts. Otherwise, this CC code shall be ZERO.

2.1.2.9.3 Service Level of Transmitting A/V

At least three bits (eight possible encodings) shall be reserved in the capability class codes for the "service level" of the transmitting ADS-B participant.

<< ~~Tony Warren~~Jonathan Hammer or possibly WG-~~1~~4 to provide definitions of the various service levels.>>

2.1.2.10 Operational Mode (OM) Codes

Operational Mode (OM) codes are used to indicate the current operational mode of transmitting ADS-B participants. Known specific operational mode codes are listed below. However, this is not an exhaustive set and provision should be made for future expansion of available OM codes, including appropriate combinations thereof.

- TCAS/ACAS resolution advisory in effect

~~Aircraft is transmitting its Aircraft Size Code~~

- TCR cycle number

- "Just transitioned" flag for previously transmitted TCR+0

2.1.2.10.1 TCAS/ACAS Resolution Advisory Active Flag

A transmitting ADS-B participant shall set the TCAS/ACAS Resolution Active Flag to ONE in the messages that it transmits to support the MS report so long as a TCAS (ACAS) resolution advisory is in effect. At all other times, the transmitting ADS-B participant shall set the TCAS/ACAS Resolution Advisory Active Flag to ZERO.

~~**Transmitting Aircraft Size Code**~~

~~A transmitting ADS-B participant shall set the "Transmitting Aircraft Size Code" flagt to ONE in the messages that it transmits to support the MS report so long as it is actually transmitting messages to support the aircraft size code element of the MS report. At all other times, it shall reset this flag to ZERO.~~

2.1.2.10.2 TCR Cycle Number

The TCR Cycle Number indicates a current "version number" for the numbering of the TCR reports.

Each TCR report (section 3.4.3.6 below) includes both a TCR number (the "N" in "TCR+N") and a TCR cycle number for the current numbering of the TCR reports. When a TCR report is inserted into or deleted from the list of current TCRs, or the trajectory change point described in the current TCR+0 report is reached, the TCR cycle number is incremented.

The TCR Cycle Number shall (R2.xx) be a number in the range from 0 to 3 that is incremented using modulo 4 arithmetic each time the numbering of TCR reports changes. (That is, the TCR cycle number increments from 0 to 1, then from 1 to 2, then from 2 to 3, and then from 3 back to 0).

2.1.2.10.3 TCR+0 Transition Flag

The TCR+0 transition flag is used to indicate when a transmitting ADS-B participant has just reached the current TCP (described in the TCR+0 report (section 2.1.2.19.1 below) so that the numbering of TCR reports (the "N" in "TCR+N") has changed.

Normally, this flag shall be ZERO. When the transmitting ADS-B participant reaches the trajectory change point described in the current TCR+0 report, it shall (R2.xx) set the transition flag to ONE for a period of TBD seconds in the messages it transmits to support the MS report. After the TBD second interval has expired, the transmitting participant shall reset the transition flag to ZERO.

[AI 9-12] Tony Warren will provide updates for this text.

~~2.1.2.3.2State Vector Integrity and Accuracy~~

~~The accuracy and integrity of the state vector information affects its utility for surveillance applications. Accuracy requirements for surveillance applications using ADS-B are based on the uncertainty in each state vector element that is required to support a given application.~~

~~*Note: The accuracy and integrity of the position and velocity elements of the state vector are communicated in the Mode Status report. See the descriptions of Navigation Integrity Category (NIC), Navigation Accuracy Categories for Position and Velocity (NAC_p and NAC_v), and Surveillance Integrity Level (SIL) in subsections 2.1.2.11.1 to 2.1.2.11.4 below.*~~

~~Factors that affect state vector accuracy include:~~

~~Errors in the navigational sensor system. For applications using ADS-B data, the measuring system is the aircraft/vehicle's navigation system. The error in the measured state vector will vary widely depending on the navigation source or sources used.~~

~~Errors in the ADS-B reporting system. Additional error may be added due to the resolution of the reported state vector element (that is, the minimum increment that can be reported).~~

~~Errors in the time of applicability. Because the A/V is moving, the reported state vector needs to meet latency requirements.~~

~~Errors introduced by processing. Errors may also be introduced through the processing of the state vector data. These may be introduced, for example, from coordinate conversions and round-off errors in representing position and time values.~~

~~The integrity and accuracy of the state vector navigation variables are characterized by Navigation Integrity Category (NIC), Navigation Accuracy Categories (NAC_p and NAC_v), and Surveillance Integrity Level (SIL).~~

~~2.1.2.3.2.1~~2.1.2.11 Navigation Integrity Category

The Navigation Integrity Category (NIC) is reported so that surveillance applications may determine whether the reported position has an acceptable level of integrity for the intended use. The NIC parameter described in this subsection is intimately associated with the SIL (Surveillance Integrity Level) parameter described in subsection 2.1.2.14 below. The value of the NIC parameter specifies an integrity containment radius, R_C. The value of the SIL parameter specifies the probability of the true position lying outside the containment radius, R_C, without alerting, ~~without the possibility of its lying outside that radius being detected at the transmitting aircraft~~including the effects of the airborne equipment condition, which airborne equipment is in use, and which external signals are used.

Note: "NIC" and "NAC_P" as used in the current version (DO-242A) of this MASPS replace the earlier term, "NUC_P", used in the first edition (DO-242) of this MASPS. [<<ref. to DO-242, dated February 19, 1998>>].

Table 2.1.2.11 defines the navigation integrity categories that transmitting ADS-B participants shall (R2.xxx) use to describe the integrity containment radius, R_C, associated with the horizontal position information in ADS-B messages from those participants.

