

AERONAUTICAL SURVEILLANCE PANEL (ASP)
SURVEILLANCE SYSTEMS
TECHNICAL SUBGROUP

**Proposed Change to Annex 10, Vol. IV for TIS-B Management
Messages**

(Prepared by Ron Jones)

Presented by Vince Orlando

SUMMARY
This CP proposes an addition of Doc 9871 to define TIS-B/ADS-R management messages..

1. Introduction

Currently the draft Doc 9871 includes DF=18 and CF=4 reserved for TIS-B management messages. As the development of TIS-B and ADS-R services have progressed a need has been identified to use the TIS-B management messages to convey the service volume of the TIS-B and ADS-R services that is being supported by the broadcasts from each specific ground station.

2. Proposal

It is proposed that the TSG review and accept the attached CP and submit the proposed changes to WG-B with the recommendation they be approved for incorporation into a future update to Doc 9871.

Submit to: Rapporteur ASP Working Group B

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1. Change No (Assigned by Rapporteur) Date submitted: July 2006
 Title: Doc 9871, Update for TIS-B Management Messages
2. List of all relevant ASP WG-B Working Papers: N/A
3. Background: Currently the draft Doc 9871 includes DF=18 and CF=4 reserved for TIS-B management messages. As the development of TIS-B and the ADS-R services have progressed a need has been identified to use TIS-B management messages to convey the service volumes of the TIS-B and ADS-R services that are being supported by the broadcasts from each specific ground station.
4. Need for change:. Aircraft receiving TIS-B and ADS-R services need to have knowledge of when they are within the TIS-B and ADS-R service volumes and can therefore expect to be receiving TIS-B and/or ADS-R messages related to nearby aircraft. Without such knowledge the operational utility of the TIS-B and ADS-R services may be compromised.
5. Change: See Attachment.
6. Category: (confirmed by Rapporteur)
 - X1. Addition - new material e.g. new GICB, MSP, or Broadcast.
 2. Update - technical change or correction to current document.
 3. Useful - will enhance understanding of the document.
 4. Cosmetic - needed to correct editorial error.

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Proposed changes and Additions to Doc 9871

1. Change to Appendix 2, Section 3.3

3.3 CONTROL FIELD ALLOCATION

The content of the DF=18 transmission shall be defined by the value of the control field, as specified in the following table.

CF Field Code Definitions in DF=18 ADS-B and TIS-B Messages		
CF Value	ICAO/Mode A Flag (IMF)	Meaning
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	Reserved for TIS-B/ADS-R management messages AA field holds TIS-B the service ID <u>in the form of the encoded latitude and longitude (12-bit CPR encoding of each) of the center of the TIS-B or ADS-R service volume (i.e., nominally the ground station location – see note). + other information (e.g., MSB of reference position for the service)</u>
5	0	TIS-B messages that relay ADS-B Messages using anonymous 24-bit addresses
	1	Reserved
6	0	ADS-B rebroadcast. (ADS-R) using the same type codes and message formats as defined for DF=17 ADS-B messages AA field contains the 24-bit ICAO aircraft address
	1	ADS-B rebroadcast. using the same type codes and message formats as defined for DF=17 ADS-B messages AA field contains a 24-bit anonymous aircraft address

Note. Typically the TIS-B and ADS-R service volumes will be centered around the location of the ground station location generating the broadcast. However, it is possible for the announced center of the service volume to be offset from the actual ground station if doing so provides for a better representation of the actual service volume. See 3.4.6.4 for more information.

3.4.6 ~~RESERVED FOR~~ TIS-B/~~ADS-R~~ MANAGEMENT MESSAGES

~~*Note. TIS-B Management Messages could announce information such as location and the service of the TIS-B ground station. There is no requirement for Management Messages. Format DF=18 with CF=4 has been reserved for such messages should they be required in the future.*~~

Note. TIS-B/ADS-R management messages are used to announce the availability of the TIS-B and/or ADS-R service and to describe the volume of airspace where the service is available.

