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Technical Standard Order

Subject: Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B) and Traffic Information Service - Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz)

1. PURPOSE. This Technical Standard Order (TSO) is for manufacturers of 1090 MHz ADS-B and TIS-B equipment applying for a TSO authorization or letter of design approval. In it, we tell you what minimum performance standards (MPS) your 1090 MHz ADS-B and TIS-B equipment must first meet for approval and identification with the applicable TSO marking.

2. APPLICABILITY. This TSO affects new applications submitted after this TSO's effective date.

3. REQUIREMENTS. New models of 1090 MHz ADS-B and TIS-B equipment identified and manufactured on or after the effective date of this TSO must meet the MPS set forth in Section 2 of RTCA Document No. (RTCA/DO-260A), Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B) and Traffic Information Services - Broadcast (TIS-B), dated April 10, 2003, with the exception detailed in item **3a(3)** below, and as modified by Section 2, Appendix A of this TSO. The 1090 MHz equipment classes applicable to this TSO are defined in RTCA/DO-260A, Section 2.1.11.

a. Functionality.

(1) The standards of this TSO apply to aircraft equipment intended to transmit or receive broadcast messages about an aircraft's position (latitude and longitude), velocity, time, integrity, and other parameters. Similarly equipped operators will share these messages with one another, and ground-based facilities, such as air traffic services. These message parameters form the basis for various ADS-B and TIS-B reports.

(2) This TSO supports two major classes of 1090 MHz ADS-B and TIS-B equipment: Class A equipment, which includes transmit and receive subsystems; and Class B equipment, which includes a transmit subsystem only.

(a) Class A equipment includes Classes A0, A1, A2 and A3. We require 1090 MHz airborne Class A equipment to include the capability of receiving both ADS-B and TIS-B messages and delivering both ADS-B and TIS-B reports, as well as the capability of transmitting ADS-B messages.

(b) Class B equipment includes Classes B0 and B1. Classes B2 and B3 are not for aircraft use. Classes B0 and B1 are the same as A0 and A1, except they do not have receive subsystems.

(3) We allow for Transmit-Only, Class B1 systems as defined by the MPS of RTCA/DO-260, Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B), dated September 13, 2000, and Section 1, Appendix A of this TSO. Manufacturers should note that equipment built to RTCA/DO-260 standards may not be compatible with future applications as defined in RTCA/DO-289 Minimum Aviation System Performance Standards for Aircraft Surveillance Applications, dated December 9, 2003.

b. Use of ADS-B Reports in Airborne Applications. This TSO addresses only broadcasting messages from transmit subsystems and assembling reports in receiver subsystems. The MPS of this TSO do not address applications that use the information in reports. Manufacturers of 1090 MHz ADS-B and TIS-B equipment must seek design approval for applications. They can get design approval by complying with an appropriate TSO for the subject application or, during installation approval, through the type certification or supplemental type certification process as the case may be. During the certification process, 1090 MHz ADS-B and TIS-B equipment approved under this TSO may require installation limitations. These limitations should draw attention to those applications that must be validated as part of the installation approval process.

> **NOTE:** For industry-recommended practices on how to display ADS-B and TIS-B information, see the guidance contained in the documents listed below:
>
> RTCA/DO-243, Guidance for Initial Implementation of Cockpit Display of Traffic Information, dated February 19, 1998;
>
> RTCA/DO-249, Development and Implementation Planning Guide for Automatic Dependant Surveillance Broadcast (ADS-B) Applications, dated October 6, 1999;
>
> RTCA/DO-259, Application Descriptions for Initial Cockpit Display of Traffic Information (CDTI) Applications, dated September 13, 2000; and
>
> SAE Aerospace Recommended Practice, Human Interface Criteria for Cockpit Display of Traffic Information, ARP5365, dated January 1999.

c. Failure Condition Classification. Failure of the function defined in paragraphs **3** and **3a** of this TSO will depend on the equipment's intended use for the ADS-B and TIS-B report information. For the least demanding uses, the failure condition classifications for the different classes of 1090 MHz equipment are as follows:

(1) For Class A0 receiver subsystems, we consider an un-annunciated failure that provides onboard applications with incorrect reports a minor failure condition. A minor failure condition should occur no more than once per 10^3 flight hours.

(2) For all other classes of 1090 MHz ADS-B and TIS-B receiver subsystems, we consider an un-annunciated failure that provides onboard applications with incorrect reports a major failure condition. A major failure condition should occur no more than once per 10^5 flight hours.

(3) For all classes of 1090 MHz ADS-B transmitter subsystems, we consider an un-annunciated failure that broadcasts incorrect ADS-B messages to users a major failure condition. An un-annunciated failure resulting in loss of function is considered minor.

> **NOTE:** The above failure condition classifications are driven by airspace considerations. They are independent of the aircraft on which the equipment is to be installed.

(4) To meet at least a design assurance level equal to a minor failure condition, manufacturers must develop software to RTCA/DO-178B, Level D. For a major failure condition, they must develop software to RTCA/DO-178B, Level C.

(5) You may develop equipment to a higher design assurance level in anticipation of more demanding applications. For example, if the 1090 MHz ADS-B equipment can broadcast messages that include information about the status of own-ship Traffic Alert and Collision Avoidance System (TCAS), and this information could be used by other aircraft to make decisions about maneuvering, the failure condition classification for erroneous data of this type could be hazardous/severe-major. Manufacturers should state, and include in the operating instructions and equipment limitations, the hardware and software design assurance levels to which they developed the equipment.

(6) You must also state – and include in the operating instructions and equipment limitations – any assumptions pertaining to the aircraft installation, software and hardware used in the interface, or procedures required for maintaining the design assurance levels.

d. Functional Qualification. Demonstrate the required performance under the test conditions in RTCA/DO-260A, Section 2.4. If you build Class B1 equipment to the MPS described in Section **3a(3)** of this TSO, use RTCA/DO-260, Section 2.4, and Section 1, Appendix A of this TSO.

e. Environmental Qualification. Test the equipment to the conditions in RTCA/DO-160D, Environmental Conditions and Test Procedures for Airborne Equipment, dated July 29, 1997. The means for verifying equipment performance must be consistent with the test procedures specified in RTCA/DO-260A, Section 2.3. If you build Class B1 equipment to the MPS described in Section **3a(3)** of this TSO, use RTCA/DO-260, Section 2.3, and Section 1, Appendix A of this TSO.

f. Software Qualification. If the article includes a digital computer, develop the software in accordance with RTCA/DO-178B, Software Considerations in Airborne Systems and Equipment Certification, dated December 1, 1992.

g. Deviations. We provide for alternative or equivalent means of compliance to the MPS of this TSO. If you invoke these provisions, demonstrate that an equivalent level of safety is maintained and apply for a deviation per 14 CFR § 21.609.

4. MARKING. Under 14 CFR § 21.607(d), mark articles manufactured under this TSO as follows:

a. At least one major component must be permanently and legibly marked with all of the information listed in 14 CFR § 21.607(d).

b. Also, mark the following permanently and legibly, with at least the name of the manufacturer, manufacturer's subassembly part number, and the TSO number:

(1) Each component that is easily removable (without hand tools);

(2) Each interchangeable element; and

(3) Each subassembly of the article that you determined may be interchangeable.

c. Transmitting and receiving components must be permanently and legibly marked. The following table explains how to mark components. Find the equipment class in RTCA/DO-260A, Section 2.1.11, and the receiving equipment type in RTCA/DO-260A, Section 2.2.6. If you build Class B1 equipment to the MPS described in Section **3a(3)** of this TSO, use RTCA/DO-260, Section 2.1.11.

If component can:	Mark it with:	Sample marking pattern:
Transmit and receive	Equipment class it supports, and Receiving equipment type	Class A0/Type 1
Transmit, but not receive	Equipment class it supports	Class B1, or Class A3-Transmitting Only
Receive, but not transmit	Equipment class it supports, and Receiving equipment type	Class A2/Type 2-Receiving Only

d. If the component includes a digital computer, then the part number must include hardware and software identification. Or, you can use a separate part number for hardware and software. Either way, you must include a means for showing the modification status.

> **Note:** Similar software versions, approved to different software levels, must be differentiated by part number.

e. When applicable, identify the component or equipment as a partial system or that the appliance does anything beyond the functions in paragraphs **3** and **3a** of this TSO.

5. APPLICATION DATAREQUIREMENTS. Under 14 CFR § 21.605(a)(2), the manufacturer must furnish the Manager, Aircraft Certification Office (ACO), responsible for the manufacturer's facilities, one copy each of the following technical data to support the FAA design and production approval:

a. Operating instructions and equipment limitations, sufficient to describe the operational capability of the equipment. In particular, manufacturers must describe in detail operational or installation limitations that result from specific deviations granted.

b. Installation procedures and limitations that sufficiently ensure the 1090 MHz ADS-B and TIS-B equipment, when installed per the installation procedures, continues to meet the requirements of this TSO. The limitations must identify any unique aspects of the installation. For non-transponder-based 1090 MHz ADS-B equipment, manufacturers must include a limitation that the equipment cannot be co-installed in aircraft with a Mode-S transponder (see RTCA/DO-260A Section 3.0). Finally, the limitations also must include a note with the following statement:

> The conditions and tests required for TSO approval of this article are minimum performance standards. Those installing this article on, or in a specific type or class of aircraft, must determine that the aircraft installation conditions are within the TSO standards. TSO articles must have separate approval for installation in an aircraft. The article may be installed only if performed under 14 CFR Part 43 or the applicable airworthiness requirements.

Note: If you build Receiving Only class of equipment (see paragraph **4c** of this TSO), you must also include the following statement:

> Installation of this Receiving Only class of equipment is intended only for those aircraft in which a 1090 MHz ADS-B transmit class of equipment, or other complementary ADS-B link transmit class of equipment (e.g., UAT), is already installed.

c. Schematic drawings, as applicable to the installation procedures.

d. Wiring diagrams, as applicable to the installation procedures.

e. List of the components, by part number, that make up the 1090 MHz ADS-B and TIS-B system complying with the standards in this TSO. Manufacturers should include vendor part number cross-references, when applicable.

f. Instructions covering periodic maintenance, calibration, repair, and continued airworthiness of the installed 1090 MHz ADS-B and TIS-B equipment. The instructions should also describe details of deviations granted, as noted in paragraph **5a** of this TSO.

g. Material and process specifications list.

h. The quality control system description required by 14 CFR §§ 21.605(a)(3) and 21.143(a), including functional test specifications for testing each production article to ensure compliance with this TSO.

i. Manufacturer's TSO qualification test report on the results of the testing required by paragraph **3d**.

j. Nameplate drawing giving the information required by paragraph **4** of this TSO.

k. A list of all drawings and processes, including revision level, necessary to define the article's design. For minor changes, manufacturers only need to provide these revisions to the drawing list on request by the ACO.

l. An environmental qualification form as described in RTCA/DO-160D, Appendix A, for each component of the system.

m. If the article includes a digital computer: Plan for Software Aspects of Certification (PSAC); Software Configuration Index; and Software Accomplishment Summary. We recommend that manufacturers submit the PSAC early in the software development process. Early submittal will allow us to quickly resolve issues, such as partitioning and determination of software levels.

