International Civil Aviation Organization

Performance Based Navigation Sub Group (PBN SG)

First Meeting
(Cairo, Egypt, 1 – 3 April 2014)

Agenda Item 3: Global and Regional Developments in PBN and GNSS

GLOBAL AND REGIONAL DEVELOPMENTS
RELATED TO GNSS

(Presented by the Secretariat)

SUMMARY

This paper provides brief information on the Fourteenth meeting of the Navigation Systems Panel (NSP) Working Group of the Whole (WGW 14) and MEDUSA workshop and other GNSS related updated information.

Action by the meeting is at paragraph 3.

REFERENCES

- MEDUSA Presentations
- Report of the NSP WGW/14 meeting

1. INTRODUCTION

1.1 The Navigation Systems Panel (NSP) Working Group of the Whole held its Fourteenth Meeting in Montreal, 12 – 21 November 2014. Seventy (70) participants from 16 States (Australia, Brazil, Canada, China, France, Germany, Italy, Japan, Netherlands, Russian Federation, Saudi Arabia, Spain, Sweden, Thailand, UK, USA, and 3 international organizations (EUROCONTROL, ICASC, ICCAIA) participated in the meeting.

1.2 The EUROMED GNSS II/MEDUSA project (Global Navigation by Satellite Systems EGNOS/GALILEO) Egypt National Workshop was held in Cairo on 12 March 2014.

2. DISCUSSION

2.1 The meeting may wish to note that the President of the Air Navigation Commission (ANC) explained to the NSP WGW 14 meeting that a proposal for the reorganization of panels is under development, and will likely affect the NSP. Changes under consideration that might affect NSP include moving all spectrum work in one location, perhaps into a new dedicated panel, and restarting the PBN work.

2.2 A total of nine Job Cards were assigned to NSP. The Secretary of the NSP confirmed that the work on a number of items that are not covered by Job Cards such as the development of SARPs for Galileo and BeiDou would continue even though they are not covered by Job Cards.

2.3 Concerning SARPs for GNSS elements and signals (ABAS, SBAS and core constellations), the papers reviewed by the NSP WGW/14 meeting covered topics that included updates to the GLONASS SARPs, initial SARPs material for the BeiDou and Galileo core constellations, updates to the SBAS SARPs, and a few other topics.

2.4 The meeting reviewed the status of GBAS implementations, and considered the maintenance of existing GBAS CAT I SARPs and the validation of the SARPs material on GBAS CATII/III.

2.5 The meeting may wish to note the Status of constellations as follows:

- BeiDou has currently 14 operational navigation satellites in orbit (5 GEOs + 5 IGSOs + 4 MEOs). The constellation provides service in Asia at this time. Satellites that will transmit the global navigation signals are scheduled to be launched after 2014. The meeting was informed that the BeiDou Performance Standard document was expected to be published in 2014 prior to the next ICAO NSP meeting. ICAO Doc9849 GNSS manual Second edition was published in 2013 with BeiDou description.

- The full service of Galileo, which will be provided by a constellation of 30 satellites, is planned to be achieved prior to 2020. The Galileo programme plans to declare “early service” in 2015 using a smaller number of satellites. The first version of the Galileo Service Center was inaugurated on May 14, 2013. The programme plans on 2 to 3 launches in 2014

- The U.S. Global Positioning System (GPS). GPS has continually met its civil performance commitments since 1993. GPS currently has 31 operational satellites spanning from Block IIA satellites to the Block IIR to the newest generation of Block IIF. As the U.S. continues to modernize GPS, new capabilities and signals are being developed and employed including L2C, L5, and L1C. The 4th signal, L1C, is designed with international partners for interoperability and will be broadcast with GPS III in 2015.

- Concerning the Russian GLONASS. In January 2012 the new GLONASS Federal Program for 2012-2020 was approved and is being implemented currently. GLONASS system was considered in its full operational capability. 24 operational satellites guarantee access to navigation services worldwide, with 4 spares and one satellite in the flight test phase. In April 2013 a GLONASS-M satellite was launched to replace a satellite with expiring service term. The next generation GLONASS-K satellites, equipped with high-precision instruments that can be used in harsh conditions of outer space, are scheduled to be launched in 2015 and will gradually replace the GLONASS-M generation. Currently GLONASS global availability is 99.9 %. GLONASS availability on the territory of the Russian Federation is 100 %. Russia informed that SDCM (system of differential correction and monitoring), the augmentation system of GLONASS, helps to improve accuracy and reliability. There are currently about 20 stations of measurement collections on the territory of the Russian Federation and one in Brazil.

2.6 The NSP WGW/14 discussed the Methodology for GPS + RAIM performance monitoring and recording, the papers presented to the meeting provided an analysis of existing document applicable for the GNSS data recording and monitoring and proposed a methodology to implement such monitoring. The study conducted identifies 4 main steps to implement GNSS monitoring (1-Data Input, 2-Data Recording, 3-Data Elaboration and 4-Reporting). The paper identified the need for further guidance on GNSS monitoring, including details on the objectives, acceptable methodology, policy for the retention of data, reporting and notification process in case of anomaly. The NSP established a drafting group to start preparing guidance material on GNSS monitoring. The group will look at existing text in SARPs, guidance material and the GNSS Manual and propose relevant amendments.

2.7 The NSP WGW/14 was informed on the main activities conducted by RTCA SC 159 Working Group 2 on SBAS. This group intended to start actively working on the development of a concept of operations for multi-frequency, multi-constellation SBAS solutions. This work should be accompanied by an assessment of the benefits of various configurations. Work will also start on the definition of the next generation SBAS signal format and integration in the receivers.

2.8 It was pointed out during the discussion that work is being done in Europe to assess the accrued benefits from multi-constellation systems. The outcome of the study will be presented at the next meeting. Also, it was noted that work is being conducted under the auspices of the SBAS Interoperability Working Group (IWG) to assess the main operational benefits expected from the next generation of SBAS.

2.9 The NSP WGW/14, discussed the development of future ICAO standards for Advanced RAIM, it was highlighted the need to establish requirements for the data delivery mechanism, or Integrity Support Messages (ISM), including the data structure and the data contents. Additional performance requirements in Annex 10 will also likely be needed. Furthermore, it was explained that research on ARAIM was being done in the frame of the coordination activity on GNSS between the U.S. and Europe. Material from this work will be brought at the NSP meeting planned for the third quarter of 2014. This material will provide a basis to establish a more detailed standardization plan for ARAIM. In the meantime, NSP members were encouraged to bring additional papers on ARAIM discussing objectives, operational concept and potential implementation constraints at the next NSP meeting.

2.10 Based on the NSP WGW/14, recommendations, amendments to Annex 10 *Aeronautical Telecommunications*, Volume I — *Radio Navigation Aids*, concerning the Global Navigation Satellite System (GNSS) are proposed as at **Appendix A** to this working paper. Furthermore, it is expected that the applicability date for the proposed amendment to Annex 10, Volume I would be 10 November 2016.

2.11 The EUROMED GNSS II/MEDUSA project (Global Navigation by Satellite Systems EGNOS/GALILEO) held a national workshop, in Cairo, on 12 March 2014. The morning session of the workshop was dedicated to civil aviation. Presentations from different stake holders such as (Egypt MOT, MEDUSA, NANSC, Egypt Air and NAVISAT) were provided. It was interesting to note that users are now considering the SBAS and its benefits.