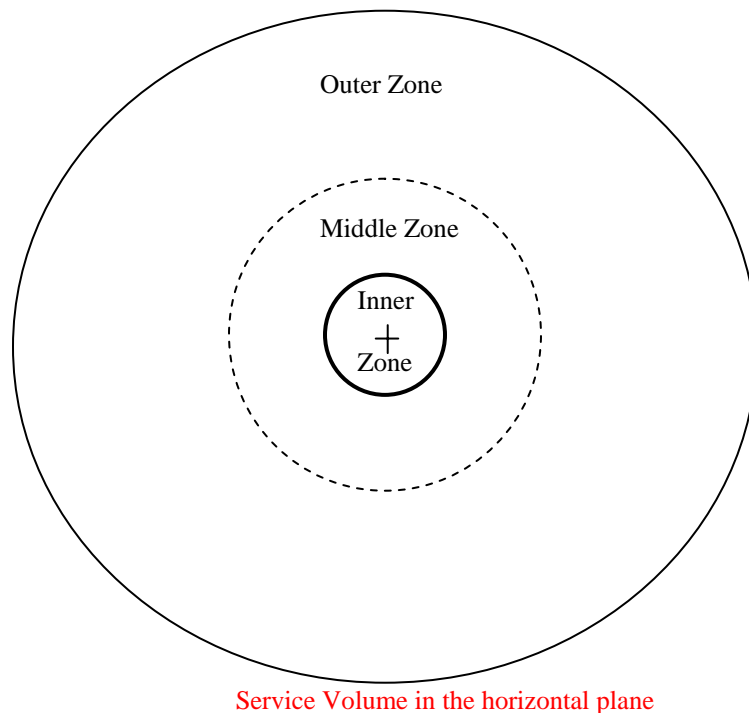
3.4.6.1 TIS-B/ADS-R Service Volume Definition

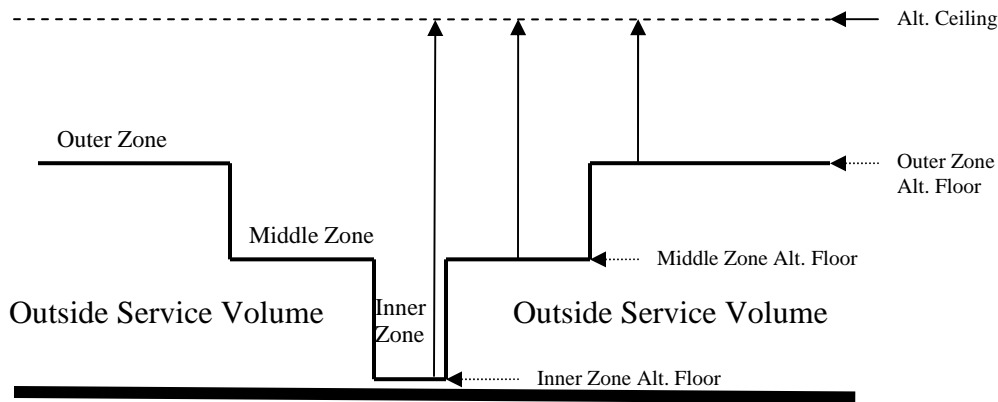
The service volume for the TIS-B and the ADS-R services may be individually defined via the broadcast from the ground of management messages that describe the airspace within which the TIS-B and/or the ADS-R services are being provided. The *TIS-B/ADS-R Service Volume and Heartbeat Message*, as defined by Table A2-3-7, **shall** be broadcast whenever TIS-B and/or ADS-R services are being offered in order to provide a 3 dimensional description of the service volume. When the actual shape of the outer bounds of the service volume is other than circular in shape (i.e., in the horizontal plane), the radius provided in the *TIS-B/ADS-R Service Volume and Heartbeat Message* **shall** be the largest value that fully fits within the actual bounds of the service volume.

Note 1. TIS-B and ADS-B use separate messages to describe the service volume for each of these services. The TIS-B service volume is constrained to the airspace having both an independent surveillance service (e.g, SSR) and ground-to-air coverage from the TIS-B ground station. The ADS-R service is constrained to the airspace having air-to-ground coverage from an alternative ADS-B link (i.e., other than Mode S Extended Squitter) and having ground-to-air coverage from the Extended Squitter ADS-R ground station. TIS-B and ADS-R may share the same ground station for the ground-to-air broadcast or use ground stations dedicated to the specific service. Also the desired service volume for the TIS-B or ADS-R services from a specific ground station may be constrained by the availability of ground-to-air services from other nearby ground stations with overlapping RF coverage.