6. MANUFACTURER DATA REQUREMENTS. Besides the data given directly to the FAA, a manufacturer must have the following technical data available for review by the responsible ACO:

a. The functional qualification specifications for qualifying each production article to ensure compliance with this TSO.

b. Equipment calibration procedures.

c. Corrective maintenance procedures within 12 months after TSO authorization.

d. Schematic drawings.

e. Wiring diagrams.

f. Material and process specifications.

g. The results of the environmental qualification tests conducted per RTCA/DO-160D and RTCA/DO-260, Section 2.3, or RTCA/DO-260A, Section 2.3, as appropriate.

h. If the article includes a digital computer, the appropriate documentation as defined in RTCA/DO-178B, including all data supporting the applicable objectives in Annex A of RTCA/DO-178B, Process Objectives and Outputs by Software Level.

7. FURNISHED DATA REQUIREMENTS. If furnishing one, or multiple articles to one source (such as an operator or repair station), provide the following for each article manufactured under this TSO:

a. One copy of the data in paragraphs **5a** through **5f** and **5l** of this TSO. Add any other data needed for the proper operation, storage, or continued airworthiness of the 1090 MHz ADS-B and TIS-B equipment.

b. One copy of the data in paragraphs **5k** and **5m** of this TSO, if the appliance performs functions beyond those described in paragraphs **3** and **3a** of this TSO.

8. HOW TO GET REFERENCED DOCUMENTS.

a. You can buy copies of RTCA document from RTCA, Inc., 1828 L Street, N.W., Suite 805, Washington, D.C. 20036; telephone (202) 833-9339, fax (202) 833-9434. You can also obtain copies through the RTCA Internet website: http://www.rtca.org.

b. You can buy copies of SAE document from SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001; telephone (724) 776-4970, fax (724) 776-0790. You can also obtain copies through the SAE Internet website @ www.sae.org.

c. You can buy copies of Federal Aviation Regulations 14 CFR Part 21, Subpart O, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402-9325; telephone (202) 512-1800, fax (202) 512-2250. You can also obtain copies from the Government Printing Office (GPO), electronic CFR Internet website @ http://www.gpoaccess.gov/ecfr/.

d. You can obtain Advisory Circular (AC) 20-110L (or current revision), "Index of Aviation Technical Standard Orders," from the U.S. Department of Transportation, Subsequent Distribution Office, DOT Warehouse, M30, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785; telephone (301) 322-5377 or fax (301) 386-5394. You can also obtain copies on the Internet from the FAA's Regulatory and Guidance Library (RGL) @ www.airweb.faa.gov/rgl. On the RGL website, click on "Advisory Circulars." Then select the desired AC "By Number."

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APPENDIX 1. Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B) and Traffic Information Service - Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz)

This Appendix prescribes the Minimum Performance Standards (MPS) for 1090 MHz Extended Squitter Transmitting and Receiving Subsystems, modified by the FAA in this TSO. The applicable standards for those changes requested in Section 1 of this Appendix is RTCA Document No. (RTCA/DO)-260, "*Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B),*" issued September 13, 2000. The applicable standards for those changes requested in Section 2 of this Appendix is RTCA/DO-260A, "*Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B),"* issued April 10, 2003.

SECTION 1 -

(1.1) In RTCA/DO-260, replace section §2.2.3.2.1.1.2, subparagraph "c," including Table 2-9A, with the following:

c. Air/Ground Determination

(1). If a transmitting ADS-B participant is not equipped with a means, such as a weight-on-wheels switch, to determine whether it is airborne or on the surface, and that participant's Emitter Category (§2.2.3.2.5.2) is one of the following, then it **shall** set its Air/Ground State to "Airborne," and broadcast the Airborne Position Message (§2.2.3.2.3):

- Unknown Emitter Category
- Light Aircraft
- Rotorcraft
- Glider or Sailplane
- Lighter Than Air
- Unmanned Aerial Vehicle
- Ultralight, Hang Glider or Paraglider
- Parachutist or Skydiver
- Point Obstacle
- Cluster Obstacle
- Line Obstacle

Notes:

1. *Because of the unique operating capabilities of "Lighter-Than-Air" vehicles, i.e., balloons, an operational "Lighter-Than-Air" vehicle will always report the "Airborne" State, unless the "ON-GROUND" State is specifically declared in compliance with subparagraph "(4)" below.*
2. *Because of the fact that it is important for Fixed Ground or Tethered Obstacles to report altitude, such objects will always report the "Airborne" state.*

3. *Because of the unique capabilities of Rotorcraft, i.e., hover, etc., an operational Rotorcraft will always report the "Airborne" state unless the "ON-GROUND" state is specifically declared in compliance with subparagraph "(4)" below.*
4. *An automatic means of determining air/ground status may include Weight-on-Wheels discrete, Airspeed, Ground Speed, Radio Altitude, or other appropriate data sources.*

(2). If a transmitting ADS-B participant's Emitter Category (§2.2.3.2.5.2) is one of the following, then that participant **shall** set its Air/Ground State to the "ON-GROUND" condition and broadcast the Surface Position Message (§2.2.3.2.4):

- Surface Vehicle – Emergency
- Surface Vehicle – Service

(3). If a transmitting ADS-B participant is not equipped with a means, such as a weight-on-wheels switch, to determine whether it is airborne or on the surface, and its ADS-B Emitter Category (§2.2.3.2.5.2) is not one of those listed under tests (1) or (2) above (i.e., the participant's Emitter Category is either: Small, Large, High Vortex Large, Heavy, Highly Maneuverable, or Space/Trans-Atmospheric), then the following tests will be performed to determine whether to broadcast the Airborne or Surface Position Messages.

a. If the participant's Radio Height (RH) parameter is available, and RH < 50 feet, and at least Ground Speed (GS) or Airspeed (AS) is available, and the available GS < 100 knots, or the available AS < 100 knots, then that participant **shall** broadcast the Surface Position Message (§2.2.3.2.4).

   If all three parameters are available, the decision to broadcast the Airborne or Surface Position Messages **shall** be determined by the logical "AND" of all three parameters.

b. Otherwise, if Radio Height (RH) is not available, and if the participant's Ground Speed (GS) and Airspeed (AS) are available, and GS < 50 knots and AS < 50 knots, then that participant **shall** broadcast the Surface Position Message (§2.2.3.2.4).

c. Otherwise, the participant **shall** broadcast the Airborne Position Message (§2.2.3.2.3).

(4). If a transmitting ADS-B participant is equipped with a means, such as a weight-on-wheels switch, to determine automatically whether it is airborne or on the surface, then such information **shall** be used to determine whether to broadcast the Airborne Position Message (§2.2.3.2.3), or the Surface Position Message (§2.2.3.2.4).

(1.2) In RTCA/DO-260, replace section §2.2.3.2.3.1.2 with the following:

If HPL (or HIL) is not available from the sensor, then the 1090 MHz Extended Squitter equipment may use other means to establish an appropriate HPL (e.g. HPL based upon known RAIM protection threshold). When this derived HPL is established, this information **shall** be used to encode NUC. If the 1090 MHz Extended Squitter equipment is not able to establish an appropriate HPL and a valid position is reported, then the NUC **shall** be encoded to indicate that the integrity containment is unknown (i.e., TYPE Code 18).

(1.3) In RTCA/DO-260 section §2.2.3.2.7.1, which was entitled "Aircraft Trajectory Intent" Messages, was completely replaced with the publication of RTCA/DO-260A. Manufacturers are directed not to implement any of the requirements in RTCA/DO-260 section §2.2.3.2.7.1 or any of its subsections.

(1.4) In RTCA/DO-260, section §2.2.3.2.7.2, which was entitled "Aircraft Operational Coordination" Messages, was completely deleted with the publication of RTCA/DO-260A. Manufacturers are directed not to implement any of the requirements in RTCA/DO-260 section §2.2.3.2.7.2 or any of its subsections.

(1.5) Implementation of the requirement for Mode A broadcast is optional for 1090 MHz Extended Squitter Transmit-Only, Class B1 equipment complying with the MPS in RTCA/DO-260 as defined in section 3a(3) of this TSO. If a manufacturer elects not to implement this requirement, then no change is required for RTCA/DO-260, section §2.2.3.2.7.4, and no transmission of the TYPE "23" TEST Message is required. However, if a manufacturer elects not to implement this optional requirement, the following statement must be included in the limitations section of their Installation Manual:

"**Note:** This equipment does not support 1090 MHz Extended Squitter broadcast of the Mode A Code, and therefore may not support future air-ground ADS-B applications that will require this information for safe separation of aircraft in non-radar environments."

If a manufacturer elects to implement this requirement, then in RTCA/DO-260, replace section §2.2.3.2.7.4 with the following:

2.2.3.2.7.4 TYPE "23" ADS-B Event – Driven Messages for "TEST"

TYPE "23" ADS-B Messages **shall** be used for Test Purposes. "TEST" Messages **shall** be used exclusively for the broadcast of information in support of bench and/or certification testing of 1090 MHz ADS-B systems, or for the broadcast of information of interest only to local ADS-B ground applications.

"TEST" Message broadcasts will not result in an ADS-B report being generated onboard any other ADS-B equipped aircraft, nor is the specific information being included in the "TEST" Message expected to be generally codified within internationally accepted standards. "TEST" Messages containing information of interest only to local ADS-B ground applications are intended to be used in support of technical or operational evaluations, or in support of local operational requirements.

These MOPS define two categories of use for "TEST" Messages, SUBTYPE=0 and SUBTYPE=7. "TEST" messages of SUBTYPEs 1 through 6 are reserved.

2.2.3.2.7.4.1 "TEST" Messages with SUBTYPE = 0

"TEST" Messages with SUBTYPE=0 **shall** be used only for messages in support of bench and or certification testing of 1090 MHz ADS-B systems. The format for the "TEST" Messages with SUBTYPE=0 shall be as shown in Figure 2.2.3.2.7.4-1.

	"TEST MESSAGE (TYPE=23 and SUBTYPE=0)"		
Msg. Bit #	33 37	38 40	41 88
"ME" Bit #	1 5	6 8	9 56
Field Name	Type = 23 [5]	Subtype = 0 [3]	Unformatted Test Data [48]
	MSB LSB	MSB LSB	MSB LSB

Figure 2.2.3.2.7.4-1: Format of "TEST" Messages with SUBTYPE=0

2.2.3.2.7.4.2 "TEST" Messages with SUBTYPE = 7

Notes:

1. *The "TEST" Message with SUBTYPE=7 is provided as a transitional feature to aid operation of ground ATC automation systems that use the Mode A code for flight plan correlation. The requirement for this message may be removed from future versions of these MOPS.*

2. *The "TEST" Message with SUBTYPE=7 is not applicable to Class B2 equipment.*

"TEST" Messages with SUBTYPE=7 **shall** be used for the broadcast of the Mode A, 4096, code currently assigned to the aircraft. The format for "TEST" Messages with SUBTYPE=7 **shall** be as shown in Figure 2.2.3.2.7.4-2. The Mode A Code subfield **shall** be coded as defined in

RTCA DO-181C, §2.2.13.1.2.b and §2.2.4.1.2. Starting with "ME" bit 9, the sequence **shall** be C1, A1, C2, A2, C4, A4, ZERO, B1, D1, B2, D2, B4, D4.

"TEST" Messages with SUBTYPE=7 **shall not** be broadcast when the aircraft is in the "On-Ground" status (§2.2.3.2.1.1.2).