2.12 The meeting may wish to recall that ACAC are persuading the SBAS Implementation in the Regions of ACAC and ASECNA (SIRAJ) project which is based on EGNOS extension. Furthermore, Egypt has adopted an initiative “NAVISAT” to establish a Regional Aeronautical Mobile Satellite (Route) System to provide Aeronautical Safety Communication, Navigation and Surveillance/Air Traffic Management Services over Africa and Middle East Regions.

2.13 The Fourth Meeting of ICAO APAC Region's s Ionospheric Studies Task Force (ISTF/4) was held in India from 05 to 07 February 2014. The first day was a joint session for the 4th ICAO Ionospheric Study Task Force (ISTF) Meeting and the 26th Interoperability Working Group (IWG) Meeting. On 06 and 07 February, ISTF met on a dedicated session. Issues related to GAGAN, MSAS and interoperability were discussed.

2.14 The meeting may wish to note that in EUR there are several activities and studies conducted under the SESAR. The results of a study conducted in Germany to investigate the response of GPS receivers onboard aircraft to repeater signals, indicated that interference by GNSS repeaters with high output powers (higher than allowed in European and German regulations) can induce severe position errors in airborne receivers without appropriate warning from the receiver. The study shows that the largest errors were obtained by TSO C-129 receivers; smaller errors were obtained with GBAS and non-aviation survey-grade receivers. The study suggested that future avionics standards should include provisions to limit the effect of such interference on aviation grade receivers.

3. ACTION BY THE MEETING

3.1 The meeting is invited to note the information contained in this working paper and take action as appropriate.

APPENDIX

PROPOSED AMENDMENT TO INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10 TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME I (RADIO NAVIGATION AIDS)

NOTES ON THE PRESENTATION OF THE PROPOSED AMENDMENT

The text of the amendment is arranged to show deleted text with a line through it and new text highlighted with grey shading, as shown below:

1.	Text to be deleted is shown with a line through it.	text to be deleted
2.	New text to be inserted is highlighted with grey shading.	new text to be inserted
3.	Text to be deleted is shown with a line through it followed by the replacement text which is highlighted with grey shading.	new text to replace existing text

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME I
(RADIO NAVIGATION AIDS)

INITIAL PROPOSAL 1

CHAPTER 3. SPECIFICATIONS FOR RADIO NAVIGATION AIDS

…

3.7 Requirements for the Global Navigation Satellite System (GNSS)

3.7.1 Definitions

…

Antenna port. A point where the received signal power is specified. For an active antenna, the antenna port is a fictitious point between the antenna elements and the antenna pre-amplifier. For a passive antenna, the antenna port is the output of the antenna itself.

…

Origin:	**Rationale:**
NSP WGW/14	The term “antenna port” is used several times in the GNSS SARPs. It is currently incorrectly defined in Attachment D, 10.2, and the scope of applicability of that definition is unclear. Rather than correct the text in Attachment D, it has been thought preferable to delete it and introduce a new definition in Section 3.7.1, which will be applicable to all GNSS SARPs. (See also Initial Proposals 2 and 22, which make use of the new definition, and Initial Proposal 26, which deletes the Attachment D text).

INITIAL PROPOSAL 2

3.7.3.4.4.3 *Signal power level*

3.7.3.4.4.3.1 Each SBAS satellite shall broadcast navigation signals with sufficient power such that, at all unobstructed locations near the ground from which the satellite is observed at an elevation angle of 5 degrees or higher, the level of the received RF signal at the ~~output~~ antenna port of a 3 dBi linearly polarized antenna is within the range of –161 dBW to –153 dBW for all antenna orientations orthogonal to the direction of propagation.

3.7.3.4.4.3.2 Each SBAS satellite placed in orbit after 31 December 2013 shall broadcast navigation signals with sufficient power such that, at all unobstructed locations near the ground from which the satellite is observed at or above the minimum elevation angle for which a trackable GEO signal needs to be provided, the level of the received RF signal at the ~~output~~ antenna port of the antenna specified in Appendix B, Table B-87, is at least –164.0 dBW.

3.7.3.4.4.3.2.1 *Minimum elevation angle.* The minimum elevation angle used to determine GEO coverage shall not be less than 5 degrees for a user near the ground.

3.7.3.4.4.3.2.2 The level of a received SBAS RF signal at the output of a 0 dBic antenna located near the ground shall not exceed –152.5 dBW.

3.7.3.4.4.4 *Polarization.* The broadcast signal shall be right-hand circularly polarized.

3.7.3.4.4.4.1 *Ellipticity*. The ellipticity shall be no worse than 2 dB for the angular range of ±9.1° from boresight.

Origin:	**Rationale:**
NSP WGW/14	The changes to 3.7.3.4.4.3.1 and 3.7.3.4.4.3.2 are consequential to Initial Proposal 1. The new Standard in 3.7.3.4.4.4.1 complements the polarization Standard in 3.7.3.4.4.4, by imposing a limit on the ellipticity of the signal (ratio between major and minor axis of the polarization ellipse). Without the new Standard, the existing Standard in 3.7.3.4.4.4 would imply ideal right-hand circularly polarization (ellipticity = 0 dB). This is not achievable in practical implementation. The proposed changes align the SARPs with the industry standard for SBAS avionics, RTCA DO-229D, *Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne Equipment*, February 2013.

INITIAL PROPOSAL 3

APPENDIX B. TECHNICAL SPECIFICATIONS FOR THE GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

…

3.5.4.2 *Geostationary orbit (GEO) ranging function parameters.* GEO ranging function parameters shall be as follows:

…

User range accuracy (URA): an indicator of the root-mean-square ranging error, excluding atmospheric effects, as described in Table B-26.

Note.— All parameters are broadcast in Type 9 message.

Table B-26. User range accuracy

URA	Accuracy (rms)
0	2 m
1	2.8 m
2	4 m
3	5.7 m
4	8 m
5	11.3 m
6	16 m
7	32 m
8	64 m
9	128 m
10	256 m
11	512 m
12	1 024 m
13	2 048 m
14	4 096 m
15	“Do Not Use”

Note.— URA values 0 to 14 are not used in the protocols for data application (3.5.5). Airborne receivers will not use the GEO ranging function if URA indicates “Do Not Use”(3.5.8.3).

Origin:	**Rationale:**
NSP WGW/14	The proposed changes align the SARPs with RTCA DO-229D, which reflects the actual behaviour of SBAS avionics, whereby values of URA other than 15 are not used by the avionics.

INITIAL PROPOSAL 4

3.5.5.4 *Range rate corrections (RRC)*. The range rate correction for satellite *i* is:

$$RRC_i = \frac{FC_{i,current} - FC_{i,previous}}{t_{i,0f} - t_{i,0f\_previous}}$$

$$RRC_i = \begin{cases} \frac{FC_{i,current} - FC_{i,previous}}{t_{i,0f} - t_{i,0f\_previous}}, & if\ a_i \neq 0 \\ 0, & otherwise \end{cases}$$

where

$FC_{i,current}$	=	the most recent fast correction;
$FC_{i,previous}$	=	a previous fast correction;
$t_{i,0f}$	=	the time of applicability of $FC_{i,current}$; and
$t_{i,0f\_previous}$	=	the time of applicability of $FC_{i,previous}$.; and
a_i	=	fast correction degradation factor (see Table B-34).

Origin:	**Rationale:**
NSP WGW/14	The proposed changes align the SARPs with RTCA DO-229D by correcting an omission in the existing Standard, which ignores the case in which the fast correction degradation factor is zero (and consequently the range rate correction factor must be zero too).

