# RTCA Special Committee 186, Working Group 3

# ADS-B 1090 MOPS, Revision A

# Meeting #12

# 1090 MHz ADS-B MOPS Revisions for ADS-B Report Formats

**Prepared by Ron Jones, FAA, ASD-140**

Summary

Changes to the ADS-B MASPS (DO-242A) were agreed by SC-186 at its plenary 10-11 April 2002. DO-260A is expected to include the specific provisions to accommodate the changes introduced in DO-242A. The attachments to this working paper include proposed DO-260A changes/additions to align the example ADS-B report formats in section 2.2.8 of DO-260A with the report contents required by DO-242A.

**References**: Proposed ADS-B MASPS DO-242A, final draft May 2002

**Attachment A1:** Proposed changes to DO-260A Sections 2.2.8.1.1.1 and table 2-65 for Report Type and Structure Identification

**Attachment A2:** Proposed changes to DO-260A Sections 2.2.8.2 to define the format of Mode Status Reports

**Attachment A3:** Proposed changes to DO-260A Section 2.2.8.3 for the format of On-Condition Reports

**Attachment A4**: Proposed changes to DO-260A Sections 2.2.8.4 through 2.2.10 for the ADS-B Report Assembly Function

## 1. Background

Changes to the ADS-B MASPS (DO-242A) were agreed by SC-186 at its plenary 10-11 April 2002. DO-260A is expected to include the specific provisions to accommodate the changes introduced in DO-242A. The attachments to this working paper include proposed DO-260A changes/additions to align the example ADS-B report formats in section 2.2.8 of DO-260A with the report contents required by DO-242A. It is recognized that DO-242A do not require a specific standardized ADS-B report format. The ADS-B report formats proposed in the attachments to this working paper generally conform to the content and sequence of parameters defined by DO-242A for each report type. A number of the proposed changes to the ADS-B reports have a direct relationship to pending changes for the 1090 ADS-B messages. Such changes include the use of NIC, NAC and SIL and the replacement of Trajectory Change Point (TCP) Reports with Target State Reports with a placeholder for the future addition of Trajectory Change Reports.

Note that additional work may be required as WG3 further refines of the definition of the specific message formats as these may impact the text for the Report formats, especially cross-references.

DO-260 took the approach for defining the report formats that parameters should be encoded into an integer number of bytes. This frequently involved the use of padding bits. Attachment A to this working paper proposes report formats for DO-260A that have retained the approach taken by DO-260 in the padding of parameters to byte boundaries.

## 2. Proposal

It is proposed that WG3 accept the revisions/additions to DO-260A included in the attachments to this working paper as being sufficiently mature for the MOPS editor to incorporate the material into the working draft of DO-260A. Further, it is proposed the members of WG3 that are developing the test procedures sections of DO-260A use the proposed report formats as the basis to define and organize the presentation of the test procedure requirements.

# ATTACHMENT A

The updated MASPS (DO-242A) now requires Mode Status reports for all Class A equipage categories and changes are proposed to DO-260A to reflect this change in requirements. Also DO-242A has defined an Air Referenced Velocity Report. Proposed DO-260A provisions for this new report type are provided in this attachment. Extensive changes to the Report structures and contents are proposed based on changes in reporting requirements introduced with DO-242A.

The Structure of the ADS-B Reports proposed in this attachment conform to the general philosophy used for DO-260 where the encoding of each parameter (with only a few exceptions) involves padding out to a byte boundary. Also a header parameter is included to define the structure of each report allowing individual parameters, or groups of related parameters, to be omitted when no data is available. For the State Vector Reports, Mode Status Reports and Air Reference Velocity Reports, the header also includes a Validity field with flag bits to report on the validity of certain of parameters. No separate validity field is proposed for Target State Reports as the essential validity information is already embedded within certain of the other reported data elements.

# Attachment A1

## Proposed changes to DO-260A Sections 2.2.8 and 2.2.8.1 for the introduction to ADS-B reports and the requirements for ADS-B State Vector Report Characteristics

Changes from current DO-260 text shown as red-lines except on tables where there are many changes made

### 2.2.8 ADS-B Report Characteristics

The intent of the following subparagraphs is to provide an example coding of each type of ADS-B report. Implementations may use alternative report structures and coding of the ADS-B reports. However, the contents of each report type shall include, as a minimum, the data parameters as defined in the following subparagaphs.

### 2.2.8.1 ADS-B State Vector Report Characteristics

Table ~~2-64~~2.2.8.1 and the subsequent subparagraphs identify the data structure for all ADS-B State Vector Reports generated **for each ADS-B vehicle being reported**.

The intent of Table ~~2-64~~2.2.8.1 is to illustrate the structure of all Items (i.e., parameters) required to be reported in an ADS-B State Vector Report. The exact structure of the data indicated in columns 10 and 11 is provided as a guide line or one possible method of satisfying the report structure. Implementers may choose to organize the data in another format; **however**, delivery to a user interface or application of all Items in Table ~~2-64~~2.2.8.1 shall be consistent with the range, resolution, and units indicated in column 7, 8, and 9 of Table ~~2-64~~2.2.8.1 respectively. Those requirements in subparagraphs 2.2.8.1.1 to 2.2.8.1.2~~8~~ below that relate to specific data structure details (byte numbers, and bit numbers within the bytes) shall only apply to equipment that uses the sample report data structure shown in columns 10-11 of Table ~~2-64~~2.2.8.1.

**Note:** *Table ~~2-64~~2.2.8.1 is structured such that column 1, 2, and 6 through 11, pertain to the State Vector Report elements and how such elements should be structured into the report. Columns 3 through 5 provide information on where the appropriate data can be located in the ADS-B Messages for each of the Report elements.*

## Table ~~2-6~~42.2.8.1: ADS-B State Vector Data Elements - Source Data Mapping To Report Structure <<Many Changes in Table & Notes>>

| | REPORT STRUCTURE | | MESSAGE STRUCTURE RELEVANT | | | REPORT STRUCTURE RELEVANT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Column #** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
| **Item #** | **Parameter / Contents** | **Notes** | **Received Message Structure** | **"ME" Field Bits** | **Message Field Bits** | **# of Bits** | **Range** | **Resolution** | **Units** | **Data Structure** | **Data Byte #** |
| 0a, 0b | Report Type and Structure Identification | 4 | Airborne Position - "DF" | N/A | 1 – 5 | 24 | N/A | N/A | discrete | MddL Mddd ddddddddddddddL | 0 -2 |
| 0c | Validity Flags | | N/A | N/A | N/A | 16 | N/A | N/A | discrete | dddddddd dddddddd | 3 - 4 |
| 1 | Participant Address | 4 | Airborne Position - "AA"<br>Surface Position - "AA"<br>Airborne Velocity – "AA" | N/A<br>N/A<br>N/A | 9 - 32<br>9 – 32<br>9 - 32 | 24 | N/A | N/A | discrete | Mddddddd ddddddddddddddL | 5 - 7 |
| 2 | Address Qualifier | | N/A | N/A | N/A | 8 | N/A | N/A | discrete | 00000MdL | 8 |
| 3 | Report Time of Applicability (Position and Velocity) | 4 | Airborne Position – "Time"<br>Surface Position – "Time"<br>Airborne Velocity | 21<br>21<br>N/A | 53<br>53<br>N/A | 48 | 511.9921875 | 0.0078125 (1/128) | seconds | Mddddddd ddddddddddddddL<br>Mddddddd ddddddddddddddL<br>Mddddddd ddddddddddddddL | 9 - 14 |
| 4 | Latitude (WGS-84) | 4 | Airborne Position – "Encoded Latitude"<br>Surface Position – "Encoded Latitude" | 23 - 39<br>23 - 39 | 55 - 71<br>55 – 71 | 24 | +/- 180 | 0.0000215 | degrees | SMddddddd ddddddddddddddL | 15 - 17 |
| 5 | Longitude (WGS-84) | 4 | Airborne Position – "Encoded Longitude"<br>Surface Position – "Encoded Longitude" | 40 - 56<br>40 - 56 | 72 - 88<br>72 – 88 | 24 | +/- 180 | 0.0000215 | degrees | SMddddddd ddddddddddddddL | 18 - 20 |
| 6 | Altitude, Geometric (WGS-84) | 4, 5 | Airborne Position – "TYPE", **&** "Altitude"<br>Airborne Velocity - "Diff. from Baro Alt sign" &<br>"Diff. from Baro. Alt." | 1 - 5, **&** 9 - 20<br>49<br>50 - 56 | 33 - 37<br>41 – 52<br>81<br>82 - 88 | 24 | +/- 131,072 | 0.015625 | feet | SMddddddd ddddddddddddddL | 21 – 23 |
| 7 | North / South Velocity | 4, 5 | Airborne Velocity – "N/S Direction" &<br>"N/S Velocity" | 25<br>26 - 35 | 57<br>58 – 67 | 16 | +/- 4,096 | 0.125 | knots | SMddddddd ddddddddL | 24 – 25 |
| 8 | East / West Velocity | 4, 5 | Airborne Velocity - "E/W direction" &<br>"E/W Velocity" | 14<br>15 - 24 | 46<br>47 – 56 | 16 | +/- 4,096 | 0.125 | knots | SMddddddd ddddddddL | 26 – 27 |
| 9 | Ground Speed while on the Surface | 4, 6 | Surface Position – "Movement" | 6 - 12 | 38 – 44 | 8 | N/A | N/A | discrete | MddddddL | 28 |
| 10 | Heading while on the Surface | 4, 6 | Surface Position – "Ground Track" | 14 - 20 | 46 – 52 | 8 | +/- 180 | 1.40625 | degrees | SMddddddL | 29 |
| 11 | Altitude, Barometric (Pressure Altitude) | 4, 5 | Airborne Position – "TYPE", **&** "Altitude" | 1 - 5<br>9 - 20 | 33 – 37<br>41 – 52 | 24 | +/- 131,072 | 0.015625 | feet | SMddddddd ddddddddddddddL | 30 – 32 |
| 12 | Vertical Rate, Geometric/Barometric (WGS-84) | 4, 5 | Airborne Velocity – "Vert. Rate Source",<br>"Vert. Rate Sign" &<br>"Vert. Rate" | 36<br>37<br>38 - 46 | 68<br>69<br>70 – 78 | 16 | +/- 32,768 | 1.0 | ft./min. | SMddddddd ddddddddL | 33 – 34 |
| 13 | Navigation Integrity Category (NIC) | 4 | Airborne Position "Type Code"<br>Surface Position "Type Code" | 1 – 5<br>1 - 5 | 33 – 37<br>33 - 37 | 8 | N/A | N/A | discrete | 0000MddL | 35 |

| | REPORT STRUCTURE | | MESSAGE STRUCTURE RELEVANT | | | REPORT STRUCTURE RELEVANT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Column #** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
| **Item #** | **Parameter / Contents** | **Notes** | **Received Message Structure** | **"ME" Field Bits** | **Message Field Bits** | **# of Bits** | **Range** | **Resolution** | **Units** | **Data Structure** | **Data Byte #** |
| 14 | Estimated Latitude (WGS-84) | 7 | Airborne Position – "Encoded Latitude"<br>Surface Position – "Encoded Latitude" | 23 - 39<br>23 - 39 | 55 - 71<br>55 – 71 | 24 | 24 | +/- 180 | 0.00002 15 | degrees | 36 – 38 |
| 15 | Estimated Longitude (WGS-84) | 7 | Airborne Position – "Encoded Longitude"<br>Surface Position – "Encoded Longitude" | 40 - 56<br>40 - 56 | 72 - 88<br>72 – 88 | 24 | 24 | +/- 180 | 0.00002 15 | degrees | 39 – 41 |
| 16 | Estimated North/South Velocity | 7 | Airborne Velocity – "N/S Direction" & "N/S Velocity" | 25<br>26 - 35 | 57<br>58 – 67 | 16 | +/- 4,096 | 0.125 | knots | SMdddddd ddddddL | 42 – 43 |
| 17 | Estimated East/West Velocity | 7 | Airborne Velocity - "E/W direction" & "E/W Velocity" | 14<br>15 - 24 | 46<br>47 – 56 | 16 | +/- 4,096 | 0.125 | knots | SMdddddd ddddddL | 44 – 45 |
| 18 | Surveillance Status/Discretes | | ***Airborne Position – "***<br>***Airborne Velocity – "*** | | | 4<br>4 | N/A | N/A | discrete | dddd dddd | 46 |
| 19 | Report Mode | | ***(N/A*** | N/A | N/A | 8 | N/A | N/A | discrete | 000000ML | 47 |
| | | | | | | | | | | **TOTAL BYTES** | 48 |

***Notes:***

1. *In the "Data Structure" column (i.e., column 10), "S" indicates the "sign-bit," "M" indicates the Most Significant Bit of the data field, "d" indicates data bits in the field, "L" indicates the Least Significant Bit of the data field, "0" indicates the bit is to always be set to a value of zero (0) and "x" indicates "Don't Care" bits in the data field.*
2. *If data is not available to support theses fields, then the entire data field shall be set to ALL ZEROs if the field is delivered to the application.*
3. *The Report Type Identifier is used to identify the type of ADS-B Report being generated as defined in section 2.2.8.1.1.1.*
4. *Items annotated with Note 4 represent "Critical" State Vector items, however certain items are only applicable while airborne and others only applicable while on the surface (see Notes 5 and 6 below).*
5. *Parameters annotated with Note 5 are only present in the State Vector Report when the aircraft is airborne*
6. *Parameters annotated with Note 6 are only present in the State Vector Report with the aircraft is on the airport surface*
7. *Estimated values may be either an actual value from a received message, if available, or a calculated value such as produced by a surveillance tracker algorithm. For example it is possible for a surveillance tracker to produce an updated estimate of the target's horizontal position based on just the receipt of a new velocity message.*
8. *The Time of Applicability is actually a grouping of 3 individual parameters as defined in 2.2.8.1.4*

### 2.2.8.1.1 State Vector Report Type and Structure Identification and Validity Flags

#### 2.2.8.1.1.1 State Vector Report Type and Structure Identification

The Report Type is used to identify the type of ADS-B Report being generated by the report generation function and being provided to the User Application. The Report Type is a 4-bit field and shall be provided in the most significant nibble (i.e., bits 7 - 4) of the first byte (i.e., byte "0") of the Report. The Report Type formats and maximum number of bytes to be contained in each report are identified in Table ~~2-65~~2.2.8.1.1.1.

**Table ~~2-65~~2.2.8.1.1.1(a): ADS-B Report Type Coding**

| Report Type Coding | Report Type | Maximum Number of Bytes in Report |
|---|---|---|
| 0000 | Undefined Report Type or no Report Available | 1 |
| 0001 | State Vector Report for ALL Class "A" Equipment | ~~45~~48 |
| 0010 | Mode-Status Report for All Class "A~~1~~" Equipment | 3~~4~~5 |
| ~~0011~~ | ~~Mode-Status Report for Class "A2" and "A3" Equipment~~ | ~~38~~ |
| ~~0100~~0011 | ADS-B ~~TCP + 1~~Target State Report for Class "A2" and "A3" Equipment (Optional for Class "A1" equipment) | ~~16~~22 |
| ~~0101~~0100 | ~~Reserved~~Air Reference Velocity Report for Class "A1", "A2" and "A3" equipment) | ~~16~~14 |
| ~~0110~~0101 | Reserved for Trajectory Change Report for Class "A2" and "A3" equipment | |
| ~~0111~~ | ~~Reserved~~ | |
| ~~1000~~0110 through 1111 | Not Assigned (Reserved for Future Assignment) | |

The Report Structure field is used to indicate the exact data parameters identified in Table ~~2-64~~2.2.8.1 that are being provided in the State Vector report and is intended to provide a methodology for the report processor to structure shorter reports when data for some parameters or groups of related parameters are~~is~~ not available. In order to provide the capability to provide shorter State Vector reports the following basic conventions shall be adhered to:

a. Any given data parameter to be used in the report shall use the designated number of bytes and format as designated in Table 2.2.8.1~~2-64~~.

b. Whenever a data parameter identified in Table ~~2-64~~2.2.8.1, or a required grouping of data parameters as identified in Table 2.2.8.1.1.1(b), is not provided in the report, then it is permissible to concatenate the next parameter to be included into the report immediately following the inclusion of the previous reported parameter. This feature shall be used accommodate the reporting of the different sets of required parameters, such as for when the aircraft in airborne versus on the airport surface as indicated in Table 2.2.8.1.

c. Each parameter of the State Vector report identified in Table ~~2-64~~2.2.8.1 ~~must~~ shall be properly declared in the Report Structure field as detailed in the following paragraphs and Table ~~2-66a~~2.2.8.1.1.1(b).

***Note:*** *Implementation of the methodology just provided is realizable and controllable due to the fact that the exact length of each report parameter is defined in Table*

~~2-64~~2.2.8.1 *and the Report Structure field identifies exactly which parameters are included in the report. Therefore, the report user can easily re-construct the length and general format of the report.*

The Report Structure is a ~~28~~20-bit field and shall be provided in the least significant nibble (i.e., bits 3 - 0) of the first byte (i.e., byte "0") and continuing into bytes 1 and~~,~~ 2~~, and 3~~ of the Report. The Report Structure format is defined in Table 2.2.8.1.1.1(b)~~2-66a~~ where each bit is associated with a particular data parameter, or group of data parameters, of the State Vector Report. If the bit is set to "1," then the data parameter, or identified group of data parameters is considered to be available and shall be transmitted in the report. Otherwise, the data parameter, or identified group of data parameters, is considered to not be available and shall not be transmitted in the report. Note that Table ~~2-66a~~2.2.8.1.1.1(b) does not address the Report Type and Structure Identification parameter, the Validity Flags parameter, nor the Participant Address parameter and the Address Qualifier, **since it is mandatory that these ~~three~~ four parameters shall be included in the State Vector Report. Also certain of the other State Vector data parameters are required to be reported, as defined in paragraph 2.2.9, even though bits have been allocated in the report structure field as shown in Table 2.2.8.1.1.1(b).**

**Table ~~2-66a~~2.2.8.1.1.1(b): ADS-B State Vector Report Structure Coding <<many changes>>**

| Byte # | Bit # | State Vector Data Parameter(s) to be Reported | Number of Bytes |
|---|---|---|---|
| 0 | 3 | Time of Applicability for Estimated Position/Velocity | 2 |
| | 2 | Position Time of Applicability | 2 |
| | 1 | Velocity Time of Applicability | 2 |
| | 0 | Latitude (WGS-84) & Longitude (WGS-84) | 7 |
| 1 | 7 | Altitude, Geometric (WGS-84) | 4 |
| | 6 | North / South Velocity & East / West Velocity | 5 |
| | 5 | Ground Speed while on the Surface | 2 |
| | 4 | Heading while on the Surface | 2 |
| | 3 | Altimeter, Barometric | 4 |
| | 2 | Vertical Rate Geometric/Baro. | 3 |
| | 1 | Navigation Integrity Category | 1 |
| | 0 | Estimated Latitude | 3 |
| 2 | 7 | Estimated Longitude | 3 |
| | 6 | Estimated North/South Velocity | 2 |
| | 5 | Estimated East/West Velocity | 2 |
| | 4 | Surveillance Status/Discretes | 1 |
| | 3 | Report Mode | 1 |
| | 2 | Reserved for Future Expansion | |
| | 1 | Reserved for Future Expansion | |
| | 0 | Reserved for Future Expansion | |

#### 2.2.8.1.1.2 State Vector Report Validity Flags

Validity Flags for data provided in the State Vector Report shall be indicated in bytes #~~4~~3 and #~~5~~4 of the State Vector Report as shown for item "0c" in Table ~~2-64~~2.2.8.1. The State Vector Report elements that require validity flags are identified in Table ~~2-66b~~2.2.8.1.1.2. Table ~~2-66b~~2.2.8.1.1.2 identifies the byte and bit that shall be used as a flag for each element that requires a validity flag. Each validity flag bit shall be set to "1" to indicate that the corresponding State Vector Report Element data is valid. If such data is not valid, then the corresponding validity flag bit shall be set to "0." Bits 0 through 6 of byte #4 of the State Vector Report are reserved for future use.

**Table ~~2-66b~~2.2.8.1.1.2: ADS-B State Vector Report Validity Flag Requirements <<Many Changes>>**

| SV Report Item # | State Vector Report Element | Validity Flag Bit Required? | Validity Flag Bit Assignment | |
|---|---|---|---|---|
| | | | Byte # | Bit # |
| 0a | Report Type | No | | |
| 0b | Structure Identification | No | | |
| 0c | Validity Flags | No | | |
| 1 | Participant Address | No | | |
| 2 | Address Qualifier | No | | |
| 3 | Report Time of Applicability | No | | |
| 4 | Latitude (WGS-84) | **Yes** (This validity flag bit is for Horizontal Position Valid) | 3 | 7 (MSB) |
| 5 | Longitude (WGS-84) | **Yes** (This validity flag bit is for Horizontal Position Valid) | 3 | 7 (MSB |
| 6 | Altitude, Geometric (WGS-84) | **Yes** (This bit is validity flag bit for Geometric Altitude Valid) | 3 | 6 |
| 7 | North / South Velocity | **Yes** (This bit is validity flag bit for Airborne Horizontal Velocity Valid) | 3 | 5 |
| 8 | East / West Velocity | **Yes** (This bit is validity flag bit for Airborne Horizontal Velocity Valid) | 3 | 5 |
| 9 | Ground Speed while on the Surface | **Yes** (This bit is validity flag bit for Surface Ground Speed Valid) | 3 | 4 |
| 10 | Heading while on the Surface | **Yes** (This bit is validity flag bit for Surface HeadingValid) | 3 | 3 |
| 11 | Altitude, Barometric (Pressure Altitude) | **Yes** (This bit is validity flag bit for Barometric Altitude Valid) | 3 | 2 |
| 12 | Vertical Rate, Geometric/Barometric (WGS-84) | **Yes** (This bit is validity flag bit for Vertical Rate Valid) | 3 | 1 |
| 13 | Navigation Integrity Category (NIC) | No | | |
| 14 | Estimated Latitude (WGS-84) | **Yes** (This validity flag bit is for Estimated Horizontal Position Valid -- If for some reason an estimation cannot be made of the horizontal position at the TOA of the report, then this could be indicated by zeroing the validity flag for the estimated horizontal position.) | 3 | 0 |
| 15 | Estimated Longitude (WGS-84) | **Yes** (This validity flag bit is for Estimated Horizontal Position Valid -- If for some reason an estimation cannot be made of the horizontal position at the TOA of the report, then this could be indicated by zeroing the validity flag for the estimated horizontal position.) | 3 | 0 |
| 16 | Estimated North/South Velocity | **Yes** (This validity flag bit is for Estimated Horizontal Velocity Valid -- It may be possible to estimate velocity at some time after the TOA of the velocity message.) | 4 | 7 (MSB) |
| 17 | Estimated East/West Velocity | **Yes** (This validity flag bit is for Estimated Horizontal Velocity Valid -- It may be possible to estimate velocity at some time after the TOA of the velocity message.) | 4 | 7 (MSB) |
| 18 | Surveillance Status/Discretes | No | | |
| 19 | Report Mode | No | | |

#### 2.2.8.1.2 Participant Address

The participant address shall be encoded as defined in 2.2.3.2.1.1.1.

#### 2.2.8.1.3 Address Qualifier

The address qualifier is used to indicate the type of participant address (2.2.8.1.2) being reported. The 3 least significant bits of the one byte field are used to convey the Address Qualifier information. The Address Qualifier subfield shall be coded as shown in Table 2.2.8.1.3.