	"TEST MESSAGE (TYPE=23 and SUBTYPE=7)"			
Msg. Bit #	33 37	38 40	41 53	54 88
"ME" Bit #	1 5	6 8	9 21	22 56
Field Name	Type = 23 [5]	Subtype = 7 [3]	Mode A Code [13]	Reserved [35]
	MSB LSB	MSB LSB	MSB LSB	MSB LSB

Figure 2.2.3.2.7.4-2: Format of "TEST" Messages with SUBTYPE=7

2.2.3.2.7.4.2.1 "TEST" Messages with SUBTYPE=7, Global Enable/Inhibit

Provision **shall** be made for a global parameter to control the transmission of the "TEST" Message with SUBTYPE=7. This parameter **shall** specify one of the following conditions:

a. Inhibit transmission of the SUBTYPE 7 TEST message
b. Enable transmission of the SUBTYPE 7 TEST message
c. Enable transmission of the SUBTYPE 7 TEST message with a geographic filter (§2.2.3.2.7.4.2.2)

For this version of these MOPS, the parameter **shall** be set as specified in subparagraph "c," above.

2.2.3.2.7.4.2.2 "TEST" Messages with SUBTYPE=7, Geographic Filter

Note: *Geographic filtering is used as a means to automatically enable or inhibit the broadcast of the "TEST" Message with SUBTYPE=7 which conveys the Mode A Code of the aircraft. The following paragraphs define the minimum level of geographic filtering necessary to satisfy this requirement. More sophisticated geographic filtering techniques may be used provided they can be demonstrated to enable the broadcast of "TEST" Messages with SUBTYPE=7 when the aircraft is operating within US airspace and inhibited when operating outside the general boundaries of North America (plus Hawaii).*

The broadcast of "TEST" Messages with SUBTYPE=7 **shall** be enabled only if the geographic conditions specified in Table 2.2.3.2.7.4.2.2 are satisfied.

The broadcast of "TEST" Messages with SUBTYPE=7 **shall** be inhibited if the current position is not available.

Table 2.2.3.2.7.4.2.2: "TEST" Messages with SUBTYPE=7, Geographic Filters

1	(Latitude-A1 $\leq$ $Lat_{current}$ $\leq$ Latitude-A2 (north positive), AND Longitude-A1 $\leq$ $Lon_{current}$ $\leq$ Longitude-A2 (east positive))
	OR
2	(Latitude-B1 $\leq$ $Lat_{current}$ $\leq$ Latitude-B2 (north positive), AND Longitude-B1 $\leq$ $Lon_{current}$ $\leq$ Longitude-B2 (east positive))
	OR
3	(Latitude-C1 $\leq$ $Lat_{current}$ $\leq$ Latitude-C2 (north positive), AND Longitude-C1 $\leq$ $Lon_{current}$ $\leq$ Longitude-C2 (east positive))

Where $Lat_{current}$ and $Lon_{current}$ define the current aircraft position.

Latitude and Longitude with a resolution of 0.1 degree or better **shall** be used for the purpose of determining whether the criteria specified in Table 2.2.3.2.7.4.2.2 are satisfied.

For this version of these MOPS:

Latitude – A1 = 18.0 degrees	Latitude – A2 = 75.0 degrees
Longitude – A1 = - 170.0 degrees	Longitude – A2 = - 65.0 degrees
Latitude – B1 = reserved	Latitude B2 = reserved
Longitude – B1 = reserved	Longitude B2 = reserved
Latitude – C1 = reserved	Latitude – C2 = reserved
Longitude – C1 = reserved	Longitude – C2 = reserved

Notes:

1. Negative longitudes listed above are synonymous with west longitude.

2. Additional geographic areas may be used if desired to better define the specified operating area.

(1.6) In RTCA/DO-260, replace section §2.2.3.3.2.7 with the following:

The "TEST" ADS-B Event-Driven Messages with SUBTYPE = "0" **shall** be broadcast NOT MORE THAN ONCE each time the Event Driven Test Information is updated to the transponder.

When enabled (§2.2.3.2.7.4.2.2), the "TEST" ADS-B Event-Driven Messages with SUBTYPE = "7" **shall** be broadcast at random intervals that are uniformly distributed over the range of 11.8 to 12.2 seconds from the time of transmission of the previous "TEST" Message with SUBTYPE=7.

(1.7) In RTCA/DO-260, add section §2.2.5.1.44 with the following:

2.2.5.1.44 Mode A (4096) Code

The ADS-B Transmitting Subsystem **shall** accept the own vehicle Mode A (4096) Code from the transponder function and use such data to establish the Mode A Code subfield transmitted in the ADS-B "TEST" Message as specified in §2.2.3.2.7.4.

(1.8) In RTCA/DO-260, replace section §2.4.3.2.1.1.2.1, Test Procedure Step 4, with the following:

For transponder based ADS-B transmitting systems that have automatic detection of on the ground status and have ground speed, airspeed or radio altitude available, the following procedure applies. For ADS-B Transmitting Systems for installations without automatic means of determining on the ground status, the following procedure shall verify that the "CA" field remains set to 6 throughout the procedure.

Set up the ADS-B transmitting system as in step 1 with on the ground status externally provided to the ADS-B transmitting system and additionally provide radio altitude input. Use a value greater than 50 feet. Vary the "Emitter Category" data input through the range of Emitter Category Sets that the system is capable. Verify that the ADS-B transmitting system correctly broadcasts each extended squitter message type with the "CA" field equal to 5 for all Emitter Category Set "A" codes 2 through 6 as specified in Table 2-9B.

Repeat the procedure given in the previous paragraph, except change the radio altitude data to a value less than 50 feet. Verify for each extended squitter type that the reported "CA" field equals 4.

Maintain the radio altitude data at a value less than 50 feet and if the system is capable of accepting ground speed data input, provide ground speed data greater than 100 knots to the ADS-B transmitting system. Verify for each extended squitter type that the reported "CA" field equals 5 for Emitter Category Set "A," codes 2 through 6.

Maintain the radio altitude data at a value less than 50 feet and set the ground speed to a value less than or equal to 100 knots. Verify for each extended squitter type that the reported "CA" field equals 4.

Maintain the radio altitude data at a value less than 50 feet and the ground speed at 100 knots or less. If the system is capable of accepting airspeed data input, provide airspeed data greater than 100 knots to the ADS-B transmitting system. Verify for each extended squitter type that the reported "CA" field equals 5 for Emitter Category Set "A," codes 2 through 6.

Maintain the radio altitude data at a value less than 50 feet and the ground speed at a value less than or equal to 100 knots. Set the airspeed to a value less than or equal to 100 knots. Verify for each extended squitter type that the reported "CA" field equals 4.

(1.9) In RTCA/DO-260, replace section §2.4.3.2.1.1.2.1, Test Procedure Step 5, with the following.

The following procedure verifies that ADS-B Transmitting Systems without automatic detection of "On-The-Ground" status and capable of inputting radio altitude, ground speed, or airspeed, correctly reports "CA" Field equal to SIX (6), even when Surface Position Message broadcast is determined according to the requirements of §2.2.3.2.1.1.2 (c). Set up the ADS-B Transmitting System as in Step 1 above. For ADS-B Transmitting Systems with automatic means of determining "On-The-Ground" status, and capable of inputting radio altitude, ground speed or airspeed, provide external input to set the system to "Airborne" status and verify that the "CA" Field remains equal to FIVE (5) throughout this procedure.

For ADS-B Transmitting Systems capable of accepting radio altitude input, ground speed or airspeed, provide radio altitude data, ground speed and airspeed data to the ADS-B transmitting system according to the values defined in Table 2-84 or in the case of no data, stop providing the data as indicated. Verify that the system broadcasts extended squitters with the "CA" Field equal to SIX (6) for each test condition in Table 2-84.

(1.10) In RTCA/DO-260, in section §2.4.3.2.1.1.2.2, Test Procedure Step 3, rename the test Step to "Air/Ground Status Determination – Input Data Variation" and replace Table 2-84 with the following:

Table 2-84: Vertical Status Determination

Vertical Status Determination					
Test	**Emitter Category / Coding**	**Ground Speed (knots)**	**Airspeed (knots)**	**Radio Altitude (feet)**	**Resulting Vertical Status**
1	A/2 – 6, B/7	100	100	50	AIRBORNE
2	A/2 – 6, B/7	100	50	25	AIRBORNE
3	A/2 – 6, B/7	50	100	25	AIRBORNE
4	A/2 – 6, B/7	50	50	50	AIRBORNE
5	A/2 – 6, B/7	99	99	49	ON-GROUND
6	A/2 – 6, B/7	50	25	No Data	AIRBORNE
7	A/2 – 6, B/7	25	50	No Data	AIRBORNE
8	A/2 – 6, B/7	49	49	No Data	ON-GROUND
9	A/2 – 6, B/7	No Data	25	No Data	AIRBORNE
10	A/2 – 6, B/7	25	No Data	No Data	AIRBORNE
11	A/2 – 6, B/7	100	No Data	25	AIRBORNE
12	A/2 – 6, B/7	No Data	100	25	AIRBORNE
13	A/2 – 6, B/7	99	No Data	49	ON-GROUND
14	A/2 – 6, B/7	No Data	99	49	ON-GROUND
15	A/2 – 6, B/7	25	No Data	50	AIRBORNE
16	A/2 – 6, B/7	No Data	25	50	AIRBORNE
17	A/2 – 6, B/7	No Data	No Data	25	AIRBORNE
18	A/2 – 6, B/7	No Data	No Data	No Data	AIRBORNE

(1.11) In RTCA/DO-260, in section §2.4.3.2.1.1.2.2, Test Procedure Step 4, rename the test step to "Air/Ground Status Validation – ON-GROUND Override." In the last sentence of the paragraph of Step 4, change the reference from Table 2-84 **to** Table 2-85, and replace Table 2-85 with the following.

Table 2-85: On-Ground Override

ON-GROUND Override					
Test	**Emitter Category / Coding**	**Ground Speed (knots)**	**Speed (knots)**	**Radio Altitude (feet)**	**Resulting Vertical Status**
1	A/2 – 6, B/7	100	100	50	ON-GROUND
2	A/2 – 6, B/7	100	100	51	AIRBORNE
3	A/2 – 6, B/7	100	101	50	AIRBORNE
4	A/2 – 6, B/7	101	100	50	AIRBORNE
5	A/2 – 6, B/7	No Data	100	50	ON-GROUND
6	A/2 – 6, B/7	No Data	100	51	AIRBORNE
7	A/2 – 6, B/7	No Data	101	50	AIRBORNE
8	A/2 – 6, B/7	No Data	No Data	50	ON-GROUND
9	A/2 – 6, B/7	No Data	No Data	51	AIRBORNE
10	A/2 – 6, B/7	100	No Data	50	ON-GROUND
11	A/2 – 6, B/7	101	No Data	50	AIRBORNE
12	A/2 – 6, B/7	100	No Data	51	AIRBORNE
13	A/2 – 6, B/7	100	No Data	No Data	ON-GROUND
14	A/2 – 6, B/7	101	No Data	No Data	AIRBORNE
15	A/2 – 6, B/7	No Data	100	No Data	ON-GROUND
16	A/2 – 6, B/7	No Data	101	No Data	AIRBORNE
17	A/2 – 6, B/7	100	101	No Data	AIRBORNE
18	A/2 – 6, B/7	101	100	No Data	AIRBORNE
19	A/2 – 6, B/7	100	100	No Data	ON-GROUND
20	A/2 – 6, B/7	No Data	No Data	No Data	ON-GROUND

(1.12) Implementation of this Test Procedure is only required if the manufacturer has elected to implement the requirements of Section 1.5 of this Appendix. If a manufacturer elects not to implement that optional requirement, then no change is required for RTCA/DO-260, section §2.4.3.2.7.4.

