1090-WP21T-05
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RTCA Special Committee 186, Working Group 3

ADS-B 1090 MHz Extended Squitter MOPS

Meeting #21

Teleconference: 1:00pm EDT

Summary of Proposed Changes to DO-260A for a Reasonableness Test

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SUMMARY
The enclosed proposed changes reflect the update to DO-260A Change 1 to incorporate a receiver reasonableness test to the 1090 ES receiver section of the MOPS.

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From the WG-3 meeting that was held on 19 April 2006, the day prior to the SC-186 Plenary on 20 April, it was agreed that WG-3 would complete the requirements for a reasonableness test and submit the final Change 1 document to RTCA by 19 May 2006 in order to allow the RTCA PMC a 30-day review period prior to their hopeful approval of the "DO-260A Change 1" document at their 27 June meeting.

A subgroup headed by Don Walker agreed to propose the changes to incorporate a reasonableness test to be discussed on a teleconference scheduled by WG-3 for 16 May at 1:00pm EDT. At the time of the SC-186 Plenary, the approach adopted by Working Group 3 agreed with the ICAO SCRSP approach, which also addressed and included a reasonableness test on the local decode. Since that time there has been further discussion followed by a meeting held in Montreal, 8 – 12 May of the ICAO SCRSP Working Group B, where proposed changes to the 1090ES SARPs and Technical Manuals were presented for their approval.

The proposed changes for a reasonableness test were first introduced during the WG-3 Teleconference on 27 February in working paper 1090-WP20-08, which initiated the development and discussion of a reasonableness test based on the observation of incorrect positions received by the Australia ADS-B Ground Station. As a result of discussions in Montreal to reach consensus on the reasonableness changes for the 1090ES SARPs Technical Manual, an approach to the reasonableness test was agreed to which is different than the original approach considered by ICAO SCRSP and different than the approach that Working Group 3 had embarked on after Meeting #21 on 19 April. The reasonableness test on a local decode was totally eliminated.

The summary of the provisions that ICAO SCRSP Working Group B agreed to incorporate into the 1090ES SARPs Technical Manual are as follows:

1) A reasonableness test will be applied to all Globally Unambiguous CPR decodes to verify that the range from the receiver is within reason.

2) A reasonableness test would be applied to the Globally Unambiguous CPR decodes performed either in track initialization or re-initialization, to validate the global decode. The approach is to validate using a second computed Globally Unambiguous CPR decode using a new "***odd***" and "***even***" position received after the initial Globally Unambiguous CPR decode. A comparison of the second global decode with the decode that is derived from the normal Locally Unambiguous CPR decode (which is based on the position update from the original global decode) would be made. If the resulting position computations are not equal, the Position Messages that were used in the first global decode are discarded and the track returns to the initialization state.

3) There would be no reasonableness test of a local CPR decode. Given that the more serious situation is an erroneous global decode which may take significant time to recover from, if ever, a position error from the local decode is not deemed critical.

We ask that you review the enclosed recommended changes for technical accuracy to accomplish the modified direction to the reasonableness test. It is hoped that WG-3 can agree to the reasonableness test as enclosed since it is aligned with the agreed upon changes to ICAO international standards."

PROPOSED CHANGES TO THE CHANGE 1 DOCUMENT:

The following changes are recommended to incorporate additional material that is required to DO-260A Change 1 to reflect the following:

1) A receiver reasonableness test applied to the received position decodes.

2) Correct the timing requirements between an "***even***" and "***odd***" reception for a surface global position decode

(1.XX) Modify DO-260A Figure 2-21 as follows:

(1) Replace the text at the upper right corner of the diagram "No Position Message received for 120 seconds" with "No Position Message received for 120 seconds or position validation failed"

(2) Add a line from the "Track State" circle to the "Initialization State" circle with the caption "Position validation failed".

(1.XX) Modify DO-260A Figure 2-22 as follows:

Discuss ability to update with Gary Furr.