**Table 2.2.8.1.3: Address Qualifier Coding**

| **Address Qualifier Coding** (MbL) | **Meaning** | **ADS-B Emitter Cateogry Set** (see Note 3) |
|---|---|---|
| xx0 | ICAO address being reported as Participant Address (see Note 2) | N/A |
| xx1 | Non-ICAO address being reported as Participant Address (see Note 1) | N/A |
| 00x | Participant Address is for an unknown emitter category | See Note 4 |
| 01x | Participant Address is for an Aircraft | "A" or "B" |
| 10x | Participant Address is for a Surface Vehicle, a Fixed Ground or Tethered Obstruction | "C" |
| 11x | Reserved for future use | N/A |

***Note 1:*** *In the Address Qualifier Coding column a value of "x" indicates "Don't Care" bits in the data field for the indicated "Meaning" to be applicable.*

***Note 2:*** *All transponder-based based 1090 MHz ADS-B systems are required to use an ICAO 24-bit address. In the future, certain types of non-transponder-based 1090 MHz ADS-B systems may under certain conditions be permitted to broadcast an address other than an ICAO 24-bit address.*

***Note 3:*** *The emitter category associated with the Participant Address is to be obtained from the "ADS-B Emitter Category" subfield (subparagraph 2.2.3.2.5.2) of the ADS-B Aircraft Identification and Type Message.*

***Note 4:*** *An Address Qualifier Code of 00x is to be reported if the value from the "ADS-B Emitter Category" subfield indicates "No ADS-B Emitter Category Information," or if an ADS-B Aircraft Identification and Type Message has not been received.*

#### 2.2.8.1.~~4~~1.~~2~~ Report Time of Applicability

Since separate messages are used for position and velocity, the time of applicability is reported individually for the position related report parameters and the velocity related report parameters. Also the State Vector Report may include estimated position and/or velocity values (i.e., not based on the receipt of a message with updated position or velocity information). In this latter case the State Vector report shall include a Time of Applicability for the estimated position/velocity parameters. The six-byte Report Time of Applicability Parameter field, as defined in Table 2.2.8.1, is sub-divided into three

subfields as shown in Table 2.2.8.1.1.5. The coding of the subfields is defined in the following subparagraphs.

**Table 2.2.8.1.4: Report Time of Applicability Parameter Coding**

| Subfield | Coding |
|---|---|
| a Time of Applicability for Estimated Position/Velocity | Mddddddd ddddddL |
| b Position Time of Applicablity | Mddddddd ddddddL |
| c Velocity Time of Applicabilty | Mddddddd ddddddL |

***Note:*** *In the "Data Structure" column (i.e., column 10), "M" indicates the Most Significant Bit of the data field and "L" indicates the Least Significant Bit of the data field.*

### 2.2.8.1.4.1 Time of Applicability for Estimated Position/Velocity

The Time of Applicability for the estimated position and velocity shall be generated under the conditions defined below:

a. Each time that an individual State Vector Report is updated as specified in sections 2.2.8.1.22, 2.2.8.1.23, 2.2.8.1.24, ***OR*** 2.2.8.1.25, the Report Assembly Function shall update the Time of Applicability for the Estimate Position/Velocity data in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. Time of Applicability data shall be provided in the State Vector report in binary format as defined in Table 2.2.8.1.1.4.

### 2.2.8.1.4.2 Position Time of Applicability

Each time that an Airborne or Surface Position message is received with valid Latitude ***AND*** Longitude data, the Report Assembly Function shall update the Position Time of Applicability data in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

### 2.2.8.1.4.3 Velocity Time of Applicability

a. Each time that an Airborne Velocity Subtype "1" or "2" message is received with valid East/West AND North/South Velocity data, the Report Assembly Function shall update the Velocity Time of Applicability data in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. Each time that a Surface Position Message is received with valid Movement AND Ground Track data, the Report Assembly Function shall update the Velocity Time of Applicability data in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

**State Vector Report Validity Flags**

Validity Flags for data provided in the State Vector Report shall be indicated in bytes #4 and #5 of the State Vector Report as shown for item "0c" in Table 2-64. The State Vector Report elements that require validity flags are identified in Table 2-66b. Table 2-66b identifies the byte and bit that shall be used as a flag for each element that requires a validity flag. Each validity flag bit shall be set to "1" to indicate that the corresponding State Vector Report Element data is valid. If such data is not valid, then the corresponding validity flag bit shall be set to "0."

**Table 2-66b: ADS-B State Vector Report Validity Flag Requirements**

| SV Report Item # | State Vector Report Element | Validity Flag Bit Required? | Validity Flag Bit Assignment | |
|---|---|---|---|---|
| | | | Byte # | Bit # |
| 0a | Report Type | No | | |
| 0b | Report Data Structure Definition | No | | |
| 0c | Validity Flags | No | | |
| 1 | Participant Address | No | | |
| 2 | Latitude (WGS-84) | Yes<br>(This validity flag bit is SV element 7a, Geometric Position Valid – Horizontal) | 4 | 7 (MSB) |
| 3 | Longitude (WGS-84) | Yes<br>(This validity flag bit is SV element 7a, Geometric Position Valid – Horizontal) | 4 | 7 (MSB) |
| 4 | Altitude Geometric (WGS-84) | Yes<br>(This bit is validity flag bit is SV element 7b, Geometric Position Valid – Vertical) | 4 | 6 |
| 5 | $NUC_P$ – Position Component | No<br>Unknown NUC_P is conveyed by NUC_P = 0, | | |
| 6 | $NUC_R$ – Velocity Component | No<br>Unknown $NUC_R$ is conveyed by $NUC_R$ = 0. | | |
| 7a | Geometric Position Valid (Horizontal) | No<br>(part of element 0c, Validity Flags) | | |
| 7b | Geometric Position Valid (Vertical) | No<br>(part of element 0c, Validity Flags) | | |
| 8 | North / South Velocity | Yes | 4 | 5 |
| 9 | East / West Velocity | Yes | 4 | 5 |
| 10 | Vertical Rate, Geometric (WGS-84) | Yes | 4 | 4 |
| 11 | Altitude, Barometric Pressure Altitude | Yes | 4 | 3 |
| 12 | Barometric Altitude Rate | Yes | 4 | 2 |
| 13a | True Airspeed (TAS) | Yes<br>(Since the SV report contains only one of the two types of airspeeds, only one validity flag bit is required.) | 4 | 1 |
| 13b | Indicated Airspeed (IAS) | Yes<br>(As provided in item #13a) | 4 | 1 |
| 14 | Ground Speed | Yes | 4 | 0 (LSB) |
| 15 | Ground Track | Yes | 5 | 7 (MSB) |
| 16 | Magnetic Heading | Yes | 5 | 6 |
| 17 | Turn Indicator | No<br>An unknown turn indicator is indicated by setting the field to zero. | | |

**TABLE 2-66b: ADS-B State Vector Report Validity Flag Requirements (continued)**

| ~~SV Report Item #~~ | ~~State Vector Report Element~~ | ~~Validity Flag Bit Required?~~ | ~~Validity Flag Bit Assignment~~ | |
|---|---|---|---|---|
| | | | ~~Byte #~~ | ~~Bit #~~ |
| ~~18~~ | ~~Position Time of Applicability~~ | ~~No~~<br>~~Position TOA is always the time of reception of the position message (or of the nearest even or odd numbered UTC 0.2 s epoch, if the "T" bit is set in that message)..~~ | | |
| ~~19~~ | ~~Velocity Time of Applicability~~ | ~~No~~<br>~~Velocity TOA is always the time of reception of the velocity message.~~ | | |
| ~~20~~ | ~~Estimated Latitude (WGS-84)~~ | ~~**Yes**~~<br>~~If for some reason an estimation cannot be made of the position at the TOA of the report, then this could be indicated by zeroing the validity flag for the estimated latitude and longitude.~~ | ~~5~~ | ~~5~~ |
| ~~21~~ | ~~Estimated Longitude (WGS-84)~~ | ~~**Yes**~~<br>~~(As provided in item #20)~~ | ~~5~~ | ~~5~~ |
| ~~22~~ | ~~Estimated N/S Velocity~~ | ~~**Yes**~~<br>~~It may not be possible to estimate velocity at some time after the TOA of the velocity message.~~ | ~~5~~ | ~~4~~ |
| ~~23~~ | ~~Estimated E/W Velocity~~ | ~~**Yes**~~<br>~~(As provided in item #22)~~ | ~~5~~ | ~~4~~ |
| ~~24~~ | ~~Surveillance Status Discretes~~ | ~~No~~<br>~~These flags are presumed to be valid if used.~~ | | |
| ~~25~~ | ~~Report Time of Applicability~~ | ~~No~~<br>~~If an estimated position is provided, the TOA of that estimated position (the TOA of the report) is known.~~ | | |
| ~~26~~ | ~~Report Mode~~ | ~~No~~<br>~~The report mode is always known to be valid since it is generated by the Report Assembly Function itself.~~ | | |

**2.2.8.1.5~~2~~ Latitude (WGS-84)**

a. The ADS-B Report Assembly Function shall decode the Encoded Latitude data (subparagraph 2.2.3.2.3.7 and /or 2.2.3.2.4.7) provided in the ADS-B broadcast. Decoding of the encoded latitude data shall be performed in accordance with sections A.7.4 through A.7.8.4 of Appendix A. Latitude data shall be provided to the user application in the State Vector report in angular weighted binary format (M bit = 90 degrees, S bit = negative, or 180 degrees) as defined in Table ~~2-64~~2.2.8.1.

b. When valid encoded latitude data is not available, the latitude data provided to the user application shall be set to ALL ZEROs, and the ~~Geometric~~ Horizontal Position Validity ~~(Horizontal)~~ Flag bit, i.e., bit #7 (MSB) of byte #3~~4~~ of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0~~.~~" to indicate the reported Horizontal Position data is not valid.

   Otherwise, the ~~Geometric~~ Horizontal Position Validity ~~(Horizontal)~~ Flag bit, i.e., bit #7 (MSB) of byte #3~~4~~ of the State Vector Report, shall be set to "1," unless modified by other conditions.

**2.2.8.1.63 Longitude (WGS-84)**

a. The ADS-B Report Assembly Function shall decode the Encoded Longitude data (subparagraph 2.2.3.2.3.8 and / or 2.2.3.2.4.8) provided in the ADS-B broadcast. Decoding of the encoded longitude data shall be performed in accordance with sections A.7.4 through A.7.8.4 of Appendix A. Latitude data shall be provided to the user application in the State Vector report in angular weighted binary format (M bit = 90 degrees, S bit = negative, or 180 degrees) as defined in Table ~~2-64~~2.2.8.1.

b. When valid encoded longitude data is not available, the longitude data provided to the user application shall be set to ALL ZEROs, and the ~~Geometric~~ Horizontal Position Validity (Horizontal) Flag bit, i.e., bit #7 (MSB) of byte #~~3~~4 of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0~~.~~" to indicate the reported Horizontal Position data is valid

Otherwise, the ~~Geometric~~ Horizontal Position Validity ~~(Horizontal)~~ Flag bit, i.e., bit #7 (MSB) of byte #~~3~~4 of the State Vector Report, shall be set to "1," unless modified by other conditions.

**2.2.8.1.74 Altitude, Geometric (WGS-84)**

a. When Geometric Altitude Data is indicated by the "TYPE" subfield (subparagraph 2.2.3.2.3.1) the ADS-B Report Assembly Function shall decode Altitude Data (subparagraph 2.2.3.2.3.4) that has been encoded by the ADS-B transmission device as specified in subparagraph 2.2.3.2.3.4.2.

b. Alternatively, Barometric Altitude Data (subparagraph 2.2.3.2.3.4.1), Difference from Barometric Altitude Sign Bit (subparagraphs 2.2.3.2.6.1.14, 2.2.3.2.6.2.14, 2.2.3.2.6.3.14, or 2.2.3.2.6.4.14), and Difference from Barometric Altitude (subparagraphs 2.2.3.2.6.1.15, 2.2.3.2.6.2.15, 2.2.3.2.6.3.15, or 2.2.3.2.6.4.15), shall be decoded and the Geometric Altitude computed by the receiver Report Assembly Function.

c. Geometric Binary Altitude data shall be provided to the user application in the State Vector report in binary format as defined in Table ~~2-64~~2.2.8.1. This format represents a true two's complement format where the MSB has a weight of 65,536 and the LSB has a weight of 0.015625. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 131,071.984375.

d. When valid Geometric Altitude data is not available, the ADS-B receiver shall set the Geometric Altitude data provided to the user interface to ALL ZEROs, and the Geometric ~~Position~~ Altitude Validity ~~(Vertical)~~ Flag bit, i.e., bit #6 of byte #~~3~~4 parameter of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0~~.~~" to indicate the reported Geometric Altitude is not valid.

Otherwise, the Geometric Altitude ~~Position~~ Validity ~~(Vertical)~~ Flag bit, i.e., bit #6 of byte #~~3~~4 of the State Vector Report, shall be set to "1," unless modified by other conditions.

***Note:*** *Geometric Altitude is not required to be estimated when a State Vector Report is prepared as a result of receiving an airborne position and velocity messages. (i.e. The State Vector Report can include the most recently received value for this field.)*

~~**2.2.8.1.5 $NUC_p$, - Position Component**~~

~~a. The ADS-B Report Assembly Function shall extract "TYPE" (subparagraph 2.2.3.2.3.1) data from the ADS-B message and provide Navigation Uncertainty~~

Categories - Position ($NUC_p$) information to the user application in the State Vector report as defined in Table 2-64. Definition of the $NUC_p$ coding is provided in Table 2-67.

b. When valid $NUC_p$ data is not available, the $NUC_p$ data sent to the user application shall be set to ALL ZEROs.

**Table 2-67: $NUC_p$, Coding Requirements**

| Coding | Horizontal Protection Level ($10^{-5}$) | Horizontal Error (95%) | Vertical Error (95%) | Comment | Corresponding TYPE Code (from Table 2-11) |
|---|---|---|---|---|---|
| 0 | No Integrity | Unknown | Unknown | No Integrity | 0 |
| 1 | < 20 NM | < 10 NM | Baro Alt | RNP - 10 | 17 |
| 2 | < 10 NM | < 5 NM | Baro Alt | RNP - 5 | 16 |
| 3 | < 2 NM | < 1 NM | Baro Alt | RNP - 1 | 15 |
| 4 | < 1 NM | < 0.5 NM | Baro Alt | RNP - 0.5 | 14 |
| 5 | < 0.5 NM | < 0.25 NM | Baro Alt | e.g. NPA, DME - DME | 13 |
| 6 | < 0.2 NM | < 0.1 NM | Baro Alt | e.g. GPS - SPS | 12 |
| 7 | < 0.1 NM | < 0.05 NM | Baro Alt | e.g. GNSS (No SA) | 11 |
| 8 | TBD | < 10 m | < 15 m | e.g. SBAS | 21 |
| 9 | TBD | < 3 m | < 4 m | e.g. GBAS | 20 |
| 10 - 15 | TBD | TBD | TBD | future expansion | TBD |

***Notes:***

*1. The $NUC_p$ 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 containment integrity (i.e., HPL). It is important to note that this is not a function that can be performed by the ADS-B equipment.*

*2. The horizontal protection level is the integrity level which is output by GNSS sets and is therefore the primary determinant of the current performance of the navigation system. This supports the determination of the aircraft's RNP as specified in RTCA Document No. DO-236. (It should be noted that RNP integrity level [10-5] is intended for airborne aircraft navigation, thus for two independent aircraft the joint probability should be on the order of 10-10). The Horizontal Error provided for Coding 1 through 7 are provided as information since these are not required outputs of the GNSS receivers. The Horizontal Protection Levels provided for Coding 8 and 9 are intended for approach and surface navigation environments where protection levels are increased (e.g., 10-7 or better) to reflect single aircraft protection with respect to fixed objects. Such protection levels are yet to be defined by RTCA; thereby, leaving Horizontal and Vertical (see section 2.2.6.2.2.2.2.6) Errors as the primary*

*performance parameters for NUC codings 8 and 9. In the approach and surface navigation environments the horizontal and vertical errors are highly correlated - thus a single NUC category will suffice for both.*

3. *The stringent probability of HPL shown in the table was derived assuming that a GPS integrity failure could affect 100 aircraft at the same time.*

#### 2.2.8.1.6 $NUC_R$ - Velocity Component

a. The ADS-B Report Assembly Function shall extract "TYPE" (subparagraph 2.2.3.2.3.1) from the ADS-B message and provide Navigation Uncertainty Categories - Velocity ($NUC_R$) information to the user interface in the State Vector report as defined in Table 2-64. Definition of the $NUC_R$ coding is provided in Table 2-68.

b. When valid $NUC_R$ data is not available, the $NUC_R$ data provided to the user application shall be set to ALL ZEROs.

**Table 2-68: $NUC_R$, Coding Requirements**

| Coding | Horizontal Velocity Error (95%) | Vertical Velocity Error (95%) |
|---|---|---|
| 0 | Unknown | Unknown |
| 1 | < 10 meters/second | < 50 feet per second |
| 2 | < 3 meters/second | < 15 feet per second |
| 3 | < 1 meters/second | < 5 feet per second |
| 4 | < 0.3 meters/second | < 1.5 feet per second |

***Notes:***

1. *When an inertial navigation system is used as the source of velocity information, error in velocity with respect to WGS-84 is reflected in the $NUC_R$.*

2. *When any component of velocity is flagged as not available (e.g., Vertical Rate) the value of $NUC_R$ will apply to the other components which are supplied.*

#### 2.2.8.1.7 Geometric Position Valid (Horizontal)

The ADS-B Report Assembly Function shall extract "TYPE" (subparagraph 2.2.3.2.3.1) data from the ADS-B message and provide Geometric Position Validity (Horizontal) information to the user application in the State Vector report Validity Flag bytes in accordance with the following subparagraphs:

a. If valid latitude and longitude information is received AND the "TYPE" code (see Table 2-11) is 5 through 8, 9 through 18, or 20 through 21 then the Geometric Position Validity (Horizontal) Flag bit, i.e., bit #7 (MSB) of byte #4 of the State Vector Report, shall be set to "1."

b. Otherwise, the Geometric Position Validity (Horizontal) Flag bit, i.e., bit #7 (MSB) of byte #4 of the State Vector Report, shall be set to "0," unless modified by other conditions.

#### 2.2.8.1.8 Geometric Position Valid (Vertical)

The ADS-B Report Assembly Function shall extract "TYPE" (subparagraph 2.2.3.2.3.1) data from the ADS-B message and provide Geometric Position Validity (Vertical) information to the user application in the State Vector report Validity Flag bytes in accordance with the following subparagraphs:

~~a. If valid altitude information is received AND the "TYPE" code (see Table 2-11) is 9 through 18, or 20 through 21 then the Geometric Position Validity (Vertical) Flag bit, i.e., bit #6 of byte #4 of the State Vector Report, shall be set to "1."~~

~~b. Otherwise, the Geometric Position Validity (Vertical) Flag bit, i.e., bit #6 of byte #4 of the State Vector Report, shall be set to "0," unless modified by other conditions.~~

**2.2.8.1.~~8~~9 North / South Velocity**

a. The ADS-B Report Assembly Function shall extract the North / South Direction Bit (subparagraph 2.2.3.2.6.1.8 or 2.2.3.2.6.2.8) and the North / South Velocity subfield (subparagraph 2.2.3.2.6.1.9 or 2.2.3.2.6.2.9) from the ADS-B message and provide North / South Velocity information to the user Application in the State Vector report in binary format as defined in Table ~~2-64~~2.2.8.1. This format represents a true two's complement format where the MSB has a weight of 2,048 and the LSB has a weight of 0.125. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 4,095.875.

b. When valid North / South Velocity data is not available, the North / South Velocity data provided to the user application shall be set to ALL ZEROs, and the ~~North / South~~Airborne Horizontal Velocity Validity Flag bit, i.e., bit #5 of byte #~~3~~4 of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0~~.~~" to indicate the reported Airborne Horizontal Velocity is not valid.

Otherwise, the Airborne Horizontal ~~North / South~~ Velocity Validity Flag bit, i.e., bit #5 of byte #4 of the State Vector Report, shall be set to "1," unless modified by other conditions.

**2.2.8.1.~~9~~10 East / West Velocity**

a. The ADS-B Report Assembly Function shall extract the East / West Direction Bit (subparagraph 2.2.3.2.6.1.6, or 2.2.3.2.6.2.6) and the East / West Velocity subfield (subparagraph 2.2.3.2.6.1.7 or 2.2.3.2.6.2.7) from the ADS-B message and provide East / West Velocity information to the user application in the State Vector report in binary format as defined in Table ~~2-64~~2.2.8.1. This format represents a true two's complement format where the MSB has a weight of 2,048 and the LSB has a weight of 0.125. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 4,095.875.

b. When valid East / West Velocity data is not available, the East / West Velocity data provided to the user application shall be set to ALL ZEROs, and the Airborne Horizontal ~~East / West~~ Velocity Validity Flag bit, i.e., bit # 5 of byte #~~3~~4 of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0~~.~~" to indicate the reported Airborne Horizontal Velocity is not valid.

Otherwise, the Airborne Horizontal ~~East / West~~ Velocity Validity Flag bit, i.e., bit #5 of byte #~~3~~4 of the State Vector Report, shall be set to "1," unless modified by other conditions.

**2.2.8.1.10 Ground Speed While on the Surface**

a. The ADS-B Report Assembly Function shall extract the Movement Data (subparagraph 2.2.3.2.4.2) from the ADS-B Surface Position message (subparagraph 2.2.3.2.4) and provide Ground Speed information to the user application in the State Vector report as defined in Table 2.2.8.1. Coding of the Movement information shall be the same as that identified for the Movement Data in subparagraph 2.2.3.2.4.2.

b. When valid Movement data is not available, the ADS-B Report Assembly Function shall set the Ground Speed data provided to the user application to ALL ZEROs, and the Surface Ground Speed Validity flag bit, i.e., bit #4 of byte #3 of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0" to indicate the reported Surface Ground Speed is not valid.

Otherwise, the Surface Ground Speed Validity flag bit, i.e., bit #4 of byte #3 of the State Vector Report, shall be set to "1," unless modified by other conditions.

### 2.2.8.1.11 Heading While on the Surface

a. The ADS-B Report Assembly Function shall extract the Status Bit for Ground Track (subparagraph 2.2.3.2.4.3) and Ground Track Data (subparagraph 2.2.3.2.4.4) from the ADS-B Surface Position message and provide Heading While on the Surface information to the user application in the State Vector report in binary format as defined in Table 2.2.8.1. This format represents a true two's complement format where the MSB has a weight of 90 degrees and the LSB has a weight of 1.40625 degrees. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 178.59375 degrees. Alternately, the format may be referred to as angular weighted binary.

b. When valid Ground Track data is not available, the ADS-B Report Assembly Function shall set the Heading While on the Surface data provided to the user application to ALL ZEROs, and the Surface Heading Validity flag bit, i.e., bit #3 of byte #3 of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0" to indicate the reported Surface Heading is not valid.

Otherwise, the Surface Heading Validity flag bit, i.e., bit #3 of byte #3 of the State Vector Report, shall be set to "1," unless modified by other conditions.

### 2.2.8.1.12 Altitude, Barometric (Pressure Altitude)

a. When Barometric Altitude Data is indicated by the "TYPE" subfield (subparagraph 2.2.3.2.3.1) of the ADS-B Airborne Position Message, the ADS-B Report Assembly Function shall decode Altitude Data (subparagraph 2.2.3.2.3.4) that has been encoded by the ADS-B transmission device as specified in subparagraph 2.2.3.2.3.4.1. Binary Altitude data shall be provided to the user application in the State Vector report as defined in Table 2.2.8.1. This format represents a true two's complement format where the MSB has a weight of 65,536 and the LSB has a weight of 0.015625. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 131,071.984375.

b. When valid Barometric Altitude data is not available, the ADS-B Report Assembly Function shall set the Barometric Altitude data provided to the user application to ALL ZEROs, and the Barometric Altitude Validity flag bit, i.e., bit #2 of byte #3 of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0" to indicate the reported Barometric Altitude is not valid.