Note 2. When the Surface Service Only – Flag bit within the TIS-B/ADS-R Service Volume and Heartbeat Message is set to 1 (one) the TIS-B or ADS-B service is limited to providing target information related to surface aircraft and vehicles at the location defined by the surface volume. In this case the inner and middle coverage zones have the service volume radius set to 0 (zero) and the boundary of the outer coverage zone then defines the surface location where the TIS-B or ADS-R service is being provided.

Note 3. The TIS-B/ADS-R Service Volume and Heartbeat Message permits the service volume to be described as the sum of 3 coverage zones (inner, middle and outer zones) with each zone defined as circular area and with a lower altitude floor. Also a altitude ceiling is provided that applies across the entire volume of airspace defined by boundary of the outer zone (i.e., also applies to the middle and inner zones). The use of three zones to depict the service volume is illustrated in the two figures below when viewed in the horizontal and in the vertical planes respectively.





Service Volume in the vertical plane

3.4.6.2 TIS-B/ADS-R Service Volume Contours

While simple circular service volumes (in the horizontal plane) can be described by the *TIS-B/ADS-R Service Volume and Heartbeat Message*, as discussed in 3.2.6.1 above, more complex shapes for the defining the outer bounds of the TIS-B and ADS-R service volumes may be necessary to avoid substantial areas of overlapping coverage from multiple ground stations. When it is determined that a more complex shape are appropriate for defining the outer boundary of the TIS-B and/or ADS-R service volume, *TIS-B/ADS-R Service Volume Contour Supplement Messages*, as defined in Table A2-3-8, **shall** be broadcast. Up to 3 supplement messages may be used providing for defining a maximum of nine points in the horizontal plane.

Note. The contour of the outer zone is then described as a polygon formed by connecting the set of 2-dimensional points conveyed in the supplemental messages. The TIS-B/ADS-R Service Volume and Heartbeat Message must have first been received and from information conveyed in that message the total number of supplement messages being broadcast can be determined. Once a complete set of supplemental messages have been received the resulting polygon is used by the airborne application for the shape of the outer zone of coverage instead of the simple circular shape conveyed within the TIS-B/ADS-R Service Volume and Heartbeat Message. The periodic rate at which each of the up to three types of supplement messages are broadcast for each the TIS-B and ADS-R service needs to be selected so as to ensure aircraft approaching the boundary of the outer service volume will have received, at high (e.g., 95%) probability, each type of these supplemental messages at least once.

3.4.6.3 TIS-B/ADS-R Heartbeat

The *TIS-B/ADS-R Service Volume and Heartbeat Message* is broadcast at a periodic rate sufficient to allow aircraft to detect when they are approaching or entering airspace where the TIS-B and/or ADS-R is available and also upon failure to receive the 'heartbeat' to detect when the TIS-B or ADS-R service is no longer available. The rate at which it is necessary for a ground station to broadcast the *TIS-B/ADS-R Service Volume and Heartbeat Message* depends on the expected reception probability for aircraft at the outermost boundary of the service volume. When the TIS-B and/or ADS-R service is provided by the ground, the *TIS-B/ADS-R Service Volume and Heartbeat Message* **shall** be transmitted at a sufficient periodic rate such that the loss of the TIS-B or ADS-R service can be detected, with high (e.g., 95%) probability, by the aircraft within 24 seconds.

Note. When providing both TIS-B and ADS-R services, separate TIS-B/ADS-R Service Volume and Heartbeat Messages are used for each service.

3.4.6.4 TIS-B/ADS-R Service Volume Center

Unlike other types of extended squitter messages, the *TIS-B/ADS-B Management Messages* (DF=18 and CF=4) encode the AA message field with information related to the location of the center of the TIS-B or ADS-R service volume rather than the address of an aircraft. This is done since the *TIS-B/ADS-R Management Messages* do not relate to any specific aircraft but rather relate to the TIS-B or ADS-R service. The coding of the AA field for *TIS-B/ADS-R Management Messages* **shall** be as shown below:

Latitude of TIS-B or ADS-R coverage center												Longitude of TIS-B or ADS-R coverage center											
1												12 13 24											

The latitude and longitude **shall** be encoded using the 12-bit CPR algorithm as defined in 2.6 supporting Globally Unique Surface Position decoding (see 2.6.8) by the receiving system on the aircraft. The Even/Odd flag bit required by CPR for Globally Unique Surface Position decoding is conveyed within each TIS-B/ADS-R Management Message (ME field bit 6).