(1.XX) In RTCA/DO-260A, replace §2.2.10.3.1, subparagraph "a" and §2.4.10.3.1 Purpose/Introduction with the following:

a. Perform a successful Globally Unambiguous CPR decode of the Participant Position in accordance with §A.1.7.7 of Appendix A. Perform a validation of the resulting position decode as follows: Compute the distance between own receiver position, if known, and the Participant Position resulting from the Globally Unambiguous CPR decode. The position validation is failed if the computed distance is greater than the maximum operating range of the receiver. If position validation is not failed, then proceed with subparagraph

"b" below. Otherwise, discard the "***odd***" and "***even***" Position Messages used in the attempted Globally Unambiguous CPR decode. The Report Mode for the given Airborne Participant remains in Initialization State.

(1.XX) In RTCA/DO-260A, replace §2.2.10.3.2 from the beginning paragraph and including subparagraph "a" with the following:

Upon receipt of an "***even***" and an "***odd***" encoded Surface Position Message from a given Participant within a time period of interval "**X**" (where **X**=50 seconds, unless the Ground Speed in either Surface Position Message is greater than 25 knots, or is unknown, in which cases **X**=25 seconds), the Report Assembly Function **shall**:

a. Perform a successful Globally Unambiguous CPR decode of the Participant Position in accordance with §A.1.7.8 of Appendix A. Perform a validation of the resulting position decode as follows: Compute the distance between own aircraft position, if known, and the Participant Position resulting from the Globally Unambiguous CPR decode. The position validation is failed if the computed distance is greater than the maximum operating range of the receiver. If position validation is not failed, then proceed with subparagraph "b" below. Otherwise, discard the "***odd***" and "***even***" Position Messages used in the attempted Globally Unambiguous CPR decode. The Report Mode for the given Surface Participant remains in Initialization State.

(1.XX) In RTCA/DO-260A, add a new §2.2.10.6 as follows:

2.2.10.6 Reasonableness Test Applied to Positions Determined from Globally Unambiguous Decoding

A validation **shall** be performed to verify the Globally Unambiguous CPR decode established per §2.2.10.3.1, subparagraph "a" or §2.2.10.3.2, subparagraph "a," using the following steps:

a. After the Globally Unambiguous CPR decode performed per §2.2.10.3.1, subparagraph "a" for Airborne Participants, or per §2.2.10.3.2, subparagraph "a" for Surface Participants, upon receipt of both a subsequent "***even***" and "***odd***" Position Message within the required times of each other as per §A.1.7.7 or §A.1.7.8, each being received after the corresponding "**even**" and "***odd***" Position Message used in the Globally Unambiguous CPR computed in §2.2.10.3.1, subparagraph "a" or §2.2.10.3.2, subparagraph "a," perform a successful Globally Unambiguous CPR decode in accordance with §A.1.7.7 for Airborne Participants or §A.1.7.8 for Surface Participants.

b. Compare the position decode resulting from the Globally Unambiguous CPR decode as per subparagraph "a" above to the Locally Unambiguous CPR

decode computed from the receipt of the current Position Message satisfying subparagraph "a" above,

> ***Note:*** *The Locally Unambiguous CPR decode is based on the update of the position derived from the current Globally Unambiguous CPR decode established in §2.2.10.3.1, subparagraph "a" or §2.2.10.3.2, subparagraph "a."*

c. If the position decodes resulting from subparagraph "b" above are equal, then the validation is complete. Otherwise, the following subparagraph applies:

d. No State Vector Report is generated from the receipt of the current Position Message. The Report Mode for the given Participant Report Mode is reset to the Initialization State. All "***even***" and "***odd***" Position Messages received prior to the respective "***even***" or "***odd***" Position Message used in the Globally Unambiguous CPR decode in subparagraph "a" above are discarded.

> ***Note:*** *Completion of validation requires reception of both an additional "**even**" and "**odd**" Position Message subsequent to the Position Messages used to satisfy the Globally Unambiguous CPR decode in Acquisition State. In the case of Airborne Participants, since reception of an Airborne Velocity Message causes a transition from Acquisition State to Track State, as per §2.2.10.4.1.1, then validation may not be completed until the Airborne Participant is in the Track State.*

(1.XX) In RTCA/DO-260A, in section §2.4.10.3.1, replace Step #1 of the test procedure with the following:

Step 1: Globally Unambiguous CPR Decode

a. For each test case in Table 2.4.10.3.1, provide the CPR Decoder function with the "***odd***" and "***even***" Airborne encodings. Provide the "***odd***" and "***even***" encodings to the CPR Decoder function (see §A.1.7.7 of Appendix A) within ten (10) seconds of each other.