Otherwise, the Barometric Altitude Validity flag bit, i.e., bit #2 of byte #3 of the State Vector Report, shall be set to "1," unless modified by other conditions.

***Note:*** *Barometric Altitude is not required to be estimated when a State Vector Report is prepared as a result of receiving an airborne position and velocity messages. (i.e. The State Vector Report can include the most recently received value for this field.)*

**2.2.8.1.13 Vertical Rate, Geometric/Barometric**

The "vertical rate" field in the State Vector report contains the altitude rate of an airborne ADS-B participant. This shall be either the rate of change of pressure altitude or of geometric altitude, as specified by the "vertical rate type" element in the Mode Status report (paragraph 2.2.8.2).

**2.2.8.1.1411 Vertical Rate, Geometric (WGS-84)**

a. When Geometric Altitude Rate Data is indicated by the "Source Bit for Vertical Rate" subfield (subparagraph 2.2.3.2.6.1.10, 2.2.3.2.6.2.10, 2.2.3.2.6.3.10, or 2.2.3.2.6.4.10) the ADS-B Report Assembly Function shall extract the Vertical Rate Sign Bit (subparagraph 2.2.3.2.6.1.11, 2.2.3.2.6.2.11, 2.2.3.2.6.3.11, or 2.2.3.2.6.4.11) and the Vertical Rate subfield (subparagraph 2.2.3.2.6.1.12, 2.2.3.2.6.2.12, 2.2.3.2.6.3.12, or 2.2.3.2.6.4.12) from the ADS-B message and provide Vertical Rate, Geometric information to the user application in the State Vector report in binary format as defined in Table ~~2-64~~2.2.8.1. This format represents a true two's complement format where the MSB has a weight of 16,384 and the LSB has a weight of 1. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 32,767.

b. When valid Geometric Altitude Rate data is not available, the ADS-B Report Assembly Function shall set the Vertical Rate, Geometric data provided to the user application to ALL ZEROs, and the Vertical Rate Validity Flag bit, i.e., bit #14 of byte #34 of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0~~.~~" to indicate the reported Vertical Rate is not valid.

   Otherwise, the Vertical Rate Validity Flag bit, i.e., bit #14 of byte #34 of the State Vector Report, shall be set to "1," unless modified by other conditions.

***Note:*** *Geometric Altitude Rate is not required to be estimated when a State Vector Report is prepared as a result of receiving an airborne position and velocity messages. (i.e. The State Vector Report can include the most recently received value for this field.)*

~~**2.2.8.1.12 Altitude, Barometric (Pressure Altitude)**~~

~~a. When Barometric Altitude Data is indicated by the "TYPE" subfield (subparagraph 2.2.3.2.3.1) the ADS-B Report Assembly Function shall decode Altitude Data (subparagraph 2.2.3.2.3.4) that has been encoded by the ADS-B transmission device as specified in subparagraph 2.2.3.2.3.4.1. Binary Altitude data shall be provided to the user application in the State Vector report as defined in Table 2-64. This format represents a true two's complement format where the MSB has a weight of 65,536 and the LSB has a weight of 0.015625. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 131,071.984375.~~

~~b. When valid Barometric Altitude data is not available, the ADS-B Report Assembly Function shall set the Barometric Altitude data provided to the user application to ALL ZEROs, and the Barometric Altitude Validity Flag bit, i.e., bit #3 of byte #4 of the State Vector Report, shall be set to "0."~~

~~Otherwise, the Barometric Altitude Validity Flag bit, i.e., bit #3 of byte #4 of the State Vector Report, shall be set to "1," unless modified by other conditions.~~

~~***Note:*** *Barometric Altitude is not required to be estimated when a State Vector Report is prepared as a result of receiving an airborne position and velocity messages. (i.e. The State Vector Report can include the most recently received value for this field.)*~~

**2.2.8.1.15~~13~~ Barometric Altitude Rate**

a. When Barometric Altitude Rate Data is indicated by the "Source Bit for Vertical Rate" subfield (subparagraph 2.2.3.2.6.1.10, 2.2.3.2.6.2.10, 2.2.3.2.6.3.10, or 2.2.3.2.6.4.10) the ADS-B Report Assembly Function shall extract the Vertical Rate Sign Bit (subparagraph 2.2.3.2.6.1.11, 2.2.3.2.6.2.11, 2.2.3.2.6.3.11, or 2.2.3.2.6.4.11) and the Vertical Rate subfield (subparagraph 2.2.3.2.6.1.12, 2.2.3.2.6.2.12, 2.2.3.2.6.3.12, or 2.2.3.2.6.4.12) from the ADS-B message and provide Vertical Rate, Barometric information to the user application in the State Vector report in binary format as defined in Table ~~2-64~~2.2.8.1. This format represents a true two's complement format where the MSB has a weight of 16,384 and the LSB has a weight of 1. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 32,767.

b. When valid Barometric Altitude Rate data is not available, the ADS-B Report Assembly Function shall set the Vertical Rate, Barometric data provided to the user application to ALL ZEROs, and the ~~Barometric Altitude~~Vertical Rate Validity ~~-~~Flag bit, i.e., bit #1~~2~~ of byte #3~~4~~ of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0~~.~~" to indicate the reported Vertical Rate is not valid.

Otherwise, the ~~Barometric Altitude~~Vertical Rate Validity Flag bit, i.e., bit #1~~2~~ of byte #3~~4~~ of the State Vector Report, shall be set to "1," unless modified by other conditions.

***Note:*** *Barometric Altitude Rate is not required to be estimated when a State Vector Report is prepared as a result of receiving an airborne position and velocity messages. (i.e. The State Vector Report can include the most recently received value for this field.)*

**2.2.8.1.16 Navigation Integrity Category (NIC)**

a. The ADS-B Report Assembly Function shall extract "TYPE" data from the ADS-B Airborne Position message (subparagraph 2.2.3.2.3.1) or from the Surface Position Message (subparagraph 2.2.3.2.4.1) and provide Navigation Integrity Category - (NIC) information to the user application in the State Vector report as defined in Table 2.2.8.1. Definition of the NIC coding is provided in Table 2.2.8.1.23.

b. When valid NIC data is not available, the NIC data sent to the user application shall be set to ALL ZEROs.

**Table 2.2.8.1.23: Navigation Integrity Category (NIC) Encoding.**

| Repoerted NIC Value | Containment Radius ($R_C$) and Vertical Protection Limit (VPL) |
|---|---|
| 0 | $R_C$ unknown |
| 1 | $R_C$ < 20 NM (37.04 km) |
| 2 | $R_C$ < 8 NM (14.816 km) |
| 3 | $R_C$ < 4 NM (7.408 km) |
| 4 | $R_C$ < 2 NM (3.704 km) |
| 5 | $R_C$ < 1 NM (1852 m) |
| 6 | $R_C$ < 0.6 NM (1111.2 m) |
| 7 | $R_C$ < 0.2 NM (370.4 m) |
| 8 | $R_C$ < 0.1 NM (185.2 m) |
| 9 | $R_C$ < 75m *and* VPL < 112 m |
| 10 | $R_C$ < 25m *and* VPL < 37.5 m |
| 11 | $R_C$ < 7.5m *and* VPL < 11 m |
| 12 - 15 | Reserved |

~~**2.2.8.1.14 True Air Speed (TAS)**~~

~~a. When indicated by the "Airspeed Type" (subparagraph 2.2.3.2.6.3.8 or 2.2.3.2.6.4.8) subfield in the Airborne Velocity - Subtype 3, 4 message, the ADS-B Report Assembly Function shall extract the True Airspeed (TAS) (subparagraph 2.2.3.2.6.3.9 or 2.2.3.2.6.4.9) data from the message and provide True Airspeed (TAS) information to the user application in the State Vector report in binary format as defined in Table 2-64. This format represents a true two's complement format where the MSB has a weight of 1,024 and the LSB has a weight of 0.0625. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 2,047.9375.~~

~~b. When valid True Airspeed (TAS) data is not available, the ADS-B Report Assembly Function shall set the True Airspeed (TAS) data provided to the user application to ALL ZEROs, and the Airspeed Validity Flag bit, i.e., bit #1 of byte #4 of the State Vector Report, shall be set to "0."~~

~~Otherwise, the Airspeed Validity Flag bit, i.e., bit #1 of byte #4 of the State Vector Report, shall be set to "1," unless modified by other conditions.~~

~~**2.2.8.1.15 Indicated Air Speed (IAS)**~~

~~a. When indicated by the "Airspeed Type" (subparagraph 2.2.3.2.6.3.8 or 2.2.3.2.6.4.8) subfield in the Airborne Velocity - Subtype 3, 4 message, the ADS-B Report Assembly Function shall extract the Indicated Airspeed (IAS) (subparagraph 2.2.3.2.6.3.9 or 2.2.3.2.6.4.9) data from the message and provide Indicated Airspeed (IAS) information to the user application in the State Vector report in binary format as defined in Table 2-64. This format represents a true two's complement format where the MSB has a weight of 1,024 and the LSB has a weight of 0.0625. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 2,047.9375.~~

b. When valid Indicated Airspeed (IAS) data is not available, the ADS-B Report Assembly Function shall set the Indicated Airspeed (IAS) provided to the user application to ALL ZEROs, and the Airspeed Validity Flag bit, i.e., bit #1 of byte #4 of the State Vector Report, shall be set to "0."

Otherwise, the Airspeed Validity Flag bit, i.e., bit #1 of byte #4 of the State Vector Report, shall be set to "1," unless modified by other conditions.

#### 2.2.8.1.16 Ground Speed

a. The ADS-B Report Assembly Function shall extract the Movement Data (subparagraph 2.2.3.2.4.2) from the ADS-B message and provide Ground Speed information to the user application in the State Vector report as defined in Table 2-64. Coding of the Movement information shall be the same as that identified for the Movement Data in subparagraph 2.2.3.2.4.2.

b. When valid Movement data is not available, the ADS-B Report Assembly Function shall set the Ground Speed data provided to the user application to ALL ZEROs, and the Ground Speed Validity Flag bit, i.e., bit #0 (LSB) of byte #4 of the State Vector Report, shall be set to "0."

Otherwise, the Ground Speed Validity Flag bit, i.e., bit #0 (LSB) of byte #4 of the State Vector Report, shall be set to "1," unless modified by other conditions..

#### 2.2.8.1.17 Ground Track

a. The ADS-B Report Assembly Function shall extract the Status Bit for Ground Track (subparagraph 2.2.3.2.4.3) and Ground Track Data (subparagraph 2.2.3.2.4.4) from the ADS-B message and provide Ground Track information to the user application in the State Vector report in binary format as defined in Table 2-64. This format represents a true two's complement format where the MSB has a weight of 90 degrees and the LSB has a weight of 1.40625 degrees. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 178.59375 degrees. Alternately, the format may be referred to as angular weighted binary.

b. When valid Ground Track data is not available, the ADS-B Report Assembly Function shall set the Ground Track data provided to the user application to ALL ZEROs, and the Ground Track Validity Flag bit, i.e., bit #7 (MSB) of byte #5 of the State Vector Report, shall be set to "0."

Otherwise, the Ground Track Validity Flag bit, i.e., bit #7 (MSB) of byte #5 of the State Vector Report, shall be set to "1," unless modified by other conditions.

#### 2.2.8.1.18 Magnetic Heading

a. The ADS-B receiver shall extract the Magnetic Heading Status Bit (subparagraph 2.2.3.2.6.3.6 or 2.2.3.2.6.4.6) and the Magnetic Heading subfield (subparagraph 2.2.3.2.6.3.7 or 2.2.3.2.6.4.7) from the ADS-B message and provide Magnetic Heading information to the user application in the State Vector report in binary format as defined in Table 2-64. This format represents a true two's complement format where the MSB has a weight of 90 degrees and the LSB has a weight of 0.0054931640625 degrees. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 179.9945068359375 degrees. Alternately, the format may be referred to as angular weighted binary.

b. When Magnetic Heading data is not available, the ADS-B receiver shall set the Magnetic Heading data provided to the user application to ALL ZEROs, and the

~~Magnetic Heading Validity Flag bit, i.e., bit #6 of byte #5 of the State Vector Report, shall be set to "0."~~

~~Otherwise, the Magnetic Heading Validity Flag bit, i.e., bit #6 of byte #5 of the State Vector Report, shall be set to "1," unless modified by other conditions.~~

~~**2.2.8.1.19 Turn Indication**~~

~~The ADS-B Report Assembly Function shall extract the Turn Indicator subfield (subparagraph 2.2.3.2.6.1.13, 2.2.3.2.6.2.13, 2.2.3.2.6.3.13, or 2.2.3.2.6.4.13) from the ADS-B message and provide Turn Indication information to the user interface in the State Vector report as defined in Table 2-66. Coding of the Turn Indicator Subfield shall be exactly as that defined in subparagraph 2.2.3.2.6.1.13.~~

~~**2.2.8.1.20 Position Time of Applicability**~~

~~Each time that an Airborne or Surface Position message is received with valid Latitude ***AND*** Longitude data, the Report Assembly Function shall update the Position Time of Applicability data in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.~~

~~**2.2.8.1.21 Velocity Time of Applicability**~~

~~a. Each time that an Airborne Velocity Subtype "1" or "2" message is received with valid East / West AND North / South Velocity data, the Report Assembly Function shall update the Velocity Time of Applicability data in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.~~

~~b. Each time that a Surface Position Message is received with valid Movement AND Ground Track data, the Report Assembly Function shall update the Velocity Time of Applicability data in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.~~

**2.2.8.1.1722 Estimated Latitude (WGS-84)**

a. New Latitude Data Received

(1). Airborne or Surface Message Received: - Each time that the Report Assembly Function establishes a new decoded Latitude in accordance with section 2.2.8.1.2, the Report Assembly Function shall update the Estimated Latitude (WGS-84) data in the State Vector Report with the new Latitude data received.

(2). Airborne or Surface Message Received: - The Estimated Latitude update shall be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. New North / South Velocity Data Received: (Airborne Velocity Message Received)

(1). Each time that an Airborne Velocity Subtype "1" or "2" message is received with valid North / South Velocity data, the Report Assembly Function shall compute a new Estimated Latitude (WGS-84) position based on the last known

Estimated Latitude (WGS-84), the last known North / South velocity (***Note:*** Not the North / South Velocity data just received), and the time that has elapsed since the last update of the Estimated Latitude (WGS-84).

Accuracy of the Estimated Latitude (WGS-84) computation shall be within +/- 20 meters of the theoretical noise free position that could be established based on the previous position, the last known velocity, and the time of travel.

***Note:*** *The accuracy requirement is stated in the manner given in order to specifically allow the implementation to use estimation techniques such as Kalman filters, alpha-beta trackers, or linear estimation as deemed necessary by the implementer to satisfy the accuracy requirement.*

(2). The new Estimated Latitude (WGS-84) computed in b.(1) shall be used by the Report Assembly Function to update the Estimated Latitude (WGS-84) data in the State Vector Report.

(3). The Estimated Latitude update shall be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

c. Estimated Horizontal Position Validity Flag Requirements

When valid estimated Latitude or Longitude position data is not available, the estimated latitude and longitude data provided to the user application shall be set to ALL ZEROs and the Estimated Horizontal Position Validity Flag bit, i.e., bit #05 of byte #35 of the State Vector Report (subparagraph 2.2.8.1.1.2) , shall be set to "0." to indicate the reported Estimated Horizontal Position is not valid.

Otherwise, the Estimated Horizontal Position Validity Flag bit, i.e., bit #05 of byte #35 of the State Vector Report, shall be set to "1," unless modified by other conditions.

**2.2.8.1.1823 Estimated Longitude (WGS-84)**

a. New Longitude Data Received

(1). Airborne or Surface Message Received: - Each time that the Report Assembly Function establishes a new decoded Longitude in accordance with section 2.2.8.1.3, the Report Assembly Function shall update the Estimated Longitude (WGS-84) data in the State Vector Report with the new Longitude data received.

(2). Airborne or Surface Message Received: - The Estimated Longitude update shall be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. New East / West Velocity Data Received: (Airborne Velocity Message Received)

(1). Each time that an Airborne Velocity Subtype "1" or "2" message is received with valid East / West Velocity data, the Report Assembly Function shall compute a new Estimated Longitude (WGS-84) position based on the last known Estimated Longitude (WGS-84), the last known East / West velocity (***Note:*** Not the East / West Velocity data just received), and the time that has elapsed since the last update of the Estimated Longitude (WGS-84).

Accuracy of the Estimated Longitude (WGS-84) computation shall be within +/- 20 meters of the theoretical noise free position that could be established based on the previous position, the last known velocity, and the time of travel.

***Note:*** *The accuracy requirement is stated in the manner given in order to specifically allow the implementation to use estimation techniques such as Kalman filters, alpha-beta trackers, or linear estimation as deemed necessary by the implementer to satisfy the accuracy requirement.*

(2). The new Estimated Longitude (WGS-84) computed in b.(1) shall be used by the Report Assembly Function to update the Estimated Longitude (WGS-84) data in the State Vector Report.

(3). The Estimated Longitude update shall be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

c. Estimated Horizontal Position Validity Flag Requirements

When valid estimated Latitude or Longitude position data is not available, the estimated latitude and longitude data provided to the user application shall be set to ALL ZEROs and the Estimated Horizontal Position Validity Flag bit, i.e., bit #05 of byte #35 of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0." to indicate the reported Estimated Horizontal Position is not valid.

Otherwise, the Estimated Position Validity Flag bit, i.e., bit #05 of byte #35 of the State Vector Report, shall be set to "1," unless modified by other conditions.

**2.2.8.1.1924 Estimated North / South Velocity**

***Note:*** *The estimation of North / South Velocity is considered to be an optional function to be implemented in the ADS-B Report Assembly Function at the discretion of the implementer. If estimation of North / South Velocity is implemented then the requirements provided in the following subparagraphs a. through b.(3) shall be used as the minimum acceptable performance for such estimation.*

a. New North / South Velocity Received: (Airborne Velocity or Surface Position Message Received)

(1). Each time that the Report Assembly Function establishes a new North / South Velocity in accordance with section 2.2.8.1.9, the Report Assembly Function shall update the Estimated North / South Velocity data in the State Vector Report with the new North / South Velocity data received.

(2). The Estimated North / South Velocity update shall be completed by the Report Assembly Function also updating the Report Time of Applicability in the State

Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. New Latitude Position Data Received: (Airborne Position or Surface Position Message Received)

(1). Each time that the Report Assembly Function establishes a new decoded Latitude in accordance with section 2.2.8.1.2, the Report Assembly Function shall compute a new Estimated North / South Velocity based on the last known Estimated Latitude (WGS-84), the new Latitude position data just received, and the time that has elapsed since the last update of the Estimated North / South Velocity.

Accuracy of the Estimated North / South Velocity computation shall be within +/- 0.3 meters/second of the theoretical noise free Estimated North / South Velocity that could be established based on the previous position, the new position, and the elapsed time of travel between the two positions.

***Note:*** *The accuracy requirement is stated in the manner given in order to specifically allow the implementation to use estimation techniques such as Kalman filters, alpha-beta trackers, or linear estimation as deemed necessary by the implementer to satisfy the accuracy requirement.*

(2). The new Estimated North / South Velocity computed in b.(1) shall be used by the Report Assembly Function to update the Estimated North / South Velocity data in the State Vector Report.

(3). The Estimated North / South Velocity update shall be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

c. Estimated Velocity Validity Flag Requirements

When valid estimated North / South or East / West Velocity data is not available, the estimated North / South or East / West Velocity data provided to the user application shall be set to ALL ZEROs and the Estimated Horizontal Velocity Validity Flag bit, i.e., bit # 7~~3~~ of byte #4~~5~~ of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0~~.~~" to indicate the reported Estimated Horizontal Velocity is not valid.

Otherwise, the Estimated Velocity Validity Flag bit, i.e., bit #3~~7~~ of byte #4~~5~~ of the State Vector Report, shall be set to "1," unless modified by other conditions.

**2.2.8.1.20~~5~~ Estimated East / West Velocity**

***Note:*** *The estimation of East / West Velocity is considered to be an optional function to be implemented in the ADS-B Report Assembly Function at the discretion of the implementer. If estimation of East / West Velocity is implemented then the requirements provided in the following subparagraphs a. through b.(3) shall be used as the minimum acceptable performance for such estimation.*

a. New East / West Velocity Data Received: (Airborne Velocity or Surface Position Message Received)

(1). Each time that the Report Assembly Function establishes a new East / West Velocity in accordance with section 2.2.8.1.10, the Report Assembly Function shall update the Estimated East / West Velocity data in the State Vector Report with the new East / West Velocity data received.

(2). The Estimated East / West Velocity update shall be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. New Longitude Position Data Received: (Airborne or Surface Position Message Received)

(1). Each time that the Report Assembly Function establishes a new decoded Longitude in accordance with section 2.2.8.1.3, the Report Assembly Function shall compute a new Estimated East / West Velocity based on the last known Estimated Longitude (WGS-84), the new Longitude position data just received, and the time that has elapsed since the last update of the Estimated East / West Velocity.

Accuracy of the Estimated East / West Velocity computation shall be within +/- 0.3 meters/second of the theoretical noise free Estimated East / West Velocity that could be established based on the previous position, the new position, and the elapsed time of travel between the two positions.

***Note:*** *The accuracy requirement is stated in the manner given in order to specifically allow the implementation to use estimation techniques such as Kalman filters, alpha-beta trackers, or linear estimation as deemed necessary by the implementer to satisfy the accuracy requirement.*

(2). The new Estimated East / West Velocity computed in b.(1) Shall be used by the Report Assembly Function to update the Estimated East / West Velocity data in the State Vector Report.

(3). The Estimated East / West Velocity update shall be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

c. Estimated Horizontal Velocity Validity Flag Requirements

When valid estimated North / South or East / West Velocity data is not available, the estimated North / South or East / West Velocity data provided to the user application shall be set to ALL ZEROs and the Estimated Horizontal Velocity Validity Flag bit, i.e., bit # 73 of byte #45 of the State Vector Report (subparagraph 2.2.8.1.1.2), shall be set to "0." to indicate the reported Estimated Horizontal Velocity is not valid.

Otherwise, the Estimated Velocity Validity Flag bit, i.e., bit #73 of byte #45 of the State Vector Report, shall be set to "1," unless modified by other conditions.

**2.2.8.1.216 Surveillance Status / Discretes**

a. The ADS-B Report Assembly Function shall extract the Surveillance Status (subparagraph 2.2.3.2.3.2) from the ADS-B Airborne Position Message (subparagraph 2.2.3.2.3) and map the surveillance status data into the most significant nibble of the State Vector Report byte on a bit for bit basis as shown in Table ~~2-64~~2.2.8.1

b. When valid Surveillance Status data is not available, the ADS-B Report Assembly Function shall set the Surveillance Status data provided to the user application to ALL ZEROs.

c. The ADS-B Report Assembly Function shall extract the Intent Change Flag (subparagraph 2.2.3.2.6.1.3 and Figure 2-7a,b) from the ADS-B Airborne Velocity Message (subparagraph 2.2.3.2.6) and map the Intent Change Flag into the bit "b1" of the least significant nibble of the State Vector Report byte on a bit for bit basis as shown in Table ~~2-64~~2.2.8.1.

d. The ADS-B Report Assembly Function shall extract the IFR Capability Flag (subparagraph 2.2.3.2.6.1.4 and Figures ~~2-7a,b~~2.2.3.2.6 a and b) from the ADS-B Airborne Velocity Message (subparagraph 2.2.3.2.6) and map the IFR Capability Flag into the bit "b0" of the least significant nibble of the State Vector Report byte on a bit for bit basis as shown in Table ~~2-64~~2.2.8.1.

