International Civil Aviation Organization

Communication Navigation and Surveillance Sub-Group (CNS SG)

Fourth Meeting
(Cairo, 25 – 27 September 2011)

Agenda Item 5: Developments in CNS

PROPOSAL FOR AMENDMENT TO ANNEX 10

(Presented by the Secretariat)

SUMMARY

This paper provides information proposal for amendment to Annex 10.

Action by the meeting is in Paragraph 2.

1. INTRODUCTION

1.1 ICAO issued State letter AN 7/1.3.98-11/25 dated 31 March 2011,reproduced at **Appendix A** to this paper, informing States that the Air Navigation Commission, at the fifth meeting of its 186th Session held on 1 March 2011, considered proposals developed by the Navigation Systems Panel (NSP) Working Group of the Whole to amend the Standards and Recommended Practices (SARPs) in Annex 10 — *Aeronautical Telecommunications*, Volume I — *Radio Navigation Aids* concerning the global navigation satellite system (GNSS). The Commission authorized their transmission to Contracting States and appropriate international organizations for comments.

1.2 For the above Proposals for the amendment of Annex 10, Volume I, concerning the global navigation satellite system (GNSS). It should be noted that minimal financial impact is anticipated from the proposed changes, with the exception of the changes to SBAS received signal power requirements. The latter will not have any cost impact on existing SBAS satellites, as these changes are only applicable to satellites placed in orbit after 31 December 2013. For SBAS satellites placed in orbit after that date, the cost impact is expected to be acceptable, as confirmed by the fact that all SBAS service providers plan to implement the changes or, in some cases, have implemented them already.

1.3 ICAO issued State letter AN 7/1.1.46-11/23 dated 15 April 2011,reproduced at **Appendix B** to this paper, informing States that Amendment 86 to the *International Standards and Recommended Practices, Aeronautical Telecommunications* (Annex 10 to the Convention on International Civil Aviation) was adopted by the Council at the third meeting of its 192nd Session on 4 March 2011. When adopting the amendment, the Council prescribed 18 July 2011 as the date on which it will become effective, except for any part concerning which majority of Contracting States have registered their disapproval before that date. In addition, the Council resolved that Amendment 86, to the extent it becomes effective, will become applicable on 17 November 2011.

1.4 Amendment 86, which affects Volume I of Annex 10, arises from the work undertaken in the Navigation Systems Panel (NSP). The objective of the amendment is to amend the Standards and Recommended Practices (SARPs) concerning the global navigation satellite system (GNSS) ground-based augmentation system (GBAS) requirements.

2. ACTION BY THE MEETING

2.1 Note the information in this information paper and its Appendix.

International Civil Aviation Organization | Organisation de l'aviation civile internationale | Organización de Aviación Civil Internacional | Международная организация гражданской авиации | منظمة الطيران المدني الدولي | 国际民用航空组织

Tel.: +1 514-954-8219, ext. 6712

Ref.: AN 7/1.3.98-11/25

31 March 2011

Subject: Proposals for the amendment of Annex 10, Volume I, concerning the global navigation satellite system (GNSS)

Action required: Comments to reach Montréal by 15 July 2011

Sir/Madam,

1. I have the honour to inform you that the Air Navigation Commission, at the fifth meeting of its 186th Session held on 1 March 2011, considered proposals developed by the Navigation Systems Panel (NSP) Working Group of the Whole to amend the Standards and Recommended Practices (SARPs) in Annex 10 — *Aeronautical Telecommunications*, Volume I — *Radio Navigation Aids* concerning the global navigation satellite system (GNSS). The Commission authorized their transmission to Contracting States and appropriate international organizations for comments.

2. Background information on elements of the proposal is included for your convenience in Attachment A. The proposed amendments, as modified by the Air Navigation Commission, are contained in Attachment B, and their rationales are contained in Attachment C.

3. It should be noted that minimal financial impact is anticipated from the proposed changes, with the exception of the changes to SBAS received signal power requirements. The latter will not have any cost impact on existing SBAS satellites, as these changes are only applicable to satellites placed in orbit after 31 December 2013. For SBAS satellites placed in orbit after that date, the cost impact is expected to be acceptable, as confirmed by the fact that all SBAS service providers plan to implement the changes or, in some cases, have implemented them already.