Table 2.1.2.11: Navigation Integrity Categories (NIC)

NIC [Note 2]	Horizontal and Vertical Containment Bounds ~~Radius, R_C~~	Comment	Notes
0	$R_C \geq$ 37.04 km (20 NM)	~~No~~ Unknown Integrity	
1	R_C < 37.04 km (20 NM)	RNP-10 containment radius	[6]
2	R_C < 14.816 km (8 NM)	RNP-4 containment radius	[3,6]
3	R_C < 7.408 km (4 NM)	RNP-2 containment radius	[6]
4	R_C < 3.704 km (2 NM)	RNP-1 containment radius	[6]
5	R_C < 1852 m (1 NM)	RNP-0.5 containment radius	[6]
6	R_C < 1111.2 m (0.6 NM)	RNP-0.3 containment radius	[6]
7	R_C < 370.4 m (0.2 NM)	RNP-0.1 containment radius	[6]
8	R_C < 185.2 m (0.1 NM)	RNP-0.05 containment radius	[6]
9	R_C < 75 m and VPL < TBD	e.g., WAAS HPL, VPL ~~Future system~~	[4,5]
10	R_C < 25 m and VPL < TBD	e.g., WAAS HPL, VPL	[4,5]
11	R_C < 7.5 m and VPL < TBD	e.g., LAAS HPL, VPL	[4,5]

Notes for Table 2.1.2.11:

1. *NIC is reported by an aircraft because there will not be a uniform level of navigation equipage among all users. Although GNSS is intended to be the primary source of navigation data used to report ADS-B horizontal position, it is anticipated that during initial uses of ADS-B or during temporary GNSS outages an alternate source of navigation data may be used by the transmitting A/V for ADS-B position information. The integration of alternate navigation sources is a function that must be performed by a navigation set that is certified to use multiple sources, which then is responsible for supplying the corresponding integrity containment radius (e.g.., HPL). It is important to point out that this is not a function that can be performed by the ADS-B equipment.*
2. *"NIC" in this column corresponds to "NUC_P" of Table 2-1(a) in the first version of this MASPS, DO-242, dated February 19, 1998.*
3. *The containment radius for NIC = 2 has been changed (from the corresponding radius for NUC_P = 2 in the first edition of this MASPS) so as to correspond to the RNP-4 RNAV limit of DO-236A, rather than the RNP-5 limit of the earlier DO-236. This is because RNP-5 is not a recognized ICAO standard RNP value.*
4. *HPL may be used to represent R_C for GNSS sensors.*
5. *If geometric altitude is not being reported than the VPL tests are not assessed.*
6. *RNP containment integrity refers to total system error containment including sources other than sensor error, where as horizontal containment for NIC only refers to sensor position error containment.*

It is recommended that the coded representations of NIC should be such that:

(a) Equipment that conforms to the current version of this MASPS ("version 1" equipment) will recognize the equivalent NUC_P codes from the first edition of this MASPS, and

(b) Equipment that conforms to the initial, DO-242, edition of this MASPS ("version 0" equipment) will treat the coded representations of NIC coming from version 1 equipment as if they were the corresponding "NUC_P" values from the initial, DO-242, version of this MASPS.

~~2.1.2.3.2.2~~2.1.2.12 Navigation Accuracy Category for Position (NAC_P)

The Navigation Accuracy Category for Position (NAC_P) is reported so that surveillance applications may determine whether the reported position has an acceptable level of accuracy for the intended use.

Note 1: "NIC" and "NAC_P" as used in this MASPS replace the earlier term, "NUC_P", used in the initial, DO-242, edition of this MASPS [<<ref. to DO-242, dated February 19, 1998>>].

Table 2.1.2.12 defines the navigation accuracy categories that shall (R2.xxx) be used to describe the accuracy of positional information in ADS-B messages from transmitting ADS-B participants.

Note 2: The Estimated Position Uncertainty (EPU) used in Table 2.1.2.12 *is a 95% accuracy bound on horizontal position. ~~The horizontal~~ EPU ~~(HEPU)~~ is defined as the radius of a circle, centered on the reported position, such that the probability of the actual position being outside the circle is 0.05. When reported by a GPS or GNSS system, EPU is commonly called HFOM (Horizontal Figure of Merit).*

Note 3: ~~Likewise, the vertical EPU (VEPU)~~Likewise, Vertical Estimated Position Uncertainty (VEPU) is a 95% accuracy limit on the vertical position. ~~is~~ VEPU is defined as a vertical position limit, such that the probability of the actual vertical position differing from the reported vertical position by more than that limit is 0.05. When reported by a GPS or GNSS system, VEPU is commonly called VFOM (Vertical Figure of Merit).

Note 4: The EPU limit for NAC = 2 has been changed (from the corresponding limit for NUC_P = 2 in the first edition of this MASP) so as to correspond to the RNP-4 RNAV limit of DO-236A, rather than the RNP-5 limit of the earlier DO-236. This is because RNP-5 is not ~~a recognized~~an ICAO standard RNP value.

Table 2.1.2.12: Navigation Accuracy Categories for Position (NAC_P).

NAC_P	95% Horizontal and Vertical Accuracy Bounds (~~H~~EPU and VEPU)	Comment	Notes
0	EPU ≥ 18.52 km (10 NM)	Unknown accuracy	
1	EPU < 18.52 km (10 NM)	RNP-10 accuracy	[1]
2	EPU ~~(or HFOM)~~ < 7.408 km (4 NM)	RNP-4 accuracy	[1]
3	EPU ~~(or HFOM)~~ < 3.704 km (2 NM)	RNP-2 accuracy	[1]
4	EPU < 1852 m (1NM)	RNP-1 accuracy	[1]
5	EPU < 926 m (0.5 NM)	RNP-0.5 accuracy	[1]
6	EPU <555.6 m (0.3 NM)	RNP-0.3 accuracy	[1]
7	EPU < 185.2 m (0.1 NM)	RNP-0.1 accuracy	[1]
8	EPU <92.6 m (0.05 NM)	e.g., GPS (with SA)	[1]
9	EPU < 30 m and VEPU < 45 m	e.g., GPS (SA off)	[2]
10	~~HEPU~~ EPU < 10 m and ~~VEPU~~VEPU < 15 m	e.g., WAAS	[2]
11	~~HEPU~~ EPU < 3 m and VEPU~~VEPU~~ < 4 m	e.g., LAAS	[2]

Notes:

1. RNP accuracy includes error sources other than sensor error, where as horizontal error for NAC only refers to horizontal position error uncertainty.

2. If geometric altitude is not being reported than the VEPU tests are not assessed.

~~2.1.2.3.2.3~~2.1.2.13 Navigation Accuracy Category for Velocity (NAC_V)

The velocity accuracy category of the least accurate velocity component being supplied by the reporting A/V's source of velocity data shall (R2.27) be as indicated in Table 2.1.2.13.

Note: NAC_V is another name for the parameter that was called NUC_R in the initial (DO-242) version of this MASPS.

Table 2.1.2.13: Navigation Uncertainty Accuracy Categories for Velocity (NAC_V).