<u>Table 2.4.10.3.1:</u> Input Data for Global Unambiguous Airborne Decode Zone Checks

Input Data for Global Unambiguous Airborne Decode Zone Checks										
	Angular Weighted Binary (AWB) Position of the Encoder in Degrees				Even Airborne Encoding			Odd Airborne Encoding		
Test Case	Latitude		Longitude		Lat.	Lon.	NL	Lat.	Lon.	NL
	(Decimal)	(HEX)	(Decimal)	(HEX)	(HEX)	(HEX)	(Dec.)	(HEX)	(HEX)	(Dec.)
1	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFE0	10D8D	53	0D79C	033F0	53
2	27.93897600	13DE22A7	45.0000	20000000	15020	14000	53	12864	10000	53
3	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFE0	033F0	**52**	0D79C	033F0	53
4	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFE0	10D8D	53	0D79C	15A53	**52**
5	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFE0	033F0	**52**	0D79C	15A53	**52**

b. For test cases 1 and 2 in Table 2.4.10.3.1, verify that the CPR Decoder function (see §A.1.7.7 of Appendix A) provides an output **latitude** position within **0.00015** degrees of the **latitude** position indicated for test cases 1 and 2.

c. For test cases 1 and 2 in Table 2.4.10.3.1, verify that the CPR Decoder function (see §A.1.7.7 of Appendix A) provides an output **longitude** position within **0.00015** degrees of the **longitude** position indicated for test cases 1 and 2.

d. For test case 3 in Table 2.4.10.3.1, verify that the CPR Decoder function (see §A.1.7.7 of Appendix A) **does not** provide an output **longitude** position that is consistent with the **longitude** position indicated for test case 3.

<u>Note:</u> *The "**even**" encoding for test case 3 has been established by forcing the NL lookup to **52** for encoding as opposed to **53**. This will result in significant error in the decoded position.*

e. For test case 4 in Table 2.4.10.3.1, verify that the CPR Decoder function (see §A.1.7.7 of Appendix A) **does not** provide an output **longitude** position consistent with the **longitude** position indicated for test case 4.

<u>Note:</u> *The "**odd**" encoding for test case 4 has been established by forcing the NL lookup to **52** for encoding as opposed to **53**. This will result in significant error in the decoded position.*

f. For test case 5 in Table 2.4.10.3.1, verify that the CPR Decoder function (see §A.1.7.7 of Appendix A) **does not** provide an output **longitude** position consistent with the **longitude** position indicated for test case 5.

Note: *The "**odd**" and "**even**" encodings for test case 5 have been established by forcing the NL lookup to **52** for encoding as opposed to **53**. This will result in the Decoder Function selecting NL "**odd**" equal to NL "**even**" and will produce what appears to be a valid decode of the position. However, the decoded position will not be consistent with the position indicated for test case 5 in Table 2.4.10.3.1.*

g. Using the Airborne scenario and simulation set up in Step 1 of §2.4.10.1.3 above, verify that for each Participant for which and "**even**" and an "**odd**" pair of encoded Airborne Position Messages is received within a ten (10) second period that the Report Assembly Function correctly performs a successful Globally Unambiguous CPR Decode in accordance with §A.1.7.7 of Appendix A.

h. Add an Airborne Participant to the simulation whose decoded position is beyond the maximum operating range of the Own Ship position. Verify that the Report Mode of the Airborne Participant is returned to the Initialization State and no State Vector Report is output. Verify that the remaining Airborne Participant tracks are not terminated due to the distance validation. Discontinue Own Ship position data so it is not available and verify that no tracks are discarded by the position validation. Some of the simulation participants may be terminated due to lack of update.