4. In examining the proposed amendments, you should not feel obliged to comment on editorial aspects as such matters will be addressed by the Air Navigation Commission during its final review of the draft amendment.

999 University Street
Montréal, Quebec
Canada H3C 5H7

Tel.: +1 514-954-8219
Fax: +1 514-954-6077

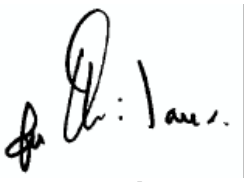
E-mail: icaohq@icao.int
www.icao.int

5. May I request that any comments you may wish to make on the amendment proposals be dispatched to reach me not later than 15 July 2011. The Air Navigation Commission has asked me to specifically indicate that comments received after the due date may not be considered by the Commission and the Council. In this connection, should you anticipate a delay in the receipt of your reply, please let me know in advance of the due date.

6. For your information, the proposed amendment to Annex 10, Volume I, is envisaged for applicability on 15 November 2012. Any comments you may have thereon would be appreciated.

7. The subsequent work of the Air Navigation Commission and the Council would be greatly facilitated by specific statements on the acceptability or otherwise of the proposals. Please note that, for the review of your comments by the Air Navigation Commission and the Council, replies are normally classified as “agreement with or without comments”, “disagreement with or without comments” or “no indication of position”. If in your reply the expressions “no objections” or “no comments” are used, they will be taken to mean “agreement without comment” and “no indication of position”, respectively. In order to facilitate proper classification of your response, a form has been included in Attachment D which may be completed and returned together with your comments, if any, on the proposals in Attachment B.

Accept, Sir/Madam, the assurances of my highest consideration.



Raymond Benjamin
Secretary General

Enclosures:

A — Background
B — Proposed amendment to Annex 10, Volume I
C — Rationale
D — Response form

ATTACHMENT A to State letter AN 7/1.3.98-11/25

BACKGROUND

1. The proposed amendment contains changes to several sections of the GNSS Standards and Recommended Practices (SARPs), as follows:

a) changes to satellite-based augmentation system (SBAS) received signal power requirements;

b) introduction of two new SBAS service provider identifiers;

c) changes to the encoding of the runway number field in the final approach segment (FAS) data block; and

d) changes to GNSS antenna gain requirements.

2. The changes to SBAS received signal power requirements are proposed because the current minimum received signal power requirements for SBAS have been found to be insufficient to cope with the increasing level of interference in the SBAS frequency band due to the introduction of additional GNSS satellites in the same band. The changes will provide a more robust SBAS signal, which will be better able to withstand interference.

3. The introduction of two new SBAS service provider identifiers is proposed because two new SBAS are currently under development: the GPS Aided Geo Augmented Navigation (GAGAN) and the System for Differential Corrections and Monitoring (SDCM). They should therefore be included in the list of SBAS service provider identifiers in Annex 10, and information about them should be included in the guidance material on SBAS coverage areas.

4. The changes to the encoding of the runway number field in the FAS data block are proposed because the current encoding of the runway number field creates difficulties in the case of heliport operations. The changes will facilitate GNSS-based heliport approach operations.

5. The changes to the GNSS antenna gain requirements are proposed because the current GNSS antenna gain requirements have proved to be very hard, if not impossible, to meet. A relaxation of the requirement is therefore required, without any adverse impact on system performance, to ensure the feasibility of SARPs-compliant GNSS antennas.

— — — — — — — —

ATTACHMENT B to State letter AN 7/1.3.98-11/25

PROPOSED AMENDMENT TO ANNEX 10, VOLUME I

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)

. . .

CHAPTER 3. SPECIFICATIONS FOR RADIO NAVIGATION AIDS

. . .

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 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 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.

. . .

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

. . .

Table B-27. SBAS service provider identifiers

Identifier	Service provider
0	WAAS
1	EGNOS
2	MSAS
3	GAGAN
4	SDCM
~~3~~5 to 13	Spare
14, 15	Reserved

. . .