INITIAL PROPOSAL 5

3.5.5.6.3.1 *Broadcast ionospheric corrections.* If SBAS-based ionospheric corrections are applied, σ^2_{UIRE} is:

$$\sigma^2_{UIRE} = F^2_{pp} \times \sigma^2_{UIVE}$$

where

F_{pp} = (as defined in 3.5.5.5.2);

$\Sigma^2_{UIVE} = \sum_{n=1}^{4} W_n \cdot \sigma^2_{n,ionogrid}$ o or $\sigma^2_{UIVE} = \sum_{n=1}^{3} W_n \cdot \sigma^2_{n,ionogrid}$

using the same ionospheric pierce point weights (W_n) and grid points selected for the ionospheric correction (3.5.5.5). For

If degradation parameters are used, for each grid point:

$$\sigma^2_{\text{in,ionogrid}} = \begin{cases} \left(\sigma_{\text{n,GIVE}} + \varepsilon_{\text{iono}}\right)^2, & \text{si if } RSS_{\text{iono}} = 0 \text{ (Type 10 message)} \\ \sigma^2_{\text{n,GIVE}} + \varepsilon^2_{\text{iono}}, & \text{si if } RSS_{\text{iono}} = 1 \text{ (Type 10 message)} \end{cases}$$

where

$\varepsilon_{iono} = C_{iono\_step} \left[\frac{t - t_{iono}}{I_{iono}}\right] + C_{iono\_ramp}(t - t_{iono})$;

t = the current time;

t_{iono} = the time of transmission of the first bit of the ionospheric correction message at the GEO; and

$[x]$ = the greatest integer less than x.

If degradation parameters are not used, for each grid point:

$$\sigma_{\text{n,ionogrid}} = \sigma_{\text{n,GIVE}}$$

Note.— For GLONASS satellites, both σ_{GIVE} and ~~σ_{IONO}~~ ε_{iono} parameters are to be multiplied by the square of the ratio of the GLONASS to the GPS frequencies $(f_{GLONASS}/f_{GPS})^2$.

Origin:	**Rationale:**
NSP WGW/14	The degradation parameters used to calculate $\sigma_{n,ionogrid}$ are provided in message Types 7 and 10, whose transmission is not mandatory. This proposal introduces a formula to calculate $\sigma_{n,ionogrid}$ if the degradation parameters are not available.

INITIAL PROPOSAL 6

3.5.7.1.2 *SBAS radio frequency monitoring.* The SBAS shall monitor the SBAS satellite parameters shown in Table B-55 and take the indicated action.

…

Table B-55. SBAS radio frequency monitoring

Parameter	Reference	Alarm limit	Required action
Signal power level	Chapter 3, 3.7.3.4.4.3	minimum specified power = –161 dBW maximum specified power = –153 dBW (Note 2)	Minimum: cCease ranging function (Note 1). Maximum: cCease broadcast.
Modulation	Chapter 3, 3.7.3.4.4.5	monitor for waveform distortion	Cease ranging function (Note 1).
SNT-to-GPS time	Chapter 3, 3.7.3.4.5	N/A (Note 3)	Cease ranging function unless σ_{UDRE} URA reflects error.
Carrier frequency stability	3.5.2.1	N/A (Note 3)	Cease ranging function unless σ^2_{UDRE} and URA reflects error.
Code/frequency coherence	3.5.2.4	N/A (Note 3)	Cease ranging function unless σ^2_{UDRE} and URA reflects error.
Maximum code phase deviation	3.5.2.6	N/A (Notes 2 and 3)	Cease ranging function unless σ^2_{UDRE} and URA reflects error.
Convolutional encoding	3.5.2.9	all transmit messages are erroneous	Cease broadcast.

Notes.—
1. *Ceasing the ranging function is accomplished by broadcasting a URA and σ^2_{UDRE} of "Do Not Use" for that SBAS satellite.*
2. *These parameters can be monitored by their impact on the received signal quality (C/N_0 impact), since that is the impact on the user.*
3. *Alarm limits are not specified because the induced error is acceptable, provided it is represented in the σ^2_{UDRE} and URA parameters. If the error cannot be represented, the ranging function must cease.*

Origin:	**Rationale:**
NSP WGW/14	The deletion of references to URA is consequential to Initial Proposal 3. The deletion of the minimum and maximum power values (respectively – 161 dBw and – 153 dBW) reflects the fact that, following Amendment 87, two different power ranges apply depending on whether a satellite was placed in orbit after 31 December 2013 or not.

INITIAL PROPOSAL 7

3.5.7.3.2 *PRN mask and Issue of data — PRN (IODP)*. SBAS shall broadcast a PRN mask and IODP (Type 1 message). The PRN mask values shall indicate whether or not data are being provided for each GNSS satellite. The IODP shall change when there is a change in the PRN mask. The change of IODP in Type 1 messages shall occur before the IODP changes in any other message. The IODP in Type 2 to 5, 7, 24 ~~and~~, 25 and 28 messages shall equal the IODP broadcast in the PRN mask message (Type 1 message) used to designate the satellites for which data are provided in that message.

Origin:	**Rationale:**
NSP WGW/14	This change corrects the inadvertent omission of Type 28 in the list of messages carrying an IODP field.

INITIAL PROPOSAL 8

3.5.8.1 *SBAS-capable GNSS receiver*. Except as specifically noted, the SBAS-capable GNSS receiver shall process the signals of the SBAS and meet the requirements specified in 3.1.3.1 (GPS receiver) and/or 3.2.3.1 (GLONASS receiver). Pseudo-range measurements for each satellite shall be smoothed using carrier measurements and a smoothing filter which deviates less than ~~0.1~~ 0.25 metre within 200 seconds after initialization, relative to the steady-state response of the filter defined in 3.6.5.1 in the presence of drift between the code phase and integrated carrier phase of up to ~~0.01~~0.018 metre per second.

Origin:	**Rationale:**
NSP WGW/14	The current Standard is based on the assumption that the code-carrier divergence would remain below 0.010 metre per second. However, data collected from SBAS reference stations indicated that the rate could be larger than 0.010. Accordingly, the value 0.018 metre per second was chosen as a more realistic maximum value in RTCA DO-229D, and the allowed maximum deviation was increased accordingly to 0.25 metre. The proposed change is intended to align the SARPs with RTCA DO-229D.

INITIAL PROPOSAL 9

3.5.8.1.1 *Conditions for use of data*. The receiver shall use data from an SBAS message only if the CRC of this message has been verified. Reception of a Type 0 message from an SBAS satellite shall result in deselection of that satellite for at least one minute and all data from that satellite shall be discarded ~~for at least 1 minute~~, except that there is no requirement to discard data from Type 12 and Type 17 messages. For GPS satellites, the receiver shall apply long-term corrections only if the IOD matches both the IODE and 8 least significant bits of the IODC.[…]

Origin:	**Rationale:**
NSP WGW/14	Transmission of a Type 0 message means that the SBAS satellite that transmitted the message should not be used for safety applications (for example, because the satellite is undergoing testing). Consequently, in general the data obtained from that satellite should also be discarded. Type 12 and 17 messages, however, do not have to be discarded as they do not convey navigation information and, as such, have no safety implications, whereas their use can enable potential performance enhancements.

INITIAL PROPOSAL 10

3.5.8.1.1.5 The receiver shall apply satellite-specific degradation to the $\sigma_{i,UDRE}^2$ as defined by a Type 28 clock-ephemeris covariance matrix message. The δ_{UDRE} derived from a Type 28 message with an IODP matching that of the PRN mask shall be applied immediately.