(1.XX) In RTCA/DO-260A, in §2.4.10.3.2, replace the existing first paragraph and subparagraph "a" of the Purpose/Introduction as follows:

Upon receipt of an "***even***" and an "***odd***" encoded Surface Position Message from a given Participant within a time period of interval "**X**" (where **X**=50 seconds, unless the Ground Speed in either Surface Position Message is greater than 25 knots, or is unknown, in which cases **X**=25 seconds), the Report Assembly Function **shall**:

a. Perform a successful Globally Unambiguous CPR decode of the Participant Position in accordance with §A.1.7.6 of Appendix A. Perform a validation of the resulting position decode as follows: Compute the distance between Own Aircraft position, if known, and the Participant Position resulting from the Globally Unambiguous CPR decode. The position validation is failed if the computed distance is greater than the maximum operating range of the receiver. If position validation is not failed, then proceed with subparagraph "b" below. Otherwise, discard the "***odd***" and "***even***" Position Messages used in the attempted Globally Unambiguous CPR decode and the Report Mode for the given Surface Participant remains in Initialization State.

(1.XX) In RTCA/DO-260A, in section §2.4.10.3.2, replace Step 1 of the test procedure with the following:

Step 1: Globally Unambiguous CPR Decode

a. For each test case in Table 2.4.10.3.2, provide the CPR Decoder function with the "***odd***" and "***even***" Surface Encodings. Provide the "***odd***" and "***even***" Encodings to the CPR Decoder function (see §A.1.7.8 of Appendix A) within twenty five (25) seconds of each other.

Table 2.4.10.3.2: Input Data for Global Unambiguous Surface Decode Zone Checks

Input Data for Global Unambiguous Surface Decode Zone Checks										
	Angular Weighted Binary (AWB)Position of the Encoder in Degrees				Even Surface Encoding			Odd Surface Encoding		
Test Case	Latitude		Longitude		Lat.	Lon.	NL	Lat.	Lon.	NL
	(Decimal)	(HEX)	(Decimal)	(HEX)	(HEX)	(HEX)	(Dec.)	(HEX)	(HEX)	(Dec.)
1	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	03636	53	15E70	0CFC1	53
2	27.93897600	13DE22A7	45.0000	20000000	14081	10000	53	0A190	00000	53
3	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	0CFC1	**52**	15E70	0CFC1	53
4	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	03636	53	15E70	1694C	**52**
5	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	0CFC1	**52**	15E70	1694C	**52**

b. For test cases 1 and 2 in Table 2.4.10.3.2, verify that the CPR Decoder function (see §A.1.7.8 of Appendix A) provides an output **latitude** position within **0.00015** degrees of the **latitude** position indicated for test cases 1 and 2.

c. For test cases 1 and 2 in Table 2.4.10.3.2, verify that the CPR Decoder function (see §A.1.7.8 of Appendix A) provides an output **longitude** position within **0.00015** degrees of the **longitude** position indicated for test cases 1 and 2.

d. For test case 3 in Table 2.4.10.3.2, verify that the CPR Decoder function (see §A.1.7.8 of Appendix A) **does not** provide an output **longitude** position consistent with the **longitude** position indicated for test case 3.

Note: *The "**even**" encoding for test case 3 has been established by forcing the NL lookup to **52** for encoding as opposed to **53**. This will result in significant error in the decoded position.*

e. For test case 4 in Table 2.4.10.3.2, verify that the CPR Decoder function (see §A.1.7.8 of Appendix A) **does not** provide an output **longitude** position consistent with the **longitude** position indicated for test case 4.

Note: *The "**odd**" encoding for test case 4 has been established by forcing the NL lookup to **52** for encoding as opposed to **53**. This will result in significant error in the decoded position.*

f. For test case 5 Table 2.4.10.3.2, verify that the CPR Decoder function (see §A.1.7.8 of Appendix A) **does not** provide an output **longitude** position consistent with the **longitude** position indicated for test case 5.