~~**2.2.8.1.27 Report Time of Applicability**~~

~~a. Each time that an individual State Vector Report is updated as specified in sections 2.2.8.1.22, 2.2.8.1.23, 2.2.8.1.24, ***OR*** 2.2.8.1.25, the Report Assembly Function shall update the Time of Applicability data in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.~~

~~b. Time of Applicability data shall be provided in the State Vector report in binary format as defined in Table 2-64.~~

**2.2.8.1.2228 Report Mode**

The Report Mode is used to indicate the current state of the Report for each ADS-B vehicle being reported. Each time that the State Vector Report is updated, the Report Mode shall be updated with the encoding being as shown in table 2-69.

**Table 2-69: REPORT MODE Encoding**

| Coding | Report Mode |
|---|---|
| XXXX 0000 | No Report Generation Capability |
| XXXX 0001 | Acquisition Mode (see paragraph 2.2.10.2) |
| XXXX 0010 | Track Mode (see paragraph 2.2.10.3) |
| XXXX 0011 | Reserved for Future Expansion |
| through | |
| XXXX 1111 | |

***Note:*** *"X" in the table above, denotes "DON'T CARE."*

# Attachment A2

## Proposed changes to DO-260A Sections 2.2.8.2 to define the format of Mode Status Reports

Changes from current DO-260 text shown as red-lines except on tables where there are many changes made

### 2.2.8.2 ADS-B Mode Status Report Characteristics

Table ~~2-70~~2.2.8.2 and the subsequent subparagraphs identify the data structure for ~~all~~ ADS-B Mode Status Reports.

The intent of Table ~~2-70~~2.2.8.2 is to illustrate the structure of all Items required to be reported in an ADS-B Mode Status Report. The exact structure of the data indicated in columns 10 and 11 is provided as a guide line or one possible method of satisfying the report structure. Implementers may choose to organize the data in another format; however, delivery to a user interface or application of all Items in Table 2.2.8.2 ~~2-70~~ shall be consistent with the range, resolution, and units indicated in column 7, 8, and 9 of Table 2.2.8.2 ~~2-70~~ respectively. Those requirements in subparagraphs 2.2.8.2.1 to 2.2.8.2.xx~~16~~ below that relate to specific data structure details (byte numbers, and bit numbers within the bytes) shall only apply to equipment that uses the sample data structure shown in columns 10-11 of Table 2.2.8.2~~2-70~~.

***Note:*** *Table 2.2.8.2 ~~2-70~~ is structured such that column 1, 2, and 6 through 11, pertain to the Mode Status Report elements and how such elements should be structured into the report. Columns 3 through 5 provide information on where the appropriate data can be located in the ADS-B Messages for each of the Report elements.*

## Table 2.2.8.2: ADS-B Mode Status Data Elements - Source Data Mapping To Report Structure <<<MANY CHANGES to Table>>>>

| | REPORT STRUCTURE | | MESSAGE STRUCTURE RELEVANT | | | REPORT STRUCTURE RELEVANT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Column #** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
| **Item #** | **Parameter / Contents** | **Notes** | **Received Message Sources** | **"ME" Field Bits** | **Message Field Bits** | **# of Bits** | **Range** | **Resolution** | **Units** | **Data Structure** | **Data Byte #** |
| 0a,0b | Report Type and Structure | | Airborne Position - "DF"<br>Operational Status – "DF" | N/A<br>N/A | 1 – 5<br>1 - 5 | 24 | N/A | N/A | discrete | MddL Mddd ddddddddddddddL | 0 - 2 |
| 0c | Validity Flags | | N/A | N/A | N/A | 8 | N/A | N/A | discrete | dddddddd | 3 |
| 1 | Participant Address | | Airborne Velocity - "AA"<br>- OR -<br>Operational Status – "AA"<br>- OR -<br>Trajectory Intent & System Status - "AAs"<br>- OR -<br>Aircraft Identification – "AA" | N/A<br><br>N/A<br><br>N/A<br><br>**N/A** | 9 – 32<br><br>9 – 32<br><br>9 – 32<br><br>9 - 32 | 24<br><br>24<br><br>24<br><br>24 | N/A | N/A | discrete | Mddddddd ddddddddddddddL | 4 – 6 |
| 2 | Address Qualifier | | N/A reserved for future use | | | 8 | N/A | N/A | discrete | ~~00000M0L~~00000MdL | 7 |
| 3 | Time of Applicability | | Operational Status<br>Airborne Position<br>Trajectory Intent & System Status | N/A | N/A | 16 | 511.9921875 | 0.0078125 (1/128) | seconds | Mddddddd ddddddddL | 8 - 9 |
| 4 | ADS-B Version | | Operational Status – "Version Number" | 41 - 43 | 73 - 75 | 8 | 0 - 7 | 1 | discrete | 00000MdL | 10 |
| 5a | Call Sign | | Aircraft Identification – "Ident Char." | 14 – 56 | 41 – 88 | 64 | N/A | N/A | Alphanumeric characters | 0MddddddL 0MddddddL<br>0MddddddL 0MddddddL<br>0MddddddL 0MddddddL<br>0MddddddL 0MddddddL | 11 – 18 |
| 5b | Emitter Category | | Aircraft Identification – "Emitter Category" | 6 – 8 | 38 - 40 | 8 | N/A | N/A | discrete | 000MdddL | 19 |
| 5c | A/V Length and Width Codes | 4 | Operational Status – "L/W Codes" | 21 – 24 | 53 – 56 | 8 | N/A | N/A | discrete | 0000MddL | 20 |
| 6 | Emergency/Priority Status | | Aircraft Status Message – Subtype 1 – "Emergency/Priority Status" | 9 - 11 | 36 - 38 | 8 | N/A | N/A | discrete | 00000MbL | 21 |
| 7 | Capability Codes | | Operational Status – "CC"<br><br>Trajectory Intent & System Status "Capability/Mode Codes" | 9 - 24<br><br>52 - 53 | 41 - 56<br><br>84 - 85 | 16<br><br>16 | See Section 2.2.8.2.10 | | | ddddddddddddddddddddddddd | 22 - ~~23~~24 |
| 8 | Operational Mode | | Operational Status – "OM"<br><br>Trajectory Intent & System Status "Capability/Mode Codes" | 25 40<br><br>52 - 53 | 57 - 72<br><br>84 - 85 | 16<br><br>16 | See Section 2.2.8.2.11 | | | ddddddddddddddddd | ~~24~~ ~~25~~ - ~~25~~26 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9a | SV Quality - NACp | | Operational Status – "NACp"<br><br>Trajectory Intent & System Status - "NACp" | 45 - 48<br><br>40 - 43 | 77 - 80<br><br>72 - 75 | 8 | N/A | N/A | discrete | 0000MddL | ~~26~~27 |
| 9b | SV Quality - NACv | | Airborne Velocity – "NACv" | 11 - 13 | 43 - 45 | 8 | N/A | N/A | discrete | 00000MdL | ~~27~~28 |
| 9c | SV Quality – SIL | | Operational Status – "SIL"<br><br>Trajectory Intent & System Status - "SIL" | 51 – 52<br><br>45 – 46 | 83 84<br><br>77 – 78 | 8 | N/A | N/A | discrete | 000000ML | ~~28~~29 |
| 9d | SV Quality – BAQ (reserved) | | | | | 8 | N/A | N/A | discrete | 000000ML | ~~29~~30 |
| 9e | SV Quality – $NIC_{BARO}$ | | Operational Status – "$NIC_{BARO}$"<br>Trajectory Intent & System Status - "$NIC_{BARO}$" | 53<br><br>44 | 85<br><br>76 | 8 | N/A | N/A | discrete | 0000000L | ~~30~~31 |
| 10a | True/Magnetic Heading (HDR) | | Operational Status – "Heading Reference Direction" | 54 | 86 | 8 | N/A | N/A | discrete | 0000000L | ~~31~~32 |
| 10b | Vertical Rate Type | | Airborne Velocity – "Vert. Rate Source" | 36 | 68 | 8 | N/A | N/A | discrete | 0000000L | ~~32~~33 |
| 11 | Other (Reserved) | | Reserved | | | 8 | Reserved | | | ddddddd | ~~33~~34 |
| | | | | | | | | | | **TOTAL BYTES:** | ~~34~~35 |

1. *In the "Data Structure" column (i.e., column 10), "S" indicates the "sign-bit," "M" indicates the Most Significant Bit of the data field, "d" indicates data bits in the field, "L" indicates the Least Significant Bit of the data field, "0" indicates the bit is to always be set to a value of zero (0), and "x" indicates "Don't Care" bits in the data field.*
2. *If data is not available to support these fields, then the entire data field shall be set to ALL ZEROs.*
3. *The Report Type Identifier is used to identify the type of ADS-B Report being generated as defined in section 2.2.8.1.1.1.*
4. *The A/V Length and Width Code and the True/Magnetic Heading parameter are only applicable to Mode Status reports for aircraft or vehicles that are on the airport surface.*
5. *Capability Class Codes, State Vector Quality-BAQ, and State Vector Quality-$NIC_{BARO}$ are only applicable to Mode Status Reports for airborne aircraft.*

### 2.2.8.2.1 Mode Status Report Type and Structure Identification and Validity Flags

#### 2.2.8.2.1.1 Mode Status Report Type and Structure Identification

The Report Type requirements were previously provided in subparagraph 2.2.8.1.1. Report Type formats and the maximum number of bytes to be contained in each report are identified in ~~Table 2-70~~Table 2.2.8.2.

The Report Structure field is used to indicate the exact data parameters identified in ~~Table 2-70~~Table 2.2.8.2 that are being provided in the Mode Status report and is intended to provide a methodology for the Report Assembly Function to structure shorter reports when data for some parameters is not available. In order to provide the capability to provide shorter Mode Status reports the following basic conventions shall be adhered to:

a. Any given data parameter to be used in the report shall use the designated number of bytes and format as designated in ~~Table 2-70~~Table 2.2.8.2.

b. Parameters that are designated in ~~Table 2-70~~Table 2.2.8.2 are restricted to byte boundaries.

c. Whenever a data parameter identified in ~~Table 2-70~~Table 2.2.8.2 is not provided in the report, then it is permissible to concatenate the next parameter to be included into the report immediately following the inclusion of the previous reported parameter.

d. Each parameter of the Mode Status report identified in ~~Table 2-70~~Table 2.2.8.2 must be properly declared in the Report Structure field as detailed in the following paragraphs and Table 2-71a.

***Note:*** *Implementation of the methodology just provided is realizable and controllable due to the fact that the exact length of each report parameter is defined in ~~Table 2-70~~Table 2.2.8.2 and the Report Structure field identifies exactly which parameters are included in the report. Therefore, the report user can easily re-construct the length and general format of the report.*

The Report Structure is a 20-bit field and shall be provided in the least significant nibble (i.e., bits 3 - 0) of the first byte (i.e., byte "0") and continuing into bytes 1 and 2 of the Report. The Report Structure format is defined in Table ~~2-71a~~2.2.8.2.1.1 where each bit is associated with a particular data parameter of the Mode Status Report. If the bit is set to "1," then the data parameter is considered to be available and shall be transmitted in the report. Otherwise, the data parameter is considered to not be available and shall not be transmitted in the report. Note that Table 2.2.8.2.1.1~~2-71a~~ does not address the Report Type and Structure Identification parameter, the Validity Flags parameter, nor the Participant Address and Address Qualifier parameters **since it is mandatory that these ~~three~~ four parameters shall be included in the Mode Status Report. Also certain of the other Mode Status data parameters are required to be reported, as defined in paragraph 2.2.9, even though bits have been allocated in the report structure field as shown in Table 2.2.8.2.1.1.**

**Table 2.2.8.2.1.12 ~~2-71a~~: ADS-B Mode Status Report Structure Coding <<<Many Changes>>>>**

| Byte # | Bit # | Mode Status Data Parameter to be Reported | Number of Bytes |
|---|---|---|---|
| 0 | 3 | Time of Applicability | 2 |
| | 2 | ADS-B Version | 1 |
| | 1 | Call Sign | 8 |
| | 0 | Emitter Category | 1 |
| 1 | 7 | A/V Length and Width Code | 1 |
| | 6 | Emergency / Priority Status | 1 |
| | 5 | Capability Codes | 2 |
| | 4 | Operational Mode | 2 |
| | 3 | SV Quality - NACp | 1 |
| | 2 | SV Quality - NACv | 1 |
| | 1 | SV Quality - SIL | 1 |
| | 0 | SV Quality – BAQ (reserved) | 1 |
| 2 | 7 | SV Quality - NICbaro | 1 |
| | 6 | True/Magnetic Heading | 1 |
| | 5 | Vertical Rate Type | 1 |
| | 4 | Other (reserved) | 1 |
| | 3 | Reserved for Future Growth | |
| | 2 | Reserved for Future Growth | |
| | 1 | Reserved for Future Growth | |
| | 0 | Reserved for Future Growth | |

### 2.2.8.2.1.2 Mode Status Report Validity Flags

Validity Flags for data provided in the Mode Status Report shall be indicated in byte #3 of the Mode Status Report as shown for item "0c" in ~~Table 2-70~~Table 2.2.8.2. The Mode Status Report elements that require validity flags are identified in Table ~~2-71b~~2.2.8.2.1.2. Table 2.2.8.2.1.2~~2-71b~~ identifies the byte and bit that shall be used as a flag for each element that requires a validity flag. Each validity flag bit shall be set to "1" to indicate that the corresponding Mode Status Report Element data is valid. If such data is not valid, then the corresponding validity flag bit shall be set to "0." Only the ~~two~~ five most significant bits of the subfield are currently assigned. The remaining ~~6~~ 3 bits are reserved for future use.

**Table ~~2-71b~~2.2.8.2.1.2: ADS-B Mode Status Report Validity Flag Requirements**

| MS Report Item # | Mode Status Report Element | Validity Flag Bit Required? | Validity Flag Bit Assignment |
|---|---|---|---|
| | | | Bit # |
| 0a | Report Type | No | |
| 0b | Report Data Structure Definition | No | |
| 0c | Validity Flags | No | |
| 1 | Participant Address | No | |
| 2 | Address Qualifier | No | |
| 3 | Time of Applicability | No<br>. | |
| 4 | ADS-B Version | No | |
| 5a | Call Sign | No | |
| 5b | Emitter Category | No | |
| 5c | A/V Length and Width Codes | No | |
| 6 | Emergency/Priority Status | No | |
| 7 | Capability Codes | **Yes**<br>If an update has not been received within 24 seconds, via a Operational Status and/or a Trajectory Intent and System Status message, then this report element is not considered valid | 7<br>(MSB) |
| 8 | Operational Mode | **Yes**<br>If an update has not been received within 24 seconds, via a Operational Status and/or a Trajectory Intent and System Status message, then this report element is not considered valid | 6 |
| 9a | SV Quality - NACp | **Yes**<br>If an update has not been received within 24 seconds, via a Operational Status and/or a Trajectory Intent and System Status message, then this report element is not considered valid | 5 |
| 9b | SV Quality - NACv | **Yes**<br>If an update has not been received within 24 seconds via Airborne Velocity message, then this report element is not considered valid | 4 |
| 9c | SV Quality – SIL | **Yes**<br>If an update has not been received within 24 seconds, via a Operational Status and/or a Trajectory Intent and System Status message then this report element is not considered valid | 3 |
| 9d | SV Quality – BAQ (reserved) | No | |
| 9e | SV Quality – NICbaro | No | |
| 10a | True/Magnetic Heading | No | |
| 10b | Vertical Rate Type | No | |
| 11 | Other (Reserved) | No | |

### 2.2.8.2.2 Participant Address

The participant address shall be encoded as defined in 2.2.3.2.1.1.1.

### 2.2.8.2.3 Address Qualifier

The address qualifier is used to indicate the type of participant address (2.2.8.2.2) being reported. The 3 least significant bits of the one byte field are used to convey the Address

Qualifier information. The Address Qualifier subfield shall be coded as shown in Table 2.2.8.1.3.

**2.2.8.2.4. Report Time of Applicability**

a. Each time that an individual Operational Status Report is updated, the Report Assembly Function shall update the Time of Applicability data in the Target State Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. Report Time of Applicability data shall be provided in the Operational Status Report in binary format as defined in Table 2.2.8.3.1.

**2.2.8.2.5 ADS-B Version**

The ADS-B Report Assembly Function shall extract the version number from in Operational Status message (subparagraph 2.2.3.2.7.3.5) for further. The ADS-B version is reported within the three least significant bits of the subfield of the Mode Status message coded the same format as the version number subfield from in Operational Status message

**2.2.8.2.6~~2~~ Call Sign**

a. The ADS-B Report Assembly Function shall first extract the Aircraft Identification Character subfields (subparagraph 2.2.3.2.5.3) from the ADS-B Flight Identification and Type message (subparagraph 2.2.3.2.5.3) for further processing.

b. Each of the eight characters extracted is encoded in a subset of International Alphabet No. 5 (IA-5) in accordance with subparagraph 2.2.3.2.5.3. The encoding of each character is 6 bits long with bit_6 being the most significant and bit_1 being the least significant. IA-5 is a seven bit encoding with bit_7 being the most significant and bit_1 being the least significant. In order to provide an IA-5 encoding in an eight bit format as indicated in ~~Table 2-70~~Table 2.2.8.2, the Report Assembly Function shall:

(1). Retain bit_6 through bit_1 of the character encoding.

(2). If bit_6 is “ZERO,” set bit_7 to “ONE”

(3). If bit_6 is “ONE,” set bit_7 to “ZERO”

(4). Set bit_8 to “ZERO”

(5). Format bit_8 through bit_6 into “0MdddddL” for entry into the report as shown in ~~Table 2-70~~Table 2.2.8.2.

c. When valid Flight Identity data is not available, the Call Sign data sent to the user application shall be set to ALL ZEROs.

**2.2.8.2.7~~3~~ ~~Participant~~ Emitter Category**

a. The ADS-B Report Assembly Function shall extract “TYPE” (subparagraph 2.2.3.2.5.1) and “ADS-B Emitter Category” (subparagraph 2.2.3.2.5.2) from the Aircraft Identification and Type Message (subparagraph 2.2.3.2.5) and encode the “~~Participant~~ Emitter Category” field of the Mode Status Report as shown in Table ~~2-72~~2.2.8.2.7.

**Table ~~2-7~~2.2.8.2.7: PARTICIPANT CATEGORY Encoding**

| Encoding | Meaning |
|---|---|
| 0 | No ~~Aircraft~~ Emitter Category Information Available |
| 1 | Light (<15,500 lbs.) |
| 2 | Reserved for Future Growth |
| 3 | Small (15,500 to 75,000 lbs.) |
| 4 | Reserved for Future Growth |
| 5 | Large (75,000 to 300,000 lbs.) |
| 6 | High-Vortex Large (aircraft such as B-757) |
| 7 | Heavy (>300,000 lbs.) |
| 8 | High Performance (>5 g acceleration ***and*** >400 knots) |
| 9 | Reserved for Future Growth |
| 10 | Rotorcraft |
| 11 | Glider / Sailplane |
| 12 | Lighter - than - Air |
| 13 | Unmanned Aerial Vehicle |
| 14 | Space / Trans-atmospheric Vehicle |
| 15 | Ultralight / hang-glider / paraglider |
| 16 | Parachutist / Skydiver |
| 17 | Reserved for Future Growth |
| 18 | Reserved for Future Growth |
| 19 | Reserved for Future Growth |
| 20 | Surface Vehicle - Emergency Vehicle |
| 21 | Surface Vehicle - Service Vehicle |
| 22 | ~~Fixed Ground or~~Point obstacle (includes Tethered ~~Obstruction~~ballons) |
| 23 | Cluster Obstacle |
| 24 | Line Obstacle |
| ~~23~~ 25 through 255 | Reserved for Future Growth |

b. When valid ADS-B Emitter Category data is not available, the Participant Category data sent to the user application shall be set to ALL ZEROs.

**2.2.8.2.8 The ADS-B Report Assembly Function shall extract the A/V Length and Width Codes**

The ADS-B Report Assembly Function shall extract the the A/V Length and Width Codes from the Operational Status message (subparagraph 2.2.3.2.7.3) when the A/V is on the airport surface. The A/V Length and Width codes shall be coded in the same format as used in the Operational Status message.

**2.2.8.2.94 Emergency / Priority Status**

a. The ADS-B Report Assembly Function shall extract the "Emergency / Priority Status" data (paragraph 2.2.3.2.7.3.2 and Appendix A, Figure A.8-9) from the Aircraft Status Message (paragraph 2.2.3.2.7.3) and provide Emergency / Priority Status information to the user application in the Mode Status Report in the binary format defined in ~~Table 2-70~~Table 2.2.8.2.

"Emergency / Priority Status," bits 9 - 11 (see Appendix A, Figure A.8-9), of the Aircraft Status Message shall be mapped bit for bit into the three least significant bits of the report byte as indicated in ~~Table 2-70~~Table 2.2.8.2.

b. When valid "Emergency / Priority Status" data is not available, the Emergency / Priority Status data sent to the user application shall be set to ALL ZEROs.

~~**2.2.8.2.5 TCP Latitude**~~

~~a. The ADS-B Report Assembly Function shall first determine if TCP Data is valid via inspection of the "TCP / TCP + 1 Data Valid Subfield" (subparagraph 2.2.3.2.7.1.4).~~

~~b. If TCP data is available, the Report Assembly Function shall determine whether it is a 3D or a 4D formatted message via inspection of the "TCP Format Subfield" (subparagraph 2.2.3.2.7.1.5).~~

~~c. If this is a 4D formatted TCP message, the ADS-B Report Assembly Function shall then concatenate 3 least significant zero bits to the 14-bit Encoded TCP Latitude data (subparagraph 2.2.3.2.7.1.7) in order to establish a 17-bit Encoded TCP Latitude Value. The ADS-B Report Assembly Function shall then decode the Encoded Trajectory Change Point (TCP) Latitude value. Using the current position of the aircraft transmitting the TCP as the reference point, decoding of the encoded TCP Latitude data shall be performed in accordance with the even format local decoding process provided in section A.7.5.4 of Appendix A.~~

~~d. If this is a 3D formatted TCP message, the ADS-B Report Assembly Function shall decode the latitude as a 17-bit two's complement signed binary numeral in which the LSB (bit 39) has a weight of $2^{-17}$ times 360 degrees. North latitudes shall have positive sign, and south latitudes shall have negative sign.~~

~~e. TCP latitude data shall be provided to the user application in the Mode Status report in angular weighted binary format (M bit = 90 degrees, S bit = negative, or 180 degrees) as defined in Table 2-70.~~

~~f. When valid encoded TCP latitude data is not available, the TCP latitude data sent to the user application shall be set to ALL ZEROs, and the TCP Latitude/Longitude/Altitude Validity Flag bit, i.e., bit #7 (MSB) of byte #3 of the Mode Status Report, shall be set to "0."~~

~~Otherwise, the TCP Latitude/Longitude/Altitude Validity Flag bit, i.e., bit #7 (MSB) of byte #3 of the Mode Status Report, shall be set to "1," unless modified by other conditions.~~

~~**2.2.8.2.6 TCP Longitude**~~

~~a. The ADS-B Report Assembly Function shall first determine if TCP Data is valid via inspection of the "TCP / TCP + 1 Data Valid Subfield" (subparagraph 2.2.3.2.7.1.4).~~

b. If TCP data is available, the Report Assembly function shall determine whether it is a 3D or a 4D formatted message via inspection of the "TCP Format Subfield" (subparagraph 2.2.3.2.7.1.5).

c. If this is a 4D formatted TCP message, the ADS-B Report Assembly Function shall decode the Encoded Trajectory Change Point (TCP) Longitude value in accordance with section A.7.5 of Appendix A.If this is a 4D formatted TCP message, the ADS-B Report Assembly Function shall then concatenate 3 least significant zero bits to the 14 bit Encoded TCP Longitude data (subparagraph 2.2.3.2.7.1.8) in order to establish a 17 bit Encoded TCP Longitude Value. The ADS-B Report Assembly Function shall then decode the Encoded Trajectory Change Point (TCP) Longitude value. Using the current position of the aircraft transmitting the TCP as the reference point, decoding of the encoded TCP longitude data shall be performed in accordance with the even format local decoding process provided in section A.7.4 of Appendix A.

d. If this is a 3D formatted TCP message, the ADS-B Report Assembly Function shall decode the longitude as a 17-bit two's complement signed binary numeral in which the LSB (bit 39) has a weight of $2^{-17}$ times 360 degrees.

e. TCP longitude data shall be provided to the user application in the Mode Status report in angular weighted binary format (M bit = 90 degrees, S bit = negative, or 180 degrees) as defined in Table 2-70.

f. When valid encoded TCP longitude data is not available, the longitude data sent to the user application shall be set to ALL ZEROs, and the TCP Latitude/Longitude/Altitude Validity Flag bit, i.e., bit #7 (MSB) of byte #3 of the Mode Status Report, shall be set to "0."