Origin:	**Rationale:**
NSP WGW/14	The new text clarifies that the information derived from Type 28 messages should be used only if it is associated with the unique pseudo-random noise (PRN) mask identifying the signal to be corrected. This is consistent with RTCA DO-229D.

INITIAL PROPOSAL 11

3.5.8.1.1.6 In the event of a loss of four successive SBAS messages during an SBAS-based approach operation, the receiver shall ~~no longer support SBAS-based precision approach or APV operations~~ invalidate all UDREI data from that SBAS satellite.

Note. — The applicable SBAS-based approach operations are identified in RTCA/DO-229D, 2.1.1.4.9.

Origin:	**Rationale:**
NSP WGW/14	The current Standard in 3.5.8.1.1.6 does not specify a mechanism to trigger the indication of loss of navigation capability when four consecutive SBAS messages are lost (indicating a probable communications link problem). Instead, it contains a broad general statement ("no longer support SBAS-based precision approach or APV operations"), which lends itself to different interpretations, both with regard to the duration of the loss of navigation capability and to the mechanism through which an indication of loss of navigation should be triggered. The current proposal aims to align the SARPs with RTCA DO-229D. The receiver behaviour specified in DO-229D is to discard all user differential range error indicator (UDREI)[1] so as to trigger an immediate indication of loss of navigation capability. This approach enables a quick return to normal operation when SBAS message transmission resumes, as new UDREI data can be reacquired in a short time. This constitutes an advantage over the current Standard, which, as mentioned, does not specify by which means the loss of navigation should be indicated.

INITIAL PROPOSAL 12

3.5.8.4.1 *Core satellite constellation(s) ranging accuracy.* The root-mean-square (1 sigma) of the total airborne contribution to the error in a corrected pseudo-range for a GPS satellite at the minimum and maximum received signal power level (Chapter 3, 3.7.3.1.5.4) under the worst interference environment as defined in 3.7 shall be less than or equal to ~~0.4~~ 0.36 metres for minimum signal level and 0.15 metres for maximum signal level, excluding multipath effects, tropospheric and ionospheric residual errors. […]

Origin:	**Rationale:**
NSP WGW/14	This proposal introduces more stringent limits on the total airborne contribution to the error (including a new limit applying to the maximum signal level case). The more stringent limits reflect actual achievable performance by current avionics and are consistent with RTCA DO-229D.

[1] UDREI data obtained from SBAS messages is used by the aircraft receiver to compute an estimate of the range error uncertainty after SBAS corrections are applied.

INITIAL PROPOSAL 13

3.5.8.4.2 *Precision approach and APV operations*

3.5.8.4.2.1 The receiver shall obtain correction and integrity data for all satellites in the position solution from the same SBAS signal (PRN code).

3.5.8.4.2.~~1~~2 The receiver shall compute and apply long-term corrections, fast corrections, range rate corrections and the broadcast ionospheric corrections. For GLONASS satellites, the ionospheric corrections received from the SBAS shall be multiplied by the square of the ratio of GLONASS to GPS frequencies $(f_{GLONASS}/f_{GPS})^2$.

3.5.8.4.2.~~2~~3 The receiver shall use a weighted-least-squares position solution.

3.5.8.4.2.~~3~~4 The receiver shall apply a tropospheric model such that residual pseudo-range errors have a mean value (μ) less than 0.15 metres and a 1 sigma deviation less than 0.07 metres.

Note.— A model was developed that meets this requirement. Guidance is provided in Attachment D, ~~6.7.3~~ 6.5.4.

3.5.8.4.2.~~4~~5 The receiver shall compute and apply horizontal and vertical protection levels defined in 3.5.5.6. In this computation, ~~σ_{tropo}~~ $\sigma_{i,tropo}$ shall be:

$$\text{~~}\frac{1}{\sqrt{0{,}002 + \text{sen}^2(\theta_i)}} \times 0{,}12\ \text{m}\text{~~}$$

$$\frac{1.001}{\sqrt{0.002001 + \sin^2(\theta_i)}} \times 0.12\ \text{m}$$

where θ_i is the elevation angle of the i^{th} satellite.

In addition, ~~σ_{air}~~ $\sigma_{i,air}$ shall satisfy the condition that a normal distribution with zero mean and a standard deviation equal to ~~σ_{air}~~ $\sigma_{i,air}$ bounds the error distribution for residual aircraft pseudo-range errors as follows:

$$\int_{y}^{\infty} f_{\text{~~ni~~}}(x)dx \le Q\left(\frac{y}{\sigma}\right) \text{ for all } \frac{y}{\sigma} \ge 0 \text{ and}$$

$$\int_{-\infty}^{-y} f_{\text{~~ni~~}}(x)dx \le Q\left(\frac{y}{\sigma}\right) \text{ for all } \frac{y}{\sigma} \ge 0$$

where

$f_{\text{~~ni~~}}(x)$ = probability density function of the residual aircraft pseudo-range error and

$Q(x)$ = $\frac{1}{\sqrt{2\pi}}\int_{x}^{\infty} e^{-\frac{t^2}{2}}dt$

Note.— The standard allowance for airborne multipath defined in 3.6.5.5.1 may be used to bound the multipath errors.

3.5.8.4.2.~~5~~6 For precision approach and APV operations, the service provider ID broadcast Type 17 message shall be identical to the service provider ID in the FAS data block, except if ID equals 15 in the FAS data block.

Note.— For SBAS, FAS data blocks are stored in airborne databases. The format of the data for validation of a cyclic redundancy check is shown in Attachment D, 6.6. It differs from the GBAS FAS data block in 3.6.4.5 in that it contains the SBAS HAL and VAL for the particular approach procedure. For approaches conducted using SBAS pseudo-range corrections, the service provider ID in the FAS data block is the same as the service provider ID broadcast as part of the health and status information in Type 17 message. If the service provider ID in the FAS data block equals 15, then any service provider can be used. If the service provider ID in the FAS data block equals 14, then SBAS precise differential corrections cannot be used for the approach.

3.5.8.4.3 *Departure, en-route, terminal, and non-precision approach operations*

3.5.8.4.3.1 The receiver shall compute and apply long-term corrections, fast corrections and range rate corrections.

3.5.8.4.3.2 The receiver shall compute and apply ionospheric corrections.

Note.— Two methods of computing ionospheric corrections are provided in 3.1.2.4 and 3.5.5.5.2.

3.5.8.4.3.3 The receiver shall apply a tropospheric model such that residual pseudo-range errors have a mean value (μ) less than 0.15 metres and a standard deviation less than 0.07 metres.

Note.— A model was developed that meets this requirement. Guidance is provided in Attachment D, ~~6.7.3~~6.5.4.

3.5.8.4.3.4 The receiver shall compute and apply horizontal and vertical protection levels as defined in 3.5.5.6. In this computation, ~~s_{tropo}~~σ_{tropo} shall be~~:~~ obtained either from the formula in 3.5.8.4.2.5, which can be used for elevation angles not less than 4 degrees, or from the alternate formula below, which can be used for elevation angles not less than 2 degrees.

~~$$\frac{1}{\sqrt{0{,}002 + \text{sen}^2(\theta_i)}} \times 0.12 \text{ m}$$~~

$$\frac{1.001}{\sqrt{0.002001 + \sin^2(\theta_i)}} \times \left(1 + 0.015 \times \left(\max(0, 4 - \theta_i)\right)^2\right) \times 0.12 \text{ m}$$

where θ_i is the elevation angle of the i^{th} satellite.