NAC_V	Horizontal Velocity Error (95%)	Vertical Geometric Velocity Error (95%)
0	Unknown or ≥ 10 m/s	Unknown or ≥ 50 feet (15.24 m) per second
1	< 10 m/s	< 50 feet (15.24 m) per second
2	< 3 m/s	< 15 feet (4.57 m) per second
3	< 1 m/s	< 5 feet (1.52 m) per second
4	< 0.3 m/s	< 1.5 feet (0.46 m) per second

Notes to Table 2.1.2.13:

1. *When an inertial navigation system is used as the source of velocity information, error in velocity with respect to the earth (or to the WGS-84 ellipsoid used to represent the earth) is reflected in the NAC_V value.*

2. *When any component of velocity is flagged as not available the value of NAC_V will apply to the other components that are supplied.*

Commentary:

Navigation sources, such as GNSS and inertial navigation systems, provide a direct measure of velocity which can be significantly better than that which could be obtained by position differences.

~~2.1.2.3.2.4~~2.1.2.14 Surveillance Integrity Level (SIL)

The Surveillance Integrity Level (SIL) defines the probability of the integrity containment radius used in the NIC parameter (subsection 2.1.2.11above) being exceeded, without alerting, including the effects of the airborne equipment condition, which airborne equipment is in use, and which external signals are used by the navigation source.~~without the possibility of exceeding that limit being detected on board the transmitting A/V.~~ The Surveillance Integrity Limit encoding shall (R2.xxx) be as indicated in Table 2.1.2.14.

Note: It is assumed that SIL is a static (unchanging) value that depends on the position sensor being used.

Table 2.1.2.14: Surveillance Integrity Levels (SIL).

SIL	Probability of Unknowingly Exceeding the R_C Integrity Containment Radius	Comment
0	Unknown	~~Usable only by~~ "~~Non-Interfering~~No Hazard Level" ~~Applications~~Navigation Source ~~(No Hazard Level)~~
1	1×10^{-3} per flight hour or per operation	~~Usable by~~ "~~Non-Essential~~Minor Hazard Level" ~~Applications~~Navigation Source ~~(Minor Hazard Level)~~
2	1×10^{-5} per flight hour or per operation	~~Usable by~~ "~~Essential~~Major Hazard Level" ~~Applications~~Navigation Source ~~(Major Hazard Level)~~
3	1×10^{-7} per flight hour or per operation	~~Usable by~~ "~~Critical~~Severe Major Hazard Level" ~~Applications~~Navigation Source ~~(Severe Major Hazard Level)~~

~~Barometric Altitude Integrity Codes~~

~~Table 2.1.2.11.5 describes the codes in the MS report that describe the integrity of barometric altitude data.~~

~~**Table 2.1.2.11.5: Barometric Altitude Integrity Codes**~~

~~MS Element #~~	~~Meaning~~	~~Size~~
~~14a~~	~~RVSM quality~~	~~1 bit~~
~~14b~~	~~Altitude source cross-checking~~	~~1 bit~~

2.1.2.15 ~~RVSM Quality Flag~~Barometric Altitude Accuracy Code

~~A transmitting ADS-B participant shall set the RVSM Quality Flag to ONE in the messages that it sends to support the MS report only if the source of barometric altitude information meets the requirements for Reduced Vertical Separation Minima. Otherwise, it shall set this flag to ZERO.~~New text including table to be provided by Jim Maynard for next version of paper.

~~2.1.2.11.5.2~~2.1.2.16 Altitude Source Cross-Checking Flag

A transmitting ADS-B participant shall set the Altitude Source Cross-Checking Flag to ONE in the messages that it sends to support the MS report only if there is more than one source of barometric pressure altitude data and cross-checking of one altitude source against the other is performed so as to clear the "barometric altitude valid" flag in the SV report if the two altitude sources do not agree. Otherwise, it shall set this flag to ZERO.

~~2.1.2.3.3~~2.1.2.17 Emergency/Priority Status

The ADS-B system shall (R2.28) be capable of supporting broadcast of emergency and priority status. The coding of emergency/priority status ~~Status~~ shall (R2.29) be ~~include the following~~as indicated in Table 2.1.2.17.

Table 2.1.2.17: Emergency/Prioirty Status Encoding.

Coding	Meaning
0	No emergency / not reported
1	General emergency
2	Lifeguard / medical emergency
3	Minimum fuel emergency
4	No communications
5	Unlawful interference
6	~~(Reserved for future definition)~~Downed Aircraft
7	(Reserved for future definition)

~~÷~~

~~- No emergency / Not reported~~

~~- General emergency~~

~~Lifeguard/medical~~

~~- Minimum fuel~~

~~- No communications~~

~~- Unlawful interference~~

~~[***Comment by Jim Maynard***: The source of the information for the "lifeguard/medical" and "minimum fuel" emergency/priority status codes is problematic. Should these emergency/priority status values be dropped from the MASPS?]~~

~~2.1.2.3.4~~2.1.2.18 Short Term Intent

~~Short-term intent parameters are assembled in the Target State Report, described in section 3.4.3.5 below. Several intent variables are being considered for broadcast by ADS-B. Short-term intent information may include Selected Altitude, Target Altitude, Target Heading or Track , intent status, and/or other variables to be determined by ongoing studies.~~

~~**Selected Altitude** is an intended altitude that the pilot has selected using the Mode Control Panel (MCP) or Flight Control Unit (FCU). Often this is the altitude to which the aircraft has most recently been cleared by ATC.~~

~~**Target Altitude** is the altitude at which the altitude is expected next to change its vertical movement, according to whichever device (MCP/FCU, FMS, etc.) is currently controlling the aircraft. This may be the altitude of the next waypoint in a flight plan that has been entered into the FMS, or the top-of-climb or bottom-of-descent altitude at which the aircraft will level off.~~

~~Note: In Mode S transponders equipped for Downlink of Aircraft Parameters (DAPs), it is expected that Selected Altitude and Target Altitude may be obtainable by a external interrogator (e.g., ground SSR or airborne TCAS/ACAS) that interrogates the transponder for the contents of its GICB register number 20 {hex}.~~

~~**Target Heading/Track** is the anticipated direction for horizontal turn completion, or the intended heading or ground track angle during a constant flight leg segment.~~

~~**Intent status** is a binary flag for onboard lateral compliance and a binary flag for onboard vertical compliance, indicating whether the current path is consistent with the broadcast intent variables described above.~~This text will be re-worked by Richard Barhydt [AI 9-13]

~~2.1.2.3.5~~2.1.2.19 Trajectory Change Intent (Current and Future)

Track extrapolations based on the use of intent data alone are increasingly inaccurate as look-ahead times are increased. The state vector can be augmented with trajectory change points (i.e., intent information) for applications on the receiving A/V or ATS to:

a) support stable separation predictions for long look-ahead times, and in monitoring required operational separations and

b) re-plan flight paths when necessary to resolve detected conflicts (deconfliction) while minimizing deviations from planned flight trajectories.