Otherwise, the TCP Latitude/Longitude/Altitude Validity Flag bit, i.e., bit #7 (MSB) of byte #3 of the Mode Status Report, shall be set to "1," unless modified by other conditions.

#### 2.2.8.2.7 TCP Altitude

a. The ADS-B Report Assembly Function shall extract the TCP Altitude data (subparagraph 2.2.3.2.7.1.6) from the ADS-B message and provide TCP Altitude information to the user application in the Mode Status Report in the binary format defined in Table 2-70. This format represents a true two's complement format where the MSB has a weight of 65,536 and the LSB has a weight of 4.0. The maximum range of the data is then given by +/- [2*MSB - LSB] or +/- 131,068.

b. When valid TCP Altitude data is not available, the TCP Altitude data sent to the user application shall be set to ALL ZEROs, and the TCP Latitude/Longitude/Altitude Validity Flag bit, i.e., bit #7 (MSB) of byte #3 of the Mode Status Report, shall be set to "0."

Otherwise, the TCP Latitude/Longitude/Altitude Validity Flag bit, i.e., bit #7 (MSB) of byte #3 of the Mode Status Report, shall be set to "1," unless modified by other conditions.

#### 2.2.8.2.8 TCP Time-to-Go (TTG)

a. The ADS-B Report Assembly Function shall extract the TCP Time-to-Go (TTG) data (subparagraph 2.2.3.2.7.1.9) from the ADS-B message and provide TCP Time-to-Go (TTG) information to the user application in the Mode Status Report in the format defined in Table 2-70.

~~b. When valid TCP TTG data is not available, the TCP TTG data sent to the user application shall be set to ALL ZEROs, and the TCP Time-To-Go Validity Flag bit, i.e., bit #6 of byte #3 of the Mode Status Report, shall be set to "0."~~

~~Otherwise, the TCP Time-To-Go Validity Flag bit, i.e., bit #6 of byte #3 of the Mode Status Report, shall be set to "1," unless modified by other conditions.~~

**2.2.8.2.10 Capability Codes**

a. The ADS-B Report Assembly Function shall extract the "Capability Class Codes" data (paragraph 2.2.3.2.7.3.3) from the Operational Status Message (paragraph 2.2.3.2.7.3), and the Target State and Status Information Message (§2.2.3.2.7.1.3), and provide the Capability Class Codes to the user application in the Mode Status Report in the binary format defined in Table 2.2.8.2.

Capability Class codes, ~~ME bits 9 – 24 (see Figure 2.2.3.2.7 and paragraph 2.2.3.2.7.3.3), of~~from the Operational Status and the Target State and Status Information Messages shall be mapped ~~bit for bit~~ into the ~~2~~3-byte length Capability Codes field of the ADS-B Mode Status Report as defined in Table 2.2.8.2.10.

b. ~~b.~~ When valid "Capability Class" data is not available for a given parameter, the Capability Class data sent to the user application for that parameter shall be set to ALL ZEROs.

c. When a Mode Status Report is generated and when the only received update to the "Capability Class" data has come from a Target State and Status Information Message, the reported value of all Capability Class parameters **shall** be based on the most recently received Operational Status Message, except updated with the data (i.e., TCAS parameter) received in the subsequent Target State and Status Information Message.

## Table 2.2.8.2.10: Capability Code Mapping

| MS Report | | | Operational Status Message Subtype 0 (Airborne) | | Operational Status Message Subtype 1 (Surface) | | Target State and Status Information Message | |
|---|---|---|---|---|---|---|---|---|
| MS Report CC Field Byte # | Bit # | Parameter | Msg. Bit # (ME field) | Mapping to MS Report | Msg. Bit # (ME field) | Mapping to MS Report | Msg. Bit # (ME field) | Mapping to MS Report |
| 0 | 7 | Service Level | 9 | Direct Mapping | 9 | Direct Mapping | | |
| | 6 | | 10 | Direct Mapping | 10 | Direct Mapping | | |
| | 5 | | 13 | Direct Mapping | 13 | Direct Mapping | | |
| | 4 | | 14 | Direct Mapping | 14 | Direct Mapping | | |
| | 3 | Reserved | | | | | | |
| | 2 | Reserved | | | | | | |
| | 1 | Reserved | | | | | | |
| | 0 | Reserved | | | | | | |
| 1 | 7 | TCAS | 11 | Inverse Mapping | | | 52 | Inverse Mapping |
| | 6 | CDTI | 12 | Direct Mapping | *tbd* | Direct Mapping | | |
| | 5 | ARV | 15 | Direct Mapping | | | | |
| | 4 | TS Report | 16 | Direct Mapping | | | | |
| | 3 | TC Report | 17 | Direct Mapping | | | | |
| | 2 | | 18 | Direct Mapping | | | | |
| | 1 | POA | | | *tbd* | Direct Mapping | | |
| | 0 | Reserved | | | | | | |
| 2 | 7 | Reserved | | | | | | |
| | 6 | Reserved | | | | | | |
| | 5 | Reserved | | | | | | |
| | 4 | Reserved | | | | | | |
| | 3 | Reserved | | | | | | |
| | 2 | Reserved | | | | | | |
| | 1 | Reserved | | | | | | |
| | 0 | Reserved | | | | | | |

***Note:*** *Direct Mapping means the message bit state (i.e., 0 or 1) remains the same when mapped into the MS Report. Inverse Mapping means the message bit state is reversed when mapped into the MS Report*

~~**2.2.8.2.9 Operational Mode Specific Data**~~

~~a. The ADS-B Report Assembly Function shall extract the "Capability Class" data (paragraph 2.2.3.2.7.3.3) from the Aircraft Status Message (paragraph 2.2.3.2.7.3) and provide Capability Class information to the user application in the Mode Status Report in the binary format defined in Table 2-70.~~

~~"CC_4," bits 9 - 12 (see Figure 2-10 and paragraph 2.2.3.2.7.3.3.1), of the Aircraft Status Message shall be mapped bit for bit into the most significant nibble of the first report byte. "CC_3," bits 13-16 (see Figure 2-10 and paragraph 2.2.3.2.7.3.3.2), of the Aircraft Status Message shall be mapped bit for bit into the least significant nibble of the first report byte.~~

~~"CC_2," bits 17 - 20 (see Figure 2-10 and paragraph 2.2.3.2.7.3.3.3), of the Aircraft Status Message shall be mapped bit for bit into the most significant nibble of the~~

~~second report byte. "CC_1," bits 21-24 (see Figure 2-10 and paragraph 2.2.3.2.7.3.3.4), of the Aircraft Status Message shall be mapped bit for bit into the least significant nibble of the second report byte.~~

~~b. When valid "Capability Class" data is not available, the Capability Class data sent to the user application shall be set to ALL ZEROs.~~

**2.2.8.2.1~~1~~0 ~~Flight~~ Operational Mode ~~Specific Data~~**

a. The ADS-B Report Assembly Function shall extract the "Operational Mode" data (paragraph 2.2.3.2.7.3.4) from the Aircraft Status Message (paragraph 2.2.3.2.7.3) and provide Flight Mode Specific information to the user application in the Mode Status Report in the binary format defined in ~~Table 2-70~~Table 2.2.8.2.

The Operational Mode subfield, ME bits 25 – 40 (see Figure 2.2.3.2.7.3.4 and paragraph 2.2.3.2.7.3.4), of the Operational Status Message shall be mapped bit for bit into the 2-byte length Operational Mode field of the ADS-B Mode Status Report. ~~"OM_4," bits 25 - 28 (see Figure 2-10 and paragraph 2.2.3.2.7.3.4.1), of the Aircraft Status Message shall be mapped bit for bit into the most significant nibble of the first report byte. "OM_3," bits 29 - 32 (see Figure 2-10 and paragraph 2.2.3.2.7.3.4.2), of the Aircraft Status Message shall be mapped bit for bit into the least significant nibble of the first report byte. "OM_2," bits 33 - 36 (see Figure 2-10 and paragraph 2.2.3.2.7.3.4.3), of the Aircraft Status Message shall be mapped bit for bit into the most significant nibble of the second report byte. "OM_1," bits 37 - 40 (see Figure 2-10 and paragraph 2.2.3.2.7.3.4.4), of the Aircraft Status Message shall be mapped bit for bit into the least significant nibble of the second report byte~~.

b. When valid "Operational Mode" data is not available, the Flight Mode Specific data sent to the user application shall be set to ALL ZEROs.

**2.2.8.2.12 SV Quality – NACp**

The ADS-B Report Assembly Function shall extract the NACp data from the Operational Status Message (paragraph 2.2.3.2.7.3.7) and from the Target State and Status Information Message (paragraph 2.2.3.2.7.1.3.11) and map the NACp value bit for bit from the received message to the Mode Status Report in the binary format defined in Table 2.2.8.2.

**2.2.8.2.13 SV Quality – NACv**

The ADS-B Report Assembly Function shall extract the NACv data from the Airborne Velocity Message (paragraph 2.2.3.2.6) and map the NACv value bit for bit from the received message to the Mode Status Report in the binary format defined in Table 2.2.8.2.

**2.2.8.2.14 SV Quality – SIL**

The ADS-B Report Assembly Function shall extract the SIL data from the Operational Status Message (paragraph 2.2.3.2.7.3.9) and from the Target State and Status Information Message (paragraph 2.2.3.2.7.1.3.13) and map the SIL value bit for bit from the received message to the Mode Status Report in the binary format defined in Table 2.2.8.2.

#### 2.2.8.2.15 SV Quality – BAQ Reserved

A one-byte field is reserved for the future reporting of Barometric Altitude Quality.

#### 2.2.8.2.16 SV Quality – $NIC_{BARO}$

The ADS-B Report Assembly Function shall extract the $NIC_{BARO}$ data from the Operational Status Message (paragraph 2.2.3.2.7.3.**10**) and from the Target State and Status Information Message (paragraph 2.2.3.2.7.1.3.12) and map the value of the $NIC_{BARO}$ bit from the received message to the Mode Status Report in the binary format defined in Table 2.2.8.2. The $NIC_{BARO}$ field in the Mode Status report uses the least significant bit of a one-byte field as a one-bit flag that indicates whether or not the barometric pressure altitude provided in the State Vector Report has been cross-checked against another source of pressure altitude.

#### 2.2.8.2.17 True/Magnetic Heading

The ADS-B Report Assembly Function shall extract the Track/Heading and the Horizontal Reference Direction (paragraph 2.2.3.2.7.3.12) flag bits from the Operational Status Message (paragraph 2.2.3.2.7.3) and set the True/Magnetic Heading field in the Mode Status Report in the binary format defined in Table 2.2.8.2. This item within the Mode Status Report is used to indicate the nature of the horizontal direction information being reported in the State Vector Reports and Target State Reports. This applies to both the aircraft reported horizontal direction (in the State Vector Report) as well as the target and/or selected horizontal direction (in the Target State Report). The encoding of bits 6 and 7 of the report True/Magnetic Heading field shall be as defined in Table 2.2.8.2.17. Bit 6 of the True/Magnetic Heading field indicates when Ground Track is being reported (i.e. set to zero) or when Heading is being reported (i.e., set to one). Bit 7 of the True/Magnetic Heading field indicates when Heading based on True North (i.e. set to zero) or when heading based on Magnetic North (i.e. set to one) is being reported.~~The ADS-B Report Assembly Function shall extract the Heading Reference Direction (paragraph 2.2.3.2.7.3.12) data from the Operational Status Message (paragraph 2.2.3.2.7.3) and set the True/Magnetic Heading Flag in the Mode Status Report in the binary format defined in Table 2.2.8.2. The True/Magnetic Heading Flag uses the least significant bit of a one-byte field in the Mode Status report. This flag bit shall be ZERO to indicate that heading is reported referenced to true north, or ONE to indicate that heading is reported referenced to magnetic north.~~

**Table 2.2.8.2.17: True/Magnetic Heading Coding**

| Encoding | | Meaning |
|---|---|---|
| bit 6 | bit 7 | |
| 0 | 0 | Ground track being reported |
| 0 | 1 | Not Valid |
| 1 | 0 | Heading relative to true north being reported |
| 1 | 1 | Heading relative to magnetic north being reported |

***Note:*** *Bits 0 through 5 of the True/Magnetic Heading field are always set to zero (0)*

#### 2.2.8.2.18 Vertical Rate Type

The ADS-B Report Assembly Function shall extract the Vertical Rate Source (paragraph 2.2.3.2.6.1.10) data from the Airborne Velocity Message (paragraph 2.2.3.2.6) and set the

Vertical Rate Type in the Mode Status Report in the binary format defined in Table 2.2.8.2. The Vertical Rate Type field uses the least significant bit of a one-byte field in the Mode Status report. This flag bit shall be set to ZERO to indicate that the vertical rate field in the State Vector report holds the rate of change of barometric pressure altitude, or ONE to indicate that the vertical rate field holds the rate of change of geometric altitude.

~~**2.2.8.2.11 Paired Address**~~

~~a. "Paired Address," bits 9 – 32 (see Figure 2-9 and paragraph 2.2.3.2.7.2.3), of the Aircraft Operational Coordination message (paragraph 2.2.3.2.7.2) shall be mapped bit for bit into the three bytes provided in the Mode Status Report as shown in Table 2-70.~~

~~b. When valid "Paired Address" data is not available, the Paired Address data sent to the user application shall be set to ALL ZEROs.~~

~~**2.2.8.2.12 Runway Threshold Speed**~~

~~a. "Runway Threshold Speed," bits 33 – 37 (see Figure 2-9 and paragraph 2.2.3.2.7.2.4), of the Aircraft Operational Coordination message (paragraph 2.2.3.2.7.2) shall be mapped bit for bit into the byte provided in the Mode Status Report as shown in Table 2-70.~~

~~b. When valid "Runway Threshold Speed" data is not available, the Runway Threshold Speed data sent to the user application shall be set to ALL ZEROs.~~

~~Otherwise, the Runway Threshold Validity Flag bit, i.e., bit #5 of byte #3 of the Mode Status Report, shall be set to "1," unless modified by other conditions~~

~~**2.2.8.2.13 Roll Angle**~~

~~a. "Roll Angle," bits 38 – 43 (see Figure 2-9 and paragraphs 2.2.3.2.7.2.5 and 2.2.3.2.7.2.6), of the Aircraft Operational Coordination message (paragraph 2.2.3.2.7.2) shall be mapped bit for bit into the byte provided in the Mode Status Report as shown in Table 2-70.~~

~~b. When valid "Roll Angle" data is not available, the Roll Angle data sent to the user application shall be set to ALL ZEROs, and the Roll Angle Validity Flag bit, i.e., bit #5 of byte #3 of the Mode Status Report, shall be set to "0."~~

~~Otherwise, the Roll Angle Validity Flag bit, i.e., bit #5 of byte #3 of the Mode Status Report, shall be set to "1," unless modified by other conditions.~~

~~**2.2.8.2.14 Discrete Data**~~

~~a. "Go Around," bits 44 – 45 (see Figure 2-9 and paragraph 2.2.3.2.7.2.7), of the Aircraft Operational Coordination message (paragraph 2.2.3.2.7.2) shall be mapped bit for bit into bit 3 and bit 2 of the least significant nibble of the byte provided in the Mode Status Report as shown in Table 2-70.~~

~~b. When valid "Go Around" data is not available, the Go Around data sent to the user application shall be set to ALL ZEROs.~~

~~c. "Engine Out," bits 46 – 47 (see Figure 2-9 and paragraph 2.2.3.2.7.2.8), of the Aircraft Operational Coordination message (paragraph 2.2.3.2.7.2) shall be mapped~~

bit for bit into the bit 1 and bit 0 of the least significant nibble of the byte provided in the Mode Status Report as shown in Table 2-70.

d. When valid "Engine Out" data is not available, the Engine Out data sent to the user application shall be set to ALL ZEROs.

#### 2.2.8.2.15 Current Trajectory Point / Leg Type

a. "Trajectory Point / Leg Type," bits 7 – 10 (see Figure 2-8 and paragraphs 2.2.3.2.7.1.3) pertaining to the current Trajectory Change Point Data of the Aircraft Trajectory Intent message (paragraph 2.2.3.2.7.1) shall be mapped bit for bit into the byte provided in the Mode Status Report as shown in Table 2-70.

b. When valid "Trajectory Point / Leg Type" data is not available for the current Trajectory Change Point, the "Trajectory Point / Leg Type" data sent to the user application shall be set to ALL ZEROs.

#### 2.2.8.2.16 Report Time of Applicability

a. Each time that an individual Mode Status Report is updated, the Report Assembly Function shall update the Report Time of Applicability data in the Mode Status Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. Report Time of Applicability data shall be provided in the Mode Status report in binary format as defined in Table 2-70.

# Attachment A3

## Proposed changes to DO-260A Section 2.2.8.3 for the format of On-Condition Reports

Changes from current DO-260 text shown as red-lines (except on tables) FOR ONLY PARAGRAPHS 2.2.8.3 AND 2.2.8.3.1. The subsequent material fully replaces the existing DO-260 material to the end of the existing section 2.2.8.3.7

### 2.2.8.3 ADS-B ~~TCP + 1~~ On-Condition Report Characteristics

ADS-B On-Condition Reports include:

- Target State Report

- Air Referenced Velocity Report

***Note:*** *It is anticipated Trajectory Change Reports will be defined by a future edition of these MOPS as an additional type of On-Condition Report*

#### 2.2.8.3.1 ADS-B Target State Report

Table ~~2-73~~2.2.8.3.1 and the subsequent subparagraphs identify the data structure for all ADS-B ~~TCP + 1~~Target State Reports.

The intent of Table ~~2-73~~2.2.8.3.1 is to illustrate the structure of all Items required to be reported in an ADS-B ~~TCP + 1~~Target Sate Report. The exact structure of the data indicated in columns 10 and 11 is provided as a guide line or one possible method of satisfying the report structure. Implementers may choose to organize the data in another format; however, delivery to a user interface or application of all Items in Table 2.2.8.3.1 ~~2-73~~ shall be consistent with the range, resolution, and units indicated in column 7, 8, and 9 of Table 2.2.8.3.1 ~~2-73~~ respectively. Those requirements in subparagraphs 2.2.8.3.1.x to 2.2.8.3.1.y~~7~~ below that relate to specific data structure details (byte numbers, and bit numbers within the bytes) shall only apply to equipment that uses the sample data structure shown in columns 10-11 of Table 2.2.8.3.1~~2-73~~.

***Note:*** *Table 2.2.8.3.1 ~~2-73~~ is structured such that column 1, 2, and 6 through 11, pertain to the ~~On - - Condition~~Target State Report elements and how such elements should be structured into the report. Columns 3 through 5 provide information on where the appropriate data can be located in the ADS-B Messages for each of the Report elements.*

**Table 2.2.8.3.12 ~~73~~: ADS-B ~~TCP + 1~~ Target State Data Elements - Source Data Mapping To Report Structure <<Many Changes>>**

| | REPORT STRUCTURE | | MESSAGE STRUCTURE RELEVANT | | | REPORT STRUCTURE RELEVANT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Column #** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
| **Item #** | **Parameter / Contents** | **Notes** | **Received Message Sources** | **"ME" Field Bits** | **Message Field Bits** | **# of Bits** | **Range** | **Resolution** | **Units** | **Data Structure** | **Data Byte #** |
| 0a,0b | Report Type and Structure Identification | 3 | Trajectory Intent & System Status - "DF" | N/A | 1 - 5 | 16 | N/A | N/A | discrete | MddL Mddd ddddddL | 0 - 1 |
| 1 | Participant Address | | Trajectory Intent & System Status - "AA" | N/A | 9 - 32 | 24 | N/A | N/A | discrete | Mddddddd ddddddd dddddddL | 2 - 4 |
| 2 | Address Qualifier | | N/A | | | 8 | N/A | N/A | discrete | 00000MdL | 5 |
| 3 | Report Time of Applicability | | Trajectory Intent & System Status | N/A | N/A | 16 | 511.9921875 | 0.0078125 (1/128) | seconds | Mddddddd ddddddL | 6 - 7 |
| 4a | Horizontal Intent: Horizontal Data Available & Horizontal Target Source Indicator | | Trajectory Intent & System Status – "Horizontal Data Available/Source Indicator" | 26 - 27 | 58 - 59 | 8 | N/A | N/A | discrete | 000000ML | 8 |
| 4b | Horizontal Intent: Target Heading or Track Angle | | Trajectory Intent & System Status – "Target Heading/Track Angle" | 28 - 36 | 60 - 68 | 16 | 0 - 359 | 1 | degree | 0000000M ddddddL | 9- 10 |
| 4c | Horizontal Intent: Target Heading/Track Indicator | | Trajectory Intent & System Status – "Target Heading/Track Indicator" | 37 | 69 | 8 | N/A | N/A | discrete | 0000000L | 11 |
| 4d | Horizontal Intent: Reserved for Heading/Track Capability | | N/A | | | 8 | N/A | N/A | discrete | 0000000L | 12 |
| 4e | Horizontal Intent: Horizontal Mode Indicator | | Trajectory Intent & System Status – "Horizontal Mode Indicator" | 38 - 39 | 70 - 71 | 8 | N/A | N/A | discrete | 000000ML | 13 |
| 4f | Horizontal Intent: Reserved for Horizontal Conformance | | N/A | | | 8 | N/A | N/A | discrete | 0000000L | 14 |

**Table 2.2.8.3.1 (Continued)~~2-73~~: ADS-B ~~TCP + 1~~ Target State Data Elements - Source Data Mapping To Report Structure**

| | REPORT STRUCTURE | | MESSAGE STRUCTURE RELEVANT | | | REPORT STRUCTURE RELEVANT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Column #** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
| **Item #** | **Parameter / Contents** | **Notes** | **Received Message Sources** | **"ME" Field Bits** | **Message Field Bits** | **# of Bits** | **Range** | **Resolution** | **Units** | **Data Structure** | **Data Byte #** |
| 5a | Vertical Intent: Vertical Data Available & Vertical Target Source Indicator | | Trajectory Intent & System Status – "Vertical Data Available/Source Indicator | 8 - 9 | 40 - 41 | 8 | N/A | N/A | discrete | 000000ML | 15 |
| 5b | Vertical Intent: Target Altitude | | Trajectory Intent & System Status – "Target Altitude" | 16 - 25 | 48 - 57 | 16 | -1000 to +100,000 | 100 | feet | 00000SMd ddddddddL | 16 - 17 |
| 5c | Vertical Intent: Target Altitude Type | | Trajectory Intent & System Status – "Target Altitude Type" | 10 | 42 | 8 | N/A | N/A | discrete | 0000000L | 18 |
| 5d | Vertical Intent: Target Altitude Capability | | Trajectory Intent & System Status – "Target Altitude Capability" | 12 - 13 | 44 - 45 | 8 | N/A | N/A | discrete | 000000ML | 19 |
| 5e | Vertical Intent: Vertical Mode Indicator | | Trajectory Intent & System Status – "Vertical Mode Indicator" | 14 - 15 | 46 - 47 | 8 | N/A | N/A | discrete | 000000ML | 20 |
| 5f | Vertical Intent: Reserved for Vertical Conformance | | N/A | | | 8 | N/A | N/A | discrete | 0000000L | 21 |
| | | | | | | | | | | **TOTAL BYTES:** | 22 |

***Notes:***

1. *In the "Data Structure" column (i.e., column 10), "S" indicates the "sign-bit," "M" indicates the Most Significant Bit of the data field, "d" indicates data bits in the field, "L" indicates the Least Significant Bit of the data field, "0" indicates the bit is to always be set to a value of zero (0), and "x" indicates "Don't Care" bits in the data field.*
2. *If data is not available to support these fields, then the entire data field shall be set to ALL ZEROs.*
3. *The Report Type Identifier is used to identify the type of ADS-B Report being generated as defined in section 2.2.8.1.1.1..*

**<<<<The remainder of this Appendix is to fully replace the existing material in DO-260 for Sections 2.2.8.3.1.1 through the end of 2.2.8.3. Note that NO Red-Lines from the current DO-260 text are shown>>>>>>**

### 2.2.8.3.1.1 Report Type and Structure Identification

The Report Type requirements were previously provided in subparagraph 2.2.8.1.1.1. The Report Type is provided in the most significant nibble of the first byte of the report. The Report Type format, coding and the maximum number of bytes (i.e., 22 bytes) to be contained in each Target State report are identified in Table 2.2.8.3.1.

