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Proposed Corrections to TIS-B and ADS-R Sections for DO-260B
Revision 1

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Summary
This Working Paper addresses some required changes that need to be made to the TIS=B and ADS-R sections of DO-260A because we are going to Version=2.

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2.2.17 Traffic Information Services – Broadcast (TIS-B)

2.2.17.1 Introduction

This section defines the formats and coding for a Traffic Information Service Broadcast (TIS-B) based on the same 112-bit 1090 MHz signal transmission that is used for ADS-B on 1090 MHz.

TIS-B complements the operation of ADS-B by providing ground-to-air broadcast of surveillance data on aircraft that are not equipped for 1090 MHz ADS-B. The basis for this ground surveillance data may be an ATC Mode S radar, a surface or approach multi-lateration system or a multi-sensor data processing system. The TIS-B ground-to-air transmissions use the same signal formats as 1090 MHz ADS-B and can therefore be accepted by a 1090 MHz ADS-B receiver.

TIS-B service is the means for providing a complete surveillance picture to 1090 MHz ADS-B users during a transition period. After transition, it also provides a means to cope with a user that has lost its 1090 MHz ADS-B capability.

2.2.17.2 TIS-B Format Structure

TIS-B information is broadcast using the 112-bit Mode S DF=18 format as shown in Figure 2-24.

TIS-B Baseline Format Definition					
Bit #	1 ----- 5	6 --- 8	9 -------- 32	33 ---------- 88	89 ------ 112
DF=18	**DF [5]**	**CF [3]**	**AA [24]**	**ME [56]**	**PI [24]**
	10010				
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB

Figure 2-24: TIS-B Baseline Format Definition

The content of the DF=18 transmission is defined by the value of the Control Field (CF), as specified in Table 2-106.

Table 2-106: "CF" Field Code Definitions in DF=18 ADS-B and TIS-B Messages

CF Value	ICAO/Mode A Flag (IMF)	Meaning
0	N/A	ADS-B Message from a non-transponder device, AA field holds 24-bit ICAO aircraft address
1	N/A	Reserved for ADS-B Message in which the AA field holds anonymous address or ground vehicle address or fixed obstruction address
2	0	Fine TIS-B Message, AA field contains the 24-bit ICAO aircraft address
	1	Fine TIS-B Message, AA field contains the 12-bit Mode A code followed by a 12-bit track file number
3	0	Coarse TIS-B Airborne Position and Velocity Message, AA field contains the 24-bit ICAO aircraft address
	1	Coarse TIS-B Airborne Position and Velocity Message, AA field contains the 12-bit Mode A code followed by a 12-bit track file number.
4	N/A	TIS-B and ADS-R Management Message AA contains TIS-B/ADS-R management information.
5	0	Fine TIS-B Message AA field contains a non-ICAO 24-bit address
	1	Reserved
6	0	Rebroadcast of ADS-B Message from an alternate data link. AA field holds 24-bit ICAO aircraft address
	1	Rebroadcast of ADS-B Message from an alternate data link. AA field holds anonymous address or ground vehicle address or fixed obstruction address
7	N/A	Reserved

2.2.17.2.1 "DF" Downlink Format

This field will be set to DF=18 for TIS-B to indicate that this transmission is not from a Mode S transponder. See §2.2.3.2.1.1.

2.2.17.2.2 "CF" Control Field

The "CF" field of DF=18 messages is a 3-bit field (bits 6 through 8) used by Non-Transponder-Based installations. This field will be set to 2, 3, 4 or 5 depending upon the TIS-B Message as specified in Table 2-106. The ADS-B Receiving Subsystem **shall** accept and process DF=18, with CF=2, CF=3, CF=4 and CF=5 as TIS-B Messages. ~~The ADS-B Receiving Subsystem **shall** accept and process DF=18, with CF=6 Messages in the same manner as a DF=17 ADS-B Message, with the exception of bits modified as identified in section §2.2.18.~~

2.2.17.2.3 "AA" Address Announced Field

As specified in Table 2-106, the ADS-B Receiving Subsystem **shall** interpret the AA field as either:

(1) the 24-bit aircraft address as specified in §2.2.3.2.1.1, or

(2) the 12-bit Mode A code followed by a 12-bit track number.

2.2.17.2.4 "ME" Message Extended Squitter Field

This field is specified in §2.2.3.2.1.6.

2.2.17.2.5 "PI" Parity/Identity Field

This field is specified in §2.2.3.2.1.7.

2.2.17.3 TIS-B Messages

2.2.17.3.1 TIS-B Fine Airborne Position Message

TIS-B Fine Airborne Position Message Format								
MSG BIT #	33 --- 37	38 --------- 39	40	41 ----- 52	53	54	55 -------- 71	72 -------- 88
"ME" BIT #	1 ----- 5	6 ---------- 7	8	9 ----- 20	21	22	23 -------- 39	40 -------- 56
Field Name	**TYPE [5]**	**Surveillance Status [2]**	**IMF [1]**	**Pressure Altitude [12]**	**Reserved [1]**	**CPR Format (F) [1]**	**CPR Encoded Latitude [17]**	**CPR Encoded Longitude [17]**
	MSB LSB	MSB LSB		MSB LSB			MSB LSB	MSB LSB

Note: *"[#]" provided in the Field Name column indicates the number of bits in the respective field.*

Figure 2-25: TIS-B Fine Airborne Position Message Format

2.2.17.3.1.1 Relationship to ADS-B Format

The following fields **shall** be decoded as specified for the ADS-B Airborne Position Message defined in §2.2.3.2.3:

TYPE Code	Surveillance Status
Altitude	CPR Format
Encoded Latitude	Encoded Longitude

The TYPE Code **shall** be decoded according to TYPE Code Format Table N-XX.

Note: TIS-B Service Airborne Position Message TYPE Codes are consistent with Version 1 definitions.