Table B-66. Final approach segment (FAS) data block

Data content	Bits used	Range of values	Resolution
Operation type	4	0 to 15	1
SBAS provider ID	4	0 to 15	1
Airport ID	32	—	—
Runway number	6	~~0~~1 to 36	1
Runway letter	2	—	—
Approach performance designator	3	0 to 7	1
Route indicator	5	—	—
Reference path data selector	8	0 to 48	1
Reference path identifier	32	—	—
LTP/FTP latitude	32	±90.0°	0.0005 arcsec
LTP/FTP longitude	32	±180.0°	0.0005 arcsec
LTP/FTP height	16	–512.0 to 6 041.5 m	0.1 m
ΔFPAP latitude	24	±1.0°	0.0005 arcsec
ΔFPAP longitude	24	±1.0°	0.0005 arcsec
Approach TCH (Note~~ 2~~)	15	0 to 1 638.35 m or 0 to 3 276.7 ft	0.05 m or 0.1 ft
Approach TCH units selector	1	—	—
GPA	16	0 to 90.0°	0.01°
Course width ~~(Note 1)~~	8	80 to 143.75 m	0.25 m
ΔLength offset	8	0 to 2 032 m	8 m
Final approach segment CRC	32	—	—

~~*Note 1.— When the runway number is set to 0, then the course width field is ignored and the course width is 38 metres.*~~

Note ~~2~~.— Information can be provided in either feet or metres as indicated by the approach TCH unit selector.

3.6.4.5.1 *FAS data block.* The FAS data block shall contain the parameters that define a single precision approach or APV. The FAS path is a line in space defined by the landing threshold point/fictitious threshold point (LTP/FTP), flight path alignment point (FPAP), threshold crossing height (TCH) and glide path angle (GPA). The local level plane for the approach is a plane perpendicular to the local vertical passing through the LTP/FTP (i.e. tangent to the ellipsoid at the LTP/FTP). Local vertical for the approach is normal to the WGS-84 ellipsoid at the LTP/FTP. The glide path intercept point (GPIP) is where the final approach path intercepts the local level plane. FAS data block parameters shall be as follows:

. . .

Runway number: the approach runway number.

Coding: ~~0 = heliport~~
1 to 36 = runway number

Note.— For heliport operations, the runway number value is the integer nearest to one tenth of the final approach course, except when that integer is zero, in which case the runway number is 36.

. . .

3.7.1 PERFORMANCE OBJECTIVES

. . .

Note 5.— The signal levels specified in this section are defined at the antenna port. ~~include a minimum standard antenna gain above 5 degree elevation angle of -4.5 dBic. Assumed maximum aircraft antenna gain in the lower hemisphere is -10 dBic. For non-standard antennas with a different minimum gain above 5 degree elevation angle, the signal interference levels can be adjusted accordingly as long as the relative interference-to-signal level is maintained.~~

. . .

3.8.2 *Antenna gain.* The minimum antenna gain shall not be less than that shown in Table B-87 for the specified elevation angle above the horizon. The maximum antenna gain shall not exceed ~~+7~~+4 dBic for elevation angles above 5 degrees.

. . .

Table B-87. Minimum antenna gain — ~~GPS/SBAS and GLONASS~~ GPS, GLONASS and SBAS

Elevation angle degrees	Minimum gain dBic
0	~~–7.5~~ –7
5	~~–4.5~~ –5.5
10	~~–3~~ –4
15 to 90	~~–2~~ –2.5

Note.— The –5.5 dBic gain at 5 degrees elevation angle is appropriate for an L1 antenna. A higher gain may be required in the future for GNSS signals in the L5/E5 band.

. . .

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

. . .

6.2.2 ~~Figure D-1[*] shows the initial coverage areas and approximated initial service areas for three SBASs:~~ Satellite-based augmentation services are provided by the Wide Area Augmentation System (WAAS) (North America), the European Geo-stationary Navigation Overlay Service (EGNOS) (Europe and North Africa) and the Multifunction Transport Satellite (MTSAT) Satellite-based Augmentation System (MSAS) (Japan). The GPS Aided Geo Augmented Navigation (GAGAN) (India) and the System for Differential corrections and Monitoring (SDCM) (Russia) are also under development to provide these services.

. . .

Replace the existing paragraph 6.4.1 with the following new text:

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 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 signal strength 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 at 5 degree

[*] All figures are located at the end of the attachment.