The Report Structure field is used to indicate the exact data parameters identified in Table 2.2.8.3.1 that are being provided in the Target State report and is intended to provide a methodology for the Report Assembly Function to structure shorter reports when data for some parameters is not available. In order to provide the capability to provide shorter Target State reports the following basic conventions shall be adhered to:

a. Any given data parameter to be used in the report shall use the designated number of bytes and format as designated in Table 2.2.8.3.1.

b. Parameters that are designated in Table 2.2.8.3.1 are restricted to byte boundaries.

c. Whenever a data parameter identified in Table 2.2.8.3.1 is not provided in the report, then it is permissible to concatenate the next parameter to be included into the report immediately following the inclusion of the previous reported parameter.

d. Each parameter of the Target State report identified in Table 2.2.8.3.1 must be properly declared in the Report Structure field as detailed in the following paragraphs and Table 2.2.8.3.1.1.

***Note:*** *Implementation of the methodology just provided is realizable and controllable due to the fact that the exact length of each report parameter is defined in Table 2.2.8.3.1 and the Report Structure field identifies exactly which parameters are included in the report. Therefore, the report user can easily re-construct the length and general format of the report.*

The Report Structure Identification parameter is a 12-bit field and shall be provided in the least significant nibble (i.e., bits 3 - 0) of the first byte (i.e., byte "0") and continuing into byte 1 of the Report. The Report Structure Identification parameter format is defined in Table 2.2.8.3.1.1 where each bit is associated with a particular subsequent data parameter of the Target State Report. If the bit is set to "1," then the data parameter is considered to be available and shall be transmitted in the report. Otherwise, the data parameter is considered to not be unavailable and shall not be transmitted in the report. Note that Table 2.2.8.3.1.1 does not address the Report Type and Structure Identification parameter, the Participant Address parameter, the Address Qualifier parameter, and the Report Time of Applicability parameter **since it is mandatory that these four parameters shall be included in each Target State Report**. **Also certain of the other Target State data parameters are required to be reported, as**

**defined in paragraph 2.2.9, even though bits have been allocated in the report structure field as shown in Table 2.2.8.3.1.1.**

**Table 2.2.8.3.1.1: ADS-B Target State Report - Structure Parameter Coding**

| Byte # | Bit # | Target State Data Parameter to be Reported | Number of Bytes |
|---|---|---|---|
| 0 | 3 | Horizontal Intent/Horizontal Data Available & Horizontal Target Source Indicator | 1 |
| | 2 | Horizontal Intent/Target Heading or Track Angle | 2 |
| | 1 | Horizontal Intent/Target Heading/Track Indicator | 1 |
| | 0 | Horizontal Intent/Reserved for Heading/Track Capability | 1 |
| 1 | 7 | Horizontal Intent/Horizontal Mode Indicator | 1 |
| | 6 | Horizontal Intent/Reserved for Horizontal Conformance | 1 |
| | 5 | Vertical Intent/Vertical Data Available & Vertical Target Source Indicator | 1 |
| | 4 | Vertical Intent/Target Altitude | 2 |
| | 3 | Vertical Intent/Target Altitude Type | 1 |
| | 2 | Vertical Intent/Target Altitude Capability | 1 |
| | 1 | Vertical Intent/Vertical Mode Indicator | 1 |
| | 0 | Vertical Intent/Reserved for Vertical Conformance | 1 |

### 2.2.8.3.1.2 Participant Address

The participant address shall be encoded as defined in 2.2.3.2.1.1.1.

### 2.2.8.3.1.3 Address Qualifier

The address qualifier is used to indicate the type of participant address (2.2.8.3.1.2) being reported. The 3 least significant bits of the one byte field are used to convey the Address Qualifier information. The Address Qualifier subfield shall be coded as shown in Table 2.2.8.1.3.

#### 2.2.8.3.1.4 Report Time of Applicability

a. Each time that an individual Target State Report is updated, the Report Assembly Function shall update the Time of Applicability data in the Target State Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. Report Time of Applicability data shall be provided in the Target State report in binary format as defined in Table 2.2.8.3.1.

#### 2.2.8.3.1.5 Horizontal Intent: Horizontal Data Available and Horizontal Target Source Indicator

The Data Available and Source Indicator parameter shall use the two least significant bits within the byte to encode the parameter values defined in paragraph 2.2.3.2.7.1.3.7.

#### 2.2.8.3.1.6 Horizontal Intent: Target Heading or Track Angle

The Target Heading or Track Angle parameter shall use the least significant bit within the first byte and the 8 bits of the second byte to encode the parameter values defined in paragraph 2.2.3.2.7.1.3.8.

#### 2.2.8.3.1.7 Horizontal Intent: Target Heading/Track Indicator

The Target Heading or Track Indicator parameter shall use the least significant bit within the byte to encode the parameter values defined in paragraph 2.2.3.2.7.1.3.9.

#### 2.2.8.3.1.8 Horizontal Intent: Horizontal Mode Indicator

The Horizontal Mode Indicator parameter shall use the two least significant bits within the byte to encode the parameter values defined in paragraph 2.2.3.2.7.1.3.10.

#### 2.2.8.3.1.9 Horizontal Intent: Reserved for Horizontal Conformance Parameter

A one byte length parameter is reserved for possible future use. The least significant bit within the byte would be used to convey the horizontal conformance information.

#### 2.2.8.3.1.10 Vertical Intent: Vertical Data Available and Vertical Target Source Indicator

The Vertical Data Available and Vertical Target Source Indicator parameter shall use the two least significant bits within the byte to encode the parameter values defined in paragraph 2.2.3.2.7.1.3.1.

#### 2.2.8.3.1.11 Vertical Intent: Target Altitude

The Target Altitude parameter shall use the three least significant bits within the first byte and the 8 bits of the second byte to encode the parameter values defined in paragraph 2.2.3.2.7.1.3.6.

#### 2.2.8.3.1.12 Vertical Intent: Target Altitude Type

The Target Altitude Type parameter shall use the least significant bit within the byte to encode the parameter values defined in paragraph 2.2.3.2.7.1.3.2.

#### 2.2.8.3.1.13 Vertical Intent: Target Altitude Capability

The Target Altitude Capability parameter shall use the two least significant bits within the byte to encode the parameter values defined in paragraph 2.2.3.2.7.1.3.4.

#### 2.2.8.3.1.14 Vertical Intent: Vertical Mode Indicator

The Vertical Mode Indicator parameter shall use the two least significant bits within the byte to encode the parameter values defined in paragraph 2.2.3.2.7.1.3.5.

#### 2.2.8.3.1.15 Vertical Intent: Reserved for Vertical Conformance

A one byte length parameter is reserved for possible future use. The least significant bit within the byte would be used to convey the vertical conformance information.

### 2.2.8.3.2 Air Referenced Velocity Report

The Air Referenced Velocity (ARV) Report is an On-Condition Report type that shall be provided when air-referenced velocity information is received from a target aircraft. Table 2.2.8.3.2 and the subsequent subparagraphs describe the data structure for all ARV Reports.

**Table 2.2.8.3.2: ADS-B Air Referenced Velocity Data Elements - Source Data Mapping To Report Structure**

| | REPORT STRUCTURE | | MESSAGE STRUCTURE RELEVANT | | | REPORT STRUCTURE RELEVANT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Column #** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
| **Item #** | **Parameter / Contents** | **Notes** | **Received Message Sources** | **"ME" Field Bits** | **Message Field Bits** | **# of Bits** | **Range** | **Resolution** | **Units** | **Data Structure** | **Data Byte #** |
| 0a,0b | Report Type and Structure Identification | | Airborne Velocity Subtype 3 or 4 – "DF" | N/A | 1 - 5 | 16 | N/A | N/A | discrete | MddL 0000 0000MddL | 0 - 1 |
| 0c | Validity Flags | | N/A | N/A | N/A | 8 | N/A | N/A | discrete | ddddddddd | 2 |
| 1 | Participant Address | | Airborne Velocity Subtype 3 or 4 – "AA" | N/A | 9 - 32 | 24 | N/A | N/A | discrete | Mddddddd ddddddddddddddL | 3 - 5 |
| 2 | Address Qualifier | | N/A Reserved for future use | | | 8 | N/A | N/A | discrete | 00000MdL | 6 |
| 3 | Report Time of Applicability | | Airborne Velocity Subtype 3 or 4– | N/A | N/A | 16 | 511.9921875 | 0.0078125 (1/128) | seconds | Mddddddd ddddddddL | 7 - 8 |
| 4a | Airspeed | 4 | Airborne Velocity - Subtype 3 – "Airspeed"<br>- OR -<br>Subtype 4 - "Airspeed" | 26 – 35<br><br>26 - 35 | 58 – 67<br><br>58 - 67 | 16<br><br>16 | 0 – 1000<br><br>1001 - 4000 | 1<br><br>4 | knots<br><br>knots | 0000Mddd ddddddddL<br><br>0000Mddd dddddL00 | 9 - 10 |
| 4b | Airspeed Type | | Airborne Velocity Subtype 3 – "Airspeed Type" | 25 | 57 | 8 | N/A | N/A1 | discrete | 000000ML | 11 |
| 5 | Heading While Airborne | | Airborne Velocity Subtype 3 – "Magnetic Heading" | 15 - 24 | 47 - 56 | 16 | 0 – 359.6484375 | 0.3515625 (360/1024) | degrees | 000000Md ddddddddL | 12 - 13 |
| | | | | | | | | | | **TOTAL BYTES** | **14** |

***Notes:***

1. *In the "Data Structure" column (i.e., column 10), "S" indicates the "sign-bit," "M" indicates the Most Significant Bit of the data field, "d" indicates data bits in the field, "L" indicates the Least Significant Bit of the data field, "0" indicates the bit is to always be set to a value of zero (0), and "x" indicates "Don't Care" bits in the data field.*
2. *If data is not available to support these fields, then the entire data field shall be set to ALL ZEROs.*
3. *The Report Type Identifier is used to identify the type of ADS-B Report being generated as defined in section 2.2.5.2.2.4.2.1.*
4. *Airspeed is coded with a fixed data structure using the 12 least significant bits of the 2-byte field. For the case where the source message for the air-referenced velocity information is of the type Aircraft Velocity – Subtype 3 (paragraph 2.2.3.2.6.3), a reported resolution of 1 knot is used for airspeed. This generally applies for aircraft airspeeds of 0 to 1000 knots, although under certain conditions, as described in 2.2.3.2.6.3, an airspeed of up to 1022 knots may be reported with 1 knot resolution. For airspeeds greater than 1000 knots and where the source message for the air-referenced velocity information is of the type Aircraft Velocity – Subtype 4 (paragraph 2.2.3.2.6.4), the two least significant bits are set to a value of zero (0) thus providing an actual reported resolution of 4 knots.*

### 2.2.8.3.2.1 Report Type and Structure Identification and Validity Flags

#### 2.2.8.3.2.1.1 Report Type and Structure Identification

The Report Type requirements were previously provided in subparagraph 2.2.8.1.1.1. The Report Type is provided in the most significant nibble of the first byte of the report. The Report Type format, coding and the maximum number of bytes (i.e., 13 bytes) to be contained in each Air Referenced Velocity report are identified in Table 2.2.8.3.2.

The Report Structure field is used to indicate the exact data parameters identified in Table 2.2.8.3.2 that are being provided in the Air Referenced Velocity report and is intended to provide a methodology for the Report Assembly Function to structure shorter reports when data for some parameters is not available. In order to provide the capability to provide shorter Air Referenced Velocity reports the following basic conventions shall be adhered to:

a. Any given data parameter to be used in the report shall use the designated number of bytes and format as designated in Table 2.2.8.3.2.

b. Parameters that are designated in Table 2.2.8.3.2 are restricted to byte boundaries.

c. Whenever a data parameter identified in Table 2.2.8.3.2 is not provided in the report, then it is permissible to concatenate the next parameter to be included into the report immediately following the inclusion of the previous reported parameter.

d. Each parameter of the Air Referenced Velocity report identified in Table 2.2.8.3.2 must be properly declared in the Report Structure field as detailed in the following paragraphs and Table 2.2.8.3.2.1.

***Note:*** *Implementation of the methodology just provided is realizable and controllable due to the fact that the exact length of each report parameter is defined in Table 2.2.8.3.2 and the Report Structure field identifies exactly which parameters are included in the report. Therefore, the report user can easily re-construct the length and general format of the report.*

The Report Structure Identification parameter is a 12-bit field and shall be encoded in the least significant nibble (i.e., bits 3 - 0) of the first byte (i.e., byte "0") and continuing into byte 1 of the Report. The Report Structure Identification parameter format is defined in Table 2.2.8.3.1.1 where each bit is associated with a particular subsequent data parameter of the Air Referenced Velocity Report. If the bit is set to "1," then the data parameter is considered to be available and shall be transmitted in the report. Otherwise, the data parameter is considered to not be unavailable and shall not be transmitted in the report. Note that Table 2.2.8.3.2.1.1 does not address the Report Type and Structure Identification parameter, the Participant Address parameter, the Address Qualifier parameter, and the Report Time of Applicability parameter **since it is mandatory that these four parameters shall be included in each Target State Report**. **Also certain of the other Air Referenced Velocity data parameters are required to be reported, as defined in paragraph 2.2.9, even though bits have been allocated in the report structure field as shown in Table 2.2.8.3.2.1.1.**

**Table 2.2.8.3.2.1.1: ADS-B Air Referenced Velocity Report - Structure Parameter Coding**

| Byte # | Bit # | Target State Data Parameter to be Reported | Number of Bytes |
|---|---|---|---|
| | 3 - 7 | Reserved for future use | N/A |
| | 2 | Airspeed | 2 |
| 0 | 1 | Airspeed Type and Validity | 1 |
| | 0 | Heading While Airborne | 2 |

### 2.2.8.3.2.1.2 Validity Flags

The only Validity Flag defined by these MOPS uses the two least significant bits of the one-byte field as shown in Table 2.2.8.3.2.1.2.

**Table 2.2.8.3.2.1.2: ADS-B Air Referenced Velocity Report – Validity Parameter Coding**

| Bit # | Target State Data Parameter to be Reported |
|---|---|
| 2 - 7 | Reserved for future use |
| 1 | Airspeed Valid |
| 0 | Heading Valid |

The "Heading Valid" flag bit in the ARV report shall be set to ONE if the "Heading While Airborne" field contains valid heading information, or ZERO if that field is known to not contain valid heading information. The reported heading shall be indicated as not valid if the received Aircraft Velocity message (paragraph 2.2.3.2.6.3.8 or 2.2.3.2.6.4.8) includes a "Magnetic Heading Status Bit" (paragraph 2.2.3.2.6.3.6) indicating that "Magnetic Heading Data is NOT Available."

The "Airspeed Valid" flag bit shall be set to ONE if the "Airspeed" field (paragraph 2.2.8.3.2.6) contains valid heading information, or ZERO if that field is known to not contain valid airspeed information. The reported airspeed shall be indicated as "Not Valid" if the received Aircraft Velocity message (para. 2.2.3.2.6.3.8 or 2.2.3.2.6.4.8) includes either a value for the "Airspeed" subfield indicating "No Airspeed Information Available" or includes a value for the "NACv" subfield that is invalid.

### 2.2.8.3.2.2 Participant Address

The participant address shall be encoded as defined in 2.2.3.2.1.1.1.

### 2.2.8.3.2.3 Address Qualifier

The address qualifier is used to indicate the type of participant address (2.2.8.3.2.3) being reported. The 3 least significant bits of the one byte field are used to convey the Address Qualifier information. The Address Qualifier subfield shall be coded as shown in Table 2.2.8.1.3.

### 2.2.8.3.2.4 Report Time of Applicability

a. Each time that an individual Air Referenced Velocity Report is updated, the Report Assembly Function shall update the Time of Applicability data in the Air Referenced

Velocity Report with either the GPS/GNSS UTC Measure Time data (see paragraph 2.2.8.4.3.1) or the Established Receiver Unit Time (see paragraph 2.2.8.4.3.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. Report Time of Applicability data shall be provided in the Air Referenced Velocity report in binary format as defined in Table 2.2.8.3.2.

#### 2.2.8.3.2.5 Airspeed

Airspeed shall be reported over the range of 0 to 4000 knots. The Airspeed parameter is coded with a fixed data structure using the 4 least significant bits of the first byte and the 8 bits of the second byte of the Airspeed field as identified in Table 2.2.8.3.2. For the case where the source message for the air-referenced velocity information is of the type Aircraft Velocity – Subtype 3 (paragraph 2.2.3.2.6.3), a reported resolution of 1 knot is used for airspeed. This generally applies for aircraft airspeeds of 0 to 1000 knots, although under certain conditions, as described in 2.2.3.2.6.3, an airspeed of up to 1022 knots may be reported with 1 knot resolution. For airspeeds greater than 1000 knots and where the source message for the air-referenced velocity information is of the type Aircraft Velocity – Subtype 4 (paragraph 2.2.3.2.6.4), the two least significant bits are set to a value of zero (0) thus providing an actual reported resolution of 4 knots.

#### 2.2.8.3.2.6 Airspeed Type

The Airspeed Type and Validity field in the Air Referenced Velocity report is a 2-bit field that shall be encoded as specified in Table 2.2.8.3.2.6. The type of airspeed being reported shall be obtained from the "Airspeed Type" subfield of the Aircraft Velocity message, Subtype 3 (para. 2.2.3.2.6.3.8) or Subtype 4 (para. 2.2.3.2.6.4.8). The reported airspeed shall be indicated as "Not Valid" if the received Aircraft Velocity message (para. 2.2.3.2.6.3.8 or 2.2.3.2.6.4.8) includes either a value for the "Airspeed" subfield indicating "No Airspeed Information Available" or includes a value for the "NACv" subfield that is invalid. When set to indicate the "Airspeed Field in Not Valid" the corresponding validity flag parameter (paragraph 2.2.8.2.2.1.2) shall also be set to indicate that that the reported airspeed is not valid.

**Table 2.2.8.3.2.6: Airspeed Type Encoding**

| Airspeed Type Value | Meaning |
|---|---|
| 00 | Airspeed Field Not Valid |
| 01 | True Airspeed (TAS) |
| 10 | Indicated Airspeed (IAS) |
| 11 | Reserved for Mach |

#### 2.2.8.3.2.7 Heading While Airborne

An aircraft's heading is reported as the angle measured clockwise from the reference direction (magnetic north) to the direction in which the aircraft's nose is pointing. The heading field in Air Reference Velocity reports shall be encoded using the 2 least significant bits of the first byte and the 8 bits of the second byte of the "Heading While Airborne" field as defined in Table 2.2.8.3.2. The encoding shall be the same as that used in the "Magnetic Heading" subfield of the Airborne Velocity message – Type 3 as defined in paragraph 2.2.3.2.6.3.7.

# Attachment A4

## Proposed changes to DO-260A Sections 2.2.8.4 through 2.2.10 for the ADS-B Report Assembly Function

Changes from current DO-260 text shown as red-lines except on new Tables or Tables that have be extensively revised

### 2.2.8.4 ADS-B Report Assembly Function Data Processing and Formatting

#### 2.2.8.4.1 Receiving Device Position - Latitude

If the Range Monitoring Technique is used for locally unambiguous decoding of tracked emitter position, as specified in section 2.2.8.1.2, then the Receiving Device shall accept own position latitude (WGS-84) as follows:

a. Own position latitude shall be used to enable locally unambiguous decoding of position information encoded in ADS-B Airborne Position Messages (see paragraph 2.2.3.2.3) in accordance with sections A.7.4 through A.7.8.4 of Appendix A.

b. Own position latitude shall be used to enable locally unambiguous decoding of position information encoded in ADS-B Surface Position Messages (see paragraph 2.2.3.2.4) in accordance with section A.7.4 through A.7.8.4 of Appendix A.

***Note:*** *Own position information can provide the information necessary to accomplish unambiguous decoding of Surface Position message data.*

#### 2.2.8.4.2 Receiving Device Position - Longitude

If the Range Monitoring Technique is used for locally unambiguous decoding of tracked emitter position, as specified in section 2.2.8.1.3, then the Receiving Device shall accept own position longitude (WGS-84) as follows:

a. Own position longitude shall be used to enable locally unambiguous decoding of position information encoded in ADS-B Airborne Position Messages (see paragraph 2.2.3.2.3) in accordance with section A.7.4 through A.7.8.4 of Appendix A.

b. Own position longitude shall be used to enable locally unambiguous decoding of position information encoded in ADS-B Surface Position Messages (see paragraph 2.2.3.2.4) in accordance with section A.7.4 through A.7.8.4 of Appendix A.

***Note:*** *Own position information can provide the information necessary to accomplish unambiguous decoding of Surface Position message data.*

#### 2.2.8.4.3 Receiving Installation Time

##### 2.2.8.4.3.1 Precision Installations

Receiving devices intended to generate ADS-B reports based on Surface Position Messages received from type 5 or 6 (see paragraph 2.2.3.2.3.1) equipment or Airborne Position Messages received from type 9 or 10 (see paragraph 2.2.3.2.3.1) equipment shall accept GPS/GNSS UTC Measure Time data via an appropriate interface. Such data shall be used to establish Time of Applicability data required in paragraphs 2.2.8.1.20 through 2.2.8.1.25, 2.2.8.1.27, 2.2.8.2.16 and 2.2.8.3.7.

UTC Measure Time data shall have a minimum range of 300 seconds and a resolution of 0.0078125 (1/128) seconds.