Note: *The "**odd**" and "**even**" encodings for test case 5 have been established by forcing the NL lookup to **52** for encoding as opposed to **53**. This will result in the Decoder Function selecting NL "**odd**" equal to NL "**even**" and will produce what appears to be a valid decode of the position. However, the decoded position will not be consistent with the position indicated for row 5 in Table 2.4.10.3.2.*

g. Using the Surface scenario and simulation set up in Step 2 of §2.4.10.1.3 above, verify that for each Participant for which an "***even***" and an "***odd***" pair of encoded Surface Position Messages is received within a twenty five (25) second period that the Report Assembly Function correctly performs a successful Globally Unambiguous CPR Decode in accordance with §A.1.7.8 of Appendix A. Input surface targets with speeds greater than 25 knots and verify that when "***even***" and "***odd***" Position Messages are spaced more than 25 seconds apart, that a successful Globally Unambiguous CPR Decode is not completed for such targets. Input surface targets with speeds less than 25 knots that have "***even***" and "***odd***" Position Messages spaced between 25 and 50 seconds and verify that the Report Assembly Function correctly performs a successful Globally Unambiguous CPR Decode in accordance with §A.1.7.8 of Appendix A. Input surface targets with speeds less than 25 knots that have "***even***" and "***odd***" Position Messages spaced greater than 50 seconds apart and verify that the Report Assembly Function does not complete a successful Globally Unambiguous CPR Decode for such targets.

h. Add a Surface Participant to the simulation whose decoded position is beyond the maximum operating range of the Own Ship position. Verify that the Report Mode of the Surface Participant is returned to the Initialization State and no State Vector Report is output. Verify that the remaining Surface Participant tracks are not terminated due to the distance validation. Discontinue Own Ship position data so it is not available and verify that no tracks are

discarded by the position validation. Some of the simulation participants may be terminated due to lack of update.

(1.XX) In RTCA/DO-260A, in section §2.4.10.3.2, replace the phrase "fifty (50) second period" in Steps 2 through 6 with the following: "within the proper time interval based on the speed of the participant".

(1.XX) In RTCA/DO-260A, in section §2.4.10.3.2, in the first sentence of Step 4, replace the word "Airborne" with "Surface".

(1.XX) In RTCA/DO-260A, in section §2.4.10.4.1.1, replace Step 1 of the test procedure with the following:

Step 1: Locally Unambiguous CPR Decode and Set Report Mode to Track

a. For the following test case, provide the CPR Decoder function (see §A.1.7.5 of Appendix A) with the "***odd***" and "***even***" Airborne Encodings within five (5) seconds of each other.

	Angular Weighted Binary (AWB)Position of the Encoder in Degrees				**Even Airborne Encoding**			**Odd Airborne Encoding**		
Test Case	**Latitude**		**Longitude**		**Lat.**	**Lon.**	**NL**	**Lat.**	**Lon.**	**NL**
	(Decimal)	**(HEX)**	**(Decimal)**	**(HEX)**	**(HEX)**	**(HEX)**	**(Dec.)**	**(HEX)**	**(HEX)**	**(Dec.)**
1	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFEO	10D8D	53	0D79C	033F0	53

b. Verify that the CPR Decoder function (see §A.1.7.5 of Appendix A) provides an "***even***" and "***odd***" output **latitude** position within **0.00015** degrees of the **latitude** position indicated.

c. Verify that the CPR Decoder function (see §A.1.7.5 of Appendix A) provides an "***even***" and "***odd***" output **longitude** position within **0.00015** degrees of the **longitude** position indicated.

d. Start this test procedure step with the assumption that for a given Airborne Participant, the Acquisition State has been established in accordance with the Test Procedures in §2.4.10.3.1.

Verify that for each Participant in the Airborne scenario and simulation set up in Step 1 of §2.4.10.1.3 above, where it has been verified that the Acquisition State has been established, and upon receipt of the first Airborne Velocity Message for the given Participant, verify that the Report Assembly Function correctly sets the Report Mode to "Track" in the State Vector Report in accordance with the formatting in §2.2.8.1.22.

(1.XX) In RTCA/DO-260A, in section §2.4.10.4.2.1, create a new Step 1 of the test procedure immediately after the Measurement Procedure with the following:

Step 1: Locally Unambiguous CPR Decode

a. For the following test case, provide the CPR Decoder function (see §A.1.7.6 of Appendix A) with the "***odd***" and "***even***" Surface Encodings within five (5) seconds of each other.