If a manufacturer elects to implement that requirement, then in RTCA/DO-260, replace section §2.4.3.2.7.4 with the following:

2.4.3.2.7.4 Verification of TYPE "23" ADS-B Event-Driven Messages for "TEST" (§2.2.3.2.7.4)

The appropriate test procedures required to validate the requirements of §2.2.3.2.7.4 are provided in §2.4.3.2.7.4.2 through §2.4.3.2.7.4.2.2.

2.4.3.2.7.4.1 Verification of "TEST" Messages with Subtype = 0 (§2.2.3.2.7.4.1)

No specific test procedure is required to validate §2.2.3.2.7.4.1.

2.4.3.2.7.4.2 Verification of "TEST" Messages with Subtype = 7 (§2.2.3.2.7.4.2)

Purpose/Introduction:

"TEST" Messages with SUBTYPE=7 **shall** be used for the broadcast of the Mode A, 4096, Code currently assigned to the aircraft. The format for "TEST" Messages with SUBTYPE=7 **shall** be as specified in Figure 2.2.3.2.7.4-2. The Mode A Code subfield **shall** be coded as defined in RTCA DO-181C, §2.2.13.1.2.b and §2.2.4.1.2. Starting with "ME" bit 9, the sequence **shall** be C1, A1, C2, A2, C4, A4, ZERO, B1, D1, B2, D2, B4, D4.

"TEST" Messages with SUBTYPE=7 **shall not** be broadcast when the aircraft is in the "On-Ground" status (§2.2.3.2.1.1.2).

Measurement Procedure:

Step 1: Verification of the Broadcast of Mode A, 4096, Code – Airborne Status

Configure the ADS-B Transmitting Subsystem to transmit TYPE "23" ADS-B "TEST" Messages. Provide the data externally at the interface to the ADS-B Transmitting Subsystem. Set the ADS-B Transmitting Subsystem to Airborne status. Input a "TEST" Message with TYPE=23, SUBTYPE=7 as per RTCA DO-181C, §2.2.13.1.2.b and §2.2.4.1.2, where beginning with "ME" bit 9 the sequence **shall** be C1, A1, C2, A2, C4, A4, ZERO, B1, D1, B2, D2, B4, D4. Verify that the input Mode A Code is reflected in the next broadcast of the "TEST" Message with SUBTYPE=7.

Step 2: Verification of the Non-Broadcast of Mode A, 4096, Code – On Ground Status

Configure the ADS-B Transmitting Subsystem to transmit TYPE "23" ADS-B "TEST" Messages. Provide the data externally at the interface to the ADS-B Transmitting Subsystem. Set the ADS-B Transmitting Subsystem to "On Ground" status. Input a "TEST" Message with TYPE=23, SUBTYPE=7 as per RTCA DO-181C, §2.2.13.1.2.b and §2.2.4.1.2, where beginning with "ME" bit 9 the sequence **shall** be C1, A1,

C2, A2, C4, A4, ZERO, B1, D1, B2, D2, B4, D4. Verify that **no** "TEST" Message with TYPE=23, SUBTYPE=7 is broadcast.

2.4.3.2.7.4.2.1 Verification of "TEST" Messages with Subtype = 7, Global Enable/Inhibit (§2.2.3.2.7.4.2.1)

The test procedures required to validate the requirements of §2.2.3.2.7.4.2.1 are included in §2.4.3.2.7.4.2.2.

2.4.3.2.7.4.2.2 Verification of "TEST" Messages with Subtype = 7, Geographic Filter (§2.2.3.2.7.4.2.2)

Purpose/Introduction:

The broadcast of "TEST" Messages with SUBTYPE=7 **shall** be enabled only if the geographic conditions specified in Table 2.2.3.2.7.4.2.2 are satisfied. The broadcast of "TEST" Messages with SUBTYPE=7 **shall** be inhibited if the current position is not available. Latitude and Longitude with a resolution of 0.1 degree or better **shall** be used for the purpose of determining whether the criteria specified in Table 2.2.3.2.7.4.2.2 are satisfied. For this version of these MOPS:

Latitude-A1 = 18.0 degrees	Latitude-A2 = 75.0 degrees
Longitude-A1 = –170.0 degrees	Longitude-A2 = –65.0 degrees

Measurement Procedure:

Step 1: Verification of Enabling on Preset Geographic Lat/Lon – Inside the Box

Configure the ADS-B Transmitting Subsystem to create Airborne Position Messages. Configure the ADS-B Transmitting Subsystem to transmit TYPE "23" ADS-B "TEST" Messages with SUBTYPE=7. Provide the data externally at the interface to the ADS-B Transmitting Subsystem. Set the ADS-B Transmitting Subsystem to Airborne status. Through the appropriate Navigation Data Source interface, provide the ADS-B Transmitting Subsystem with Latitude and Longitude values, where:

$$18^{o} \leq Lat_{current} \leq 75^{o}$$
and
$$-170^{o} \leq Lon_{current} \leq -65^{o}$$

Verify that the ADS-B Transmitting Subsystem begins, and continues transmitting TYPE "23" ADS-B "TEST" Messages with SUBTYPE=7.

Step 2: Verification of Enabling on Preset Geographic Lat/Lon – Outside the Box

Configure the ADS-B Transmitting Subsystem as in Step 1 above. Through the appropriate Navigation Data Source interface, provide the ADS-B Transmitting Subsystem with Latitude and Longitude values, where:

$$18^o > Lat_{current}$$
and
$$-170^o \leq Lon_{current} \leq -65^o$$

Verify that the TYPE "23" ADS-B "TEST" Message with SUBTYPE=7 is **not** being broadcast.

Repeat this step for each of the following additional four cases:

1	$Lat_{current} > 75^o$	**and**	$-170^o \leq Lon_{current} \leq -65^o$
2	$18^o \leq Lat_{current} \leq 75^o$	**and**	$-170^o > Lon_{current}$
3	$18^o \leq Lat_{current} \leq 75^o$	**and**	$Lon_{current} > -65^o$
4	Position information is not available.		

In each of the above four cases, verify that the TYPE "23" ADS-B "TEST" Message with SUBTYPE=7 is **not** being broadcast.

Step 3: Verification of Inhibiting on Crossing the Boundary of the Box

Repeat Step 1 above and verify that the ADS-B Transmitting Subsystem begins, and continues transmitting TYPE "23" ADS-B "TEST" Messages with SUBTYPE=7. Now update the Latitude and Longitude information individually with each of the five cases in Step 2 above, and verify that the broadcast of the TYPE "23" ADS-B "TEST" Message with SUBTYPE=7 is properly terminated when the Latitude and Longitude specified in each individual case in Step 2 is provided.

SECTION 2-

(2.1) In RTCA/DO-260A, to add the definition of DF=18 and CF=6 as a Rebroadcast by ground equipment of an ADS-B Message from an alternate data link using the same TYPE Codes and Message formats as are defined for DF=17 ADS-B Messages, replace Figure 2-2 with the following:

<table>
<tr><th colspan="6">ADS-B and TIS-B Overall Message Format Structures</th></tr>
<tr><td>Bit # →</td><td>1 ------ 5</td><td>6 ------ 8</td><td>9 ------ 32</td><td>33 ------ 88</td><td>89 ------ 112</td></tr>
<tr><td>DF = 17 Field Names →</td><td>DF = 17
[5]</td><td>CA
[3]</td><td>AA
ICAO Address
[24]</td><td>ADS-B Message ME Field
[56]</td><td>PI
[24]</td></tr>
<tr><td rowspan="7">DF = 18 Field Names →</td><td rowspan="7">DF = 18
[5]</td><td>CF = 0
[3]</td><td>AA
ICAO Address
[24]</td><td rowspan="2">ADS-B Message ME Field
[56]</td><td rowspan="2">PI
[24]</td></tr>
<tr><td>CF = 1
[3]</td><td>AA
non-ICAO Address
[24]</td></tr>
<tr><td>CF = 2 to 3
[3]</td><td>AA
[24]</td><td>TIS-B Message ME Field
[56]</td><td>PI
[24]</td></tr>
<tr><td>CF = 4
[3]</td><td colspan="2">Reserved for TIS-B Management Messages</td><td>PI
[24]</td></tr>
<tr><td>CF = 5
[3]</td><td>AA
non-ICAO Address
[24]</td><td>TIS-B Message ME Field
[56]</td><td rowspan="3">PI
[24]</td></tr>
<tr><td>CF = 6
[3]</td><td colspan="2">Rebroadcast of an ADS-B Message from an alternate data link using the same TYPE Codes and Message Formats as are defined for DF=17 ADS-B Messages</td></tr>
<tr><td>CF = 7</td><td colspan="2">Reserved</td></tr>
<tr><td rowspan="2">DF = 19 Field Names→</td><td rowspan="2">DF = 19
[5]</td><td>AF = 0
[3]</td><td>AA
ICAO Address
[24]</td><td>ADS-B Message ME Field
[56]</td><td>PI
[24]</td></tr>
<tr><td>AF = 1 to 7
[3]</td><td colspan="3">Reserved for Military Applications</td></tr>
<tr><td></td><td>MSB LSB</td><td>MSB LSB</td><td>MSB LSB</td><td>MSB LSB</td><td>MSB LSB</td></tr>
</table>

Figure 2-2: ADS-B and TIS-B Message Baseline Format Structure

(2.2) In RTCA/DO-260A, replace the last paragraph of section §2.2.3.2 with the following:

TIS-B Messages **shall** use Extended Squitter formats in which DF = 18 and CF is in the range from 2 to 5. An ADS-B Message from an alternate data link that is being rebroadcast by ground equipment as a TIS-B Message using 1090 MHz Extended Squitter **shall** use formats in which DF = 18 and CF = 6, and **shall** use the same TYPE Codes and Message formats as are defined for DF = 17 ADS-B Messages. Receiving equipment **shall not** process as TIS-B Messages any Extended Squitter receptions in which DF is not equal to 18, or in which CF is not in the range from 2 to 6.

(2.3) In RTCA/DO-260A, replace section §2.2.3.2.1.2, subparagraph "c," including Table 2-9, with the following:

c. Air/Ground Determination

(1). If a transmitting ADS-B participant is not equipped with a means, such as a weight-on-wheels switch, to determine whether it is airborne or on the surface, and that participant's Emitter Category (§2.2.3.2.5.2) is one of the following, then it **shall** set its Air/Ground State to "Airborne," and broadcast the Airborne Position Message (§2.2.3.2.3):

- Unknown Emitter Category
- Light Aircraft
- Rotorcraft
- Glider or Sailplane
- Lighter Than Air
- Unmanned Aerial Vehicle
- Ultralight, Hang Glider or Paraglider
- Parachutist or Skydiver
- Point Obstacle
- Cluster Obstacle
- Line Obstacle

Notes:

1. *Because of the unique operating capabilities of "Lighter-Than-Air" vehicles, i.e., balloons, an operational "Lighter-Than-Air" vehicle will always report the "Airborne" State, unless the "ON-GROUND" State is specifically declared in compliance with subparagraph "(4)" below.*
2. *Because of the fact that it is important for Fixed Ground or Tethered Obstacles to report altitude, such objects will always report the "Airborne" state.*
3. *Because of the unique capabilities of Rotorcraft, i.e., hover, etc., an operational Rotorcraft will always report the "Airborne" state unless the "ON-GROUND" state is specifically declared in compliance with subparagraph "(4)" below.*
4. *An automatic means of determining air/ground status may include Weight-on-Wheels discrete, Airspeed, Ground Speed, Radio Altitude, or other appropriate data sources.*

(2). If a transmitting ADS-B participant's Emitter Category (§2.2.3.2.5.2) is one of the following, then that participant **shall** set its Air/Ground State to the "ON-GROUND" condition and broadcast the Surface Position Message (§2.2.3.2.4):

- Surface Vehicle – Emergency
- Surface Vehicle – Service

(3). If a transmitting ADS-B participant is not equipped with a means, such as a weight-on-wheels switch, to determine whether it is airborne or on the surface, and its ADS-B Emitter Category (§2.2.3.2.5.2) is not one of those listed under tests (1) or (2) above (i.e., the participant's Emitter Category is either: Small, Large, High Vortex Large, Heavy, Highly Maneuverable, or Space/Trans-Atmospheric), then the following tests will be performed to determine whether to broadcast the Airborne or Surface Position Messages.

a. If the participant's Radio Height (RH) parameter is available, and RH < 50 feet, and at least Ground Speed (GS) or Airspeed (AS) is available, and the available GS < 100 knots, or the available AS < 100 knots, then that participant **shall** broadcast the Surface Position Message (§2.2.3.2.4).