***Note:*** *Time of Applicability information is required in Item #'s 18 through 23, and 25 of Table 2-64, Item #16 of Table 2-70, and Item #7 of Table 2-73. Each of these table entries specify the data to entered in 9 bits of whole number and 7 bits of fractional data. Therefore, the full range can be up to 511.9921875 seconds having the required resolution of 0.0078125 seconds.*

#### 2.2.8.4.3.2 Non-Precision Installations

Receiving devices that are not intended to generate ADS-B reports based on Surface Position Messages received from type 5 or 6 (see paragraph 2.2.3.2.3.1) equipment or Airborne Position Messages received from type 9, 10, 20 or 21 (see paragraph 2.2.3.2.3.1) equipment may choose not to use GPS/GNSS UTC Measure Time data if there is no requirement to do so by the end user of the ADS-B reports. In such cases, where there is no appropriate time reference, the Receiving device shall establish an appropriate internal clock or counter having a maximum clock cycle or count time of 20 milliseconds. The established cycle or clock count shall have a range of 300 seconds and a resolution of 0.0078125 (1/128) seconds in order to maintain commonality with the requirements of paragraph 2.2.8.4.3.1.

***Note:*** *Time of Applicability information is required in Item #'s 18 through 23, and 25 of Table 2-64, Item #16 of Table 2-70, and Item #7 of Table 2-73. Each of these table entries specify the data to entered in 9 bits of whole number and 7 bits of fractional data. Therefore, the full range can be up to 511.9921875 seconds having the required resolution of 0.0078125 seconds.*

### 2.2.9 ADS-B Report Type Requirements

Equipage classes are defined to accommodate tiered capabilities according to increasingly complex operational objectives while preserving basic inter-operability between classes of equipage. Each equipage class is required to receive messages and process the recovered information into specific ADS-B reports according to the applicable capability. The required ADS-B report capabilities for each class of equipage are defined in the following paragraphs.

#### 2.2.9.1 ADS-B Receiver Reporting ~~Content~~ Requirements for Class A Equipage

ADS-B Report Requirements for Class A Equipage are defined in Table ~~2-75~~2.2.9.1(a). For each required report type all data elements, as defined in paragraphs 2.2.8.1 through 2.2.8.3 (inclusive of subparagraphs), shall be included for which valid information is available (i.e., current information that has been received via one or multiple ADS-B messages or is available from an onboard data source). Although the report assembly function is required to support all data elements defined for the report types applicable to that Equipage Class, as per Table 2.2.9.1(a), reports may be generated that convey only a subset of the report elements. This is a consequence of certain data elements only being applicable while airborne and others that are only applicable while on the surface. Also the ADS-B messages may not have been received that included the information necessary to report a valid value for a given report data element. For each of the four types of reports there is a set of mandatory data elements that shall be included. The required mandatory set of data elements is defined in Tables 2.2.9.1(b through e inclusive) for the four report types.

**Table ~~2-75~~2.2.9.1(a): ADS-B Class A Equipment Reporting Requirements ~~Contents~~<<many changes>>**

| Equipage Class | INTERACTIVE AIRCRAFT/VEHICLES OPERATIONAL CAPABILITIES | | | | | | |
|---|---|---|---|---|---|---|---|
| | Aid to Visual Acquisition | Conflict Detection | Conflict Avoidance | Separation Assurance and Sequencing | Flight Path Deconfliction Planning | Simultaneous Approaches | Airport Surface |
| | ADS-B OUTPUT REPORTS REQUIRED (Note 1) | | | | | | |
| **AO** **Basic VFR** Aircraft/ Ground Vehicles | SV | SV MS | Not Applicable | Not Applicable | Not Applicable | Not Applicable | SV MS |
| **A1** **Basic IFR** Aircraft and Ground Vehicles | SV | SV MS | SV MS ARV | Not Applicable | Not Applicable | SV MS ARV | SV MS |
| **A2** **Enhanced IFR** Aircraft Only (Note 2) | SV | SV MS | SV MS TS ARV | SV MS TS ARV | Not Applicable | SV MS ARV | SV MS |
| **A3** **Extended Capability** Aircraft Only (Note 2) | SV | SV MS | SV MS TS ARV | SV MS TS ARV | SV MS TS ARV | SV MS ARV | SV MS |

*Notes:*

1. *The report structure and contents are defined in paragraphs 2.2.8.1 through 2.2.8.3, inclusive of the subparagraphs.*
2. *It is anticipated that future versions of these MOPS will require that Equipage Class A2 and A3 systems will also be capable of generating Trajectory Change Reports.*

~~1. All State Vector (SV) entries require elements 0 through 26 (i.e., Items # 0 - 26) identified in Table 2-64.~~

~~2. Mode Status (MS) elements 0 through 4, 9 and 10 (i.e., Items # 0 - 4, 9 and 10) identified in Table 2-70 are required. This comprises the Partial Mode Status Report.~~

~~3. Mode Status (MS) elements 0 through 16 (i.e., Items # 0 - 16) identified in Table 2-70 are required. This comprises the full Mode status Report.~~

~~4. All TCP + 1 reports should provide elements 0 through 6 (i.e., Items # 0 - 6) identified in Table 2-73.~~

~~5. Not Applicable for Ground Vehicles~~

**Table 2.2.9.1(b): ADS-B State Vector Mandatory Report Elements <<NEW Table>>**

| Report Element # | Report Element Description | Mandatory |
|---|---|---|
| 0a, 0b | Report Type and Structure Identification | Yes |
| 0c | Validity Flags | Yes |
| 1 | Participant Address | Yes |
| 2 | Address Qualifier | Yes |
| 3 | Time of Applicability (Position and Velocity) | Yes |
| 4 | *Latitude* (WGS-84) | Note 3 |
| 5 | *Longitude* (WGS-84) | Note 3 |
| 6 | *Altitude, Geometric* (WGS-84) | No |
| 7 | North / South Velocity | Note 3 |
| 8 | East / West Velocity | Note 3 |
| 9 | Ground Speed while on the Surface | Note 1 |
| 10 | Heading while on the Surface | Note 1 |
| 11 | Altitude, Barometric (Pressure Altitude) | Note 2 |
| 12 | Vertical Rate, Geometric/Barometric (WGS-84) | No |
| 13 | Navigation Integrity Category (NIC) | Yes |
| 14 | Estimated Latitude (WGS-84) | Yes |
| 15 | Estimated Longitude (WGS-84) | Yes |
| 16 | Estimated North/South Velocity | Note 2 |
| 17 | Estimated East/West Velocity | Note 2 |
| 18 | Surveillance Status/Discretes | No |
| 19 | Report Mode | No |

*Notes:*

1. *Mandatory when the report is for a target aircraft/vehicle that is on the airport surface*
2. *Mandatory when the report is for a target aircraft that is airborne*
3. *It is mandatory that each new state vector report for an airborne target include report elements 4 and 5 and/or report elements 7 and 8 since a new state vector report should only be generated based on the reception of an airborne position and/or an airborne velocity message.*

**Table 2.2.9.1(c): ADS-B Mode Status Mandatory Report Elements <<NEW Table>**

| Report Element Number | Report Element Description | Mandatory when A/V is on Surface | Mandatory when Aircraft is Airborne |
|---|---|---|---|
| 0a, 0b | Report Type and Structure | Yes | Yes |
| 0c | Validity Flags | Yes | Yes |
| 1 | Participant Address | Yes | Yes |
| 2 | Address Qualifier | Yes | Yes |
| 3 | Time of Applicability | Yes | Yes |
| 4 | ADS-B Version | Yes | Yes |
| 5a | Call Sign | Note 1 | Note 1 |
| 5b | Emitter Category | Note 1 | Note 1 |
| 5c | A/V Length and Width Codes | Note 2 | No |
| 6 | Emergency/Priority Status | Note 2 | Note 2 |
| 7 | Capability Codes | Note 3 | Note 3 |
| 8 | Operational Mode | Note 3 | Note 3 |
| 9a | SV Quality - NACp | Note 3 | Note 3 |
| 9b | SV Quality - NACv | Note 4 | Note 4 |
| 9c | SV Quality – SIL | Note 3 | Note 3 |
| 9d | SV Quality – BAQ (reserved) | No | No |
| 9e | SV Quality – $NIC_{BARO}$ | No | Note 3 |
| 10a | True/Magnetic Heading | Note 2 | Note 2 |
| 10b | Vertical Rate Type | Note 4 | Note 4 |
| 11 | Other (Reserved) | No | No |

*Notes:*

1. *Mandatory if an Aircraft Identification message has been received within the past 200 seconds*
2. *Mandatory if an Operational Status message has been received within the past 100 seconds*
3. *Mandatory if an Operational Status and/or a Trajectory Intent and System Status message has been received within the past 100 seconds*
4. *Mandatory if an Airborne Velocity message has been received within the past 100 seconds*

**Table 2.2.9.1(d): ADS-B Target State Mandatory Report Elements <<NEW Table>>**

| Report Element Number | Report Element Description | Mandatory |
|---|---|---|
| 0a,0b | Report Type and Structure Identification | Yes |
| 1 | Participant Address | Yes |
| 2 | Address Qualifier | Yes |
| 3 | Report Time of Applicability | Yes |
| 4a | Horizontal Intent: Horizontal Data Available & Horizontal Target Source Indicator | Yes |
| 4b | Horizontal Intent: Target Heading or Track Angle | Note 1 |
| 4c | Horizontal Intent: Target Heading/Track Indicator | Note 1 |
| 4d | Horizontal Intent: Reserved for Heading/Track Capability | Note 1 |
| 4e | Horizontal Intent: Horizontal Mode Indicator | Note 1 |
| 4f | Horizontal Intent: Reserved for Horizontal Conformance | No |
| 5a | Vertical Intent: Vertical Data Available & Vertical Target Source Indicator | Yes |
| 5b | Vertical Intent: Target Altitude | Note 2 |
| 5c | Vertical Intent: Target Altitude Type | Note 2 |
| 5d | Vertical Intent: Target Altitude Capability | Note 2 |
| 5e | Vertical Intent: Vertical Mode Indicator | Note 2 |
| 5f | Vertical Intent: Reserved for Vertical Conformance | No |

*Notes:* 1. *Mandatory if Report Element 4a indicates data is available*

2. *Mandatory if Report Element 5a indicates data is available*

**Table 2.2.9.1(e): ADS-B Air Referenced Velocity Mandatory Report Elements <<NEW Table>>**

| Report Element Number | Report Element Description | Mandatory |
|---|---|---|
| 0a,0b | Report Type and Structure Identification | Yes |
| 0c | Validity Flags | Yes |
| 1 | Participant Address | Yes |
| 2 | Address Qualifier | Yes |
| 3 | Report Time of Applicability | Yes |
| 4a | Airspeed | Yes |
| 4b | Airspeed Type and Validity | Yes |
| 5 | Heading While Airborne | Yes |

**2.2.9.1.1 ADS-B State Vector Reports for Class A Equipage**

Equipage Class A0, A1, A2, and A3 equipment shall provide State Vector Reports as indicated in ~~Table~~paragraph ~~2-75~~2.2.9.1. ~~as amplified by Note 1 of Table 2-75~~ An example report format is shown in Table 2.2.8.1.

**2.2.9.1.2 ADS-B Mode Status Reports for Class A Equipage**

Equipage Class A0, A1, A2 and A3 equipment shall provide Mode Status Reports as indicated in paragraph 2.2.9.1. An example report format is shown in Table 2.2.8.2.

~~a. Equipage Class A0 equipment are not required to generate or deliver Mode Status or Partial Mode Status Reports.~~

~~b. As a minimum, equipage Class A1 equipment shall provide Partial Mode Status Reports as indicated in Table 2-75 as amplified by Note 2 of Table 2-75.~~

~~c. As a minimum, equipage Class A2 and A3 equipment shall provide Mode Status Reports as indicated in Table 2-75 as amplified by Note 3 of Table 2-75.~~

**2.2.9.1.3 ADS-B ~~TCP + 1~~Target State Reports for Class A Equipage**

a. Equipage Class A0 ~~,~~and A1 ~~and A2~~ equipment are not required to provide ~~TCP + 1~~Target State Reports.

b. ~~As a minimum, e~~Equipage Class A2 and A3 equipment shall provide ~~TCP + 1~~Target State Reports as indicated in ~~Table~~paragraph ~~2-75~~2.2.9.1. ~~as amplified by Note 4 of Table 2-75~~ An example report format is shown in Table 2.2.8.3.1.

**2.2.9.1.4 ADS-B Air Referenced Velocity Reports for Class A Equipage**

a. Equipage Class A0 equipment is not required to provide Air Referenced Reports.

b. Equipage Class A1, A2 and A3 equipment shall generate an Air Referenced Velocity Report as indicated in paragraph 2.2.9.1. An example report format is shown in Table 2.2.8.3.2.

**2.2.9.2 ADS-B Receiver Report Content Requirements for Class B Equipage**

There are no report requirements for Class B, i.e., Broadcast Only, Equipage.

## 2.2.10 ADS-B Receiver Report Assembly and Delivery

### 2.2.10.1 Fundamental Principals of Report Assembly and Delivery

#### 2.2.10.1.1 General Data Flow

Figure 2-15 illustrates the general data flow of ADS-B Messages and Reports for the purposes of establishing the baseline requirements for Report Assembly and Delivery.

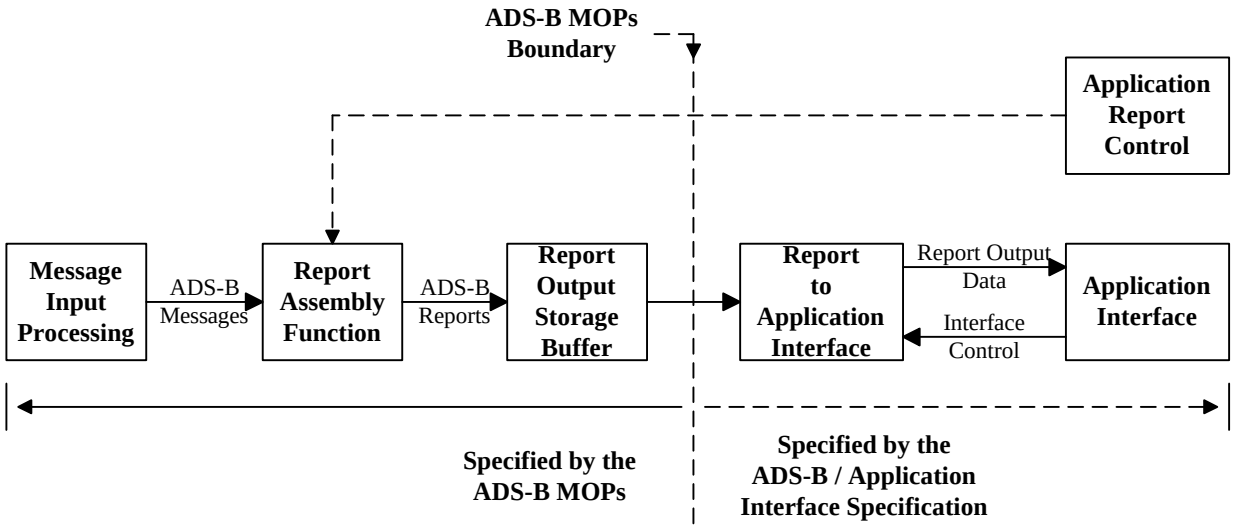


**Figure ~~2-15~~2.2.10.1.1(a): ADS-B Message And Report General Data Flow**

a. **Message Input Processing** -- The Message Input Processing is performed by the ADS-B Message Reception Function previously depicted in Figure ~~2-12~~2.2.6 and described in section 2.2.6.1. The primary function of the Message Input Processing function is to deliver all received ADS-B messages to the Report Assembly Function.

b. **Report Assembly Function** -- The Report Assembly Function receives all ADS-B Messages from the Message Input Processing Function and structures ADS-B Reports for delivery to the Report Output Storage Buffer.

It is important to note that the specification of requirements within this document is considered complete once the ADS-B Reports have been structured and delivered to the Report Output Storage Buffer. Specifically, the specification of data delivery via the Application Interface is not addressed in this document. Figure ~~2-15~~2.2.10.1.1(a) illustrates the boundary of the ADS-B MOPS specification.

c. **Report Output Storage Buffer** -- The primary purpose of the Report Output Storage Buffer is to store and maintain all ADS-B reports such that the Reports are available for extraction by the Application Interface upon demand or as needed.

d. **Application Report Control** -- The Application Report Control depicted in Figure ~~2-15~~2.2.10.1.1(a) represents an ***optional*** function that may be implemented for the application to provide commands or control to the Report Assembly Function in order to control the size of various ADS-B reports and/or the conditions under which such reports are issued.

e. **Application Interface** -- The Application Interface is responsible for the extraction of ADS-B reports from the Report Output Storage Buffer via the Report to Application Interface. Requirements for the Application Interface and Report to Application Interface are to be specified in various Application Interface specifications and therefore are not addressed in this document.

***Note:*** *Figures 2.2.10.1.1(b) ~~2-16a, b, and~~ (c) and (d) ~~is~~ are provided below as a guideline to assist in understanding the Report Assembly and Delivery Process. As such, these figures should not be construed as presenting the actual requirements. Rather, the requirements for Report Assembly and Delivery are provided in the remaining sub-sections of section 2.2.10.*

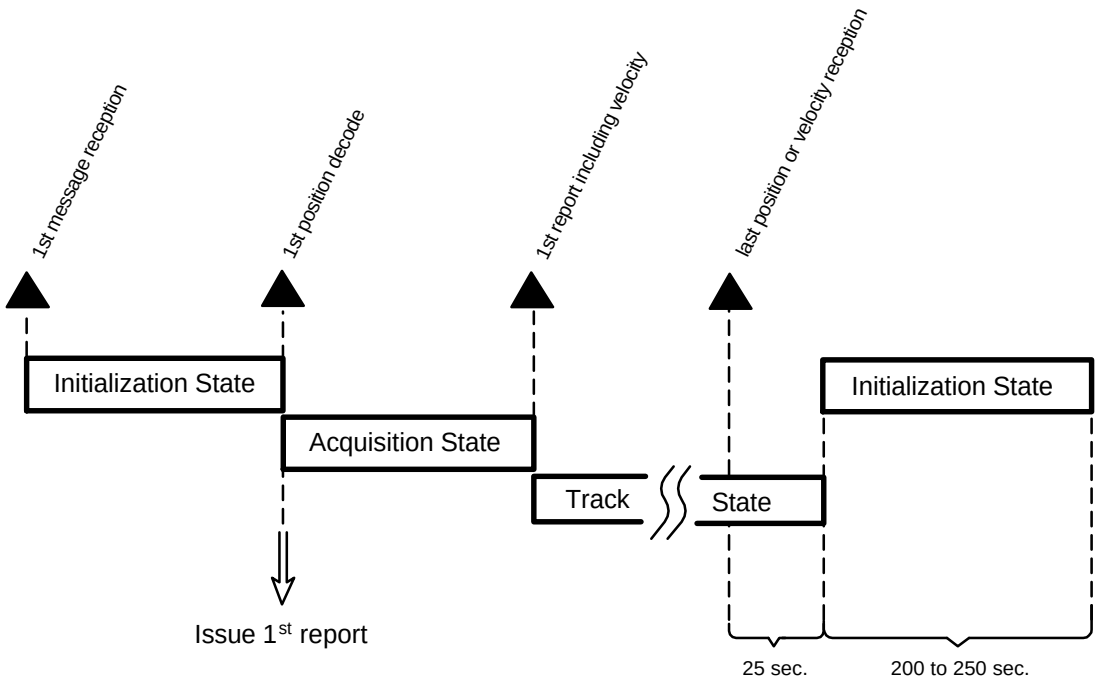


**Figure ~~2-16a~~2.2.10.1.1(b): Illustration Of Report State Changes In A Typical Case**

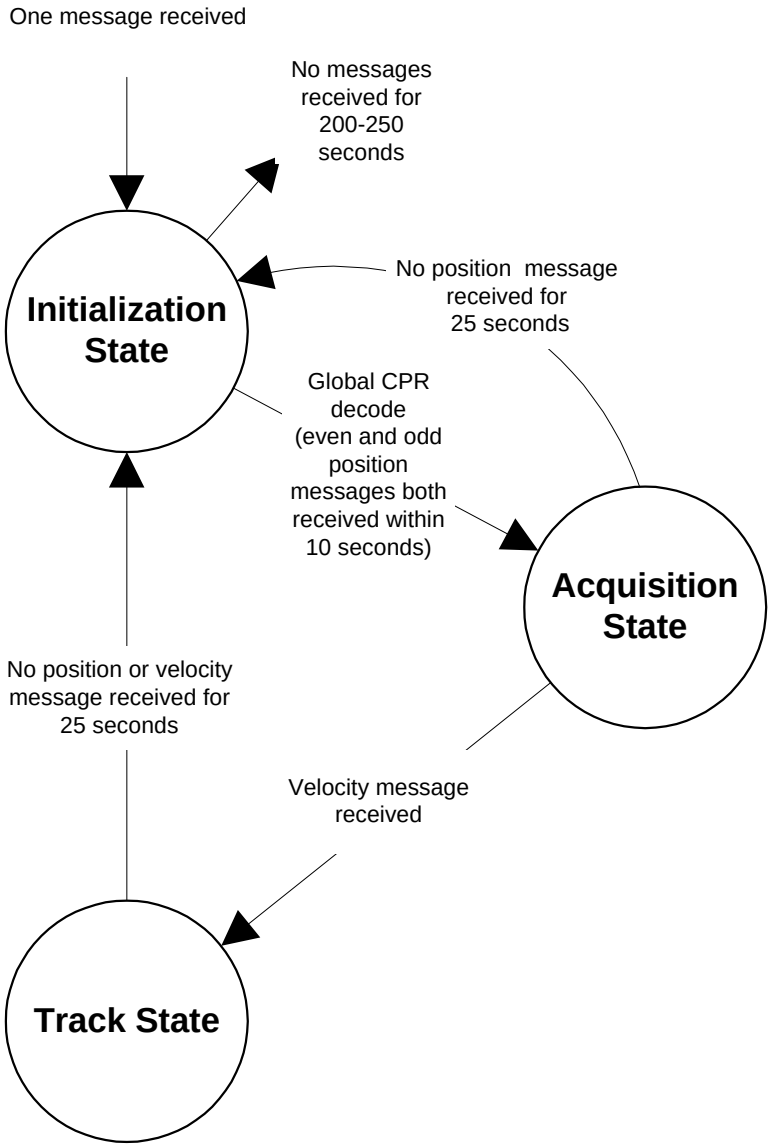


**Figure ~~2-16b~~2.2.10.1.1(c): Report Assembly State Transition Diagram.**

**<<<Modify Figure as per WP2-03>>>**

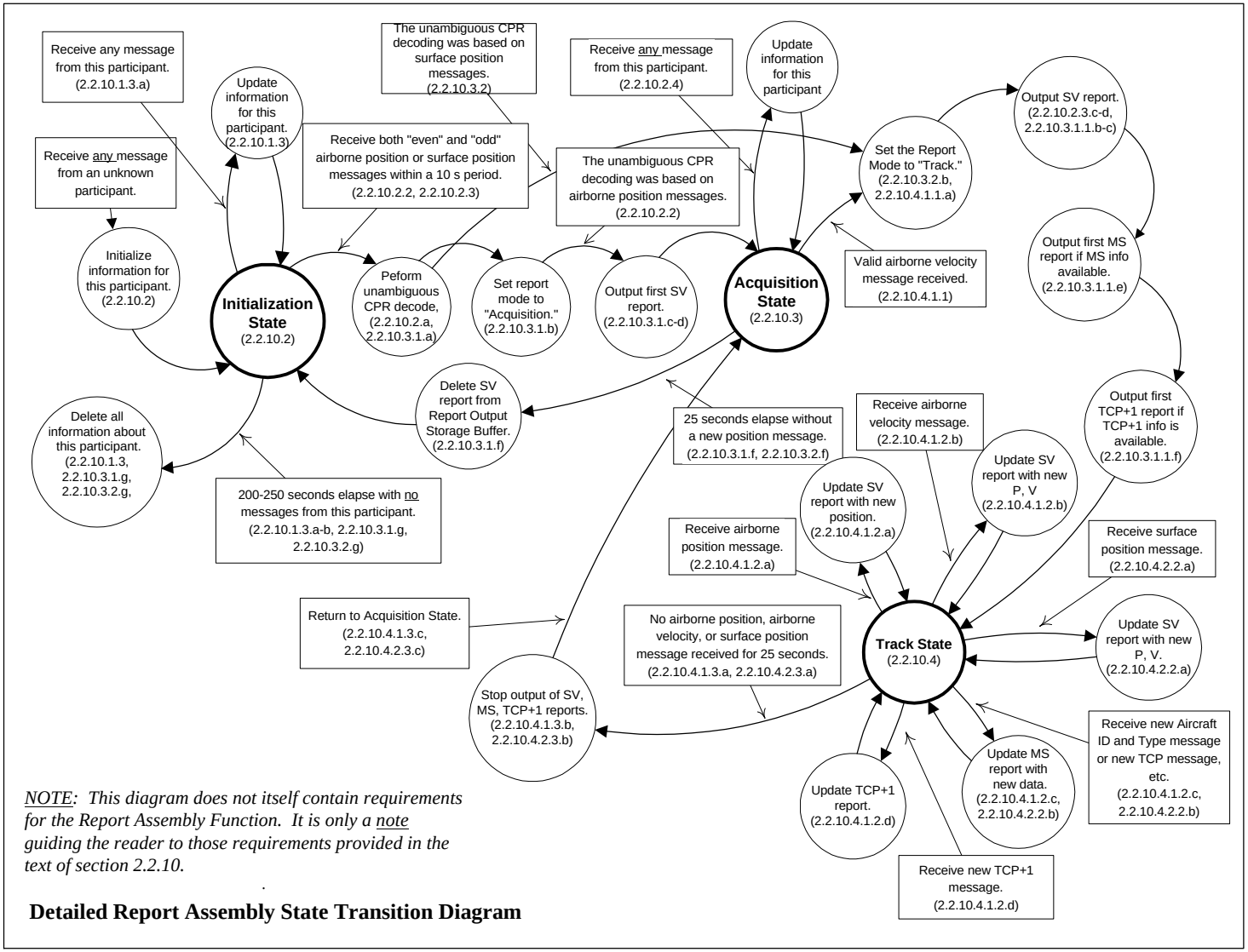


**Figure ~~2-16c~~2.2.10.1.1(d) : Detailed Report Assembly State Transition Diagram**

**<<Modidfy Figure as per WP2-03>>**

#### 2.2.10.1.2 ADS-B Report Organization

a. All ADS-B message receptions and Reports shall be organized (i.e., indexed) in accordance with the Participant Address that is transmitted in the "AA" Address Field of all ADS-B transmitted messages (see section 2.2.3.2.1.1.1).

b. The Participant Address shall be a mandatory element in all ADS-B Reports (see Table ~~2-64~~2.2.8.1 Item 1, Table ~~2-70~~2.2.8.2 Item 1, Table 2.2.8.3.1 Item 1 and Table ~~2-73~~2.2.8.3.2 Item 1).