2.2.17.3.1.2 ICAO/Mode A Flag (IMF)

This 1-bit ("ME" bit 8) field **shall** be used to indicate the type of identity associated with the aircraft data reported in the TIS-B Message. IMF equal to ZERO (0) **shall** indicate that the TIS-B data is identified by a~~n~~ 24-bit Aircraft address. IMF equal to ONE (1) ~~**shall**~~ indicates that the TIS-B data is identified by a "Mode A" code. A "Mode A" code of all ZEROs ~~**shall**~~ indicates a primary radar target.

***Note**: The AA field is coded differently for 24-bit addresses and Mode A codes as specified in Table 2-106.*

2.2.17.3.2 TIS-B Fine Surface Position Message

TIS-B Fine Surface Position Message Format								
MSG BIT #	33 -- 37	38 ------- 44	45	46 ----- 52	53	54	55 ------- 71	72 -------- 88
"ME" BIT #	1 ----- 5	6 --------- 12	13	14 ----- 20	21	22	23 ------- 39	40 -------- 56
Field Name	**TYPE [5]**	**Movement [7]**	**Heading Status [1]**	**Heading [7]**	**IMF [1]**	**CPR Format (F) [1]**	**CPR Encoded Latitude [17]**	**CPR Encoded Longitude [17]**
	MSB LSB	MSB LSB		MSB LSB			MSB LSB	MSB LSB

***Note:** "[#]" provided in the Field Name column indicates the number of bits in the respective field.*

Figure 2-26: TIS-B Fine Surface Position Message Format

2.2.17.3.2.1 Relationship to ADS-B Format

The following fields **shall** be coded as specified for the ADS-B Surface Position Message defined in §2.2.3.2.4:

TYPE Code	Movement
Heading Status	Heading
CPR Format	Encoded Latitude
Encoded Longitude	

The TYPE Code **shall** be decoded according to TYPE Code Format Table N-XX.

Note: TIS-B Service Surface Position Message TYPE Codes are consistent with Version 1 definitions.~~§2.2.3.2.4:~~

~~TYPE Code~~
~~Heading Status~~
~~CPR Format~~
~~Encoded Longitude~~
~~Movement~~
~~Heading~~
~~Encoded Latitude~~

2.2.17.3.2.2 ICAO/Mode A Flag (IMF)

This 1-bit ("ME" bit 21) field **shall** be set as specified in §2.2.17.3.1.2.

2.2.17.3.3 TIS-B Identification and Category Message

TIS-B Identification and Category Message Format										
MSG BIT #	33 - 37	38 - 40	41 - 46	47 - 52	53 - 58	59 - 64	65 - 70	71 - 76	77 - 82	83 – 88
"ME" BIT #	1 - 5	6 - 8	9 - 14	15 - 20	21 - 26	27 - 32	33 - 38	39 - 44	45 - 50	51 – 56
FIELD NAME	**TYPE [5]**	**Emitter Category [3]**	**Ident Char #1 [6]**	**Ident Char #2 [6]**	**Ident Char #3 [6]**	**Ident Char #4 [6]**	**Ident Char #5 [6]**	**Ident Char #6 [6]**	**Ident Char #7 [6]**	**Ident Char #8 [6]**
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB

Note: *"[#]" provided in the Field Name column indicates the number of bits in the respective field.*

Figure 2-27: TIS-B Identification and Category Message Format

2.2.17.3.3.1 Relationship to ADS-B Format

All of the fields of the TIS-B Identification and Category Message **shall** be coded as specified for the ADS-B Identification and Category Message specified in §2.2.3.2.5.

Note: *This message will only be used for aircraft identified with a 24-bit Aircraft address.*

2.2.17.3.4 TIS-B Velocity Message

TIS-B Velocity Message – Subtypes "1" and "2"															
MSG BIT #	33 - 37	38 - 40	41	42 - 45	46	47 - 56	57	58 - 67	68	69	70 - 78	79	80 - 82	83 - 84	85 – 88
"ME" BIT #	1 - 5	6 - 8	9	10 - 13	14	15 - 24	25	26 - 35	36	37	38 - 46	47	48 - 50	51 - 52	53 – 56
FIELD NAME	**TYPE [5]**	**Subtype [3]**	**IMF [1]**	**NAC_P [4]**	**E/W Direction Bit [1]**	**E/W Velocity [10]**	**N/S Direction Bit [1]**	**N/S Velocity [10]**	**GEO Flag =0 [1]** **GEO Flag =1 [1]**	**Vertical Rate Sign Bit [1]**	**Vert Rate [9]**	**NIC Supplement [1]**	**NAC_V [3]** **Reserved [1]** / **Difference Sign Bit [1]** / **Geometric Height Difference From Barometric [7]**	**SIL [2]**	**Reserved [4]**
	MSB LSB	MSB LSB		MSB LSB		MSB LSB		MSB LSB			MSB LSB		MSB LSB	MSB LSB	MSB LSB

Note: *"[#]" provided in the Field Name column indicates the number of bits in the respective field.*

Figure 2-28: TIS-B Velocity Message, Subtypes 1 and 2

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TIS-B Velocity Message – Subtypes “3” and “4”																		
MSG BIT #	33 - 37	38 - 40	41	42 - 45	46	47 - 56	57	58 - 67	68	69	70 - 78	79	80 - 82		83 - 84	85 – 88		
“ME” BIT #	1 - 5	6 - 8	9	10 - 13	14	15 - 24	25	26 - 35	36	37	38 - 46	47	48 - 50		51 - 52	53 – 56		
FIELD NAME	**TYPE [5]**	**Subtype [3]**	**IMF [1]**	**NAC_P [4]**	**Heading Status Bit [1]**	**Heading [10]**	**Airspeed Type~~t~~ [1]**	**Airspeed [10]**	**GEO Flag =0 [1]**	**Vertical Rate Sign Bit [1]**	**Vert Rate [9]**	**NIC Supplement [1]**	**NAC_V [3]**		**SIL [2]**	**Reserved [2]**	**True/Mag [1]**	**Reserved [1]**
									GEO Flag =1 [1]				**Reserved [1]**	**Difference Sign Bit [1]**	**Geometric Height Difference From Barometric [7]**			
	MSB LSB	MSB LSB		MSB LSB		MSB LSB		MSB LSB			MSB LSB		MSB LSB		MSB LSB	MSB LSB		