	Angular Weighted Binary (AWB)Position Of the Encoder in Degrees				**Even Surface Encoding**			**Odd Surface Encoding**		
Test Case	**Latitude**		**Longitude**		**Lat.**	**Lon.**	**NL**	**Lat.**	**Lon.**	**NL**
	(Decimal)	**(HEX)**	**(Decimal)**	**(HEX)**	**(HEX)**	**(HEX)**	**(Dec.)**	**(HEX)**	**(HEX)**	**(Dec.)**
1	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	03636	53	15E70	0CFC1	53

b. Verify that the CPR Decoder function (see §A.1.7.6 of Appendix A) provides an "***even***" and "***odd***" output **latitude** position within **0.00015** degrees of the **latitude** position indicated.

c. Verify that the CPR Decoder function (see §A.1.7.6 of Appendix A) provides an "***even***" and "***odd***" output **longitude** position within **0.00015** degrees of the **longitude** position indicated.

Step 2: Track State Initialization
[the original Measurement Procedure paragraphs "a" through "d" come under the new Step 2 heading.]

(1.XX) In RTCA/DO-260A, add a new section §2.4.10.6 and subparagraphs as follows:

2.4.10.6 Verification of the Globally Unambiguous CPR Decode Validation (§2.2.10.6)

Purpose/Introduction

A validation **shall** be performed on a given Airborne Participant to verify the Globally Unambiguous CPR decode established per §2.2.10.3.1, subparagraph "a," using the following steps:

a. After the Globally Unambiguous CPR decode performed per §2.2.10.3.1, subparagraph "a," upon receipt of both a subsequent "***even***" and "***odd***" Position Message within 10 seconds of each other, each received after the corresponding "***even***" and "***odd***" Position Message used in the Globally Unambiguous CPR computed in §2.2.10.3.1, subparagraph "a," perform a successful Globally Unambiguous CPR decode of the Airborne Participant Position in accordance with §A.1.7.7 of Appendix A,

b. Compare the position decode resulting from the Globally Unambiguous CPR decode as per step a. above to the Locally Unambiguous CPR decode computed from the receipt of the current Position Message satisfying subparagraph "a" above,

Note: *The Locally Unambiguous CPR decode is based on the update of the position derived from the current Globally Unambiguous CPR decode established in §2.2.10.3.1, subparagraph "a."*

c. If the position difference resulting from subparagraph "b" above is within 1 nautical mile, the validation of the given Airborne Participant is complete. Otherwise, the following subparagraph applies:

d. No State Vector Report is generated from the receipt of the current Position Message. The Report Mode for the given Airborne Participant Report Mode is reset to the Initialization State. All "***even***" and "***odd***" Position Messages received prior to the respective "***even***" and "***odd***" Position Message used in the Globally Unambiguous CPR decode in subparagraph "a" above are discarded.

Note: *Completion of validation requires reception of both an additional "**even**" and "**odd**" Position Message subsequent to the Position Messages used to satisfy the Globally Unambiguous CPR decode in Acquisition State. Since reception of an Airborne Velocity Message will transition an Airborne Participant from Acquisition State to Track State, as per §2.2.10.4.1.1, then validation may not be completed until the Airborne Participant is in the Track State.*

Measurement Procedure:

Step 1: Airborne Target Setup

Set up the Test Generator to input to the receiver an Airborne participant encoded using the following Messages to demonstrate proper position validation processing:

Test inputs:

Pair 1: A Position Message set consisting of first an "***even***" and then an "***odd***" Position Message, both encoded with the same NL value that produces a Globally Unambiguous CPR decode within the maximum operating range of the receiver, and both input to the receiver within 10 seconds of each other.

Pair 2: A Position Message set consisting of first an "***even***" and then an "***odd***" Position Message, both encoded with the same NL value but different than Pair 1 that produces a Globally Unambiguous CPR decode within maximum receiver range, and both input to the receiver within 10 seconds of each other.

Along with the Position Messages, configure the target to output Airborne Velocity, Aircraft ID and Type Messages and Aircraft Operational Status Messages beginning at the same time the input of the Position Messages in the steps below and at the proper Airborne transmit rate.