The ADS-B system shall (R2.30) provide the capability to exchange Trajectory Change Point (TCP) and Trajectory Change Point + 1 (TCP+1) data defined below. ADS-B transmissions shall (r2.31) indicate the ability of the transmitting participant to engage in path monitoring and/or de-confliction operations. The transmitting A/V shall (R2.32) also indicate its capability to use intent information received from other participants.

For certain pairwise operations, an addressed crosslink may be used external to the ADS-B system.

~~2.1.2.3.5.1~~2.1.2.19.1 Current Trajectory Change Point (TCP)

The TCP from the transmitting aircraft is the point in three-dimensional space where the current operational trajectory is planned to change, and estimated remaining flight time to that point. A TCP transmission indicates that the aircraft intends to fly directly, via a great circle route, to that point. The TCP is defined as a four-element vector consisting of the following:

- Latitude (WGS-84)
- Longitude (WGS-84)
- Altitude (pressure altitude or flight level)
- Time to go (TTG) to the indicated point in space

The TCP required received update rate may be lower than for the state vector. The rate shall (R2.33) be sufficient to ensure continuous positive assessment by the receiving aircraft at least 2 minutes (5 minutes within the range limitations specified in Table 2-3) prior to reaching closes point of approach for class A2 (A3) equipage. In the event of an immediate trajectory change generated via the RNav, new TCP information should be issued immediately.

The augmentation data should be provided as data transmitted indicating planned changes in trajectory. These indications should be provided as TCP information and TCP+1 information described below. This data is required only from participants intending operations based on some level of cooperative conflict management. The TCP and TCP+1 should be used to convey information operationally significant to separation and conflict management. Points constructed by RNav equipment to generate curvilinear paths (e.g., curved transitions between flight legs) should not be conveyed as TCP information.

System designs should be flexible enough to support parameters that might not be available from all ADS-B participating A/Vs. Information acquisition of intent information is provided in Appendix L.

~~2.1.2.3.5.2~~2.1.2.19.2 Next Trajectory Change Point (TCP+1)

De-confliction is most efficient when adjustments to the flight path can be minimized. Knowledge of planned changes to the current path is needed to support the conflict management tools for stable operational re-planning required due to any conflict that may be predicted.

For the de-confliction capability, additional augmenting information should be provided to determine any change in horizontal and/or vertical flight path planned. The aircraft planning the change shall (R2.34) issue the TCP+1 information at least 5 minutes prior to commencing the trajectory change associated with the TCP. The TCP+1 data to be supplied should provide the target or predicted altitude, the target horizontal coordinates and the estimated time remaining from the time of generation of the message to the estimated time to arrive at TCP+1. Upon initiation of the flight path change at TCP, the TCP+1 should increment to become the new TCP. TCP+1 information shall (R2.35) be provided until commencing the change maneuver. The TCP+1 required transmission rate shall (R2.36) be the same as that of the TCP.

Notes:

1. *TCP and TCP+1 data are provided by broadcast media to supply real-time, event-related data to proximate air and ground systems involved in advanced air operations requiring real time intent detail. Details of more complete flight plan or detailed procedures are conveyed, when required, via addressed datalink media.*

2. *No TCP is needed for speed changes along a trajectory. The data indicating the time to go for TCP and TCP+1 should include any results of planned or predicted changes. For RNav equipment capable of such predictions or scheduling, the time data should include the impacts. Less capable equipment should provide the best estimate available. Air or Ground systems receiving the TCP/TCP+1 data should be capable of applying these data as appropriate to their respective applications in conflict management, sequencing, spacing or conformance.*

3. *TCP and TCP+1 data are envisioned in current planning future procedures in the terminal area and transitions between en route flight regimes to enhance sequencing in arrival and departure. These data are intended for applications by both air and ground systems. The ADS-B system will enable the delivery of TCP and/or TCP+1 data when required by the procedures supported by the RNav onboard the transmitting participant. Receiving participants would use the transmitted capability codes to determine pair-wise compatibility with their respective applications.*

   For example, at shorter ranges, a pair of points (TCP and TCP+1) could be issued in conjunction with Terminal Maneuvering Area metering operations and/or when maneuvering to join or depart published procedures.

4. *Lateral TCPs are fly-by points unless indicated to be fly-over. TCP and tCP+1 points are intended to convey trajectory target and trajectory change only. Accordingly, they are not necessarily RNav flight plan waypoints. They must be represented only in binary data form. Example TCPs are top of descent, reach climb altitude or intercept points used to capture procedures or join the flight plan.*

5. *Under some common operational sequences an aircraft may be manually departing or returning to an RNav flight plan. An example case would result from a period of vectored operation by ATS. In such cases the application should determine when to assume the intent is "direct-to" or if the aircraft is operating with a different intent.*

~~2.1.2.4~~2.1.2.20 Other Information

2.2 System Performance – Standard Operational Conditions

2.2.1 ADS-B System-Level Performance

2.2.2 ADS-B System Level Performance – Aircraft Needs

2.2.2.1 Aircraft Needs While Performing Aid to Visual Acquisition

2.2.2.2 Aircraft Needs for Conflict Avoidance and Collision Avoidance

3 ADS-B System definition and Functional Requirements

3.1 System Scope and Definition of Terms

3.2 ADS-B System Description

3.3 Requirements

3.4 ADS-B Report Definitions

3.4.1 Report Assembly Design Considerations

3.4.2 ADS-B Message Exchange Technology Considerations in Report Assembly

3.4.3 Specific ADS-B Report Definitions

3.4.3.1 State Vector Report

Table 3.4.3.1 lists the report elements that comprise the state vector (SV) report. The SV report contains information about an aircraft or vehicle's current kinematic state. ~~(~~Measures of the state vector quality are contained in the NIC element of the SV report and in the NAC, SIL, and VIC elements of the Mode Status Report, section 3.4.3.2 below.~~)~~

Table 3.4.3.1: State Vector Report Definition.