Note: *“[#]” provided in the Field Name column indicates the number of bits in the respective field.*

Figure 2-29: TIS-B Velocity Message, Subtypes 3 & 4

2.2.17.3.4.1 Relationship to ADS-B Format

The following fields **shall** be coded as specified for the ADS-B Velocity Message with Subtype=1, as specified in §2.2.3.2.6.1, or Subtype=2, as specified in §2.2.3.2.6.2:

TYPE Code	Subtype Code
E/W Direction Bit	E/W Velocity
N/S Direction Bit	N/S Velocity
Vertical Rate Sign	Vertical Rate
Height Difference Sign Bit	Geometric Height Difference from Baro
Vertical Rate Type	

2.2.17.3.4.2 ICAO/Mode A Flag (IMF)

This one-bit ("ME" bit 9) field **shall** be set as specified in §2.2.17.3.1.2.

2.2.17.3.4.3 Navigation Integrity Code (NIC) Supplement

This one-bit ("ME" bit 47) field **shall** be used together with the Message TYPE Code to define the NIC value for the Airborne and Surface Position Messages.

Coding of the NIC Supplement field **shall** be as specified in Table ~~2-70~~N-XX.

2.2.17.3.4.4 Navigation Accuracy Category for Position (NAC_P)

This four-bit ("ME" bits 10 through 13) field **shall** define the NAC_P value for the Airborne and Surface Position Messages.

Coding of the NAC_P field **shall** be as specified for the Aircraft Operational Status Message in Table 2-71.

2.2.17.3.4.5 Navigation Accuracy Category for Velocity (NAC_V)

This 3-bit ("ME" bits 48 through 50) field **shall** define the NAC_V value for the Airborne Velocity Message when the GEO Flag is equal to ZERO (0). Coding of the NAC_V field **shall** be as specified in §2.2.3.2.6.1.5.

2.2.17.3.4.6 Surveillance Integrity Level (SIL)

This two-bit ("ME" bits 52 and 53) field **shall** define the SIL value for the Airborne and Surface Position Messages when the GEO Flag is equal to ZERO (0). Coding of the SIL field **shall** be as specified in Table ~~2-72~~N-XX.

2.2.17.3.4.7 True/Magnetic Heading Type

This one-bit ("ME" bit 55) field **shall** define the True or Magnetic Heading value for the Airborne Velocity Message when the GEO Flag is equal to ZERO (0) for a Subtype of 3 or 4. Coding of the True/Magentic Heading Type field **shall** be as specified in §2.2.3.2.7.2.13.

2.2.17.3.5 TIS-B Coarse Position Message

TIS-B Coarse Position Message Format										
MSG BIT #	33	34 ------- 35	36 -----39	40 -- 51	52	53 --- 57	58 -- 63	64	65 ------ 76	77 ------ 88
"ME" BIT #	1	2 --------- 3	4 ------- 7	8 ---19	20	21 --- 25	26 -- 31	32	33 ------ 44	45 ------ 56
Field Name	IMF [1]	Surveillance Status [2]	Service Volume ID (SVID) [4]	Pressure Altitude [12]	Ground Track Status [1]	Ground Track Angle [5]	Ground Speed [6]	CPR Format (F) [1]	CPR Encoded Latitude [12]	CPR Encoded Longitude [12]
		MSB LSB	MSB LSB	MSB LSB		MSB LSB	MSB LSB		MSB LSB	MSB LSB

Note: *"[#]" provided in the Field Name column indicates the number of bits in the respective field.*

Figure 2-30: TIS-B Coarse Position Message Format

2.2.17.3.5.1 Relationship to ADS-B Format

The format of the TIS-B Coarse Position Message is not related to any ADS-B format. The format is specified in the following subparagraphs.

2.2.17.3.5.2 ICAO/Mode A Flag (IMF)

This one-bit ("ME" bit 1) field **shall** be set as specified in §2.2.17.3.1.2.

2.2.17.3.5.3 Service Volume ID (SVID)

The 4-bit ("ME" bits 4 through 7) SVID field **shall** be decoded to identify the TIS-B site that delivered the surveillance data.

Note: *In the case where TIS-B Messages associated with a specific target are being received from more than one TIS-B ground station, the receiving application can use the SVID to select coarse messages from a single source. This will prevent the receiving application's TIS-B track from wandering due to the different error biases associated with different sources.*

2.2.17.3.5.4 Pressure Altitude

This 12-bit ("ME" bits 8 – 19) field **shall** be decoded as specified in §2.2.3.2.3.4.1.

2.2.17.3.5.5 Ground Track Status

This one bit ("ME" bit 20) field **shall** define the validity of the Ground Track value. Coding for this field **shall** be as follows: 0=not valid and 1= valid.

2.2.17.3.5.6 Ground Track Angle

This 5-bit ("ME" bits 21 through 25) field **shall** define the direction (in degrees clockwise from true north) of aircraft motion. The Ground Track **shall** be encoded as an unsigned angular weighted binary numeral, with an MSB of 180 degrees and an LSB of 360/32 degrees, with ZERO (0) indicating true north. The data in the field **shall** be rounded to the nearest multiple of 360/32 degrees.

2.2.17.3.5.7 Ground Speed

This 6-bit ("ME" bits 26 through 31) field **shall** define the aircraft speed over the ground. Coding of this field **shall** be as shown in Table 2-107.