Step 2: Verify Airborne Position Not Validated

Input a Pair 1 and verify that a State Vector Report is generated by the receipt of the "***odd***" Position Message of Pair 1. Input a Pair 2 and verify that no State Vector Report is output by the receipt of the "***odd***" Position Message or by the receipt of Airborne Velocity Messages after Pair 2.

Step 3: Verify Airborne Position Validated – Case 1

Input a Pair 1 and verify that a State Vector Report consistent with the Globally Unambiguous CPR position of Pair 1 is generated by the receipt of the "***odd***" Position Message of Pair 1. Input a Pair 2 and verify that no State Vector Report is output by the receipt of the "***odd***" Position Message. Repeat input of Pair 1 and verify that no State Vector Report is output by the receipt of the "***even***" Position Message and that a State Vector Report consistent with the Globally Unambiguous CPR position of Pair 1 is generated by the receipt of the "***odd***" Position Message. Repeat input of Pair 1 and verify that each Position and Velocity Message received results in a State Vector Report with position consistent with the Globally Unambiguous CPR position of Pair 1.

Step 4: Verify Airborne Position Validated – Case 2

Input a Pair 1 and verify that a State Vector Report consistent with the Globally Unambiguous CPR position of Pair 1 is generated by the receipt of the "***odd***" Position Message of Pair 1. Input a Pair 2 and verify that no State Vector Report is output by the receipt of the "***odd***" Position Message. Repeat input of Pair 2 and verify that no State Vector Report is output by the receipt of the "***even***" Position Message and that a State Vector Report consistent with the Globally Unambiguous CPR position of Pair 2 is generated by the receipt of the "***odd***" Position Message. Repeat input of Pair 2 and verify that each Position and Velocity Message received results in a State Vector Report with position consistent with the Globally Unambiguous CPR position of Pair 2.

Step 5: Surface Target Setup

Set up the Test Generator to input to the receiver a Surface participant encoded using the following Messages to demonstrate proper position validation processing:

Test inputs:

Pair 1: A Position Message set consisting of first an "***even***" and then an "***odd***" Position Message, both encoded with the same NL value that produces a Globally Unambiguous CPR decode within the maximum operating range of the receiver, and both input to the receiver within 25 seconds of each other.

Pair 2: A Position Message set consisting of first an "***even***" and then an "***odd***" Position Message, both encoded with the same NL value but different than Pair 1 that produces a Globally Unambiguous CPR decode within maximum receiver range, and both input to the receiver within 25 seconds of each other.

Along with the Position Messages, configure the target to output Aircraft ID and Type Messages and Aircraft Operational Status Messages beginning at the same time the input of the Position Messages in the steps below and at the proper Surface transmit rate.

Step 6: Verify Surface Position Not Validated

Input a Pair 1 and verify that a State Vector Report is generated by the receipt of the "***odd***" Position Message of Pair 1. Input a Pair 2 and verify that no State Vector Report is output by the receipt of the "***odd***" Position Message.

Step 7: Verify Surface Position Validated – Case 1

Input a Pair 1 and verify that a State Vector Report consistent with the Globally Unambiguous CPR position of Pair 1 is generated by the receipt of the "***odd***" Position Message of Pair 1. Input a Pair 2 and verify that no State Vector Report is output by the receipt of the "***odd***" Position Message. Repeat input of Pair 1 and verify that no State Vector Report is output by the receipt of the "***even***" Position Message and that a State Vector Report consistent with the Globally Unambiguous CPR position of Pair 1 is generated by the receipt of the "***odd***" Position Message. Repeat input of Pair 1 and verify that each Position Message received results in a State Vector Report with position consistent with the Globally Unambiguous CPR position of Pair 1.

Step 8: Verify Surface Position Validated – Case 2

Input a Pair 1 and verify that a State Vector Report consistent with the Globally Unambiguous CPR position of Pair 1 is generated by the receipt of the "***odd***" Position Message of Pair 1. Input a Pair 2 and verify that no State Vector Report is output by the receipt of the "***odd***" Position Message. Repeat input of Pair 2 and verify that no State Vector Report is output by the receipt of the "***even***" Position Message and that a State Vector Report consistent with the Globally Unambiguous CPR position of Pair 2 is generated by the receipt of the "***odd***" Position Message. Repeat input of Pair 2 and verify that each Position Message received results in a State Vector Report with position consistent with the Globally Unambiguous CPR position of Pair 2.