In addition, ~~σ_{air}~~$\sigma_{i,air}$ shall satisfy the condition that a normal distribution with zero mean and standard deviation equal to ~~σ_{air}~~$\sigma_{i,air}$ bounds the error distribution for residual aircraft pseudo-range errors as follows:

$$\int_{y}^{\infty} f_{\sout{ni}}(x)dx \le Q\left(\frac{y}{\sigma}\right) \text{ for all } \frac{y}{\sigma} \ge 0 \text{ and}$$

$$\int_{-\infty}^{-y} f_{\sout{ni}}(x)dx \le Q\left(\frac{y}{\sigma}\right) \text{ for all } \frac{y}{\sigma} \ge 0$$

where

$f_{ni}(x)$	=	probability density function of the residual aircraft pseudo-range error and
$Q(x)$	=	$\frac{1}{\sqrt{2\pi}}\int_{x}^{\infty} e^{-\frac{t^2}{2}}\,dt$

Note.— The standard allowance for airborne multipath defined in 3.6.5.5.1 may be used to bound the multipath errors.

Origin:	**Rationale:**
NSP WGW/14	The new Standard 3.5.8.4.2.1 is introduced because different SBAS signals (i.e. signals with different PRN codes) may have small discrepancies, which in turn could result in small position errors. These small errors are not considered a practical threat in the case of en route and non-precision approach, but could have a minor impact in the case of PA/APV. The modifications to existing Standards 3.5.8.4.2.4 (now 3.5.8.4.2.5) and 3.5.8.4.3.4 are intended to ensure full consistency with RTCA DO-229D by using more accurate formula(s) to compute the $\sigma_{i,tropo}$ values. Additionally, this proposal corrects some typographical errors in the formulae.

INITIAL PROPOSAL 14

3.7 Resistance to interference

3.7.1 PERFORMANCE OBJECTIVES

Note 1.— For unaugmented GPS and GLONASS receivers the resistance to interference is measured with respect to the following performance parameters:

	GPS	*GLONASS*
Tracking error (1 sigma)	*~~0.4~~0.36 m*	*0.8 m*

…

Origin:	**Rationale:**
NSP WGW/14	Consequential to Initial Proposal 12.

INITIAL PROPOSAL 15

3.7 Resistance to interference

3.7.1 PERFORMANCE OBJECTIVES

…

Note 6.— The performance requirements are to be met in the interference environments defined below for various phases of flight. This defined interference environment is relaxed during initial acquisition of GNSS signals when the receiver cannot take advantage of a steady-state navigation solution to aid signal acquisition.

3.7.2 CONTINUOUS WAVE (CW) INTERFERENCE

3.7.2.1 *GPS AND SBAS RECEIVERS*

3.7.2.1.1 After steady-state navigation has been established, GPS and SBAS receivers used for the precision approach phase of flight or used on aircraft with on-board satellite communications shall meet the performance objectives with CW interfering signals present with a power level at the antenna port equal to the interference thresholds specified in Table B-83 and shown in Figure B-15 and with a desired signal level of 164.5 164 dBW at the antenna port.

3.7.2.1.2 GPS and SBAS receivers used for non-precision approach shall meet the performance objectives with interference thresholds 3 dB less than specified in Table B-83. For terminal area and en-route steady-state navigation operations and forDuring initial acquisition of the GPS and SBAS signals prior to steady-state navigation, the GPS and SBAS receivers shall meet the performance objectives with interference thresholds shall be 6 dB less than those specified in Table B-83.

Table B-83. CW interference thresholds for GPS and SBAS receivers in steady-state navigation

Frequency range f_i of the interference signal	Interference thresholds for receivers used for precision approach phase of flight in steady-state navigation
$f_i \leq$ 1 315 MHz	–4.5 dBW
1 315 MHz < $f_i \leq$ 1 5251 500 MHz	Linearly decreasing from –4.5 dBW to –42 –38 dBW
1 500 MHz < $f_i \leq$ 1 525 MHz	Linearly decreasing from –38 dBW to –42 dBW
1 525 MHz < $f_i \leq$ 1 565.42 MHz	Linearly decreasing from –42 dBW to –150.5 dBW
1 565.42 MHz < $f_i \leq$ 1 585.42 MHz	–150.5 dBW
1 585.42 MHz < $f_i \leq$ 1 610 MHz	Linearly increasing from –150.5 dBW to –60 dBW
1 610 MHz < $f_i \leq$ 1 618 MHz	Linearly increasing from –60 dBW to –42 dBW*
1 618 MHz < $f_i \leq$ 2 000 MHz	Linearly increasing from –42 dBW to –8.5 dBW*
1 610 MHz < $f_i \leq$ 1 626.5 MHz	Linearly increasing from –60 dBW to –22 dBW**
1 626.5 MHz < $f_i \leq$ 2 000 MHz	Linearly increasing from –22 dBW to –8.5 dBW**
f_i > 2 000 MHz	–8.5 dBW

* Applies to aircraft installations where there are no on-board satellite communications.
** Applies to aircraft installations where there is on-board satellite communications.

…

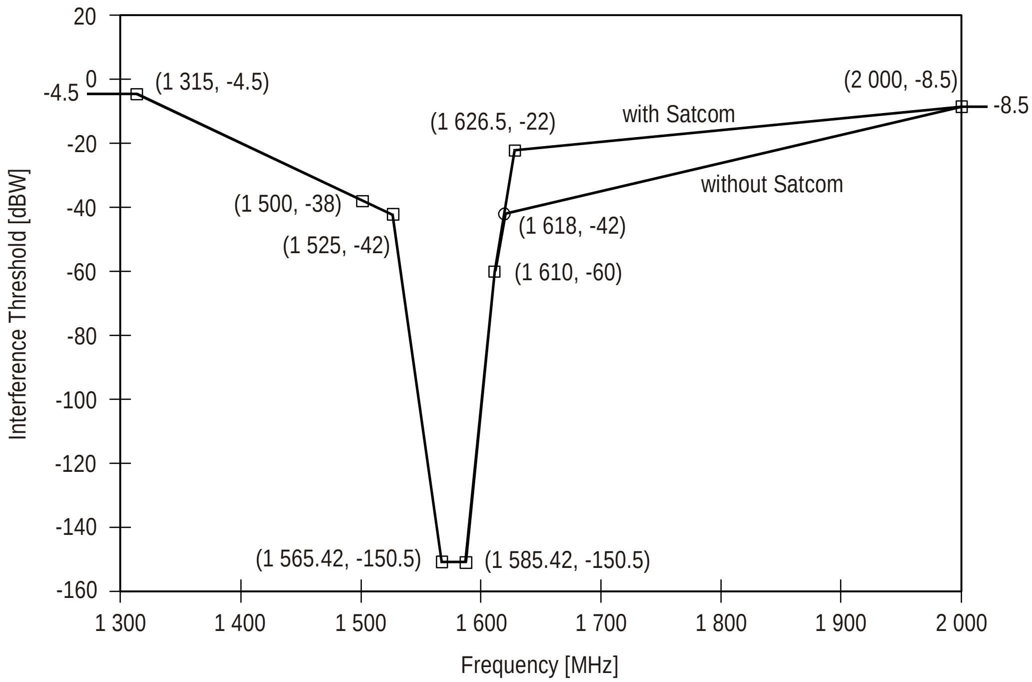

Figure B-15. CW interference thresholds for GPS and SBAS receivers ~~used for precision approach~~ in steady-state navigation

