1090-WP27-15
12 – 15 May 2009

RTCA Special Committee 186, Working Group 3
EUROCAE WG-51, SG-1

ADS-B 1090ES MOPS Maintenance

Meeting #27

United Airlines, Chicago, IL
12 – 15 May 2009

Removal of Vertical Components for NIC, NACp and SIL

Dean Miller
Boeing Commercial Airplanes

Summary
This Working Paper addresses the modifications to DO-260B to remove the requirements for the vertical components of NIC, NACp and SIL. It is presented in response to Action Item 25-18.

The following changes are proposed to Section 2.2.3.2.7.2.6 "NIC Supplement Subfield in Aircraft Operational Status Messages" of DO-260B. A revised Table 2-70 should be included in this section. Identical changes should be made to Table A-25 in Section A.1.4.10.6 "NIC Supplement".

Table 2-70: Navigation Integrity Category (NIC) Encoding

and

Table A-25: Navigation Integrity Category (NIC) Encoding

NIC Value	Containment Radius (R_C) ~~and Vertical Protection Limit (VPL)~~	Airborne		Surface	
		Airborne Position TYPE Code	NIC Supplement Code	Surface Position TYPE Code	NIC Supplement Code
0	R_C unknown	0, 18 or 22	0	0, 8	0
1	R_C < 20 NM (37.04 km)	17	0	N/A	N/A
2	R_C < 8 NM (14.816 km)	16	0	N/A	N/A
3	R_C < 4 NM (7.408 km)	16	1	N/A	N/A
4	R_C < 2 NM (3.704 km)	15	0	N/A	N/A
5	R_C < 1 NM (1852 m)	14	0	N/A	N/A
6	R_C < 0.6 NM (1111.2 m)	13	1	N/A	N/A
	R_C < 0.5 NM (926 m)	13	0		
7	R_C < 0.2 NM (370.4 m)	12	0	8	1
8	R_C < 0.1 NM (185.2 m)	11	0	7	0
9	R_C < 75m ~~*and* VPL < 112 m~~	11	1	7	1
10	R_C < 25m ~~*and* VPL < 37.5 m~~	10 or 21	0	6	0
11	R_C < 7.5m ~~*and* VPL < 11 m~~	9 or 20	0	5	0

Note: *"N/A" means "This NIC value is not available in the ADS-B Surface Position Message formats."*

The following changes are proposed to Section 2.2.3.2.7.2.7 "Navigation Accuracy Category for Position (NACP) Subfield in Aircraft Operational Status Messages" of DO-260B. A revised Table 2-71 should be included in this section. Identical changes should be made to Table A-15 in Section A.1.4.9.12 "Navigation Accuracy Category for Position (NACp)".

Table 2-71: Navigation Accuracy Category for Position (NAC_P) Encoding

And

Table A-15: Navigation Accuracy Category for Position (NAC_P) Encoding

Coding		95% Horizontal and Vertical Accuracy Bounds (EPU ~~and VEPU~~)	Comment	Notes
(Binary)	(Decimal)			
0000	0	EPU ≥ 18.52 km (≥10 NM)	Unknown accuracy	1
0001	1	EPU < 18.52 km (10 NM)	RNP-10 accuracy	1, 3
0010	2	EPU < 7.408 km (4 NM)	RNP-4 accuracy	1, 3
0011	3	EPU < 3.704 km (2 NM)	RNP-2 accuracy	1, 3
0100	4	EPU < 1852 m (1 NM)	RNP-1 accuracy	1, 3
0101	5	EPU < 926 m (0.5 NM)	RNP-0.5 accuracy	1, 3
0110	6	EPU < 555.6 m (0.3 NM)	RNP-0.3 accuracy	1, 3
0111	7	EPU < 185.2 m (0.1 NM)	RNP-0.1 accuracy	1, 3
1000	8	EPU < 92.6 m (0.05 NM)	e.g., GPS (with SA on)	1
1001	9	EPU < 30 m ~~and VEPU < 45 m~~	e.g., GPS (SA off)	1, 2, 4
1010	10	EPU < 10 m ~~and VEPU < 15 m~~	e.g., WAAS	1, 2, 4
1011	11	EPU < 3 m ~~and VEPU < 4 m~~	e.g., LAAS	1, 2, 4
1100 - 1111	12 - 15	Reserved		

Notes for Table 2-71:

1. *The Estimated Position Uncertainty (EPU) used in the table is a 95% accuracy bound on horizontal position. EPU is defined as the radius of a circle, centered on the reported position, such that the probability of the actual position lying outside the circle is 0.05. When reported by a GPS or GNSS system, EPU is commonly called HFOM (Horizontal Figure of Merit).*

2. ~~*Vertical Estimated Position Uncertainty (VEPU) is a 95% accuracy limit on the vertical position (geometric altitude). VEPU is defined as a vertical position limit, such that the probability of the actual geometric altitude differing from the reported geometric altitude by more than that limit is 0.05. When reported by a GPS or GNSS system, VEPU is commonly called VFOM (Vertical Figure of Merit).*~~

~~3.~~ *RNP accuracy includes error sources other than sensor error, whereas horizontal error for NAC_P only refers to horizontal position error uncertainty.*

~~4. *If geometric altitude is not being reported, then the VEPU tests are not assessed.*~~

The following changes are proposed to Section 2.2.3.2.7.2.9 "Surveillance Integrity Level (SIL) Subfield in Aircraft Operational Status Messages" of DO-260B. A revised Table 2-72 should be included in this section. Identical changes should be made to Table A-17 in Section A.1.4.9.14 "Surveillance Integrity Level (SIL)". The proposed changes to the definition of SIL also affect this table and notes but are not included in this paper.

Table 2-72: "SIL" Subfield Encoding

and

Table A-17: "SIL" Subfield Encoding

SIL Coding		**Probability of Exceeding the Horizontal Integrity Containment Radius (R_C) Reported in the NIC Subfield Without an Indication**	~~**Probability of Exceeding the Vertical Integrity Containment Region (VPL) Without an Indication**~~	**Corresponding Hazard Classification**
(Binary)	(Decimal)			
00	0	Unknown	~~Unknown~~	No Safety Effect
01	1	$\leq 1 \times 10^{-3}$ per flight hour or per sample	~~$\leq 1 \times 10^{-3}$ per flight hour or per sample~~	Minor
10	2	$\leq 1 \times 10^{-5}$ per flight hour or per sample	~~$\leq 1 \times 10^{-5}$ per flight hour or per sample~~	Major
11	3	$\leq 1 \times 10^{-7}$ per flight hour or per sample	~~$\leq 2 \times 10^{-7}$ per 150 seconds or per sample~~	Severe Major/Hazardous

Notes:

1. *The NIC parameter is broadcast partly in the TYPE subfield of Airborne Position and Surface Position Messages, and partly in the NIC Supplement subfield of Aircraft Operational Status Messages (§**Error! Reference source not found.**).*

2. *"An Indication" may include, for example, a flag for invalid position report, or a change in NIC, or switching to another data source. See §2.1.2.15 of the ADS-B MASPS, RTCA DO-242A, for a more complete description of SIL.*

~~*3. The vertical integrity containment column only applies to NIC values greater than 8.*~~

~~*4. The SIL encoding is the most stringent of the horizontal or vertical values.*~~

5. *At the time of publication of these MOPS, it is recognized that there are three possible derivations of SIL: (a) the integrity value provided by navigation sensors with self-monitoring capability (e.g., GPS), (b) the reliability of aircraft systems given as indicated by a failure rate commensurate with the equipment design assurance, and (c) the integrity of other navigation systems, (e.g., RNP) that rely on ground-based self-monitoring equipment for integrity assurance, and for which no specific hourly integrity value can be ascribed. These three values are not readily interchangeable. Selection of the largest of the values as specified in Table 2-72 is felt to provide a reasonable bound on the order of magnitude of the probability of possible failures affecting ADS-B applications. Future revisions of these MOPS may refine the SIL definition as more is understood.*

6. *Since the SIL is intended to reflect the integrity of the navigation source of the position information broadcast, the SIL value transmitted should be indicative of the true integrity of the ADS-B position data. A problem for installations that include currently available GNSS receivers and FMS systems is that SIL is not output by these systems. With the lack of SIL information being provided by the navigation source, implementers should not arbitrarily set a SIL value of ZERO (0) indicating unknown integrity. It is suggested, unless there is a tightly coupled navigation source where SIL can be unambiguously determined and set dynamically, that the ADS-B Transmitting Subsystem should provide for the static setting of SIL as part of the installation procedure. Most implementers are expected to determine SIL by off-line analysis of the installed configuration. This off-line analysis can be performed on the various primary and alternate means of determining the reported position. SIL is a static value for each of these configurations.*