Table 2-107: Ground Speed Encoding

Coding		Meaning
(Binary)	(Decimal)	(Ground Speed in knots)
00 0000	0	No Ground Speed information available
00 0001	1	Ground Speed < 16 knots
00 0010	2	16 knots ≤ GS < 48 knots
00 0011	3	48 knots ≤ GS < 80 knots
***	***	***
11 1110	62	1936 knots ≤ GS < 1968 knots
11 1111	63	GS ≥ 1968 knots

Notes:

1. *The encoding shown in the table represents Positive Magnitude data only.*
2. *Raw data used to establish the Ground Speed Subfield will normally have more resolution (i.e., more bits) than that required by the Ground Speed Subfield. When converting such data to the Ground Speed Subfield, the accuracy of the data must be maintained such that it is not worse than ±½ LSB where the LSB is that of the Ground Speed Subfield.*

2.2.17.3.5.8 Encoded Latitude and Longitude

The Encoded Latitude field **shall** be decoded~~encoded~~ consistent with the format ~~as~~ specified in §2.2.3.2.3.7, except that the 12-bit CPR coding specified in Appendix A, §A.1.7 **shall** be used.

The Encoded Longitude field **shall** be decoded consistent with the format ~~encoded as~~ specified in §2.2.3.2.3.8, except that the 12-bit CPR coding specified in Appendix A, §A.1.7 **shall** be used.

2.2.17.4 TIS-B Message Processing and Report Generation

The information received in TIS-B Messages is reported directly to applications, with one exception. The exception is latitude-longitude position information, which is CPR-encoded when it is received, and must be decoded before reporting. In order to accomplish CPR decoding, it is necessary to track received messages, so that even-format and odd-format messages can be combined to determine the latitude and longitude of the target.

In the most common case, a particular target will result in TIS-B Message receptions or ADS-B Message receptions, but not both. It is possible, however, for both types of messages to be received for a single target. If this happens, the TIS-B information is processed and reported independently of the ADS-B receptions and reporting.

2.2.17.4.1 TIS-B Message-to-Track Correlation

Tracking makes it possible to associate a received message with information previously received about that same target, in the presence of many other intervening messages about other targets. Such associations are necessary for global decodes (§2.2.17.4.2), for estimating velocity when position was received (§2.2.17.4.6) and for estimating position when velocity was received (§2.2.17.4.6).

2.2.17.4.1.1 TIS-B Messages Having a 24-Bit Address

For a target that has a 24-bit address, that address is used for correlating new receptions with information in the TIS-B track file. Correlation is successful if the address matches exactly. ~~If the 24-bit address in a received message is either all ZEROs or all ONEs, it is considered to be illegal, and the message **shall** be discarded. W~~~~Otherwise, w~~hen a TIS-B Position Message having a 24-bit address is received, and an existing TIS-B track has the same address, the message **shall** be correlated with the track.

2.2.17.4.1.2 TIS-B Messages Having Mode A Code and Track Number

For a target not identified by a 24-bit address, but instead having a Mode A code and a TIS-B track number, then these are used to correlate with information in the track file. Correlation is successful if the Mode A code and the track number both match exactly. When a TIS-B Message having a Mode A code and TIS-B track number is received, and an existing TIS-B track has the same Mode A code and ADS-B track number, the message **shall** be correlated with the track.

2.2.17.4.2 TIS-B Position Message Decoding

When a received TIS-B Position Message correlates to an existing TIS-B track, the message and the track are used together to decode the latitude and longitude of the target. If the track is "Complete," meaning that a global decode has been accomplished, then the new latitude-longitude information **shall** be decoded using local decoding, as specified in §A.1.7.4 in Appendix A, taking the previous position of the target as the reference.

If the TIS-B track is "Incomplete," meaning that a global decode has not yet been accomplished prior to this reception, then a global decode may be computed depending on the contents of the track. If the information in the track together

with the new position message consist of at least one even format message and at least one odd format message received within 10 seconds, then a global decode **shall** be computed as specified in §A.1.7.7 of Appendix A. Otherwise the received encoded position, the even/odd format, and the time of applicability, **shall** be saved in the track file for later use.

Note: *When decoding positions, a reasonableness test may be applied.*

2.2.17.4.3 TIS-B Track Update

When a position message is correlated to a TIS-B track that is Complete, then a new position is computed as specified in §2.2.17.4.2 and the tracked position **shall** be updated with the new position and time of applicability. The previous position and time need not be saved. Figure 2-31 illustrates the transition from Incomplete track to Complete track and later track drop.

When a position message is correlated with a TIS-B track that is Incomplete, the new information may make it possible for a global decode, as specified in §2.2.17.4.2. If a global decode is accomplished, the track **shall** be promoted to Complete, and the latitude, longitude, and time of applicability **shall** be saved in the track. The previous position and time information need not be saved. If a global decode is not accomplished, the even and odd encoded positions **shall** be saved for future decodes.

Note: *It is not necessary to save any encoded positions longer than 10 seconds.*