	SV Elem. #	Contents	[Resolution or # of bits]	Required from surface participants	Required from airborne participants	Reference Section
ID	1	Participant Address	[24 bits]	•	•	2.1.2.3.1
	2	Address Qualifier	[4 bits]	•	•	2.1.2.3.2
TOA	3	Time Of Applicability	[0.2 s]	•	•	2.1.2.1
Geometric Position	4a	Latitude (WGS-84)	[0.1 minutes of arc]	•	•	2.1.2.9
	4b	Longitude (WGS-84)	[0.1 minutes of arc]	•	•	
	4c	Horizontal Position Valid	[1 bit]	•	•	
	5a	Geometric Altitude	[TBD]	•		2.1.2.6.2
	5b	Geometric Altitude Valid	[1 bit]	•		
Horizontal Velocity	6a	North Velocity while airborne	[1 knot or 4 knot]	•		2.1.2.7.1
	6b	East Velocity while airborne	[1 knot or 4 knot]	•		
	6c	Airborne Horizontal Velocity Valid	[1 bit]	•		
	7a	Ground Speed while on the surface	[TBD]		•	2.1.2.7.1
	7b	Surface Ground Speed Valid	[1 bit]		•	
Heading	8a	Heading while on the Surface	[6 bits]		•	2.1.2.8
	8b	Heading Valid	[1 bit]		•	
Baro Altitude	9a	Barometric Pressure Altitude	[25 ft or 100 ft]	•		2.1.2.6.2
	9b	Pressure Altitude Valid	[1 bit]	•		
Vertical Rate	10a	Vertical Rate (Baro/Geo)	[TBD]	•		2.1.2.7.2
	10b	Vertical Rate Valid	[1 bit]	•		
NIC	11	Navigation Integrity Category	[4 bits]	•	•	2.1.2.11
Report Mode	12	Report Mode	[2 bits]			3.4.3.1.5

ADS-B participants that are known to be on the surface shall (R3.xxx) transmit those ~~*Time-critical* state vector elements are those indicated by bullets in the "Time-Critical SV Elements" column of Table 3.4.3.1. For systems utilizing segmented messages for SV data, time-critical state vector elements not updated in the current received message shall (R3.35) be estimated when the report is updated; otherwise SV elements shall (R3.35) be updated as new data is received.~~

State vector elements that are indicated with ~~"R"~~bullets ("•") in the "required from surface participants" column of Table 3.4.3.1~~3-5 shall (R3.xxx)be transmitted by ADS-B participants that indicate that they are on the surface~~. Likewise, participants that ~~do not indicate that they~~ are known to be ~~on the surface~~airborne shall (R3.xxx) ~~-~~transmit those SV elements that are indicated by ~~"R"~~bullets in the "required from airborne participants" column ~~by~~. Any transmitting ADS-B participant for which the air/ground state is uncertain shall (R3.xx) transmit all SV elements with bullets in either column.

3.4.3.1.1 State Vector Update Rate

Required SV report update rates ~~for this report~~, described by operational capability and operating range, are given in Section **Error! Reference source not found.**.

3.4.3.1.2 State Vector Time of Applicability

The time of applicability relative to local system time shall (R3.37) be updated with each State Vector report update. For other elements of the SV report, the report assembly function shall (R3.38) either provide updates when data is received or indicate "no data available" if no data are received in the preceding 10 second period.

3.4.3.1.3 State Vector Geometric Position and Velocity Elements

Geometric based state vector information is referenced to the WGS-84 ellipsoid and consists of latitude, longitude, height above the ellipsoid, horizontal velocity, and rate of change of height above the ellipsoid.

3.4.3.1.4 ~~Other~~ Non-Geometric State Vector Elements

~~The surveillance SV report for each acquired participant contains the participant address and address qualifier for correlation purposes. Other~~Non-geometric state vector ~~information~~ report elements ~~includes~~ include pressure altitude, pressure altitude rate, and, for participants on the surface, ~~the~~ heading ~~of participants on the surface~~.

Note: Airspeed and heading for airborne participants are reported in the Air Referenced Velocity report, which is one of the On Condition reports. See section 3.4.3.4 below.

3.4.3.1.5 State Vector Report Mode

The "Report Mode" (SV element #11) provides a positive indication when SV acquisition is complete and all applicable data sets and modal capabilities have been determined for the participant or that a default condition is determined by the Report Assembly function. The information for this SV element is not transmitted over the ADS-B data link, but is provided by the report assembly function at the receiving ADS-B participant. Table 3.4.3.1.5 lists the possible values for the SV Report Mode.

Table 3.4.3.1.5 : SV Report Mode Values.

Value	Meaning
0	Acquisition
1	Track
2	Default

<<Note: We need text to describe the meanings of "acquisition," "track," and "default" SV report modes.>>

3.4.3.2 Mode Status Reports

The mode-status (MS) report contains current operational information about the transmitting participant. This information includes participant type, mode specific parameters, status data needed for certain pairwise operations, and assessments of the integrity and accuracy of position and velocity elements of the SV report. These elements require lower update rates than the SV report. Specific requirements for a participant to supply data for and/or generate this report subgroup will vary according to the equipage class of each participant. Paragraph 0 defines the required capabilities for each Equipage Class defined in Section **Error! Reference source not found.**. Equipage classes define the level of MS information to be exchanged from the source participant to support correct classification onboard the user system.

The Mode-Status report for each acquired participant contains the unique participant address for correlation purposes, static and operational mode information and Time of Applicability. Contents of the Mode-Status report are summarized in Table 3.4.3.2.

The static and operational mode data includes the following information:

- Capability Class (CC) Codes – used to indicate the capabilities of a transmitting ADS-B participant.
- Operational Mode (OM) ~~Specific Parameters~~Codes – used to indicate the current operating mode of a transmitting ADS-B participant. ~~e.g., Speed target, Mag/True track, IAS/TAS.~~

For each participant the Mode-status report shall (R3.41) be updated and made available to ADS-B applications any time a new message containing all, or a portion of, its component information is accepted from that participant. For all applications other than Aid to Visual Acquisition the required MS report must be available to qualify for ADS-B operations.

The time of applicability relative to local system time shall (R3.42) be updated with every Mode-status report update. For all elements of MS report the assembly function shall (R3.43) provide update when received or indicate “no data available” if none is received in the preceding 10 second period.

Table 3.4.3.2: Mode-Status (MS) Report Definition.