   If all three parameters are available, the decision to broadcast the Airborne or Surface Position Messages **shall** be determined by the logical "AND" of all three parameters.

b. Otherwise, if Radio Height (RH) is not available, and if the participant's Ground Speed (GS) and Airspeed (AS) are available, and GS < 50 knots and AS < 50 knots, then that participant **shall** broadcast the Surface Position Message (§2.2.3.2.4).

c. Otherwise, the participant **shall** broadcast the Airborne Position Message (§2.2.3.2.3).

(4). If a transmitting ADS-B participant is equipped with a means, such as a weight-on-wheels switch, to determine automatically whether it is airborne or on the surface, then such information **shall** be used to determine whether to broadcast the Airborne Position Message (§2.2.3.2.3), or the Surface Position Message (§2.2.3.2.4).

(2.4) In RTCA/DO-260A, to add the definition of DF=18 and CF=6 as a Rebroadcast by ground equipment of an ADS-B Message from an alternate data link using the same TYPE Codes and Message formats as are defined for DF=17 ADS-B Messages, in section 2.2.3.2.1.3, replace Table 2-11 and the paragraph that follows the table with the following:

Table 2-11: "CF" Field Code Definitions

Coding		Meaning	
(Binary)	(Decimal)		
000	0	ADS-B Message	AA field holds the transmitting ADS-B Participant's 24-bit ICAO address.
001	1		AA field holds another kind of address for the transmitting ADS-B Participant: a self-assigned "anonymous" address, a ground vehicle address, or a surface obstruction address.
010	2	TIS-B Message	Fine TIS-B Message using ICAO 24-bit address
011	3		Coarse TIS-B Airborne Position and Velocity Message.
100	4		Reserved for TIS-B Management Message.
101	5		Fine TIS-B Message using non-ICAO 24-bit address
110	6	Rebroadcast of an ADS-B Message from an alternate data link using the same TYPE Codes and Message Formats as are defined for DF=17 ADS-B Messages	
111	7	Reserved	

ADS-B Messages from ADS-B Transmitting Subsystems that are not based on Mode S transponders **shall** use CF = 0 or 1, according to the type of address conveyed in the AA field. TIS-B Messages **shall** use CF = 2, 3 or 5. An ADS-B Message from an alternate data link that is being rebroadcast by ground equipment as a TIS-B Message using 1090 MHz Extended Squitter **shall** use formats in which DF = 18 and CF = 6, and **shall** use the same TYPE Codes and Message formats as are defined for DF = 17 ADS-B Messages. CF code of 4 and 7 are reserved for future standardization and **shall not** be transmitted by equipment that conforms to these MOPS (RTCA DO-260A).

(2.5) In RTCA/DO-260A, to add the definition of DF=18 and CF=6 as a Rebroadcast by ground equipment of an ADS-B Message from an alternate data link using the same TYPE Codes and Message formats as are defined for DF=17 ADS-B Messages, in section §2.2.3.2.1.5, replace Table 2-13 with the following:

Table 2-13: Determining The Type of Address in the AA Field

DF Field	CF or AF Field	IMF Subfield	AA Field Contents
17	N/A	N/A	24-bit ICAO address of transmitting ADS-B Participant
18	CF = 0	N/A	24-bit ICAO address of transmitting ADS-B Participant
	CF = 1		Anonymous address or ground vehicle address or fixed obstacle address of transmitting ADS-B Participant
	CF = 2	0	TIS-B target's 24-bit ICAO address
		1	TIS-B target's 12-bit Mode A code and track file number
	CF = 3	0	TIS-B target's 24-bit ICAO address
		1	TIS-B target's 12-bit Mode A code and track file number
	CF = 4	N/A	Reserved for TIS-B Management Messages; AA field holds TIS-B Service Volume ID + other information
	CF = 5	0	TIS-B target's 24-bit non-ICAO address
		1	Reserved
	CF = 6	0	24-bit ICAO address of transmitting ADS-B Participant
		1	Anonymous address or ground vehicle address or fixed obstacle address of transmitting ADS-B Participant
	CF = 7	N/A	Reserved for future standardization; AA field does not necessarily exist in messages. For which DF = 18 and CF is equal to 7.
19	AF = 0	N/A	24-bit ICAO address of transmitting ADS-B participant
	AF = 1 to 7		Reserved for military use; AA field does not necessarily exist in messages for which DF= 19 and AF is in the range from 1 to 7.

(2.6) In RTCA/DO-260A, to clarify the use of DF=18 and CF=6 as a Rebroadcast by ground equipment of an ADS-B Message from an alternate data link using the same TYPE Codes and Message formats as are defined for DF=17 ADS-B Messages, in section §2.2.3.2.2, replace the third paragraph (just prior to Table 2-14) and the title of Table 2-14 as follows:

For ADS-B Messages (those for which DF=17, or DF=18 and CF=0, 1 or 6, or DF=19 and AF=0), the possible message Types are those listed in Table 2-14. An ADS-B Message from an alternate data link that is being rebroadcast by ground equipment as a TIS-B Message using 1090 MHz Extended Squitter uses formats in which DF = 18 and CF = 6, and uses the same TYPE Codes and Message formats as are defined for DF = 17 ADS-B Messages. In Table 2-14, the word "***Reserved***" indicates ADS-B Message Types for which the message formats have not yet been defined, but which may be defined in future versions of these MOPS. The TYPE Code, together with the SUBTYPE Code (if present for a given TYPE Code value), identifies the TYPE of ADS-B Message being broadcast, in accordance with Table 2-14.

Table 2-14: Determining ADS-B Message Type
(DF=17 or DF=18 and CF=0, 1 or 6, or DF=19 and AF=0)
[change occurs in title only]

(2.7) In RTCA/DO-260A, in order to correct an error in the title of Table 2-15 and to rename the previous "TIS-B Airborne Velocity Message" to only the "TIS-B Velocity Message," in section §2.2.3.2.2, replace Table 2-15 with the following:

Table 2-15: Determining TIS-B Message Type (DF=18, CF=2 to 5)

CF Field Value	TYPE Code ("ME" bits 1-5)	SUBTYPE Code ("ME" bits 6-8)	TIS-B Message Type
2 or 5	0	Not Present	TIS-B Fine Airborne Position Message (§2.2.17.3.1), or TIS-B Fine Surface Position Message (§2.2.17.3.2)
	1 – 4	Not Present	TIS-B Identification and Type Message (§2.2.17.3.3)
	5 – 8	Not Present	TIS-B Fine Surface Position Message (§2.2.17.3.2)
	9 – 18	Not Present	TIS-B Fine Airborne Position Message (§2.2.17.3.1)
	19	0	Reserved
		1 – 4	TIS-B Velocity Message (§2.2.17.3.4)
		5 – 7	Reserved
	20 – 22	Not Present	TIS-B Fine Airborne Position Message (§2.2.17.3.1)
	23 – 31	Not Present	Reserved
3	Not Present	Not Present	TIS-B Coarse Airborne Position and Velocity Message (§2.2.17.3.5)
4	Not Present	Not Present	Reserved (for TIS-B Management Message)

(2.8) In RTCA/DO-260A, add the following onto the end of the paragraph in section §2.2.3.2.7.1.3.5 and prior to Table 2-50.

In this version of these MOPS (RTCA/DO-260A), the Vertical Mode Indicator **shall** be set to ZERO (binary 00).

Note: *Inconsistencies have been identified with how existing onboard data sources represent the data associated with the Vertical Mode Indicator parameter. Until these inconsistencies are resolved through a future update to these MOPS (RTCA/DO-260A), this parameter must be encoded as ALL ZEROs, indicating an Unknown Mode or that Information is Unavailable.*

(2.9) In RTCA/DO-260A, add the following onto the end of the paragraph in section §2.2.3.2.7.1.3.10 and prior to Table 2-55.

In this version of these MOPS (RTCA/DO-260A), the Horizontal Mode Indicator **shall** be set to ZERO (binary 00).

Note: *Inconsistencies have been identified with how existing onboard data sources represent the data associated with the Horizontal Mode Indicator parameter. Until these inconsistencies are resolved through a future update to these MOPS (RTCA DO-260A), this parameter must be encoded as ALL ZEROs, indicating an Unknown Mode or that Information is Unavailable.*

(2.10) In RTCA/DO-260A, section §2.2.3.2.7.2.3.1, the reference to "ME" bits and "Message bits" is reversed in the first sentence. Replace the text of the first paragraph with the following:

Within the CC Code subfield, a 4-bit ("ME" bits 9-10 and 13-14, Message bits 41-42, and 45-46) subfield **shall** be reserved for the "Service Level" of the ADS-B Transmitting Subsystem. ADS-B equipment conforming to this version (RTCA/DO-260A) of these MOPS **shall** set the Service Level code to ALL ZEROs.

(2.11) In RTCA/DO-260A, section §2.2.3.2.7.2.11, in order to eliminate an ambiguity in the Length and Width Code definitions, replace the last sentence of the first paragraph with the following:

Once the actual Length and Width of the A/V has been determined, each A/V **shall** be assigned the smallest A/V Length and Width Code from Table 2-74 for which the actual length is less than or equal to the upper bound length for that Length/Width Code, and for which the actual width is less than or equal to the upper bound width for that Length/Width Code.

(2.12) In RTCA/DO-260A, section §2.2.3.2.7.2.11, in order to eliminate an ambiguity in the Length and Width Code definitions, replace Table 2-74 with the following:

Table 2-74: "Aircraft/Vehicle Length and Width Code" Encoding

A/V - L/W Code (Decimal)	Length Code			Width Code	Upper-Bound Length and Width for Each Length/Width Code	
	ME Bit 49	ME Bit 50	ME Bit 51	ME Bit 52	Length (meters)	Width (meters)
0	0	0	0	0	15	11.5
1				1		23
2	0	0	1	0	25	28.5
3				1		34
4	0	1	0	0	35	33
5				1		38
6	0	1	1	0	45	39.5
7				1		45
8	1	0	0	0	55	45
9				1		52
10	1	0	1	0	65	59.5
11				1		67
12	1	1	0	0	75	72.5
13				1		80
14	1	1	1	0	85	80
15				1		90

If the Aircraft or Vehicle is longer than 85 meters, or wider than 90 meters, then decimal Aircraft/Vehicle Length/Width Code 15 **shall** be used.

(2.13) In RTCA/DO-260A, in section §2.2.8.4.1, in the third line of the first paragraph, change the phrase "from TYPE 9 or 10" **to** "from TYPE 9, 10, 20 or 21."