Note. Typically the TIS-B and ADS-R service volumes will be centered around the location of the ground station that is generating the broadcast. However, it is possible for the announced center of the service volume to be offset from the actual ground station location if using such an offset permits a more accurate representation of the actual service volume. The announced latitude plus longitude for each TIS-B service volume, and for each ADS-R service volume, must be unique (i.e., have a unique value for the 24-bit AA field).

**Table A2-3-7 – TIS-B/ADS-R Management Message – Message Identifier = 0 or 4
TIS-B/ADS-R Service Volume and Heartbeat Messages**

ME FIELD

1	MSB	Purpose: To define the TIS-B and/or ADS-R service volume and to provide 'Heartbeat' indicating service availability.
2		
3	Message Identifier	
4		
5	LSB	Message Identifier Coding: 0 = TIS-B Service Radius/Heartbeat Message 1 = TIS-B Service Volume Contour Supplemental Message #1 2 = TIS-B Service Volume Contour Supplemental Message #2 3 = TIS-B Service Volume Contour Supplemental Message #3 4 = ADS-R Service Radius/Heartbeat Message 5 = ADS-R Service Volume Contour Supplemental Message #1 6 = ADS-R Service Volume Contour Supplemental Message #2 7 = ADS-R Service Volume Contour Supplemental Message #3 8 – 15 = Reserved
6	CPR Format (even/odd) for encoded Latitude and Longitude	
7	MSB	
8		
9	Outer Zone Service Volume Radius from Center Point (0 to 255 NM in 1.0 NM increments)	Service Volume Radius Encoded in binary where: - Outer Zone: radius = encoded binary value - Middle & Inner Zones: radius = 0.5 X (encoded binary value) - A binary value of 0 (zero) indicates that this zone is not used to define the overall service volume
10		
11		
12		
13		Service Volume Altitude Floor Encoded in binary where altitude floor = 100 X (encoded binary value)
14	LSB	
15	MSB	
16		
17	Outer Zone Service Volume Altitude Floor (0 to 25,500 feet in 100 foot increments)	
18		
19		
20		
21		
22	LSB	
23	MSB	
24		
25	Middle Zone Service Volume Radius from Center Point (0 to 63 NM in 0.5 NM increments)	
26		
27		
28		
29	LSB	
30	LSB	
31		
32	Middle Zone Service Volume Altitude Floor (9 to 6,300 feet in 100 foot increments)	
33		
34		
35	LSB	
36	MSB	
37		Number of supplemental messages used to broadcast Outer Zone Contour: = 0 (no contour available) = 1 (1 supplemental message) = 2 (2 supplemental messages) = 3 (3 supplemental messages)
38	Inner Zone Service Volume Radius from Center Point (0 to 15 NM in 0.5 NM increments)	
39		
40	LSB	
41	MSB	
42	Inner Zone Service Volume Altitude Floor (0 to 1,500 feet in 100 foot increments)	
43		
44	LSB	
45	MSB	Service Altitude Ceiling Encoded in binary where altitude ceiling = 1000 X (encoded binary value)
46	LSB Number of Messages used for Outer Zone Contour	
47	MSB	
48		
49	Service Altitude Ceiling (0 to 63,000 feet in 1,000 foot increments)	Surface Service Only - Flag = 0 (service applicable for airborne aircraft) = 1 (service only applicable to ground aircraft/vehicles)
50		
51		
52	LSB	
53	Surface Service Only – Flag	
54		
55	Reserved	
56		

**Table A2-3-8 – TIS-B/ADS-R Management Message – Message Identifier = 1, 2, 3, 5, 6 or 7
TIS-B/ADS-R Service Volume Contour Supplemental Messages**