	MS Elem. #	Contents [Resolution or # of bits]	Reference Section
ID	~~1a~~1	Participant Address [24 bits]	2.1.2.3.1
	~~1b~~2	Address Qualifier [4 bits]	2.1.2.3.2
TOA	~~2~~3	Time of Applicability [1 s resolution]	2.1.2.1
ID	~~3~~4	Call sign [up to 8 alpha-numeric characters]	2.1.2.2
	~~4~~4	Participant Category [5 bits]	2.1.2.4
	~~5~~6	Aircraft Size Code [Note 1] [4 bits]	2.1.2.5
Status	~~6~~7	Surveillance Support Code [Note 2] [1 bit]	
	~~7~~8	Emergency/Priority Status [3 bits]	2.1.2.17
CC	~~8~~9	Capability Class Codes [~~16~~ TBD bits ~~reserved~~]	2.1.2.9
		8a: CDTI display enabled [1 bit]	2.1.2.9.1
		8b: TCAS enabled [1 bit]	2.1.2.9.2
		8c: Service Level [~~2 bits~~ 3 bits]	2.1.2.9.3
		(Reserved for future growth) [TBD bits]	
OM	~~9~~10	Operational Mode Parameters [~~16~~ TBD bits ~~reserved~~]	2.1.2.10
		~~9a~~10a: ACAS/TCAS resolution advisory active [1 bit]	2.1.2.10.1
		10b: Transmitting Aircraft Size Code [1 bit]	1.1.1.1.1
		10c: TCR Cycle # [2 bits]	2.1.2.10.2
		10d: TCR+0 transition flag [1 bit]	2.1.2.10.3
		(Reserved for future growth) [TBD bits]	
SV Integrity and Accuracy	~~10a~~11	Nav. Acc. Category for Position (NAC_P) [4 bits]	2.1.2.12
	~~10b~~12	Nav Acc. Category for Velocity (NAC_V) [2 bits]	2.1.2.13
	~~10c~~13	Surveillance Integrity Level (SIL) [2 bits]	2.1.2.14
	~~10d~~14	Baro Altitude Integrity Codes ~~(VIC)~~ [2 bits]	1.1.1.1
		14a:	
		14b:	
Data Reference	~~11a~~15	True/Magnetic Heading [1 bit]	
	~~11b~~16	IAS/TAS/Mach Airspeed [2 bits]	
	~~11c~~17	Primary Vertical Rate Type (Baro./Geo.) [1 bit]	
Other	~~12~~18	Flight Mode Specific Data [Note 3] [TBD bits]	

Notes for Table 3.4.3.2:

1. *The aircraft size code (SV element 4) only has to be transmitted by aircraft above a certain size, and only while those aircraft are on the ground. (See section 2.1.2.5 for details.)*
2. *The Surveillance Support code can be Normal or Default. "Normal" means that for the stated capability class codes (field 7), all data are reliable. "Default" means that the transmitting ADS-B participant advises that some transmitted data are not reliable or unavailable.*
3. *Flight mode specific data will be defined in a lower level of documentation and be included through revision to the MASPS. Examples are: touchdown speed and pair-wise operational capabilities.*

~~4.~~3.4.3.2.1 Mode-Status Update Rate

<<Insert text here to define – or reference – requirements on the update rate for the data in MS reports.>>

3.4.3.3 On-Condition Reports

The following sections (3.4.3.4 to 3.4.3.6) describe various On Condition (OC) reports. The OC reports are those for which messages are not transmitted all the time, but only when certain conditions are satisfied. Several OC report types are currently defined, as follows:

ARV: Air Referenced Velocity Report (section 3.4.3.4).

TSR: Target State Report (section 3.4.3.5).

~~**TCP**~~**TCR, ~~TCP~~TCR+1, ~~TCP~~TCR+2, ~~TCP~~TCR+3**: Trajectory Change Reports (section 3.4.3.6). This may be for either the current trajectory change point towards which the aircraft is being controlled (the TCP), or for subsequent trajectory change points (TCP+1, TCP+2, TCP+3).

Other OC reports may be defined in future versions of this MASPS. Examples of such reports are to be found in Appendix M.

3.4.3.4 ~~On Condition~~ Air Referenced Velocity (~~OC~~ ARV) Report

The ~~On Condition~~ Air Referenced Velocity (~~OC~~ ARV) report contains velocity information that is not required from all airborne ADS-B transmitting participants, and that may not be required at the same update rate as the position and velocity elements in the SV report. Table 3.4.3.4 lists the elements of the OC-ARV Report.

Table 3.4.3.4: Air Referenced Velocity (~~OC~~ ARV) Report Definition.

	~~OC~~ ARV Elem. #	Contents [Resolution or # of bits]	Reference Section
ID	1	Participant Address [24 bits]	2.1.2.3.1
	2	Address Qualifier [4 bits]	2.1.2.3.2
TOA	3	Time of Applicability [1 s resolution]	2.1.2.1
Airspeed	4a	Airspeed [1 knot or 4 knots]	
	4b	Airspeed Valid [1 bit]	
Heading	5a	Heading while airborne [Note 1] [1 degree ~~of arc~~]~~[~~	2.1.2.8
	5b	Heading Valid [1 bit]	

Notes for Table 3.4.3.4:

1. *The heading reference direction (true north or magnetic north) is given in the MS report..*

Conditions for transmitting OC-ARV report elements. An airborne ADS-B participant of equipage class A3 [A2 or A3??] shall (R3.xx) transmit messages to support the OC-ARV report when ~~either of~~ the following conditions is met:

~~–~~ <<Text TBD>> ~~The participant is capable of transmitting the airspeed report element (as indicated in the capability codes (CC) element of the MS report) and it has received an OC-RFI report (see section 1.1.1.1) requesting that it transmit airspeed; or~~

- ~~The participant is capable of transmitting the heading report element (as indicated in the capability codes (CC) element of the MS report) and it has received an OC-RFI report (section 1.1.1.1) requesting that it transmit heading.~~

~~An ADS-B participant that is transmitting messages to support the OC-ARV report shall (R2.xx) cease such transmissions when at least [TBD: 2 minutes?] have elapsed without its receiving an OC-RFI report requesting transmission of messages to support the OC-ARV report.~~

Update Interval for OC-ARV report elements.

<<Text TBD>>

3.4.3.5 Target State Report (TSR)

The Target State Report (TSR) contains information about the current heading or altitude towards which the aircraft is being controlled. Table 3.4.3.5 lists the elements of this report.

Table 3.4.3.5~~Table 3.4.3.4~~: ~~OC-~~Target State Report (TSR) ~~Report~~ Definition.