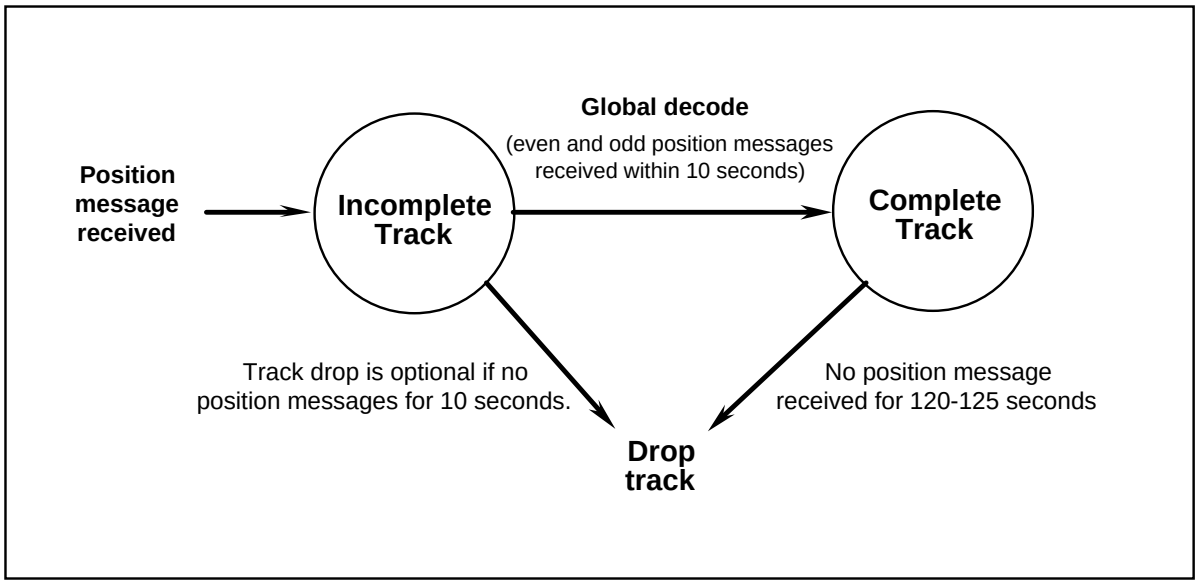

Figure 2-31: TIS-B Tracks

2.2.17.4.4 TIS-B Track Initiation

A TIS-B track begins with the reception of one position message. A new Incomplete track **shall** be created, and the encoded position, even/odd format bit, and time of applicability **shall** be saved.

2.2.17.4.5 TIS-B Track Drop

A TIS-B track that is Complete **shall** not be dropped within 120 seconds after any TIS-B Position Message reception. If 125 seconds elapses without any TIS-B Message reception, the track **shall** be dropped.

Note: *As specified in §2.2.17.4.3, for an Incomplete TIS-B track, it is not necessary to save any information more than 10 seconds after reception. Therefore the track can be dropped after 10 seconds.*

2.2.17.4.6 TIS-B Report Generation

As TIS-B Messages are received, the information is reported to applications. All received information elements, other than position, **shall** be reported directly, including all reserved fields for the TIS-B fine format messages (§2.2.17.3.1 to §2.2.17.3.4) and the entire message content (i.e., including the complete 88-bit content of the DF, CF, AA and ME fields of the Extended Squitter Message) of any received TIS-B Management Message (Table 2-106, for CF=4). The reporting format is not specified in detail, except that the information content reported **shall** be the same as the information content received. The report **shall** be issued within 0.5 seconds of the message reception.

When a TIS-B Position Message is received, it is compared with tracks to determine whether it can be decoded into target position, as specified in §2.2.17.4.2. If the message is decoded into target position, a report **shall** be generated, within 0.5 seconds of the message reception. The report **shall** contain the received position information with its time of applicability, the most recently received velocity measurement with its time of applicability, estimated position and velocity, applicable to a common time of applicability, address, and all other information in the received message. The estimated values **shall** be based on the received position information and the track history of this target.

When a TIS-B Velocity Message is received, if it is correlated to a complete track, then a report **shall** be generated, within 0.5 seconds of the message reception. The report **shall** contain the received velocity information with its time of applicability, the most recently received position measurement with its time of applicability, estimated position and velocity, applicable to a common time of applicability, address, and all other information in the received message. The estimated values **shall** be based on the received ground referenced velocity information and the track history of this target.

Notes:

1. *Whereas ADS-B reports are classified as to "State Vector Reports" and certain other defined types, TIS-B reports are not. Instead, TIS-B reporting follows the general principle that all received information is reported directly upon reception.*

2. *In the absence of TIS-B Message receptions, it is possible for reports to be generated, but this is not required. Such additional reports might be useful as a means of counteracting possible flaws in an on-board data bus between ADS-B and an application.*

3. *Track drop (§2.2.17.4.5) is the only TIS-B function for which time-out performance is required. It is expected that TIS-B applications will take account of the times when information is reported and will apply the time-out functions that are appropriate for each application.*

2.2.18 ADS-B Rebroadcast Service – Formats and Coding

2.2.18.1 Introduction

The TIS-B MASPS, RTCA DO-286B defines, in addition to the "Fundamental TIS-B Service," an "ADS-B Rebroadcast Service" as an additional service that may be provided. The Messages of the ADS-B Rebroadcast Service are not transmitted by aircraft, but by ADS-B ground stations.

Notes:

1. *This section defines the formats and coding for an ADS-B Rebroadcast (ADS-R) Service (see the TIS-B MASPS, RTCA DO-286B, §1.4.1) based on the same 112-bit 1090 MHz Extended Squitter signal transmission that is used for DF=17 ADS-B Messages on 1090 MHz.*

2. *The ADS-B Rebroadcast Service complements the operation of ADS-B and the Fundamental TIS-B Service (see the TIS-B MASPS, RTCA DO-286B, §1.4.1) by providing ground-to-air rebroadcast of ADS-B data about aircraft that are not equipped for 1090 MHz Extended Squitter ADS-B, but are equipped with an alternate form of ADS-B (e.g., Universal Access Transceiver (UAT)). The basis for the ADS-R transmission is the ADS-B Report received at the Ground Station using a receiver compatible with the alternate ADS-B data link.*

3. *The ADS-R ground-to-air transmissions use the same signal formats as the DF=17 1090 MHz Extended Squitter ADS-B and can therefore be accepted by a 1090 MHz ADS-B Receiving Subsystem, with the exceptions identified in the following sections.*

2.2.18.2 ADS-B Rebroadcast Format Definition

ADS-B Rebroadcast information is~~shall be~~ transmitted using the 112-bit Mode S DF=18 format specified in Figure 2-2.