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). In this case, advantage is taken from the gain characteristic of the standard antenna to perform a trade-off between the GEO signal power and the size of the service area in which a trackable signal needs to be ensured. When planning for the introduction of new operations based on SBAS, States are expected to conduct an assessment of the signal power level as compared to the level interference from RNSS and non-RNSS sources. If the outcome of this analysis indicates that the level of interference is adequate to operate, then operations can be authorized.

End of new text

. . .

Table D-1. SBAS FAS data block

Data content	Bits used	Range of values	Resolution
Operation type	4	0 to 15	1
SBAS provider ID	4	0 to 15	1
Airport ID	32	–	–
Runway number ~~(Note 1)~~	6	~~0~~1 to 36	1
Runway letter	2	–	–
Approach performance designator	3	0 to 7	1
Route indicator	5	–	–
Reference path data selector	8	0 to 48	1
Reference path identifier	32	–	–
LTP/FTP latitude	32	± 90.0°	0.0005 arcsec
LTP/FTP longitude	32	± 180.0°	0.0005 arcsec
LTP/FTP height	16	–512.0 to 6 041.5 m	0.1 m
ΔFPAP latitude	24	± 1.0°	0.0005 arcsec
ΔFPAP longitude	24	± 1.0°	0.0005 arcsec
Approach threshold crossing height (TCH) (Note ~~2~~1)	15	0 to 1 638.35 m (0 to 3 276.7 ft)	0.05 m (0.1 ft)
Approach TCH units selector	1	–	–
Glide path angle (GPA)	16	0 to 90.0°	0.01°
Course width at threshold ~~(Note 1)~~	8	80.0 to 143.75 m	0.25 m
ΔLength offset	8	0 to 2 032 m	8 m
Horizontal alert limit (HAL)	8	0 to 50.8 m	0.2 m
Vertical alert limit (VAL) (Note ~~3~~2)	8	0 to 50.8 m	0.2 m
Final approach segment CRC	32	–	–

~~*Note 1.— When the runway number is set to 00, then the course width field is ignored and the course width is 38 m.*~~

Note ~~2~~1.— Information can be provided in either feet or metres as indicated by the approach TCH unit sector.

Note ~~3~~2.— VAL of 0 indicates that the vertical deviations are not to be used (i.e. a lateral guidance only

Data content	Bits used	Range of values	Resolution
approach).			

. . .

Table D-9. Example of a Type 4 message

In Table D-9, *replace* "0 to 36" with " 1 to 36" in the Runway number rows of FAS Data Block 1 and FAS Data Block 2

. . .

Replace Figure D-1, including its caption, with the following new text

Figure D-1. *Reserved*

End of new text

Origin:	**Rationale:**
NSP WGW/9	See Initial Proposal 5.

. . .

— — — — — — — —

Proposed change	Rationale
Chapter 3	
3.7.3.4.4.3 (including sub-paragraphs)	The current SBAS minimum power levels were established over a decade ago, when the interference environment in the SBAS band was significantly less challenging than now. Since then, the ongoing introduction of additional navigation satellites and/or constellations into the same band has changed the situation to a point where the current SBAS minimum power levels may become inadequate to cope with the evolving interference environment. It is proposed that the issue be addressed through a twofold action, by: 1) increasing the minimum power level for SBAS satellites placed in orbit from 2014 onwards (Chapter 3, 3.7.3.4.4.3); and 2) providing guidance on how legacy SBAS satellites (i.e., those are already in operation with a minimum power level lower than the new requirement) can be used safely by restricting the nominal service area in such a way as to ensure that the desired signal to interference ratio is achieved within the area (Attachment D, 6.4.1 – see Initial Proposal 6).
Appendix B	
Table B-27	The new identifiers are required for two new SBAS currently under development: the GPS Aided Geo Augmented Navigation (GAGAN) and the System for Differential Corrections and Monitoring (SDCM).
Table B-66, 3.6.4.5.1	Currently, the runway number field is set to “0” in the case of heliport operations. However, there are two issues with the current provisions. The first issue is that, when the field is set to zero, the course width (i.e. the lateral displacement from the final approach segment path at which full scale deflection of a course deviation indicator is attained) is set to only 38 m at the landing threshold. This has been shown to be difficult to fly manually, due to the resulting high sensitivity to deviations. The second issue is that “0” (or “00”) is not a valid runway number. This may result in incompatibility with airborne database requirements.