#### 2.2.10.1.3 ADS-B Message Temporary Retention

a. Unless otherwise specified, all ADS-B Messages and decoded latitude and longitude values received for a given Participant Address shall be appropriately time tagged and temporarily stored for at least 200 seconds unless replaced by a received message of equivalent type.

***Note:*** *This requirement is intended to aid in the start-up of Report Assembly for a given Participant such that as much data as possible can be provided as soon as a Track is initialized on the given participant.*

b. If no new messages have been received from a given Participant for 250 seconds, then all records (including temporary storage) relevant to the Participant Address shall be deleted from temporary storage and from the Report Output Storage Buffer.

#### 2.2.10.1.4 Participant ADS-B Track Files

A Track File is defined as the accumulation of reports maintained on a given participant. In the ADS-B case, the Track File refers to the State Vector, Mode Status, ~~and TCP+1~~Target State and Air Referenced Velocity Reports, which comprise a set of reports maintained on a given participant.

The ADS-B Report Assembly function shall maintain one, and only one, Track File, i.e., set of reports on any given participant.

### 2.2.10.2 Report Assembly Initialization State

The Initialization State is entered for any given Participant for which there is no information upon receipt of any of the following ADS-B messages received from the given Participant:

a. Airborne Position Message (i.e., a State Vector Position Message --- Airborne) (see section 2.2.3.2.3)

b. Surface Position Message (i.e., a State Vector Position Message --- Surface) (see section 2.2.3.2.4)

c. ADS-B Aircraft Identification and Type Message (see section 2.2.3.2.5)

d. ADS-B Airborne Velocity Information Message (see section 2.2.3.2.6)

e. "Aircraft" Trajectory Intent and System Status Message (see section 2.2.3.2.7.1)

~~f. "Aircraft" Operational Coordination Message (see section 2.2.3.2.7.2)~~

~~fg~~. "Aircraft" Operational Status Message (see section 2.2.3.2.7.3)

### 2.2.10.3 Report Assembly Acquisition State

#### 2.2.10.3.1 Report Assembly Acquisition State --- Airborne Participant

Upon receipt of an ***"even"*** and an ***"odd"*** encoded Airborne Position Message from a given Participant within a ten second period, the Report Assembly Function shall:

a. Perform a successful Globally Unambiguous CPR decode of the Participant Position in accordance with section A.7.7 of Appendix A,

b. Set the Report Mode to "Acquisition" for the given Airborne Participant in the State Vector Report (see section 2.2.8.1) in accordance with section 2.2.8.1.28,

c. Structure all possible fields of the State Vector Report for the given Airborne Participant in accordance with section 2.2.8.1 (all subsections inclusive),

d. Deliver the first structured State Vector Report for the given Airborne Participant to the Report Output Storage Buffer for subsequent access by the Application Interface on demand,

e. Continue to maintain the integrity of the State Vector Report for the given Airborne Participant in the Report Output Storage Buffer for at least 200 seconds unless replaced by an updated State Vector Report or otherwise specified in the following sections, the conditions of the following subparagraphs shall apply:

f. If a new Position Message is not received within a ~~25~~ 120 second period, then the Globally Unambiguous CPR decode performed in step a. shall be considered to be invalid, and the Report Assembly Function shall return to the Initialization State. (In order to proceed to the Track State for the airborne participant, the Globally Unambiguous CPR decode will need to be repeated.)

***Note:*** *This action effectively represents a return to the Initialization State with the exception that the return is to step a. above, and the report is retained as per step e. The purpose of this action is to minimize the need to perform the Globally Unambiguous CPR decode since it is not necessary when position messages have been received within the reasonable time limit of ~~25~~ 120 seconds. This action is illustrated in Figure 2-16b.*

g. If no new messages have been received from a given Airborne Participant for at least 200 seconds, then all reports relevant to the Participant Address shall be deleted from the Report Output Storage Buffer.

#### 2.2.10.3.1.1 Latency, Report Assembly Acquisition State --- Airborne Participant

Step 2.2.10.3.1d shall be completed within 500 milliseconds of receipt of the second Airborne Position Message of the "***even***" and "***odd***" pair.

#### 2.2.10.3.2 Report Assembly Acquisition State --- Surface Participant

Upon receipt of an ***"even"*** and an ***"odd"*** encoded Surface Position Message from a given Participant within a ten second period, the Report Assembly Function shall:

a. Perform a successful Local Unambiguous CPR decode of the Participant Position in accordance with section A.7.6 of Appendix A,

b. Set the Report Mode to "Track" for the given Surface Participant in the State Vector Report (see section 2.2.8.1) in accordance with section 2.2.8.1.28,

c. Structure all possible fields of the State Vector Report for the given Surface Participant in accordance with section 2.2.8.1 (all subsections inclusive),

d. Deliver the first structured State Vector Report for the given Surface Participant to the Report Output Storage Buffer for subsequent access by the Application Interface on demand,

e. Continue to maintain the integrity of the State Vector Report for the given Surface Participant in the Report Output Storage Buffer for at least 200 seconds unless replaced by an updated State Vector Report or otherwise specified in the following sections, and the conditions of the following subparagraphs shall apply:

f. If a new Position Message is not received within a ~~25~~ 120 second period, then the Local Unambiguous CPR decode performed in step a. shall be considered to be invalid, and the Report Assembly Function shall return to the Initialization State. In order to proceed from the Acquisition State to the Track State, the Local Unambiguous CPR decode must be repeated.

***Note:*** *This action effectively represents a return to the Initialization State with the exception that the return is to step a. above, and the report is retained as per step e. The purpose of this action is to minimize the need to perform the Local Unambiguous CPR decode since it is not necessary when position messages have been received within the reasonable time limit of ~~25~~ 120 seconds. This action is illustrated in Figure 2-16b.*

g. If no new messages have been received from a given Surface Participant for at least 200 seconds, then all reports relevant to the Participant Address shall be deleted from the Report Output Storage Buffer.

#### 2.2.10.3.2.1 Latency, Report Assembly Acquisition State --- Surface Participant

Step 2.2.10.3.2.d shall be completed within 500 milliseconds of receipt of the second Surface Position Message of the "***even***" and "***odd***" pair.

#### 2.2.10.3.3 Acquisition State Data Retention

Upon receipt of any of the messages identified in section 2.2.10.2 for any given participant, the received message shall either:

a. Use the message as required in section 2.2.10.3.1 for Airborne Participants or section 2.2.10.3.2 for Surface Participants, or

b. Retain the message for future use as specified in section 2.2.10.1.3.

### 2.2.10.4 Report Assembly Track State

#### 2.2.10.4.1 Report Assembly Track State --- Airborne Participant

##### 2.2.10.4.1.1 Report Assembly Track State Initialization --- Airborne Participant

Initialization of the Track State for a given Airborne Participant assumes that the Acquisition State has been established for the given Participant in accordance with section 2.2.10.2.2.

Upon receipt of a valid Airborne Velocity Information Message (see section 2.2.3.2.6) for a given Airborne Participant, the Report Assembly Function shall:

a. Set the Report Mode to "Track" for the given Airborne Participant in the State Vector Report (see section 2.2.8.1) in accordance with section 2.2.8.1.28,

b. Structure all possible fields of the State Vector Report for the given Airborne Participant in accordance with section 2.2.8.1 (all subsections inclusive),

c. Deliver the new State Vector Report for the given Airborne Participant to the Report Output Storage Buffer within 500 milliseconds of receipt of the Airborne Velocity Information Message,

d. Maintain the integrity of the State Vector Report for the given Airborne Participant in the Report Output Storage Buffer for 100 +/- 5 seconds unless replaced by an updated State Vector Report or otherwise specified in the following sections,

e. Initiate Assembly of Mode Status Reports:

   (1). The Report Assembly Function shall review all messages received from the given Airborne Participant that may have been placed in temporary storage in accordance with section 2.2.10.1.3.

   (2). Upon completion of the message review, the Report Assembly Function shall structure all possible fields of the Mode Status Report for the given Airborne Participant in accordance with section 2.2.8.2 (all subsections inclusive).

   (3). The Report Assembly Function shall deliver the new Mode Status Report for the given Airborne Participant to the Report Output Storage Buffer within 500 milliseconds of receipt of the Airborne Velocity Information Message which initialized the Track State.

   (4). The Report Assembly Function shall maintain the integrity of the Mode Status Report for the given Airborne Participant in the Report Output Storage Buffer 100 +/- 5 seconds unless replaced by an updated Mode Status Report or otherwise specified in the following sections.

f. Initiate Assembly of ADS-B ~~TCP + 1~~Target State Reports:

   (1). The Report Assembly Function shall review all messages received from the given Airborne Participant that may have been placed in temporary storage in accordance with section 2.2.10.1.3.

   (2). Upon completion of the message review, the Report Assembly Function shall structure all possible fields of the ADS-B ~~TCP + 1~~TS Report for the

given Airborne Participant in accordance with section 2.2.8.3 (all subsections inclusive).

(3). The Report Assembly Function shall deliver the new ADS-B ~~TCP + 1~~TS Report for the given Airborne Participant to the Report Output Storage Buffer within 500 milliseconds of receipt of the Airborne Velocity Information Message which initialized the Track State.

(4). The Report Assembly Function shall maintain the integrity of the ADS-B ~~TCP + 1~~TS Report for the given Airborne Participant in the Report Output Storage Buffer for 100 +/- 5 seconds unless replaced by an updated ADS-B ~~TCP + 1~~TS Report or otherwise specified in the following sections.

**2.2.10.4.1.2 Report Assembly Track State Maintenance --- Airborne Participant**

The Track State shall be maintained for a given Airborne Participant for as long as Airborne Position Messages (see section 2.2.3.2.3) and Airborne Velocity Information Messages (see section 2.2.3.2.6) are being received from the Participant.

a. Each time that a new Airborne Position Message is received from the given Airborne Participant, the Report Assembly Function shall:

(1). Perform a CPR decode of the Participant Position in accordance with section A.7.4 and A.7.5 of Appendix A,

(2). Update all possible fields of the State Vector Report for the given Airborne Participant in accordance with section 2.2.8.1 (all subsections inclusive),

(3). Deliver the updated State Vector Report to the Report Output Storage Buffer within 500 milliseconds of receipt of the new Airborne Position Message, and

(4). Maintain the integrity of the State Vector Report for the given Airborne Participant in the Report Output Storage Buffer for 100 +/- 5 seconds unless replaced by an updated State Vector Report or otherwise specified in the following sections.

b. Each time that a new Airborne Velocity Information Message is received from the Airborne Participant that contains ground referenced velocity information, the Report Assembly Function shall:

(1). Update all possible fields of the State Vector Report for the given Airborne Participant in accordance with section 2.2.8.1 (all subsections inclusive),

(2). Deliver the updated State Vector Report to the Report Output Storage Buffer within 500 milliseconds of receipt of the new Airborne Position Message, and

(3). Maintain the integrity of the State Vector Report for the given Airborne Participant in the Report Output Storage Buffer for 100 +/- 5 seconds unless replaced by an updated State Vector Report or otherwise specified in the following sections.

c. Each time a Airborne Velocity Information Message (paragraph 2.2.3.2.6) with SUBTYPE = 3 or 4 (i.e., providing air referenced velocity information) is received from the Airborne Participant the Report Assembly Function shall:

(1). Update all possible fields of the Air Referenced Velocity Report for the given Airborne Participant in accordance with section 2.2.8.3.2 (all subsections inclusive),

(2). Deliver the updated ARV Report to the Report Output Storage Buffer within 500 milliseconds of receipt of the new Airborne Velocity Message, and

(3). Maintain the integrity of the ARV Report for the given Airborne Participant in the Report Output Storage Buffer for 100 +/- 5 seconds unless replaced by an updated ARV Report or otherwise specified in the following sections.

~~c~~d. Each time that a new Aircraft Identification and Type Message (see section 2.2.3.2.5), Aircraft Trajectory Intent and System Status Message (see section 2.2.3.2.7.1) having ~~TCP~~ system status information, ~~Aircraft Operational Coordination Message (see section 2.2.3.2.7.2),~~ Aircraft Operational Status Message (see section 2.2.3.2.7.3), Airborne Velocity Message (see section 2.2.3.2.6) or Aircraft Status Message (see section 2.2.3.2.7.9) is received from the Airborne Participant, the Report Assembly Function shall:

(1). Update all possible fields of the Mode Status Report for the given Airborne Participant in accordance with section 2.2.8.2 (all subsections inclusive),

(2). Deliver the updated Mode Status Report to the Report Output Storage Buffer within 500 milliseconds of receipt of the new Message, and

(3). Maintain the integrity of the Mode Status Report for the given Airborne Participant in the Report Output Storage Buffer for 100 +/- 5 seconds unless replaced by an updated Mode Status Report or otherwise specified in the following sections.

~~d~~e. Each time that a new Aircraft Trajectory Intent and System Status Message (see section 2.2.3.2.7.1) having ~~TCP + 1~~Target State information is received from the given Airborne Participant, the Report Assembly Function shall:

(1). Update all possible fields of the ADS-B ~~TCP + 1~~TS Report for the given Airborne Participant in accordance with section 2.2.8.3 (all subsections inclusive),

(2). Deliver the updated ADS-B ~~TCP + 1~~TS Report to the Report Output Storage Buffer within 500 milliseconds of receipt of the new Message, and

(3). Maintain the integrity of the ADS-B ~~TCP + 1~~TS Report for the given Airborne Participant in the Report Output Storage Buffer for 100 +/- 5 seconds unless replaced by an updated ADS-B ~~TCP + 1~~TS Report or otherwise specified in the following sections.

#### 2.2.10.4.1.3 Report Assembly Track State Termination --- Airborne Participant

a. The Track State shall be terminated for a given Airborne Participant if no Airborne Position (see section 2.2.3.2.3) or Airborne Velocity Information (see section 2.2.3.2.6) Messages have been received from the Participant in 25 +/- 5 seconds.

b. Upon termination of the Track State for a given Airborne Participant, the Report Assembly Function shall immediately delete all State Vector, Mode Status, ~~and~~ ADS-B ~~TCP + 1~~TS, and Air Referenced Velocity Reports that were placed in the Report Output Storage Buffer for the given Participant.

***Note:*** *The track state termination requires deletion of all reports structured for a given participant into the Report Output Storage Buffer. Track state termination does not intend that temporary storage (see section 2.2.10.1.3) established for the given Participant be deleted. The temporary storage is only deleted if NO ADS-B messages have been received from the given Participant for 225 +/- 25 seconds.*

c. Upon completion of the preceding step b., the Report Assembly Function shall return to the Report Assembly Acquisition State for the given Airborne Participant as specified in section 2.2.10.~~2.2~~3.1.

#### 2.2.10.4.2 Report Assembly Track State --- Surface Participant

#### 2.2.10.4.2.1 Report Assembly Track State Initialization --- Surface Participant

Initialization of the Track State for a given Surface Participant is established in accordance with section 2.2.10.3.2.

In addition to the requirements specified in section 2.2.10.3.2, the Report Assembly Function shall initiate assembly of Mode Status Reports as follows:

a. The Report Assembly Function shall review all messages received from the given Surface Participant that may have been placed in temporary storage in accordance with section 2.2.10.1.3.

b. Upon completion of the message review, the Report Assembly Function shall structure all possible fields of the Mode Status Report for the given Surface Participant in accordance with section 2.2.8.2 (all subsections inclusive).

c. The Report Assembly Function shall deliver the new Mode Status Report for the given Surface Participant to the Report Output Storage Buffer within 500 milliseconds of receipt of the last received Surface Position Message which initialized the Track State.

d. The Report Assembly Function shall maintain the integrity of the Mode Status Report for the given Surface Participant in the Report Output Storage Buffer 100 +/- 5 seconds unless replaced by an updated Mode Status Report or otherwise specified in the following sections.

#### 2.2.10.4.2.2 Report Assembly Track State Maintenance --- Surface Participant

The Track State shall be maintained for a given Surface Participant for as long as Surface Position Messages (see section 2.2.3.2.4) are being received from the Surface Participant.

a. Each time that a new Surface Position Message is received from the given Surface Participant, the Report Assembly Function shall:

(1). Perform a CPR decode of the Participant Position in accordance with section A.7.4 and A.7.6 of Appendix A,

(2). Update all possible fields of the State Vector Report for the given Surface Participant in accordance with section 2.2.8.1 (all subsections inclusive),

(3). Deliver the updated State Vector Report to the Report Output Storage Buffer within 500 milliseconds of receipt of the new Surface Position Message, and

(4). Maintain the integrity of the State Vector Report for the given Surface Participant in the Report Output Storage Buffer for 100 +/- 5 seconds unless replaced by an updated State Vector Report or otherwise specified in the following sections.

b. Each time that a new Aircraft Identification and Type Message (see section 2.2.3.2.5), ~~Aircraft Operational Coordination Message (see section 2.2.3.2.7.2),~~ Aircraft Operational Status Message (see section 2.2.3.2.7.3), or Aircraft Status Message (see section 2.2.3.2.7.9) is received from the Surface Participant, the Report Assembly Function shall:

(1). Update all possible fields of the Mode Status Report for the given Surface Participant in accordance with section 2.2.8.2 (all subsections inclusive),

(2). Deliver the updated Mode Status Report to the Report Output Storage Buffer within 500 milliseconds of receipt of the new Message, and

(3). Maintain the integrity of the Mode Status Report for the given Surface Participant in the Report Output Storage Buffer for 100 +/- 5 seconds unless replaced by an updated Mode Status Report or otherwise specified in the following sections.

### 2.2.10.4.2.3 Report Assembly Track State Termination --- Surface Participant

a. The Track State shall be terminated for a given Surface Participant if no Surface Position Message (see section 2.2.3.2.4) has been received from the Participant in 25 +/- 5 seconds.

b. Upon termination of the Track State for a given Surface Participant, the Report Assembly Function shall immediately delete all State Vector and Mode Status Reports that were placed in the Report Output Storage Buffer for the given Participant.

***Notes:***

*1. The track state termination requires deletion of all reports structured into the Report Output Storage Buffer. Track state termination does not intend that temporary storage (see section 2.2.10.1.3) established for the given Participant be deleted. The temporary storage is only deleted if NO ADS-B messages have been received from the given Participant for 225 +/- 25 seconds.*

2. *ADS-B Surface Participants do not generate ~~TCP nor TCP~~trajectory intent information; therefore, ADS-B ~~TCP + 1~~TS Report assembly is not required for Surface Participants.*

c. Upon completion of the preceding step b., the Report Assembly Function shall return to the Report Assembly Acquisition State for the given Surface Participant as specified in section 2.2.10.~~2.3~~3.2.

### 2.2.10.5 Minimum Number of Participant Track Files

In the absence of an applied interference environment and other interference, the ADS-B Report Assembly Function shall be capable of:

a. Maintaining the minimum number of track files (see 2.2.10.1.4) of ADS-B participants as specified in Table 2-76 for a given equipage class, and

**Table 2-76: Minimum Participant Track File Capacity**

| Equipage Class of ADS-B Receiving Subsystem | Minimum Number of Participant Track Files |
|---|---|
| A0 | 100 |
| A1 | 200 |
| A2 | 400 |
| A3 | ~~400~~600 |

b. If the track file capacity of the ADS-B Receiving Subsystem is being exceeded by the number of participants whose messages are being received by the subsystem, then the subsystem may choose to discard track files of those participants that are at farther ranges relative to the receiving subsystem.

### 2.2.10.6 Participant Track File Maintenance in the Interference Environment

**<<<The following original DO-260 requirement now applies to only Equipage Class A0 equipment (without the enhanced decoder). We need to expand the following requirements to define the required performance for equipage Class A1 (i.e, at least center sample) and for Class A2 and A3 (i.e., enhanced multi-sample) decoders. >>>>>>**

#### 2.2.10.6.1 Track File Maintenance for Class A0 Receiving Device

The Equipage Class A0 ADS-B Receiving Device Message Processor and Report Assembly functions shall properly decode at least 90% of valid ADS-B messages that have been received in the following ATCRBS interference environment:

a. Each of the ADS-B messages shall be valid, and shall be overlaid with an ATCRBS MODE-C Reply (see RTCA Document No. DO-181B subparagraph 2.2.4.1 through 2.2.4.1.6) (EUROCAE ED-73A, sections 3.5.1 through 3.5.5)having the appropriate altitude encoding for an altitude of 50,000 feet,

b. The ATCRBS MODE-C message shall overlay the ADS-B message at any point after the “DF” subfield,

c. The ADS-B message signal level shall be a minimum of MTL + 6 dB and a maximum of -21 dBm, and

d. The ATCRBS MODE-C reply signal level shall be 3 dB greater than the ADS-B message signal level.

#### 2.2.10.6.2 Track File Maintenance for Class A1 Receiving Device

***To be developed***

#### 2.2.10.6.3 Track File Maintenance for Class A2 and A3 Receiving Devices

***To be developed***