Origin:	**Rationale:**
NSP WGW/14	The current formulation of the GNSS Standards on resistance to interference (Appendix B, 3.7) was based on the assumption that interference decreased at higher altitude as the distance from interference sources increased. Thus, different requirements were defined depending on the different phases of flight for which the GNSS receiver was intended to be used. However, further analysis of the interference environment showed that the assumption was invalid. As the altitude increases, individual external interference sources are indeed farther away (which does decrease their individual contribution to the interference at the aircraft), but more interference sources become visible to the aircraft, so that the aggregate interference level does not decrease. These considerations are reflected in the latest version of RTCA DO-229D in which the requirements on resistance to interference were reformulated to be independent from the phase of flight and to depend only on the receiver acquisition state, namely on whether the GNSS signal has been acquired (steady-state navigation) or is in the process of being acquired (initial acquisition). The present proposal introduces a reformulation of the GPS and SBAS receiver requirements for resistance to continuous wave (CW) interference along similar lines to RTCA DO-229D. Additionally, the desired signal level value in 3.7.2.1.1 is modified as a consequence of the change to Chapter 3, 3.7.3.4.4.3.2 introduced by Amendment 87, and a correction to the interference thresholds defined in Table B-83 is introduced.

INITIAL PROPOSAL 16

3.7.2.2 *GLONASS RECEIVERS*

3.7.2.2.1 After steady-state navigation has been established, GLONASS receivers ~~used for the precision approach phase of flight or used on aircraft with on-board satellite communications~~(except those identified in 3.7.2.2.1.1) shall meet the performance objectives with CW interfering signals present with a power level at the antenna port equal to the interference thresholds specified in Table B-84 and shown in Figure B-16 and with a desired signal level ~~of –165.5~~ –166.5 dBW at the antenna port.

3.7.2.2.1.1 After steady-state navigation has been established, GLONASS receivers used for all phases of flight (excluding those used for the precision approach phase of flight) and put into operation before 1 January 2017 shall meet the performance objectives with CW interfering signals present with a power level at the antenna port 3 dB less than the interference thresholds specified in Table B-84 and shown in Figure B-16 and with a desired signal level of –166.5 dBW at the antenna port.

Table B-84. CW ~~I~~interference thresholds for GLONASS receivers in steady-state navigation

Frequency range f_i of the interference signal	Interference thresholds for receivers ~~used for precision approach phase of flight~~in steady-state navigation
$f_i \leq$ 1 315 MHz	–4.5 dBW
1 315 MHz < $f_i \leq$ 1 562.15625 MHz	Linearly decreasing from –4.5 dBW to –42 dBW
1 562.15625 MHz < $f_i \leq$ 1 583.65625 MHz	Linearly decreasing from –42 dBW to –80 dBW
1 583.65625 MHz < $f_i \leq$ 1 592.9525 MHz	Linearly decreasing from –80 dBW to –149 dBW
1 592.9525 MHz < $f_i \leq$ 1 609.36 MHz	–149 dBW
1 609.36 MHz < $f_i \leq$ 1 613.65625 MHz	Linearly increasing from –149 dBW to –80 dBW
1 613.65625 MHz < $f_i \leq$ 1 635.15625 MHz	Linearly increasing from –80 dBW to –42 dBW*
1 613.65625 MHz < $f_i \leq$ 1 626.15625 MHz	Linearly increasing from –80 dBW to –22 dBW**
1 635.15625 MHz < $f_i \leq$ 2 000 MHz	Linearly increasing from –42 dBW to –8.5 dBW*
1 626.15625 MHz < $f_i \leq$ 2 000 MHz	Linearly increasing from –22 dBW to –8.5 dBW**
$f_i >$ 2 000 MHz	–8.5 dBW

* Applies to aircraft installations where there are no on-board satellite communications.
** Applies to aircraft installations where there is on-board satellite communications.

3.7.2.2.2 ~~GLONASS receivers used for non-precision approach shall meet the performance objectives with interference thresholds 3 dB less than specified in Table B-84. For terminal area and en-route steady-state navigation operations and for~~ During initial acquisition of the GLONASS signals prior to steady-state navigation, ~~the~~ GLONASS receivers shall meet the performance objectives with interference thresholds ~~shall be~~ 6 dB less than those specified in Table B-84.

Origin:	**Rationale:**
NSP WGW/14	This proposal is based on the same considerations as Initial Proposal 15, applied here to GLONASS receivers. It differs from Initial Proposal 15 in that it introduces transitional provisions for certain types of GLONASS receivers put into operations before 1 January 2017 (3.7.2.2.1.1). Additionally, the desired signal level value in 3.7.2.2.1 is modified as a consequence of the 1-dB reduction in minimum antenna gain introduced by Amendment 87 (Table B-88).

INITIAL PROPOSAL 17

3.7.3 BAND-LIMITED NOISE-LIKE INTERFERENCE

3.7.3.1 *GPS AND SBAS RECEIVERS*

3.7.3.1.1 After steady-state navigation has been established, GPS and SBAS receivers ~~used for the precision approach phase of flight or used on aircraft with on-board satellite communications~~ shall meet the performance objectives with noise-like interfering signals present in the frequency range of 1 575.42 MHz $\pm Bw_i/2$ and with power levels at the antenna port equal to the interference thresholds specified in Table B-85 and shown in Figure B-17 and with the desired signal level of ~~–164.5~~ –164 dBW at the antenna port.

Note.— Bw_i is the equivalent noise bandwidth of the interference signal.

3.7.3.1.2 ~~GPS and SBAS receivers used for non-precision approach shall meet their performance objectives with interference thresholds for band-limited noise-like signals 3 dB less than specified in Table B-85. For terminal area and en-route steady-state navigation operations and for~~During initial acquisition of the GPS and SBAS signals prior to steady-state navigation, ~~the~~ GPS and SBAS receivers shall meet the performance objectives with interference thresholds ~~for band-limited noise-like signals shall be~~ 6 dB less than those specified in Table B-85.

…

Table B-85. Interference threshold for band-limited noise-like interference to GPS and SBAS receivers ~~used for precision approach~~in steady-state navigation

Interference bandwidth	Interference threshold for receivers in steady-state navigation
0 Hz < Bw_i ≤ 700 Hz	–150.5 dBW
700 Hz < Bw_i ≤ 10 kHz	Linearly increasing from –150.5 to –143.5 dBW ~~–150.5 + 6 $\log_{10}$(BW/700) dBW~~
10 kHz < Bw_i ≤ 100 kHz	Linearly increasing from –143.5 to –140.5 dBW ~~–143.5 + 3 $\log_{10}$(BW/10000) dBW~~
100 kHz < Bw_i ≤ 1 MHz	–140.5 dBW
1 MHz < Bw_i ≤ 20 MHz	Linearly increasing from –140.5 to –127.5 dBW*
20 MHz < Bw_i ≤ 30 MHz	Linearly increasing from –127.5 to –121.1 dBW*
30 MHz < Bw_i ≤ 40 MHz	Linearly increasing from –121.1 to –119.5 dBW*
40 MHz < Bw_i	–119.5 dBW*

* The interference threshold is not to exceed –140.5 dBW/MHz in the frequency range 1 575.42 ±10 MHz.

…

Replace Figure B-17 with the figure below.