Proposed change	Rationale
	The proposed new provisions address both issues by eliminating encoding "0" and providing an explanatory note addressing the specific heliport case.
3.7.1, Note 5, 3.8.2, Table B-87	The proposed changes are intended to align the SARPs with current industry specifications for GNSS antennas, which closely reflect the achievable performance of the antennas. The proposal is based on the results of a performance assessment of GNSS antennas, which showed that commercially available antennas were not able to meet the current SARPs requirements for minimum GNSS antenna gain unless the requirements were slightly relaxed (by 1dB). A subsequent assessment led to the conclusion that the relaxation would have no adverse impact on L1 band performance and was therefore acceptable without affecting safety.
Attachment D	
6.2.2, Figure D-1	The deletion of Figure D-1 is justified by the fact that it is not practical to provide and maintain a reasonably accurate representation of coverage and service areas in Annex 10. This is due to the fact that both coverage and service areas vary as a function of system evolution. Furthermore, service areas for a given SBAS also vary as a function of the level of service. As a result, a single static representation of coverage and service areas would be more misleading than helpful. A more in-depth treatment of the topic is intended to be provided in the next edition of Doc 9849 (GNSS Manual).
6.4.1	Same rationale as the changes to Chapter 3, paragraph 3.7.3.4.4.3.
Table D-1	Same rationale as the changes to Appendix B, Table B-66.

— — — — — — — —

ATTACHMENT D to State letter AN 7/1.3.98-11/25

RESPONSE FORM TO BE COMPLETED AND RETURNED TO ICAO TOGETHER WITH ANY COMMENTS YOU MAY HAVE ON THE PROPOSED AMENDMENTS

To: The Secretary General
International Civil Aviation Organization
999 University Street
Montreal, Quebec
Canada, H3C 5H7

(**State)** ———————————————

Please make a checkmark (✓) against one option for each amendment. If you choose options "agreement with comments" or "disagreement with comments", **please provide your comments on separate sheets.**

	Agreement without comments	*Agreement with comments**	*Disagreement without comments*	*Disagreement with comments*	*No position*
Amendment Annex 10 — *Aeronautical Telecommunications*, Volume I — *Radio Navigation Aids* (Attachment B refers)					

* "Agreement with comments" indicates that your State or organization agrees with the intent and overall thrust of the amendment proposal; the comments themselves may include, as necessary, your reservations concerning certain parts of the proposal and/or offer an alternative proposal in this regard.

Signature ——————————————— Date ———————————————

— END —

International Civil Aviation Organization | Organisation de l'aviation civile internationale | Organización de Aviación Civil Internacional | Международная организация гражданской авиации | منظمة الطيران المدني الدولي | 国际民用航空组织

Tel.: +1 514-954-8219, ext. 6712

Ref.: AN 7/1.1.46-11/23 15 April 2011

Subject: Adoption of Amendment 86 to Annex 10

Action Required: a) Notify any disapproval before 18 July 2011; b) Notify any differences and compliance before 17 October 2011; c) Consider the use of the Electronic Filing of Differences System (EFOD) for notification of differences and compliance

Sir/Madam,

1. I have the honour to inform you that Amendment 86 to the *International Standards and Recommended Practices, Aeronautical Telecommunications* (Annex 10 to the Convention on International Civil Aviation) was adopted by the Council at the third meeting of its 192nd Session on 4 March 2011. Copies of the Amendment and the Resolution of Adoption are available as attachments to the electronic version of this State letter on the ICAO-NET (www.icao.int/icaonet).

2. When adopting the amendment, the Council prescribed 18 July 2011 as the date on which it will become effective, except for any part concerning which a majority of Contracting States have registered their disapproval before that date. In addition, the Council resolved that Amendment 86, to the extent it becomes effective, will become applicable on 17 November 2011.

3. Amendment 86, which affects Volume I of Annex 10, arises from the work undertaken in the Navigation Systems Panel (NSP).

4. The subjects of the amendment are shown in the amendment to the Forewords of Annex 10, Volumes I, II, III, IV and V, a copy of which is at Attachment A. The objective of the amendment is to amend the Standards and Recommended Practices (SARPs) concerning the global navigation satellite system (GNSS) ground-based augmentation system (GBAS) requirements.