(2.14) In RTCA/DO-260A, in section §2.2.10.2, after subparagraph "f," and prior to the section heading for §2.2.10.3, place the following *Note*:

Note: *Upon the first receptions of airborne-format messages from a target that is already in the Track State as a surface participant, it is not necessary to enter the Initialization State or the Acquisition State. The target remains in the Track State, now as an airborne participant. Similarly, for the transition from airborne-format to surface-format messages, if the target is currently in the Track State, it remains in the Track State, now as a surface participant.*

(2.15) In RTCA/DO-260A, in section §2.2.10.3.1, after subparagraph "a," and prior to subparagraph "b," place the following *Note*:

Note: *If the Airborne Participant has already been in the Track State as a Surface Participant, then it is not necessary to perform the Globally Unambiguous CPR Decode.*

(2.16) In RTCA/DO-260A, in section §2.2.10.3.2, to correct an ambiguity condition encountered in operational testing, replace subparagraph "a" with the following:

a. Perform a successful Globally Unambiguous CPR Decode of the Participant Position in accordance with §A.1.7.8 of Appendix A.

(2.17) In RTCA/DO-260A, in section §2.2.10.3.2, after subparagraph "a," and prior to subparagraph "b," place the following *Note*:

Note: *If the Surface Participant has already been in the Track State as an Airborne Participant, then it is not necessary to perform the Globally Unambiguous CPR Decode.*

(2.18) In RTCA/DO-260A, in section §2.2.10.3.2, in subparagraph "f," and in the *Note* following subparagraph "f," change all references from "Local Unambiguous" **to** "Globally Unambiguous."

(2.19) In RTCA/DO-260A, to add the use of DF=18 and CF=6 as a Rebroadcast by ground equipment of an ADS-B Message from an alternate data link using the same TYPE Codes and Message formats as are defined for DF=17 ADS-B Messages, replace Table 2-106 with the following:

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	Reserved for TIS-B Management Message AA field holds TIS-B Service Volume ID + other information (e.g., MSB of reference position for the service volume)
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

(2.20) In RTCA/DO-260A, to add the use of DF=18 and CF=6 as a Rebroadcast by ground equipment of an ADS-B Message from an alternate data link using the same TYPE Codes and Message formats as are defined for DF=17 ADS-B Messages, replace the paragraph of section §2.2.17.2.2 with the following:

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, 5 or 6 depending upon the TIS-B Message as specified in Table 2-106. The ADS-B Receiving Subsystem shall accept and process DF=18, CF=2, CF=3, CF=5 and CF=6 as TIS-B Messages.

(2.21) In RTCA/DO-260A, in order to rename the previous "TIS-B Airborne Velocity Message" to only the "TIS-B Velocity Message," in section §2.2.17.3.4, and to correct an incorrect specification of the use of the Vertical Rate Type in ME Bit #56, replace the title of section §2.2.17.3.4 and Figure 2-28 with the following:

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]**	**SIL [2]** / **Difference Sign Bit [1]**	**Reserved [4]** / **Geometric Height Difference From Barometric [7]**
	MSB LSB	MSB LSB		MSB LSB		MSB LSB		MSB LSB			MSB LSB		MSB LSB	MSB LSB	MSB LSB

Notes:

1. *"[#]" provided in the Field Name column indicates the number of bits in the respective field.*
2. *The "Vertical Rate" and "Geometric Height Difference From Barometric" fields for surface aircraft do not need to be processed by TIS-B receivers.*

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

(2.22) In RTCA/DO-260A, in order to rename the previous "TIS-B Airborne Velocity Message" to only the "TIS-B Velocity Message," in section §2.2.17.3.4, and to correct an incorrect specification of the use of the Vertical Rate Type in ME Bit #56, replace Figure 2-29 with the following:

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 Typet [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		

Notes:

1. *"[#]" provided in the Field Name column indicates the number of bits in the respective field.*
2. *The "Vertical Rate" and "Geometric Height Difference From Barometric" fields for surface aircraft do not need to be processed by TIS-B receivers.*

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

(2.23) In RTCA/DO-260A, in order to rename the previous "TIS-B Airborne Velocity Message" to only the "TIS-B Velocity Message," in section §2.2.17.3.4.1, delete the word "Airborne" from the first line of the paragraph.

(2.24) In RTCA/DO-260A, in section §2.2.17.4.6, replace the entire first paragraph with the following:

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 of any received TIS-B Management Message (Table 2-106, CF Value =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.

(2.25) In RTCA/DO-260A, replace section §2.4.3.2.1.2.1, Test Procedure Step 3, with the following.

For transponder based ADS-B transmitting systems that have automatic detection of on the ground status and have ground speed, airspeed or radio altitude available, the following procedure applies. For ADS-B Transmitting Systems for installations without automatic means of determining on the ground status, the following procedure shall verify that the "CA" field remains set to 6 throughout the procedure.

Set up the ADS-B transmitting system as in step 1 with on the ground status externally provided to the ADS-B transmitting system and additionally provide radio altitude input. Use a value greater than 50 feet. Vary the "Emitter Category" data input through the range of Emitter Category Sets that the system is capable. Verify that the ADS-B transmitting system correctly broadcasts each extended squitter message type with the "CA" field equal to 5 for all Emitter Category Set "A" codes 2 through 6 as specified in Table 2-10.

Repeat the procedure given in the previous paragraph, except change the radio altitude data to a value less than 50 feet. Verify for each extended squitter type that the reported "CA" field equals 4.

Maintain the radio altitude data at a value less than 50 feet and if the system is capable of accepting ground speed data input, provide ground speed data greater than 100 knots to the ADS-B transmitting system. Verify for each extended squitter type that the reported "CA" field equals 5 for Emitter Category Set "A," codes 2 through 6.

Maintain the radio altitude data at a value less than 50 feet and set the ground speed to a value less than or equal to 100 knots. Verify for each extended squitter type that the reported "CA" field equals 4.

Maintain the radio altitude data at a value less than 50 feet and the ground speed at 100 knots or less. If the system is capable of accepting airspeed data input, provide airspeed data greater than 100 knots to the ADS-B transmitting system. Verify for each extended squitter type that the reported "CA" field equals 5 for Emitter Category Set "A," codes 2 through 6.

Maintain the radio altitude data at a value less than 50 feet and the ground speed at a value less than or equal to 100 knots. Set the airspeed to a value less than or equal to 100 knots. Verify for each extended squitter type that the reported "CA" field equals 4.

(2.26) In RTCA/DO-260A, replace section §2.4.3.2.1.2.1, Test Procedure Step 4, with the following:

The following procedure verifies that ADS-B Transmitting Systems without automatic detection of "On-The-Ground" status and capable of inputting radio altitude, ground speed, or airspeed, correctly reports "CA" Field equal to SIX (6), even when Surface Position Message broadcast is determined according to the requirements of section 2.2.3.2.1.2.1 (c). Set up the ADS-B Transmitting System as in Step 1 above. For ADS-B Transmitting Systems with automatic means of determining "On-The-Ground" status, and capable of inputting radio altitude, ground speed or airspeed, provide external input to set the system to "Airborne" status and verify that the "CA" Field remains equal to FIVE (5) throughout this procedure.

For ADS-B Transmitting Systems capable of accepting radio altitude input, ground speed or airspeed, provide radio altitude data, ground speed and airspeed data to the ADS-B transmitting system according to the values defined in Table 2-124 or in the case of no data, stop providing the data as indicated. Verify that the system broadcasts extended squitters with the "CA" Field equal to SIX (6) for each test condition in Table 2-124.

(2.27) In RTCA/DO-260A, in section §2.4.3.2.1.2.2, Test Procedure Step 3, rename the test Step to "Air/Ground Status Determination – Input Data Variation" and replace Table 2-124 with the following:

Table 2-124: Vertical Status Determination

Vertical Status Determination					
Test	**Emitter Category / Coding**	**Ground Speed (knots)**	**Airspeed (knots)**	**Radio Altitude (feet)**	**Resulting Vertical Status**
1	A/2 – 6, B/7	100	100	50	AIRBORNE
2	A/2 – 6, B/7	100	50	25	AIRBORNE
3	A/2 – 6, B/7	50	100	25	AIRBORNE
4	A/2 – 6, B/7	50	50	50	AIRBORNE
5	A/2 – 6, B/7	99	99	49	ON-GROUND
6	A/2 – 6, B/7	50	25	No Data	AIRBORNE
7	A/2 – 6, B/7	25	50	No Data	AIRBORNE
8	A/2 – 6, B/7	49	49	No Data	ON-GROUND
9	A/2 – 6, B/7	No Data	25	No Data	AIRBORNE
10	A/2 – 6, B/7	25	No Data	No Data	AIRBORNE
11	A/2 – 6, B/7	100	No Data	25	AIRBORNE
12	A/2 – 6, B/7	No Data	100	25	AIRBORNE
13	A/2 – 6, B/7	99	No Data	49	ON-GROUND
14	A/2 – 6, B/7	No Data	99	49	ON-GROUND
15	A/2 – 6, B/7	25	No Data	50	AIRBORNE
16	A/2 – 6, B/7	No Data	25	50	AIRBORNE
17	A/2 – 6, B/7	No Data	No Data	25	AIRBORNE
18	A/2 – 6, B/7	No Data	No Data	No Data	AIRBORNE

(2.28) In RTCA/DO-260A, in section §2.4.3.2.1.2.2, Test Procedure Step 4, rename the test step to "Air/Ground Status Validation – ON-GROUND Override." In the last sentence of the paragraph of Step 4, change the reference from Table 2-124 **to** Table 2-125, and replace Table 2-125 with the following:

Table 2-125: On-Ground Override

ON-GROUND Override					
Test	**Emitter Category / Coding**	**Ground Speed (knots)**	**Speed (knots)**	**Radio Altitude (feet)**	**Resulting Vertical Status**
1	A/2 – 6, B/7	100	100	50	ON-GROUND
2	A/2 – 6, B/7	100	100	51	AIRBORNE
3	A/2 – 6, B/7	100	101	50	AIRBORNE
4	A/2 – 6, B/7	101	100	50	AIRBORNE
5	A/2 – 6, B/7	No Data	100	50	ON-GROUND
6	A/2 – 6, B/7	No Data	100	51	AIRBORNE
7	A/2 – 6, B/7	No Data	101	50	AIRBORNE
8	A/2 – 6, B/7	No Data	No Data	50	ON-GROUND
9	A/2 – 6, B/7	No Data	No Data	51	AIRBORNE
10	A/2 – 6, B/7	100	No Data	50	ON-GROUND
11	A/2 – 6, B/7	101	No Data	50	AIRBORNE
12	A/2 – 6, B/7	100	No Data	51	AIRBORNE
13	A/2 – 6, B/7	100	No Data	No Data	ON-GROUND
14	A/2 – 6, B/7	101	No Data	No Data	AIRBORNE
15	A/2 – 6, B/7	No Data	100	No Data	ON-GROUND
16	A/2 – 6, B/7	No Data	101	No Data	AIRBORNE
17	A/2 – 6, B/7	100	101	No Data	AIRBORNE
18	A/2 – 6, B/7	101	100	No Data	AIRBORNE
19	A/2 – 6, B/7	100	100	No Data	ON-GROUND
20	A/2 – 6, B/7	No Data	No Data	No Data	ON-GROUND

(2.29) In RTCA/DO-260A, in section §2.4.3.2.7.1.3.5, replace the sentence after the "Purpose/Introduction" with the following:

In this version of these MOPS (RTCA/DO-260A), the Vertical Mode Indicator **shall** be set to ZERO (binary 00).