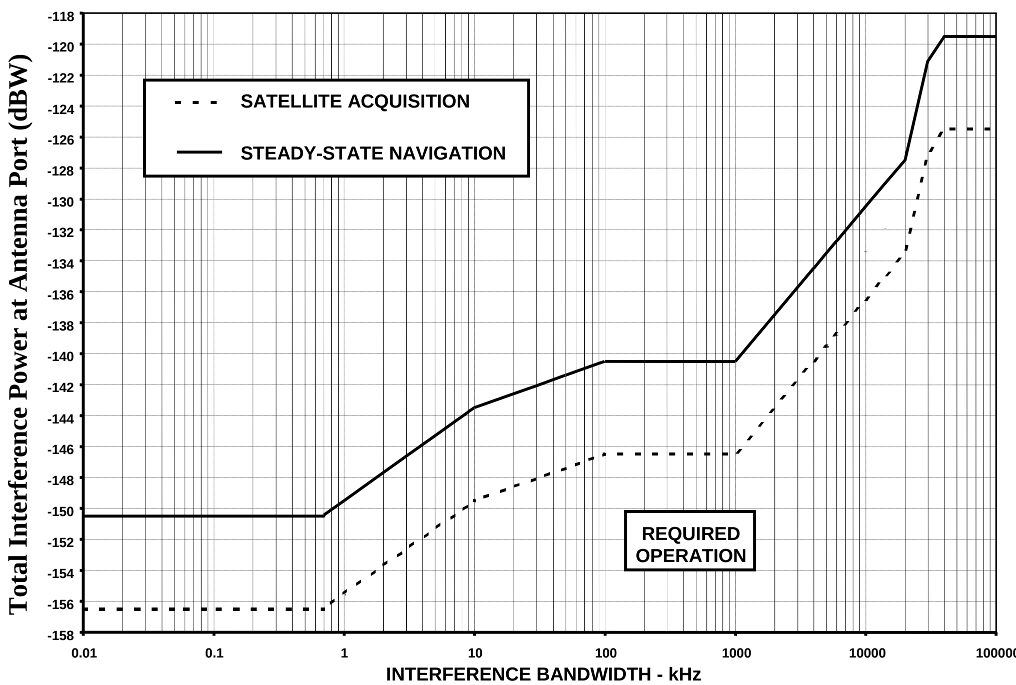

Figure B-17. Interference thresholds versus bandwidth for GPS and SBAS receivers

Origin:	**Rationale:**
NSP WGW/14	This proposal is equivalent to Initial Proposal 15, but for band-limited noise-like interference (as opposed to continuous wave interference).

INITIAL PROPOSAL 18

3.7.3.2 *GLONASS RECEIVERS*

3.7.3.2.1 After steady-state navigation has been established, GLONASS receivers ~~used for the precision approach phase of flight or used on aircraft with on-board satellite communications~~(except those identified in 3.7.3.2.1.1) shall meet the performance objectives while receiving noise-like interfering signals in the frequency band $f_k \pm Bw_i/2$, with power levels at the antenna port equal to the interference thresholds ~~defined~~ specified in Table B-86 and shown in Figure B-18 and with a desired signal level of ~~–165.5~~ –166.5 dBW at the antenna port.

3.7.3.2.1.1 After steady-state navigation has been established, GLONASS receivers used for all phases of flight (excluding those used for the precision approach phase of flight) and put into operation before 1 January 2017 shall meet the performance objectives while receiving noise-like interfering signals in the frequency band $f_k \pm Bw_i/2$, with power levels at the antenna port 3 dB less than the interference thresholds specified in Table B-86 and shown in Figure B-18 and with a desired signal level of –166.5 dBW at the antenna port.

Note.— f_k is the centre frequency of a GLONASS channel with f_k = 1 602 MHz + k × ~~0.6525~~ 0.5625 MHz and k = –7 to +~~13~~ 6 as defined in Table B-16 and Bw_i is the equivalent noise bandwidth of the interference signal.

3.7.3.2.2 ~~GLONASS receivers used for non-precision approach shall meet their performance objectives with interference thresholds for band-limited noise-like signals 3 dB less than specified in Table B-85. For terminal area and en-route steady-state navigation operations, and for~~During initial acquisition of the GLONASS signals prior to steady-state navigation, ~~the~~ GLONASS receivers shall meet the performance objectives with interference thresholds ~~for band-limited noise-like signals shall be~~ 6 dB less than those specified in Table B-86.

~~*Note.— For the approach phase of flight it is assumed that the receiver operates in tracking mode and acquires no new satellites.*~~

…

Table B-86. Interference threshold for band-limited noise-like interference to GLONASS receivers in steady-state navigation

Interference bandwidth	Interference threshold
0 Hz < Bw_i ≤ 1 kHz	–149 dBW
1 kHz < Bw_i ≤ 10 kHz	Linearly increasing from –149 to –143 dBW
10 kHz < Bw_i ≤ 0.5 MHz	–143 dBW
0.5 MHz < Bw_i ≤ 10 MHz	Linearly increasing from –143 to –130 dBW
10 MHz < Bw_i	–130 dBW

…

Replace Figure B-18 with the figure below.

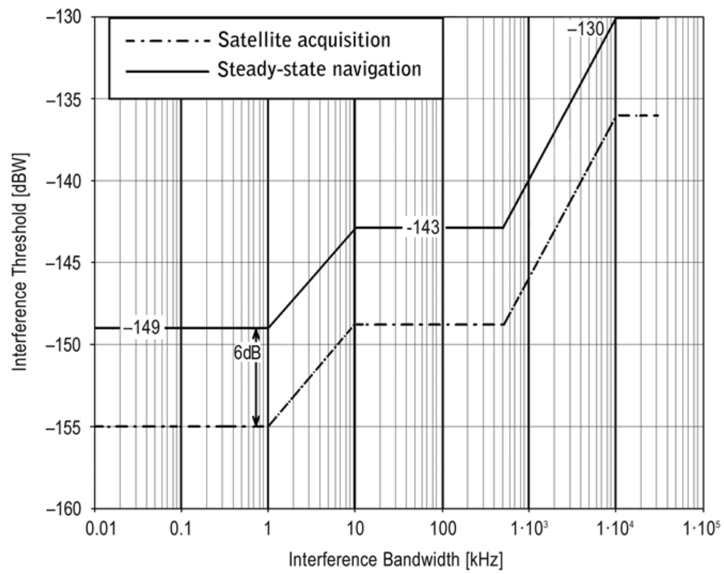

Figure B-18. Interference thresholds versus bandwidth for GLONASS receivers

Origin:	**Rationale:**
NSP WGW/14	This proposal is equivalent to Initial Proposal 16, but for band-limited noise-like interference (as opposed to continuous wave interference).

INITIAL PROPOSAL 19

Table B-87. Interference thresholds for pulsed interference

	GPS and SBAS	GLONASS
Frequency range	1 575.42 MHz ± 10 MHz	1 592.9525 MHz to 1 609.36 MHz
Interference threshold (Pulse peak power)	–20 dBW	–20 dBW
Pulse width	≤125 µs	≤250 µs
Pulse duty cycle	≤1%	≤1%
Interference signal bandwidth	≥1 MHz	≥500 kHz

Note.— The interference signal is additive white Gaussian noise centered around the carrier frequency with bandwidth and pulse characteristics specified in the table.

Origin:	**Rationale:**
NSP WGW/14	The current Table B-87 does not fully specify the characteristics of the pulsed interference signal referred to by the interference resistance Standard in 3.7.3.3 because the bandwidth of the interference signal is not defined. The interference signal bandwidth is, however, specified in RTCA DO-229D. This proposal aligns the Annex 10 requirement with RTCA DO-229D.