999 University Street
Montréal, Quebec
Canada H3C 5H7

Tel.: +1 514-954-8219
Fax: +1 514-954-6077

E-mail: icaohq@icao.int
www.icao.int

5. In accordance with the decision of the 26th Session of the Assembly, I would like to bring to your attention the Organization's long-standing practice of providing documentation to States upon request. In this regard, I wish to refer you to the ICAO-NET website (www.icao.int/icaonet) where you can access all relevant documentation. The practice of dispatching printed copies of such documentation has now been discontinued.

6. In conformity with the Resolution of Adoption, may I request:

a) that before 18 July 2011 you inform me if there is any part of the adopted SARPs amendments in Amendment 86 concerning which your Government wishes to register disapproval, using the form in Attachment B for this purpose. Please note that only statements of disapproval need be registered and if you do not reply it will be assumed that you do not disapprove of the amendment. Moreover, the documents referred to herein provide guidance on technical methodologies for means of compliance with the Standards but are not intended to represent the exclusive methods for compliance;

b) that before 17 October 2011 you inform me of the following, using the form in Attachment C for this purpose:

1) any differences that will exist on 17 November 2011 between the national regulations or practices of your Government and the provisions of the whole of Annex 10, as amended by all amendments up to and including Amendment 86, and thereafter of any further differences that may arise; and

2) the date or dates by which your Government will have complied with the provisions of the whole of Annex 10, as amended by all amendments up to and including Amendment 86.

7. With reference to the request in paragraph 6 a) above, it should be noted that a registration of disapproval of Amendment 86 or any part of it in accordance with Article 90 of the Convention does not constitute a notification of differences under Article 38 of the Convention. To comply with the latter provision, a separate statement is necessary if any differences do exist, as requested in paragraph 6 b) 1). It is recalled in this respect that International Standards in Annexes have a conditional binding force, to the extent that the State or States concerned have not notified any difference thereto under Article 38 of the Convention.

8. With reference to the request in paragraph 6 b) above, it should be also noted that the Council, at the third meeting of its 192nd Session on 4 March 2011, agreed that pending the development of a concrete policy and operational procedures governing the use of EFOD, this system be used as an alternative means for filing of differences to all Annexes, except for Annex 9 — *Facilitation* and Annex 17 — *Security — Safeguarding International Civil Aviation against Acts of Unlawful Interference.* EFOD is currently available on the USOAP restricted website (http://www.icao.int/soa) which is accessible by all Member States (AN 1/1-11/28 refers) and you are invited to consider using this for notification of compliance and differences.

9. Guidance on the determination and reporting of differences is given in the Note on the Notification of Differences in Attachment D.

10. Please note that a detailed repetition of previously notified differences, if they continue to apply, may be avoided by stating the current validity of such differences.

11. I would appreciate it if you would also send a copy of your notifications, referred to in paragraph 6 b) above, to the ICAO Regional Director accredited to your Government.

12. As soon as practicable after the amendment becomes effective, on 18 July 2011, replacement pages incorporating Amendment 86 will be forwarded to you.

Accept, Sir/Madam, the assurances of my highest consideration.

Raymond Benjamin
Secretary General

Enclosures:

A — Amendment to the Forewords of Annex 10, Volumes I, II, III, IV and V
B — Form on notification of disapproval of all or part of Amendment 86 to Annex 10
C — Form on notification of compliance with or differences from Annex 10
D — Note on the Notification of Differences

ATTACHMENT A to State letter AN 7/1.1.46-11/23

AMENDMENT TO THE FOREWORDS OF
ANNEX 10 — *AERONAUTICAL TELECOMMUNICATIONS*,
VOLUMES I, II, III, IV AND V

VOLUME I
(Sixth Edition)

Add the following at the end of Table A:

Amendment	***Source(s)***	***Subject***	***Adopted/Approved*** ***Effective*** ***Applicable***
86	Navigation Systems Panel (NSP)	Changes reflecting experience gained with initial implementation of the global navigation satellite system (GNSS) ground-based augmentation system (GBAS)	4 March 2011 18 July 2011 17 November 2011

VOLUME II
(Sixth Edition)

Add the following at the end of Table A:

Amendment	***Source(s)***	***Subject***	***Adopted/Approved*** ***Effective*** ***Applicable***
86		No change	

VOLUME III
(Second Edition)

Add the following at the end of Table A:

Amendment	***Source(s)***	***Subject***	***Adopted/Approved Effective Applicable***
86		No change	

VOLUME IV
(Fourth Edition)

Add the following at the end of Table A:

Amendment	***Source(s)***	***Subject***	***Adopted/Approved Effective Applicable***
86		No change	

VOLUME V
(Second Edition)

Add the following at the end of Table A:

Amendment	***Source(s)***	***Subject***	***Adopted/Approved Effective Applicable***
86		No change	

— — — — — — — —

ATTACHMENT B to State letter AN 7/1.1.46-11/23

NOTIFICATION OF DISAPPROVAL OF ALL OR PART OF AMENDMENT 86 TO ANNEX 10

To: The Secretary General
International Civil Aviation Organization
999 University Street
Montreal, Quebec
Canada H3C 5H7

(State) ———————————————— hereby wishes to disapprove the following parts of Amendment 86 to Annex 10:

Signature ————————————————

Date ————————————

NOTES

1) If you wish to disapprove all or part of Amendment 86 to Annex 10, please dispatch this notification of disapproval to reach ICAO Headquarters by 18 July 2011. If it has not been received by that date it will be assumed that you do not disapprove of the amendment. **If you approve of all parts of Amendment 86, it is not necessary to return this notification of disapproval.**

2) This notification should not be considered a notification of compliance with or differences from Annex 10. Separate notifications on this are necessary. (See Attachment C.)

3) Please use extra sheets as required.

— — — — — — — —

ATTACHMENT C to State letter AN 7/1.1.46-11/23

NOTIFICATION OF COMPLIANCE WITH OR DIFFERENCES FROM ANNEX 10
(including all amendments up to and including Amendment 86)

To: The Secretary General
International Civil Aviation Organization
999 University Street
Montreal, Quebec
Canada H3C 5H7

1. No differences will exist on ———————————————— between the national regulations and/or practices of **(State)** ———————————————— and the provisions of Annex 10, including all amendments up to and including Amendment 86.

2. The following differences will exist on ———————————————— between the regulations and/or practices of **(State)** ———————————————— and the provisions of Annex 10, including Amendment 86. (Please see Note 3) below.)

a) **Annex Provision** (Please give exact paragraph reference)	b) **Difference Category** (Please indicate A, B, or C)	c) **Details of Difference** (Please describe the difference clearly and concisely)	d) **Remarks** (Please indicate reasons for the difference)

(Please use extra sheets as required)

3. By the dates indicated below, **(State)** ———————————————— will have complied with the provisions of Annex 10, including all amendments up to and including Amendment 86 for which differences have been notified in 2 above.

a) Annex Provision (Please give exact paragraph reference)	**b) Date**	**c) Comments**

(Please use extra sheets as required)

Signature ————————————————

Date ————————————

NOTES

1) If paragraph 1 above is applicable to you, please complete paragraph 1 and return this form to ICAO Headquarters. If paragraph 2 is applicable to you, please complete paragraphs 2 and 3 and return the form to ICAO Headquarters.

2) Please dispatch the form to reach ICAO Headquarters by 17 October 2011.

3) A detailed repetition of previously notified differences, if they continue to apply, may be avoided by stating the current validity of such differences.

4) Guidance on the notification of differences from Annex 10 is provided in the Note on the Notification of Differences at Attachment D.

5) Please send a copy of this notification to the ICAO Regional Director accredited to your Government.

— — — — — — — —

NOTE ON THE NOTIFICATION OF DIFFERENCES TO ANNEX 10 AND FORM OF NOTIFICATION

(Prepared and issued in accordance with instructions of the Council)

1. *Introduction*

1.1 The Assembly and the Council, when reviewing the notification of differences by States in compliance with Article 38 of the Convention, have repeatedly noted that the state of such reporting is not entirely satisfactory.

1.2 With a view to achieving a more comprehensive coverage, this note is issued to facilitate the determination and reporting of such differences and to state the primary purpose of such reporting.

1.3 The primary purpose of reporting of differences is to promote safety and efficiency in air navigation by ensuring that governmental and other agencies, including operators and service providers, concerned with international civil aviation are made aware of all national regulations and practices in so far as they differ from those prescribed in the ICAO Standards.