(2.30) In RTCA/DO-260A, in section §2.4.3.2.7.1.3.5, replace the last sentence in each of the Test Procedure Steps 2 and 3 with the following:

"Verify that ME bits 14 and 15 are set to a value of ZERO (binary 00)."

(2.31) In RTCA/DO-260A, in section §2.4.3.2.7.1.3.10, replace the sentence after the "Purpose/Introduction" with the following:

In this version of these MOPS (RTCA/DO-260A), the Horizontal Mode Indicator **shall** be set to ZERO (binary 00).

(2.32) In RTCA/DO-260A, in section §2.4.3.2.7.1.3.10, replace the last sentence in each of the Test Procedure Steps 2 and 3 with the following:

"Verify that ME bits 38 and 39 are set to a value of ZERO (binary 00)."

(2.33) In RTCA/DO-260A, in section §2.4.3.2.7.2.3.1, in the "Purpose / Introduction" the references to "ME bits" and "Message bits" are reversed. Replace the text of the "Purpose/Introduction" with the following:

Within the CC Code subfield, a 4-bit subfield ("ME" bits 9-10 and 13-14, Message bits 41-42, and 45-46) that **shall** be reserved for the "Service Level" of the ADS-B Transmitting Subsystem. ADS-B equipment conforming to Version 1 (RTCA DO-260A) of these MOPS **shall** set the Service Level code to ALL ZEROs.

(2.34) In RTCA/DO-260A, in section §2.4.3.2.7.2.3.1, in the "Measurement Procedure" the references to "ME bits" and "Message bits" were exchanged. Replace the last sentence of the "Measurement Procedure" with the following:

Verify that the ME bits 9 and 10 and ME bits 13 and 14 are set to ALL ZEROs.

(2.35) In RTCA/DO-260A, in section §2.4.5.1.52, in the second line of the paragraph, change the reference from §2.2.3.2.7.3.2 **to** §2.4.3.2.7.3.2.

(2.36) In RTCA/DO-260A, in section §2.4.8.4.1, in the third line of the first paragraph of the "Purpose/Introduction" and again in the second line of the "Equipment" paragraph, and finally in the first line of the 'Step 2' test procedure, change "TYPE 9 or 10" **to** "TYPE 9, 10, 20 or 21."

(2.37) In RTCA/DO-260A, in section §2.4.10.3.1, in the "Purpose / Introduction," after subparagraph "a," and prior to subparagraph "b," place the following *Note*:

Note: *If the Airborne Participant has already been in the Track State as a Surface Participant, then it is not necessary to perform the Globally Unambiguous CPR Decode.*

(2.38) In RTCA/DO-260A, in section §2.4.10.3.2, in the "Purpose / Introduction," replace subparagraph "a" with the following:

a. Perform a successful Globally Unambiguous CPR Decode of the Participant Position in accordance with §A.1.7.8 of Appendix A.

(2.39) In RTCA/DO-260A, in section §2.4.10.3.2, in the "Purpose / Introduction," after subparagraph "a," and prior to subparagraph "b," place the following *Note*:

Note: *If the Surface Participant has already been in the Track State as an Airborne Participant, then it is not necessary to perform the Globally Unambiguous CPR Decode.*

(2.40) In RTCA/DO-260A, in section §2.4.10.3.2, in the "Purpose / Introduction," in subparagraph "f," and in the *Note* following subparagraph "f," change all references from "Local Unambiguous" **to** "Globally Unambiguous."

(2.41) In RTCA/DO-260A, in section §2.4.10.3.2, in Step 1 of the test procedure (a) Change the title of Step 1 to "Globally Unambiguous CPR Decode," and in the last line of the second paragraph of Step 1, change "Locally Unambiguous" to "Globally Unambiguous" and change the reference in Appendix A to §A.1.7.8.

(2.42) In RTCA/DO-260A, section §2.4.17.4.6, replace the first paragraph of the "Purpose/Introduction" with the following:

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 of any received TIS-B Management Message (Table 2-106, CF Value =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.

(2.43) In RTCA/DO-260A, section §3.3.4.6.1, in the definition for Equation #3 at the top of page 751, where the value (-1.574302725) is raised to the power of 10. These values are backwards and should be reversed. Change the value to 10 raised to the power of (-1.574302725).

(2.44) In RTCA/DO-260A, Appendix A, section §A.1.4.1.2.3, subparagraph "a," second line, replace "Airborne" **with** "Surface."

(2.45) In RTCA/DO-260A, Appendix A, section §A.1.4.9.6, add the following onto the end of the paragraph in section §A.1.4.9.6 and prior to Table A-10.

In this version of these MOPS (RTCA/DO-260A), the Vertical Mode Indicator **shall** be set to ZERO (binary 00).

Note: *Inconsistencies have been identified with how existing onboard data sources represent the data associated with the Vertical Mode Indicator parameter. Until these inconsistencies are resolved through a future update to these MOPS (RTCA DO-260A), this parameter must be encoded as all zeroes, indicating Unknown Mode or Information Unavailable.*

(2.46) In RTCA/DO-260A, Appendix A, section §A.1.4.9.11, add the following onto the end of the paragraph in section §A.1.4.9.11 and prior to Table A-14.

In this version of these MOPS (RTCA/DO-260A), the Horizontal Mode Indicator **shall** be set to ZERO (binary 00).

Note: *Inconsistencies have been identified with how existing onboard data sources represent the data associated with the Horizontal Mode Indicator parameter. Until these inconsistencies are resolved through a future update to these MOPS (RTCA DO-260A), this parameter must be encoded as all zeroes, indicating Unknown Mode or Information Unavailable.*

(2.47) In RTCA/DO-260A, Appendix A, section §A.1.4.10, in the first line of the paragraph, change "Register 63 {HEX}" to "Register 65 {HEX}."

(2.48) In RTCA/DO-260A, Appendix A, section §A.1.4.10.11, replace the last sentence of the first paragraph with the following:

Once the actual Length and Width of the A/V has been determined, each A/V will be assigned the smallest A/V Length and Width Code from Table 2-74 for which the actual length is less than or equal to the upper bound length for that Length/Width Code, and for which the actual width is less than or equal to the upper bound width for that Length/Width Code.

(2.49) In RTCA/DO-260A, Appendix A, section §A.1.4.10.11, replace Table A-26 with the following:

Table A-26: Aircraft/Vehicle Length and Width Code

A/V - L/W Code (Decimal)	Length Code			Width Code	Upper-Bound Length and Width for Each Length/Width Code	
	ME Bit 49	ME Bit 50	ME Bit 51	ME Bit 52	Length (meters)	Width (meters)
0	0	0	0	0	15	11.5
1				1		23
2	0	0	1	0	25	28.5
3				1		34
4	0	1	0	0	35	33
5				1		38
6	0	1	1	0	45	39.5
7				1		45
8	1	0	0	0	55	45
9				1		52
10	1	0	1	0	65	59.5
11				1		67
12	1	1	0	0	75	72.5
13				1		80
14	1	1	1	0	85	80
15				1		90

If the Aircraft or Vehicle is longer than 85 meters, or wider than 90 meters, then decimal Aircraft/Vehicle Length/Width Code 15 **shall** be used.

(2.50) In RTCA/DO-260A, Appendix A, section A.1.7.2, replace subparagraph "1" with the following:

1. The number of bits used to encode a position coordinate, *Nb*, is set as follows:

For airborne encoding, used in the ADS-B Airborne Position Message and the TIS-B Fine Airborne Position Message:	*Nb* = 17
For surface encoding, used in the ADS-B Surface Position Message and the TIS-B Fine Surface Position Message:	*Nb* = 19
For intent encoding:	*Nb* = 14
For TIS-B encoding, used only in the TIS-B Coarse Airborne Position Message:	*Nb* = 12

(2.51) In RTCA/DO-260A, Appendix A, section §A.1.7.3, subparagraphs "b," "c," "e," and "f" make the following replacements:

Replace:	For airborne encoding:	**with**	For *Nb* = 17:
Replace:	For surface encoding:	**with**	For *Nb* = 19:
Replace:	For intent encoding:	**with**	For *Nb* = 14:
Replace:	For TIS-B encoding:	**with**	For *Nb* = 12:

(2.52) In RTCA/DO-260A, Appendix A, replace the title of section §A.1.7.6 with the following:

A.1.7.6 Locally Unambiguous CPR Decoding for Surface Position

(2.53) In RTCA/DO-260A, Appendix A, renumber section §A.1.7.8, and its subsections, beginning with §A.1.7.9.

(2.54) In RTCA/DO-260A, Appendix A, insert a new section §A.1.7.8 entitled "**Globally Unambiguous CPR Decoding of Surface Position**" with content as follows:

A.1.7.8 Globally Unambiguous CPR Decoding of Surface Position

This algorithm **shall** utilize one CPR surface position encoded "**even**" format message together with one CPR surface position encoded "**odd**" format message, to regenerate the geographic position of the aircraft or target.

As surface-format messages are initially received from a particular aircraft, if there is no prior history of this aircraft, then a global decode **shall** be performed using even and odd format receptions, as described in this section.

Note 1: *If the aircraft has been transmitting airborne format messages and their receptions were in-track, then it is not necessary to use even-odd decoding. Beginning with the first individual surface message reception, the location can be decoded using the local-decode technique, based on the previous target location as the reference.*

Note 2: *Even if the aircraft is appearing for the first time in surface format receptions, any single message could be decoded by itself into multiple locations, one being the correct location of the transmitting aircraft, and all of the others being separated by 90 NM or more from the correct location. Therefore, if it were known that the transmitting aircraft cannot be farther away than 45 NM from a known location, then the first received message could be decoded using the locally unambiguous decoding method described in §A.1.7.6. Under some circumstances it may be possible for an aircraft to be first detected when it is transmitting surface position messages farther than 45 NM away from the receiving station. For this reason, even-odd decoding is required when messages are initially received from a particular aircraft. After this initial decode, as subsequent messages are received, they can be decoded individually (without using the even-odd technique), provided that the intervening time is not excessive. This subsequent decoding is based on the fact that the aircraft location has not changed by more than 45 NM between each new reception and the previously decoded location.*

The even-odd decoding process **shall** begin by identifying a pair of receptions, one in the even format, the other in the odd format, and whose separation in time does not exceed 25 seconds.

Note: *The limit of 25 seconds is based on the possible change of location within this time interval. Detailed analysis of CPR indicates that if the change of location is 0.75 NM or less, then the decoding will yield the correct location of the aircraft. To assure that the change of location is actually no larger, and considering the maximum aircraft speed of 100 kt specified for the transmission of the surface format, the combination indicates that 25 seconds will provide the needed assurance.*

Given a CPR 17-bit surface position encoded in the "**even**" format (*XZ*0, *YZ*0) and another encoded in the "**odd**" format (*XZ*1, *YZ*1), separated by no more than 25 seconds, the algorithm shall regenerate the geographic position (latitude *Rlat*, and longitude *Rlon)* of the aircraft or target by performing the following sequence of steps:

a. Compute the latitude zone sizes $Dlat_0$ and $Dlat_1$ from the equation:

$$Dlat_i = \frac{90°}{60 - i}$$

b. Compute the latitude index:

$$j = floor\left(\frac{59 \cdot YZ_o - 60YZ_1}{2^{17}} + \frac{1}{2} \right)$$

c. Latitude. The following formulas will yield two mathematical solutions for latitude (for each value of i), one in the northern hemisphere and the other in the southern hemisphere. Compute the northern hemisphere solution of $Rlat_0$ and $Rlat_1$ using the following equation:

$$Rlat_i = Dlat_i \left(MOD(j, 60 - i) + \frac{YZ_i}{2^{17}} \right)$$

The southern hemisphere value is the above value minus 90 degrees.