INITIAL PROPOSAL 20

3.8.3 *Polarization*. The GNSS antenna polarization shall be right-hand circular (clockwise with respect to the direction of propagation).

3.8.3.1 The antenna axial ratio shall not exceed 3.0 dB as measured at boresight.

Note. — The axial ratio is the ratio, expressed in decibels, between the maximum output power and the minimum output power of an antenna to an incident linearly polarized wave as the polarization orientation is varied over all directions perpendicular to the direction of propagation.

Origin:	**Rationale:**
NSP WGW/14	In the absence of a specification of the maximum acceptable value for the antenna axial ratio, the current Standard 3.8.3 implies ideal right-hand circularly polarization (axial ratio = 0). This is not achievable in practical implementation. Current industry standards for GNSS antennas (RTCA DO-301, *Minimum Operational Performance Standards for Global Navigation Satellite System (GNSS) Airborne Active Antenna Equipment for the L1 Frequency Band*) specify a 3-dB limit on the acceptable antenna axial ratio. The proposed change introduces the same limit in the Annex.

INITIAL PROPOSAL 21

ATTACHMENT D. INFORMATION AND MATERIAL FOR GUIDANCE IN THE APPLICATION OF THE GNSS STANDARDS AND RECOMMENDED PRACTICES

…

4.4 GNSS antenna and receiver

4.4.1 The antenna specifications in Appendix B, 3.8, do not control the antenna axial ratio except at boresight. Linear polarization should be assumed for the airborne antenna for GEO signals received at low-elevation angles. For instance, if the minimum elevation angle for which a trackable GEO signal needs to be provided is 5 degrees, the antenna should be presumed to be linearly polarized with −2.5 dBil (−5.5 dBic) gain when receiving this signal. This should be taken into account in the GEO link budget in order to ensure that the minimum received RF signal at the antenna port meets the requirements of Chapter 3, 3.7.3.4.4.3.2.

4.4.~~1~~2 The failures caused by the receiver can have two consequences on navigation system performance which are the interruption of the information provided to the user or the output of misleading information. Neither of these events are accounted for in the signal-in-space requirement.

4.4.~~2~~3 The nominal error of the GNSS aircraft element is determined by receiver noise, interference, and multipath and tropospheric model residual errors. Specific receiver noise requirements for both the SBAS airborne receiver and the GBAS airborne receiver include the effect of any interference below the protection mask specified in Appendix B, 3.7. The required performance has been demonstrated by receivers that apply narrow correlator spacing or code smoothing techniques.

Origin:	**Rationale:**
NSP WGW/14	The new text contains clarifications intended to alert SBAS service providers that the SBAS satellite power budget should account for the polarization mismatch loss between the satellite signal and the user antenna at low elevations, in order to ensure that the minimum received signal level is sufficient.

INITIAL PROPOSAL 22

6.4.1 *Minimum GEO signal power level*. The minimum aircraft equipment (e.g. RTCA/DO-229D) is required to operate with a minimum signal strength of –164 dBW at the ~~input of the receiver~~antenna port in the presence of non-RNSS interference (Appendix B, 3.7) and an aggregate RNSS noise density of –173 dBm/Hz. In the presence of interference, receivers may not have reliable tracking performance for ~~an input~~a signal strength at the antenna port below –164 dBW (e.g. with GEO satellites placed in orbit prior to 2014). A GEO that delivers a signal power below –164 dBW at the ~~output of the standard~~ receiving antenna port at 5-degree elevation on the ground can be used to ensure signal tracking in a service area contained in a coverage area defined by a minimum elevation angle that is greater than 5 degrees (e.g. 10 degrees). […]

Origin:	**Rationale:**
NSP WGW/14	Consequential to Initial Proposal 1.

INITIAL PROPOSAL 23

6.4.3 *SBAS convolutional encoding.* Information on the convolutional coding and decoding of SBAS messages can be found in RTCA/DO-229~~C~~D, Appendix A.

Origin:	**Rationale:**
NSP WGW/14	Updated reference (latest edition of referenced RTCA document).

INITIAL PROPOSAL 24

6.5.4 *Tropospheric function.* Because tropospheric refraction is a local phenomenon, users will compute their own tropospheric delay corrections. A tropospheric delay estimate for precision approach is described in RTCA/DO-229~~C~~D, although other models can be used.

Origin:	**Rationale:**
NSP WGW/14	Updated reference (latest edition of referenced RTCA document).

INITIAL PROPOSAL 25

Editorial Note: The text within square brackets in paragraph 8.11.4 and paragraph 8.11.4.1 is not contained in the currently applicable version of Annex 10. It is new text that is to be introduced into Annex 10 as part of Amendment 89 (applicability date: 13 November 2014). It is shown here in order to clarify the context of the current proposal.

8.11.4 For aircraft receivers using early-late correlators and tracking GPS satellites, the precorrelation bandwidth of the installation, the correlator spacing and the differential group delay are within the ranges defined in Table D-11[, except as noted below].

[8.11.4.1 For GBAS airborne equipment using early-late correlators and tracking GPS satellites, the precorrelation bandwidth of the installation, the correlator spacing and the differential group delay (including the contribution of the antenna) are within the ranges defined in Table D-11, except that the region 1 minimum bandwidth will increase to 4 MHz and the average correlator spacing is reduced to an average of 0.21 chips or instantaneous of 0.235 chips.]

8.11.4.2 For SBAS airborne equipment using early-late correlators and tracking GPS satellites, the precorrelation bandwidth of the installation, the correlator spacing and the differential group delay (including the contribution of the antenna) are within the ranges of the first three regions defined in Table D-11.

…

Table D-11. GPS tracking constraints for early-late correlators

Region	3 dB precorrelation bandwidth, BW	Average correlator spacing (chips)	Instantaneous correlator spacing (chips)	Differential group delay
1	2 < BW ≤ 7 MHz	0.045 – 1.1	0.04 – 1.2	≤ 600 ns
2	7 < BW ≤ 16 MHz	0.045 – 0.21	0.04 – 0.235	≤ 150 ns
3	16 < BW ≤ 20 MHz	0.045 – 0.12	0.04 – 0.15	≤ 150 ns
4	20 < BW ≤ 24 MHz	0.08 – 0.12	0.07 – 0.13	≤ 150 ns

Origin:	**Rationale:**
NSP WGW/12	The proposed changes are intended to align the SARPs to RTCA DO-229D. The changes to paragraph 8.11.4.1 simply highlight the fact that the antenna contribution must be included when computing the differential group delay, as explicitly stated in DO-229D. The new paragraph 8.11.4.2 has been added to clarify that the fourth row of Table D-11 is not applicable to SBAS receivers.

INITIAL PROPOSAL 26

~~10.2 Specification of the interference threshold at the antenna port~~

~~The indications of the interference threshold levels are referenced to the antenna port. In this context, the term "antenna port" means the interface between the antenna and the GNSS receiver where the satellite signal power corresponds to the nominal minimum received signal power of -164.5 dBW for GPS and -165.5 dBW for GLONASS. Due to the reduced distance from potential interference sources, GNSS receivers that are used for the approach phase of flight must have a higher interference threshold than receivers that are only used for en-route navigation.~~

Renumber sections 10.3 – 10.6 to reflect the deletion of section 10.2

Origin:	**Rationale:**
NSP WGW/14	Consequential to Initial Proposals 1 and 15 – 18.

— END —