2.2.18.3 Control Field Allocation

The content of the DF=18 transmission is defined by the value of the Control Field (CF). As specified in Table 2-11, ADS-B Rebroadcast (i.e., ADS-R) transmissions ~~shall~~ use CF=6, and ADS-R Management information

transmissions (i.e., defining ADS-R Service Volume and service availability) use CF=4. The ADS-B Receiving Subsystem **shall** accept and process ADS-R Messages, DF=18, with CF=4 and CF=6.

2.2.18.4 ADS-R ~~B Rebroadcast Surveillance~~ Message ~~Definition~~Processing

The Rebroadcast of ADS-B information on the 1090 MHz Extended Squitter data link is accomplished by utilizing the same ADS-B Message formats ~~defined in Figure A-1 through Figure A-10,~~ used by aircraft/vehicles with the exception of the need to transmit an indication to the 1090 MHz Receiving Subsystem as to the type of identity associated with the aircraft data being reported in the ADS-B Rebroadcast Message. This identification is performed using the ICAO/Mode A Flag (IMF), which was previously discussed in §2.2.17.3.1.2 for the TIS-B transmissions.

The insertion of this one bit into the ADS-B Messages identified in the subparagraphs below allows the ADS-B Receiving Subsystem to interpret the Address Field (AF) in the following manner:

IMF = 0 ~~**shall**~~ indicates that the ADS-B Rebroadcast data is identified by an ICAO 24-bit Address.

IMF = 1 ~~**shall**~~ indicates that the ADS-B Rebroadcast data is identified by an anonymous 24-bit address or ground vehicle address or fixed obstruction address.

The ADS-B Receiving System outputs data to ADS-B applications for aircraft/vehicles received via ADS-R Messages similar to direct reception of ADS-B Messages from aircraft/vehicles. ADS-R Messages may be received ~~form~~from a Ground Station transmitting Version 1 or Version 2 ~~equipped aircraft/vehicles~~ADS-B Messages that ~~are~~have been ~~transmitting~~received by the Ground Station ~~on~~from an aircraft or vehicle transmitting on an alternate ADS-B data link. Therefore, to correctly decode the data, knowledge of the MOPS Version number is required. The ADS-B Receiver **shall** decode all valid ADS-R transmitted messages and structure the information from such messages into the appropriate ADS-B Reports as per §2.2.8 and designate them as ADS-R Reports.

Note: ADS-B applications may need to distinguish ADS-B Reports generated from direct receipt and those received via ADS-R.

2.2.18.4.1 ~~Rebroadcast of~~ ADS-R~~B~~ Airborne Position Messages

The ADS-B Receiving Subsystem **shall** decode and process t~~T~~he ME Field of the ~~Rebroadcast~~ ADS-R~~B~~ Airborne Position Message and update and maintain ADS-R Reports with the decoded data in accordance with §2.2.18.5. ~~**shall be formatted**~~ The format is as specified in Figure 2-2.18.4.1~~3~~.

Note1: The format is identical to the Airborne Position Message depicted in Figure 2-3~~,~~ except that ME bit 8 is redefined to be the ICAO/Mode A Flag (IMF).

Note 2: The interpretation of the TYPE Code is different between Version 1 and Version 2. See Appendix N-XX for decoding Version 1 and §2.2.3.2.3 for decoding Version 2.

ADS-R Airborne Position Message "ME" Field								
MSG BIT #	33 -37	38 ---------- 39	40	41 ----- 52	53	54	55 ---- 71	72 ---- 88
"ME" BIT #	1 – 5	6 ---------- 7	8	9 ----- 20	21	22	23 --- 39	40 --- 56
FIELD NAME	**TYPE [5]**	**SURVEILLANCE STATUS [2]**	**IMF [1]**	**ALTITUDE [12]**	**TIME (T) [1]**	**CPR FORMAT (F) [1]**	**ENCODED LATITUDE [17]**	**ENCODED LONGITUDE [17]**
	MSB LSB	MSB LSB		MSB LSB			MSB LSB	MSB LSB

Note: *"[#]" provided in the Field indicates the number of bits in the field.*

Figure 2-2.18.4.1: ADS-R Airborne Position Message Format

2.2.18.4.2 ~~Rebroadcast of~~ ADS-R~~B~~ Surface Position Messages

The ADS-B Receiving Subsystem **shall** decode and process the ME Field of the ADS-R Surface Position Message and update and maintain ADS-R Reports with the decoded data in accordance with §2.2.18.5. The format is as specified in Figure 2-2.18.4.2~~The ME Field of the Rebroadcast ADS-B Surface Position Message **shall** be formatted as specified in Figure 2-5~~.

Note: The format is identical to the Surface Position Message depicted in Figure 2-5 except that ME bit 21 is redefined to be the ICAO/Mode A Flag (IMF).

Note 2: The interpretation of the TYPE Code is different between Version 1 and Version 2. See Appendix N-XX for decoding Version 1 and §2.2.3.2.4 for decoding Version 2.

~~, except that ME bit 21 is redefined to be the ICAO/Mode A Flag (IMF).~~

ADS-R Surface Position Message "ME" Field								
MSG BIT #	33 - 37	38 - 44	45	46 - 52	53	54	55 - 71	72 - 88
"ME" BIT #	1 - 5	6 - 12	13	14 - 20	21	22	23 - 39	40 – 56
FIELD NAME	**TYPE [5]**	**MOVEMENT [7]**	**HEADING/ GROUND TRACK STATUS [1]**	**HEADING/ GROUND TRACK [7]**	**IMF [1]**	**CPR FORMAT (F) [1]**	**ENCODED LATITUDE [17]**	**ENCODED LONGITUDE [17]**
	MSB LSB	MSB LSB		MSB LSB			MSB LSB	MSB LSB

Note: *"[#]" provided in the Field indicates the number of bits in the field.*

Figure ~~2-5~~2.2.18.4.2: ADS-R Surface Position Message Format

2.2.18.4.3 ~~Rebroadcast of~~ ADS-R~~B~~ Aircraft Identification and Category Messages

The ADS-B Receiving Subsystem **shall** decode and process the ME Field of the ADS-R Aircraft Identification and Category Message and update and maintain ADS-R Reports with the decoded data in accordance with §2.2.18.5. The format is as specified in ~~The ME Field of the Rebroadcast ADS-B Aircraft Identification and Category Message **shall** be formatted exactly as specified in~~ Figure 2-6.