ME FIELD

1	MSB	Purpose: To convey a set of points that together define a polygon representing the outer contour of the TIS-B or ADS-R service volume.
2	Message Identifier (MI)	
3		
4		
5	LSB	Message Identifier Coding: 0 = TIS-B Service Radius/Heartbeat Message
6	CPR Format (even/odd) for encoded Latitude and Longitude	
7	MSB	1 = TIS-B Service Volume Contour Supplemental Message #1 2 = TIS-B Service Volume Contour Supplemental Message #2 3 = TIS-B Service Volume Contour Supplemental Message #3 4 = ADS-R Service Radius/Heartbeat Message 5 = ADS-R Service Volume Contour Supplemental Message #1 6 = ADS-R Service Volume Contour Supplemental Message #2 7 = ADS-R Service Volume Contour Supplemental Message #3 8 – 15 = Reserved
8	Bearing Angle from Service Volume Center	
9	(0 to 359 degrees in 1.4078431 degree increments)	
10	For MI=1 or 5: contour point #1	
11	For MI=2 or 6: contour point #4	Bearing Angle from Service Volume Center (as indicated by the latitude/longitude conveyed in the Message AA field) to the Outer Zone Contour Point: Encoded as a weighted binary value with a resolution of 359/255 degrees
12	For MI=3 or 7: contour point #7	
13	LSB	
14		
15	MSB	Distance to Outer Zone Contour Point: Encoded binary value in nautical miles. A value of 0 (zero) is used to indicate that no contour point is provided
16	Distance from Service Volume Center	
17	(0 to 255 NM in 1.0 NM increments)	
18	For MI=1 or 5: contour point #1	
19	For MI=2 or 6: contour point #4	Distance to Outer Zone Contour Point: Encoded binary value in nautical miles. A value of 0 (zero) is used to indicate that no contour point is provided
20	For MI=3 or 7: contour point #7	
21	LSB	
22		
23	MSB	Distance to Outer Zone Contour Point: Encoded binary value in nautical miles. A value of 0 (zero) is used to indicate that no contour point is provided
24	Bearing angle from Service Volume Center	
25	(0 to 359 degrees in 1.4078431 degree increments)	
26	For MI=1 or 5: contour point #2	
27	For MI=2 or 6: contour point #5	Distance to Outer Zone Contour Point: Encoded binary value in nautical miles. A value of 0 (zero) is used to indicate that no contour point is provided
28	For MI=3 or 7: contour point #8	
29	LSB	
30		
31	MSB	Distance to Outer Zone Contour Point: Encoded binary value in nautical miles. A value of 0 (zero) is used to indicate that no contour point is provided
32	Distance from Service Volume Center	
33	(0 to 255 NM in 1.0 NM increments)	
34	For MI=1 or 5: contour point #2	
35	For MI=2 or 6: contour point #5	Distance to Outer Zone Contour Point: Encoded binary value in nautical miles. A value of 0 (zero) is used to indicate that no contour point is provided
36	For MI=3 or 7: contour point #8	
37	LSB	
38		
39	MSB	Distance to Outer Zone Contour Point: Encoded binary value in nautical miles. A value of 0 (zero) is used to indicate that no contour point is provided
40	Bearing Angle from Service Volume Center	
41	(0 to 359 degrees in 1.4078431 degree increments)	
42	For MI=1 or 5: contour point #3	
43	For MI=2 or 6: contour point #6	Distance to Outer Zone Contour Point: Encoded binary value in nautical miles. A value of 0 (zero) is used to indicate that no contour point is provided
44	For MI=3 or 7: contour point #9	
45	LSB	
46		
47	MSB	Distance to Outer Zone Contour Point: Encoded binary value in nautical miles. A value of 0 (zero) is used to indicate that no contour point is provided
48	Distance from Service Volume Center	
49	(0 to 255 NM in 1.0 NM increments)	
50	For MI=1 or 5: contour point #3	
51	For MI=2 or 6: contour point #6	Distance to Outer Zone Contour Point: Encoded binary value in nautical miles. A value of 0 (zero) is used to indicate that no contour point is provided
52	For MI=3 or 7: contour point #9	
53	LSB	
54		
55	Reserved	Distance to Outer Zone Contour Point: Encoded binary value in nautical miles. A value of 0 (zero) is used to indicate that no contour point is provided
56		