To determine the correct latitude of the target, it is necessary to make use of the location of the receiver. Only one of the two latitude values will be consistent with the known receiver location, and this is the correct latitude of the transmitting aircraft.

d. The first step in longitude decoding is to check that the even-odd pair of messages do not straddle a transition latitude. It is rare, but possible, that $NL(Rlat_0)$ is not equal to $NL(Rlat_1)$. If so, a solution for longitude cannot be calculated. In this event, abandon the decoding of this even-odd pair, and examine further receptions to identify another pair. Perform the decoding computations up to this point and check that these two NL values are equal. When that is true, proceed with the following decoding steps.

e. Compute the longitude zone size $Dlon_i$, according to whether the most recently received surface position message was encoded with the even format ($i = 0$) or the odd format ($i = 1$):

$Dlon_i = \frac{90°}{n_i}$, where n_i is the greater of [$NL(Rlat_i) - i$] and 1.

f. Compute m, the longitude index:

$$m = floor\left(\frac{XZ_0 \cdot (NL - 1) - XZ_1 \cdot NL)}{2^{17}} + \frac{1}{2} \right)$$

where $NL = NL\ (Rlat_i)$

g. Longitude. The following formulas will yield four mathematical solutions for longitude (for each value of i), one being the correct longitude of the aircraft, and the other three separated by at least 90 degrees. To determine the correct location of the target, it will be necessary to make use of the location of the receiver. Compute the longitude, $Rlon_0$ or $Rlon_1$, according to whether the most recently received surface position message was encoded using the even format (that is, with $i = 0$) or the odd format ($i = 1$):

$$Rlon_i = Dlon_i \cdot \left(MOD(m, n_i) + \frac{XZi}{2^{17}} \right)$$

where n_i is the greater of $[NL(Rlat_i) - i]$ and 1.

This solution for $Rlon_i$ will be in the range 0° to 90°. The other three solutions are 90°, 180°, and 270° to the east of this first solution.

To then determine the correct longitude of the transmitting aircraft, it is necessary to make use of the known location of the receiver. Only one of the four mathematical solutions will be consistent with the known receiver location, and this is the correct longitude of the transmitting aircraft.

Note: *Near the equator the minimum distance between the multiple longitude solutions is more than 5000 NM, so there is no question as to the correct longitude. For locations away from the equator, the distance between solutions is less, and varies according to the cosine of latitude. For example at 87 degrees latitude, the minimum distance between solutions is 280 NM. This is sufficiently large to provide assurance that the correct aircraft location will always be obtained. Currently no airports exist within 3 degrees of either pole, so the decoding as specified here will yield the correct location of the transmitting aircraft for all existing airports.*

(2.55) In RTCA/DO-260A, Appendix A, section §A.1.8, Figure A-10, replace "**BDS 6,3**" with "**BDS 6,5**."

(2.56) In RTCA/DO-260A, Appendix A, section §A.2.3, to add the use of DF=18 and CF=6 as a Rebroadcast by ground equipment of an ADS-B Message from an alternate data link using the same TYPE Codes and Message formats as are defined for DF=17 ADS-B Messages, replace Table A-29 with the following:

Table A-29: 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	Reserved for TIS-B Management Message AA field holds TIS-B Service Volume ID + other information (e.g., MSB of reference position for the service volume)
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

(2.57) In RTCA/DO-260A, Appendix A, section §A.2.4.4, in order to rename the previous "TIS-B Airborne Velocity Message" to only the "TIS-B Velocity Message," delete the word "Airborne" from the title of §A.2.4.4 and from the first line of the paragraph.

(2.58) In RTCA/DO-260A, Appendix A, section §A.2.4.4.1, in order to rename the previous "TIS-B Airborne Velocity Message" to only the "TIS-B Velocity Message," delete the word "Airborne" from the first line of the paragraph.

(2.59) In RTCA/DO-260A, Appendix A, after the existing section §A.2.5, insert a new section §A.2.6 entitled "**Formats for 1090 MHz TIS-B Messages**."

(2.60) In RTCA/DO-260A, Appendix A, in order to rename the previous "TIS-B Airborne Velocity Message" to only the "TIS-B Velocity Message," and to correct an incorrect specification of the use of the Vertical Rate Type in ME Bit #56, replace Figure A-15 with the following:

Figure A-15: TIS-B Velocity Messages (Subtypes 1 and 2: Velocity Over Ground)

1	MSB	**1**
2		**0**
3	FORMAT TYPE CODE = 19	**0**
4		**1**
5	LSB	**1**

6	SUBTYPE 1	**0**	SUBTYPE 2	**0**
7		**0**		**1**
8		**1**		**0**

9	IMF (See §A.2.4.4.2)
10	MSB
11	Navigation Accuracy Category for Position (NAC_P)
12	(§A.1.4.10.7)
13	LSB
14	DIRECTION BIT for E-W Velocity **(0=East, 1=West)**
15	EAST – WEST VELOCITY (10 bits)

16	NORMAL: LSB = 1 knot		SUPERSONIC: LSB = 4 knots	
17	All zeros = no velocity info		All zeros = no velocity info	
18	Value	Velocity	Value	Velocity
19	1	0 kts	1	0 kts
20	2	1 kt	2	4 kts
21	3	2 kts	3	8 kts
22	---	---	---	---
23	1022	1021 kts	1022	4084 kts
24	1023	>1021.5 kts	1023	> 4086 kts

25	DIRECTION BIT for N – S Velocity **(0=North, 1=South)**
26	NORTH – SOUTH VELOCITY (10 bits)

27	NORMAL: LSB = 1 knot		SUPERSONIC: LSB = 4 knots	
28	All zeros = no velocity info		All zeros = no velocity info	
29	Value	Velocity	Value	Velocity
30	1	0 kts	1	0 kts
31	2	1 kt	2	4 kt
32	3	2 kts	3	8 kts
33	---	---	---	---
34	1022	1021 kts	1022	4084 kts
35	1023	>1021.5 kts	1023	>4086 kts

36	GEO Flag Bit (1 bit) **GEO = 0** (Barometric)
37	SIGN BIT FOR VERTICAL RATE: **(0 = up, 1 = down)**
38	VERTICAL RATE (9 bits)
39	All zeros = no vertical rate information, LSB = 64 ft/min

40	Value	Vertical Rate
41	1	0 ft/min
42	2	64 ft/min
43	---	---
44	510	32576 ft/min
45	511	> 32608 ft/min
46		
47	NIC Supplement (See §A.1.4.10.6)	
48	Navigation Accuracy Category for Velocity (NAC_V)	
49	(See §A.1.4.5.5)	
50		
51	Surveillance Integrity Level (SIL)	
52	LSB (See §A.1.4.10.9)	
53		
54	Reserved (4 bits)	
55		
56		

Purpose: To provide velocity information for aircraft that are not equipped with 1090 MHz ADS-B when the TIS-B service is based on high quality surveillance data.

Subtype Coding

Code	Velocity	Type
1	Ground Speed	Normal
2		Supersonic

Note: The "Vertical Rate" and "Geometric Height Difference From Barometric" fields for surface aircraft do not need to be processed by TIS-B receivers.

	GEO Flag Bit (1 bit) **GEO = 1** (Geometric)
	SIGN BIT FOR VERTICAL RATE: **(0 = up, 1 = down)**
	VERTICAL RATE (9 bits)
	All zeros = no vertical rate information, LSB = 64 ft/min

Value	Vertical Rate
1	0 ft/min
2	64 ft/min
----	---
510	32576 ft/min
511	> 32608 ft/min

	NIC Supplement (See §A.1.4.10.6)
	Reserved (1 bit)
	DIFFERENCE SIGN BIT **(0 = above baro, 1 = below baro)**
	GEOMETRIC HEIGHT DIFFERENCE FROM BARO ALT (7 bits)
	Same coding as Airborne Velocity Message

(2.61) In RTCA/DO-260A, Appendix A, in order to rename the previous "TIS-B Airborne Velocity Message" to only the "TIS-B Velocity Message," and to correct an incorrect specification of the use of the Vertical Rate Type in ME Bit #56, replace Figure A-16 with the following:

Figure A-16: TIS-B Velocity Messages (Subtypes 3 and 4: Air Referenced Velocity)

1	MSB	**1**
2		**0**
3	FORMAT TYPE CODE = 19	**0**
4		**1**
5	LSB	**1**
6	SUBTYPE 3 **0**	SUBTYPE 4 **1**
7	**1**	**0**
8	**1**	**0**
9	IMF (See §A.2.4.4.2)	
10	MSB	
11	Navigation Accuracy Category for Position (NAC_P)	
12	(§A.1.4.10.7)	
13	LSB	
14	HEADING STATUS BIT **(0=not available, 1=available)**	
15	MSB	
16		
17		
18	HEADING (10 bits)	
19	(§A.1.4.5.6)	
20		
21		
22		
23		
24	LSB	
25	AIRSPEED TYPE **(0 = IAS, 1 = TAS)**	
26	AIRSPEED (10 bits)	
27	NORMAL: LSB = 1 knot	SUPERSONIC: LSB = 4 knots
28	All zeros = no velocity info	All zeros = no velocity info
29	Value Velocity	Value Velocity
30	1 0 kts	1 0 kts
31	2 1 kt	2 4 kt
32	3 2 kts	3 8 kts
33	--- ---	--- ---
34	1022 1021 kts	1022 4084 kts
35	1023 >1021.5 kts	1023 >4086 kts
36	GEO Flag Bit (1 bit) **GEO = 0** (Barometric)	
37	SIGN BIT FOR VERTICAL RATE: **(0 = up, 1 = down)**	
38	VERTICAL RATE (9 bits)	
39	All zeros = no vertical rate information, LSB = 64 ft/min	
40	Value Vertical Rate	
41	1 0 ft/min	
42	2 64 ft/min	
43	--- ---	
44	510 32576 ft/min	
45	511 > 32608 ft/min	
46		
47	NIC Supplement (See §A.1.4.10.6)	
48	Navigation Accuracy Category for Velocity (NAC_V)	
49	(See §A.1.4.5.5)	
50		
51	Surveillance Integrity Level (SIL)	
52	LSB (See §A.1.4.10.9)	
53	Reserved	
54	Reserved	
55	True/Magnetic Heading **(0 = True, 1 = Magnetic)**	
56	Reserved	

Purpose: To provide velocity information for aircraft that are not equipped with 1090 MHz ADS-B when the TIS-B service is based on high quality surveillance data.

Subtype Coding

Code	Velocity	Type
3	Air Speed	Normal
4		Supersonic

Note: The "Vertical Rate" and "Geometric Height Difference From Barometric" fields for surface aircraft do not need to be processed by TIS-B receivers.

GEO Flag Bit (1 bit) **GEO = 1** (Geometric)	
SIGN BIT FOR VERTICAL RATE: **(0 = up, 1 = down)**	
VERTICAL RATE (9 bits)	
All zeros = no vertical rate information, LSB = 64 ft/min	
Value	Vertical Rate
1	0 ft/min
2	64 ft/min
----	---
510	32576 ft/min
511	> 32608 ft/min
NIC Supplement (See §A.1.4.10.6)	
Reserved (1 bit)	
DIFFERENCE SIGN BIT **(0 = above baro, 1 = below baro)**	
GEOMETRIC HEIGHT DIFFERENCE FROM BARO ALT (7 bits)	
Same coding as Airborne Velocity Message	