Note: *Any Rebroadcast ADS-B Aircraft Identification and Category Message does not contain the IMF bit since aircraft using an anonymous 24-bit address will not provide identity and category information.*

2.2.18.4.4 ~~Rebroadcast of~~ ADS-R~~B~~ Airborne Velocity Messages

The ADS-B Receiving Subsystem **shall** decode and process the ME Field of the ADS-R Airborne Velocity Message and update and maintain ADS-R Reports with the decoded data in accordance with §2.2.18.5. The ~~The ME Field of the Rebroadcast ADS-B Airborne Velocity Messages **shall** be~~ format ~~isted~~ as specified in Figure 2-~~7~~2.18.4.4.1 for Subtype 1 & 2 Messages, and in Figure 2-2.18.4.4.2~~8~~ for Subtype 3 & 4 Messages.

Note 1: The formats are identical to the Airborne Velocity Messages depicted in Figure 2-7 and Figure 2-8 except that ME bit 9 is redefined to be the ICAO/Mode A Flag (IMF).

Note 2: Bit 10 of the ME field in Version 1 is the IFR Capability Flag which is not conveyed in Version 2 transmitters.

~~, except that ME bit 9 is redefined to be the ICAO/Mode A Flag (IMF).~~

Airborne Velocity Message Subtype=1 and "2" "ME" Field

MSG BIT #	33 - 37	38 - 40	41	42	43 - 45	46	47 - 56	57	58 - 67	68	69	70 - 78	79 - 80	81	82 – 88
"ME" BIT #	1 - 5	6 - 8	9	10	11 - 13	14	15 - 24	25	26 - 35	36	37	38 - 46	47 - 48	49	50 – 56
FIELD NAME	TYPE [5]	Subtype [3]	IMF [1]	Spare [1]	NAC_V [3]	E/W Direction Bit [1]	E/W Velocity [10]	N/S Direction Bit [1]	N/S Velocity [10]	Vert Rate Source [1]	Vert Rate Sign [1]	Vert Rate [9]	Reserved [2]	Diff from Baro Alt Sign [1]	Diff from Baro Alt [7]
	MSB LSB	MSB LSB			MSB LSB		MSB LSB		MSB LSB			MSB LSB	MSB LSB		MSB LSB

Figure 2-2.18.4.4.1: ADS-R Airborne Velocity Message Subtype "1&2" Format

Airborne Velocity Message Subtype=3 and "4" "ME" Field													
MSG BIT #	33 - 37	38 - 40	41	42	43 - 45	46	47 - 56	57	58 - 67	68	69	70 - 78	79 - 80
"ME" BIT #	1 - 5	6 - 8	9	10	11 - 13	14	15 - 24	25	26 - 35	36	37	38 - 46	47 - 48
FIELD NAME	TYPE [5]	Subtype [3]	IMF [1]	Spare [1]	NAC_V [3]	Heading Status Bit [1]	Heading [10]	Airspeed Type [1]	Airspeed [10]	Vert Rate Source [1]	Vert Rate Sign [1]	Vert Rate [9]	Reserved [2]
	MSB LSB	MSB LSB			MSB LSB		MSB LSB		MSB LSB			MSB LSB	MSB LSB

Figure 2-2.18.4.4.2: ADS-R Airborne Velocity Message Subtype "3&4" Format

Note: *The "[#]" provided in the Field description columns of Figure 2-2.18.4.4.1 and Figure 2-2.14.4.4.2 indicates the number of bits in the respective FIELD.*

2.2.18.4.5 ~~Rebroadcast of~~ ADS-R~~B~~ Aircraft Emergency/Priority Status Messages

The ADS-B Receiving Subsystem **shall** decode and process the ME Field of the ADS-R Aircraft Emergency/Priority Status Messages and update and maintain ADS-R Reports with the decoded data in accordance with §2.2.18.5. The format is as specified in Figure 2-2.18.4.5.

Note 1: The format is identical to the Aircraft Emergency/Priority Status Message depicted in Figure 2-13 except that ME bit 56 is redefined to be the ICAO/Mode A Flag (IMF).

Note 2: The Mode A Code, bits 12 through 24 of the ME field is not conveyed in Version 1 Aircraft Emergency/Priority Status Messages (See Appendix N-XX.

~~The ME Field of the Rebroadcast ADS-B Aircraft Emergency/Priority Status Message **shall** be formatted as specified in Figure 2-13, except that ME bit 56 is redefined to be the ICAO/Mode A Flag (IMF).~~

"1090ES Aircraft Status Message (Emergency/Priority Status) (TYPE=28, Subtype=1)"						
Msg Bit #	33 ----- 37	38 ------ 40	41 -------- 43	44 --------- 56	57 ---------~~---~~ 87	88
"ME" Bit #	1 ------- 5	6 -------- 8	9 --------- 11	12 --------- 24	25 ---------~~---~~ 55	56
Field Name	TYPE=28 [5]	Subtype=1 [3]	Emergency/ Priority Status [3]	Mode A Code [13]	Reserved [44]	IMF
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	

Figure 2-2.18.4.5: ADS-R Aircraft Emergency/Priority Status Message Format

2.2.18.4.6 ~~Rebroadcast of~~ ADS-R~~B~~ Target State and Status Messages

The ADS-B Receiving Subsystem **shall** decode and process the ME Field of the ADS-R Target State and Status Messages and update and maintain ADS-R Reports with the decoded data in accordance with §2.2.18.5. The format is as specified in Figure 2-2.18.4.6.