	~~OC-ARV~~TSR Element ~~.~~ #	Contents ~~[number of bits]~~ ~~[Notes]~~[Resolution or # of bits]		Reference Section
ID	1	Participant Address	[24 bits]	2.1.2.3.1
	2	Address Qualifier	[4 bits]	2.1.2.3.2
TOA	3	Time of Applicability	[1 s resolution]	2.1.2.1
Target Heading (or Track Angle)	4	Target Heading or Track Angle	[1 degree]	3.4.3.5.3
	5	Heading/Track Indicator	[1 bit]	
	~~2c~~6	Target Source Indicator (Horizontal)	~~d~~ [2 bits]	
	7	Mode Indicator (Horizontal)	[1 bit]	
	8	(Reserved for Horizontal Validity Flag)	[1 bit]	
	9	Data Available (Horizontal)	[1 bit]	
		(Reserved for future growth)	[2 bits]	
Target Altitude	10	Target Altitude	[100 ft resolution]	3.4.3.5.4
	11	Target Altitude Type	[2 bits]	
	12	Target Source Indicator (Vertical)	[2 bits]	
	13	Mode Indicator (Vertical)	[1 bit]	
	14	(Reserved for Vertical Conformance)	[1 bit]	
	15	Data Available (Vertical)	[1 bit]	
		(Reserved for future growth)	[1 bits]	

3.4.3.5.1 Conditions for Transmitting TSR Information

~~**Conditions for transmitting OC-TSR report elements.**~~ An ADS-B participant in an airborne aircraft shall (R3.xx) transmit messages to support the OC-TSR report when any of the following conditions are met:

<<Text TBD >>

3.4.3.5.2 Update Rate for TSR Information

~~**Update Interval for OC-TSR report elements.**~~ <<Text TBD>>

~~3.4.3.5.1~~3.4.3.5.3 Target Heading or Track Angle

The target heading or track angle (~~OC~~ TSR element #~~2a~~4) may be either the current heading (track angle) if in heading (track angle) hold mode, or the next intended heading (track angle) towards which the aircraft is being controlled.

3.4.3.5.3.1 Heading/Track Indicator

The orientation type (heading or track angle) is conveyed in ~~OC~~ TSR element #~~2b~~5, the Heading/Track Indicator. This field shall be ZERO to indicate that element #~~2a~~ 4 conveys target heading, or ONE to indicate that element #~~2a~~ 4 conveys target track angle. The reference direction (true north or magnetic north) is conveyed in the MS report.

3.4.3.5.3.2 Horizontal Data Available

The ~~validity~~ Horizontal Data Available flag for the target heading, ~~OC~~ TSR element #~~2c~~9, shall be ONE to indicate that data in the target heading or track angle field (element #~~2a~~4) is valid, or ZERO otherwise.

3.4.3.5.3.3 Horizontal Target Source Indicator

The ~~target heading/track~~Horizontal Target ~~s~~Source indicator (~~OC~~ TSR element #~~2d~~6) is a two-bit field ~~that is reserved for future definition.~~indicates the source of the Target Heading/Track Angle information. <<***Need text to define the values of this field.***>>

3.4.3.5.3.4 Horizontal Mode Indicator

The ~~mode indicator~~Horizontal Mode Indicator ~~for target heading/track angle~~ (~~OC~~ TSR element #~~2e~~7) is a ~~two~~one-bit ~~field~~ flag that ~~is reserved for future definition~~…. <<***Need text to define the values of this field.***>>

~~3.4.3.5.2~~3.4.3.5.4 Target Altitude

The target altitude (~~OC~~ TSR element #~~3a~~10) may be either the current altitude, if in altitude hold mode, or the next intended altitude towards which the aircraft is being controlled.

3.4.3.5.4.1 Vertical Data Available

<< Need text>>

3.4.3.5.4.2 Target Altitude Type

<< Need text>>

3.4.3.5.4.3 Vertical Target Source Indicator

<< Need text>>

3.4.3.5.4.4 Vertical Mode Indicator

<< Need text>>

3.4.3.6 ~~On Condition~~ Trajectory Change Report (~~OC-TCP~~TCR, ~~OC-TCP+1~~TCR+1, etc.) Definition~~Reports~~

Table 3.4.3.6 shows the overall structure for ~~On Condition~~ Trajectory Change ~~Point~~ reports (TCRs~~OC-TCP~~) ~~reports~~. The structure shown here is intended to accommodate up to four trajectory change points, and to provide for additional fields as more types and subtypes of TCP reports are developed for later versions of this MASPS.

Table 3.4.3.6: ~~Generalized OC-TCP~~Trajectory Change Report (TCR) Definition.

	~~OC-TCP~~TCR Elem. #	Contents [Notes] [~~number~~ Resolution or # of B~~b~~its] ~~[Notes]~~	Reference Section
ID	1	Participant Address [24 bits]	2.1.2.3.1
	2	Address Qualifier [4 bits]	2.1.2.3.2
TOA	3	Time of Applicability [1 s resolution]	
TCR Sequence #	4	TCR # (“N” in “TCR+N”) [Note 2] [2 bits]	
TCR Cycle #	5	[2 bits]	
TTG	6	Time To Go [1 s resolution]	
Horizontal TCP Information	7	Horizontal TCP Type [Note 1] [4 bits]	
	8a	TCP Latitude [0.1 minute of arc]	
	8b	TCP Longitude [0.1 minute of arc]	
	9	Turn Radius [0.1 NM]	
	10	Track to TCP [1 degree]	
	11	Track from TCP [1 degree]	
	12	(Reserved for Horizontal Conformance) [1 bit]	
	13	Command/Planned (Horizontal) [1 bit]	
	14	Data Available (Horizontal) [1 bit]	
Vertical TCP Information	15	TCP Type (Vertical) [4 bits]	
	16	TCP Altitude [100 ft resolution]	
	17	(Reserved for Altitude Constraint Type) [2 bits]	
	18	(Res. for Altitude Constraint Conformance) [1 bit]	
	19	Command/Planned (Vertical) [1 bit]	
	20	Data Available (Vertical) [1 bit]	

3.4.3.6.1 Conditions for Transmitting TCR Information

<<Text TBD >>

3.4.3.6.2 Update Interval for TCR Information

-<<Text TBD>>

~~3.4.3.6.3Type 0 TCP Report Format~~

~~Table 3.4.3.6.3 shows the structure of Type 0 TCP reports. This report structure accommodates the fields of TCP and TCP+1 reports as they were defined in the initial version (DO-240) of this MASPS.~~

~~Table 3.4.3.6.3: Type 0 TCP Report Definition.~~

~~Notes for Table 3.4.3.6.3:~~

~~1.ADS-B transmitting equipment that conforms to the initial (DO-242) version of this MASPS need not transmit messages that convey the TCP Type field. Therefore, for backwards compatibility, ADS-B receiving equipment should interpret messages that convey information for TCP reports, but do not contain the TCP Type field, as if those messages specified TCP Type = 0.~~