(1.XX) In RTCA/DO-260A, at the end of §A.1.7.7, add the following:

h) A reasonableness test is applied to the resulting decoded position in accordance with §A.1.7.10.2.

(1.XX) Modify the change for the addition of a new section A.1.7.8 to include: In RTCA/DO-260A, replace the two paragraphs and one Note in the newly proposed §A.1.7.8 which are between "Note #2" and the subparagraph "a" with the following:

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 the time interval of **X** seconds, where **X**=50 seconds, unless the Ground Speed in either Surface Position Message is greater than 25 knots, or is unknown, in which cases **X**=25 seconds.

Note 3.— 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 knots specified for the transmission of the surface format, the combination indicates that 25 seconds will provide the needed assurance. For targets on the airport surface when speeds are much less and the transmission rate is as low as one per 5 seconds, the corresponding time limit is 50 seconds.

Given a CPR 17-bit surface position encoded in the "***even***" format (XZ0, YZ0) and another encoded in the "***odd***" format (XZ1, YZ1), separated by no more than X 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:

(1.XX) In RTCA/DO-260A, at the end of the newly proposed §A.1.7.8, add the following:

h) A reasonableness test is applied to the resulting decoded position in accordance with A.1.7.10.2.

(1.XX) In RTCA/DO-260A, add a new section and subsections, §A.1.7.10, entitled "**Reasonableness Test for CPR Decoding of Received Position Messages**" per the following:

A.1.7.10 Reasonableness Test for CPR Decoding of Received Position Messages

A.1.7.10.1 Overview

Note: *Although receptions of Position Messages will normally lead to a successful target position determination, it is necessary to safeguard against Position Messages that would be used to initiate or update a track with an erroneous position. A reasonableness test applied to the computed position resulting from receipt of a Position Message can be used to discard erroneous position updates. Since an erroneous globally unambiguous CPR decode could potentially exist for the life of a track, a reasonableness test and validation of the position protects against such occurrences.*

A.1.7.10.2 Reasonableness Test Applied to Position Determined from Globally Unambiguous Decoding

A reasonableness test **shall** be applied to a position computed using the globally unambiguous CPR decoding per A.1.7.7 for airborne participants or per A.1.7.8 for surface participants. Upon receipt of the "***even***" or "***odd***" encoded Position Message that completes the globally unambiguous CPR decode, the receiver **shall** perform a

reasonableness test on the position decode by the following:

If the receiver position is known, calculate the distance between the decoded position and the receiver position and verify that the distance is less than the maximum operating range. If the validation fails, the receiver **shall** discard the decoded position, the "***even***" and "***odd***" Position Messages used to perform the globally unambiguous CPR decode, and reinitiate the globally unambiguous CPR decode process.

A further validation of the globally unambiguous CPR decode, passing the above test, **shall** be performed by the computation of a second globally unambiguous CPR decode based on reception of a new "***odd***" and an "***even***" Position Message as per §A.1.7.7 for an Airborne participant, or per §A.1.7.8 for a Surface participant, both received subsequent to the respective "***odd***" and "***even***" Position Message used in the globally unambiguous CPR decode under validation. Upon accomplishing the additional globally unambiguous CPR decode, this decoded position and the position from the locally unambiguous CPR decode resulting from the most recently received Position Message **shall** be checked to be identical. If the two positions are not identical, the validation is failed and the initial globally unambiguous CPR decode under validation **shall** be discarded and the track **shall** be reinitialized.

Note: *The position obtained from the initial global CPR decode is subsequently updated using local CPR decoding, until an independent "odd" and "even" Position Message pair has been received. When this occurs, a second global CPR decode is performed. The resulting position is compared to the position update obtained from the local CPR decode using the most recently received Position Message. These two positions should agree since they are computed from the same message.*