Note 1: The format is identical to the Target State and Status Message depicted in Figure 2-10 except that ME bit 51 is redefined to be the ICAO/Mode A Flag (IMF).

~~*Note 2: The*~~

Target State and Status Message					
Msg Bit #	33 ---------- 37	38 --------- 39	40 ---------- ---------- 88	83	84 ------ 88
"ME" Bit #	1 ---------- 5	6 ---------- 7	8 ---------- ---------- 50	51	52 ------ 56
Field Name	**TYPE Code = 29 (11101) [5]**	**Subtype Code [2]**	**Intent/Status Information [43]**	**IMF [1~~49~~]**	**Intent/Status Information [5]**
	MSB LSB	MSB LSB	MSB LSB		MSB LSB

Figure 2-2.18.4.6: ADS-R "Target State and Status" Message Format

~~The ME Field of the Rebroadcast ADS-B Target State and Status Message **shall** be formatted as specified in Figure 2-10, except that ME bit 51 is redefined to be the ICAO/Mode A Flag (IMF).~~

2.2.18.4.7 ~~Rebroadcast of~~ ADS-R~~B~~ Aircraft Operational Status Messages

The ADS-B Receiving Subsystem **shall** decode and process the ME Field of the ADS-R Operational Status Messages and update and maintain ADS-R Reports with the decoded data in accordance with §2.2.18.5. The format is as specified in Figure 2-2.18.4.7-1 for Version 2 Operational Status Messages and Figure 2-2.18.4.7-2 for Version 1 format.

Note 1: The Version 2 format is identical to the Aircraft Operational Status Message depicted in Figure 2-11 except that ME bit 56 is redefined to be the ICAO/Mode A Flag (IMF) and ME bit 11 is redefined to be the NIC SUPPLEMENT B.

Note 2: The Version 1 format is identical to the Aircraft Operational Status Message depicted in Figure N-XX except that ME bit 56 is redefined to be the ICAO/Mode A Flag (IMF).

~~*The ME Field of the Rebroadcast ADS-B Aircraft Operational Status Message **shall** be formatted as specified in Figure 2-11, except that ME bit 56 is redefined to be the ICAO/Mode A Flag (IMF).*~~

Aircraft Operational Status ADS-B Message "ME" Field Format														
MSG BIT #	33 - 37	38 - 40	41 - 52	53 - 56	57 - 72	73 - 75	76	77 - 80	81 - 82	83 - 84	85	86	87	88
"ME" BIT #	1 - 5	6 - 8	9 - 20	21 - 24	25 - 40	41 - 43	44	45 - 48	49 - 50	51 - 52	53	54	55	56
FIELD NAME	**TYPE=31 [5]**	**Subtype=0 [3]**	**Capability Class (CC) Codes [16]**		**Operational Mode (OM) Codes [16]**	**MOPS Version Number [3]**	**NIC Supp. [1]**	**NAC_P [4]**	**GVA [2]**	**Source Integrity Level (SIL)**	**NIC_{BARO} [1]**	**HRD [1]**	**SIL Supp [1]**	**IMF [1]**

		Subtype=1 [3]	**CC Codes [12]**	**L/W Codes [4]**					**Reserved [2]**	**[2]**	**TRK/HDG [1]**			
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB		MSB LSB	MSB LSB	MSB LSB				

Note: *Subfields relevant only to Airborne Participants are allocated to Subtype ZERO (binary 000), while those that pertain only to Surface Participants are allocated to Subtype ONE (binary 001).*

Figure 2-2.18.4.7-1: ADS-R Aircraft Operational Status Message Version 2 Format

Aircraft Operational Status ADS-B Message "ME" Field Format														
MSG BIT #	33 - 37	38 - 40	41 - 52	53 - 56	57 - 72	73 - 75	76	77 - 80	81 - 82	83 - 84	85	86	87	88
"ME" BIT #	1 - 5	6 - 8	9 - 20	21 - 24	25 - 40	41 - 43	44	45 - 48	49 - 50	51 - 52	53	54	55	56
FIELD NAME	**TYPE=31 [5]**	**Subtype=0 [3]** / **Subtype=1 [3]**	**Capability Class (CC) Codes [16]** / **CC Codes [12]**	**L/W Codes [4]**	**Operational Mode (OM) Codes [16]**	**MOPS Version Number [3]**	**NIC Supp. [1]**	**NAC_P [4]**	**BAQ=0 [2]** / **Reserved [2]**	**Surveillance Integrity Level (SIL) [2]**	**NIC_{BARO} [1]** / **TRK/HDG [1]**	**HRD [1]**	**Reserved [1]**	**IMF [1]**
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB		MSB LSB	MSB LSB	MSB LSB				

Figure 2-2.18.4.7-2: ADS-R Aircraft Operational Status Message Version 1 Format

2.2.18.5 ADS-R Report Processing

ADS-R Reports **shall** be maintained and output for DF=18, with CF=4 ADS-R Messages consistent with the ADS-B Report Characteristics requirements of §2.2.8 and the Report Assembly and Delivery requirements of §2.2.10. ADS-R Reports **shall** be provided for both Version 1 and Version 2 formatted ADS-R Messages in accordance with the message formats provided in §2.2.18.4.

Note: ADS-R Reports are for Participants that do not have ADS-B Reports since they are ADS-B Messages transmitted by the Ground for aircraft/vehicles that transmit on a different ADS-B link (e.g. UAT). ADS-R Messages are processed by the 1090ES ADS-B Receiving System in the same manner as ADS-B Messages received directly from aircraft/vehicle Participants.