~~2.Only two values (0 and 1) are valid in the TCP # field. (This is for compatibility with ADS-B transmitting equipment that conforms to the initial, DO-242, version of this MASPS.)~~

~~3.4.3.6.4Type 1 TCP Report Format~~

~~Table 3.4.3.6.4 shows the structure of Type 1 TCP reports. This report structure accommodates the fields of TCP, TCP+1, TCP+2, and TCP+3 reports as they are defined in the current version (DO-240A) of this MASPS.~~

~~Table 3.4.3.6.4: Type 1 TCP Report Definition~~

~~Notes for Table 3.4.3.6.4:~~

~~1.ADS-B transmitting equipment that conforms to the initial (DO-242) version of this MASPS need not transmit messages that convey the TCP Type field. Therefore, for backwards compatibility, ADS-B receiving equipment should interpret messages that convey information for TCP reports, but do not contain the TCP Type field, as if those messages specified TCP Type = 0.~~

~~2.Four possible values (0, 1, 2, and 3) are valid in the TCP # field.~~

3.4.3.7On Condition – Request for Information (OC-RFI) Report

Note: The proper place for this information is Appendix M, not the body of the MASPS. It is shown here in this draft only by way of example, to show how this kind of OC report might later be incorporated in the body of the MASPS.

Table 3.4.3.7 shows the format of a possible future On Condition report by which one ADS-B participant might request On Condition reports to be transmitted by another ADS-B participant. The "condition" that causes a participant to transmit a message to support this report is that the participant desires to participate in a pairwise operation with the other participant – the "addressee" to which the message is directed.

Note: Strictly speaking, this report may not be proper for a broadcast system such as ADS-B, because the message that transmits this information is not really broadcast, but is addressed to a particular ADS-B participant. Indeed, messages to support the OC-RFI report might not be transmitted on an ADS-B data link at all, but instead be transmitted on a different data link, that provides an addressed (rather than broadcast) communication service.

Table 3.4.3.7: On Condition – Request For Information (OC-RFI) Report Definition.

Conditions for transmitting OC-RFI report elements. An ADS-B participant in an airborne aircraft shall (R3.xx) transmit messages to support the OC-TCP report when any of the following conditions are met:

<<Text TBD >>

Update Interval for OC-RFI report elements. <<Text TBD>>

<<Text TBD >>

3.4.3.8On Condition – Airborne Information for Lateral Spacing (OC-AILS) Report

Note: This information is copied from Appendix M, where it should remain. It is shown here in this draft only by way of example, to show how this kind of OC report might later be incorporated in the body of the MASPS.

Table 0 shows the format of a possible future On Condition – Airborne Information for Lateral Spacing (OC-AILS) report.

Table 0: OC-AILS Report Definition.

Conditions for transmitting OC-AILS report elements. An ADS-B participant in an airborne aircraft shall (R3.xx) transmit messages to support the OC-TCP report when any of the following conditions are met:

<<Text TBD >>

Update Interval for OC-AILS report elements. <<Text TBD>>

Minimum ADS-B Report Requirements for Equipage Classes

Equipage classes are defined to accommodate tiered capabilities according to increasingly complex operational objectives while preserving basic interoperability between classes. Equipage decisions are determined on the basis the operational approval desired. Each equipage class discussed in Table 3-1 is required to receive messages and process the recovered information into specific ADS-B reports according to the applicable capability. This section defines the required ADS-B report capabilities for each class.

For certain pair-wise operations, more data is required to support the desired applications than that provided by the state vector alone. Table 3-3 states general requirements to perform or support certain operational capabilities. The receiving participant must determine the pair-wise capabilities between own and the transmitting (other) participant. This capability determination is determined by reading the class code (item 6) defined in the Mode-Status report. Therefore, this section also identifies the transmitted information required from each class operating within the ADS-B system.

Interactive Aircraft/Vehicles Subsystems (Class A)

Table 3-8(a) defines requirements for the contents of ADS-B reports to be provided by each Class A equipment. Table 3-8(b) defines requirements for minimum information to be broadcast by class A equipment.

Table 3-8(a): Class A Equipment ADS-B Report Contents

Notes for Table 3-8(a):

ADS-B Collision Avoidance can be performed without acquiring Mode-status data. Mode-status data is needed in applications which determine separation assessment based on the information provided in Partial MS report. Such assessments and predictions are performed well outside the operational conditions of Collision Avoidance.

Numbers (#) refer to data elements in Tables 3.4-1, 3.4-2, and 3.4-3.

All SV (state vector) entries require elements 1 through 17.

Mode-status elements 1 though 6 and 12 required.

Mode-status elements 1 through 12 required.

Not applicable for ground vehicles.

Table 3-8(b): Class A Equipment Broadcast Information Required

Notes for Table 3-8(b):

Message content required to support report Element # in Tables 3.4-1, 3.4-2, and 3.4-3. Only the appropriate information ned be broadcast.

Contents to support SV elements 1 through 15.

Contents to support MS elements 1 through 4.

Contents to support MS elements 1 though 6.

Contents to support MS elements 1 through 11.

Contents to support OC elements 1 through 5

Not applicable for ground vehicles.

Contents to support SV elements 1, 2, 3, 5-8, 10, 14.

~~Broadcast-Only Subsystems (Class B)~~

~~As a broadcast-only subsystem no reports are required. Table 3-9 indicates the required information to support users in locating and identifying the transmitting participant. Certification of these classes is required to support the overall quality and safe usage of information used in ADS-B dependent applications.~~

~~Table 3-9): Class B Equipment ADS-B Information Transmission~~

~~*Notes for Table 3-9:*~~

~~*Numbers (#) refer to data elements in Tables 3-5, 3-6, and 3-7.*~~

~~*State Vector elements 1-9, 11, and 14 required.*~~

~~*State Vector elements 1 through 6 required.*~~

~~*Mode-status elements 1, 3,4 required.*~~

~~*On the airport surface, aircraft are not required to report altitude, but must indicate that they are on the surface.*~~

~~*Ground vehicles are not required to broadcast altitude or altitude rate.*~~

~~Receive-Only Subsystems (Class C)~~

~~Table 3-10 defines ADS-B reports required in ground applications.~~

~~Table 10: Class C Equipment ADS-B Report Contents~~

~~*Note: "All elements" consists of every element of the State Vector, Mode-status, and On-Condition report.*~~