1.4 Contracting States are, therefore, requested to give particular attention to the notification before 17 October 2011 of differences with respect to Standards in Annex 10. The Council has also urged Contracting States to extend the above considerations to Recommended Practices.

1.5 Contracting States are asked to note further that it is necessary to make an explicit statement of intent to comply where such intent exists, or where such is not the intent, of the difference or differences that will exist. This statement should be made not only to the latest amendment but to the whole Annex, including the amendment.

1.6 If previous notifications have been made in respect of this Annex, detailed repetition may be avoided, if appropriate, by stating the current validity of the earlier notification. States are requested to provide updates of the differences previously notified after each amendment, as appropriate, until the difference no longer exists.

2. *Notification of differences to Annex 10 including Amendment 86*

2.1 Past experience has indicated that the reporting of differences to Annex 10 has in some instances been too extensive since some appear merely to be a different manner of expressing the same intent.

2.2 Guidance to Contracting States in the reporting of differences to Annex 10 can only be given in very general terms. Where the national regulations of States call for compliance with procedures that are not identical but essentially similar to those contained in the Annex, no difference should be reported since the details of the procedures existing are the subject of notification through the medium of aeronautical information publications. Although differences to Recommended Practices are not notifiable under Article 38 of the Convention, Contracting States are urged to notify the Organization of the differences between their national regulations and practices and any corresponding Recommended Practices contained in an Annex. States should categorize each difference notified on the basis of whether the corresponding national regulation is:

a) ***More exacting or exceeds the ICAO Standard or Recommended Practice (SARP) (Category A)***. This category applies when the national regulation is more demanding than the corresponding SARP, or imposes an obligation within the scope of the Annex which is not covered by a SARP. This is of particular importance where a State requires a higher standard which affects the operation of aircraft of other Contracting States in and above its territory;

b) ***Different in character or other means of compliance (Category B)***[*]. This category applies when the national regulation is different in character from the corresponding ICAO SARP, or when the national regulation differs in principle, type or system from the corresponding SARP, without necessarily imposing an additional obligation; and

c) ***Less protective or partially implemented/not implemented (Category C)***. This category applies when the national regulation is less protective than the corresponding SARP; or when no national regulation has been promulgated to address the corresponding SARP, in whole or in part.

2.3 When a Contracting State deems an ICAO Standard concerning aircraft, operations, equipment, personnel, or air navigation facilities or services to be not applicable to the existing aviation activities of the State, notification of a difference is not required. For example, a Contracting State that is not a State of Design or Manufacture and that does not have any national regulations on the subject, would not be required to notify differences to Annex 8 provisions related to the design and construction of an aircraft.

2.4 For States that have already fully reported differences from Annex 10 or have reported that no differences exist, the reporting of any further differences occasioned by the amendment should be relatively straightforward; however, attention is called to paragraph 1.5 wherein it is indicated that this statement should be made not only to the latest amendment but to the whole Annex, including the amendment.

3. *Form of notification of differences*

3.1 Differences should be notified in the following form:

a) *Reference*: The number of the paragraph or subparagraph in Annex 10 as amended which contains the Standard or Recommended Practice to which the difference relates;

b) *Category:* Indicate the category of the difference as A, B or C in accordance with paragraph 2.2 above;

c) *Description of the difference*: Clearly and concisely describe the difference and its effect;

d) *Remarks*: Under "Remarks" indicate reasons for the difference and intentions including any planned date for implementation.

---

* The expression "different in character or other means of compliance" in b) would be applied to a national regulation which achieves, by other means, the same objective as that of the corresponding ICAO SARPs and so cannot be classified under a) or c).

3.2 The differences notified will be recorded in a Supplement to the Annex, normally in the terms used by the Contracting State when making the notification. In the interest of making the Supplement as useful as possible, please make statements as clear and concise as possible and confine remarks to essential points. Comments on implementation, in accordance with paragraph 4 b) 2) of the Resolution of Adoption, should not be combined with those concerning differences. The provision of extracts from national regulations cannot be considered as sufficient to satisfy the obligation to notify differences. General comments that do not relate to specific differences will not be published in Supplements.

— END —

AMENDMENT No. 86

TO THE

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME I
(RADIO NAVIGATION AIDS)

The amendment to Annex 10, Volume I, contained in this document was adopted by the Council of ICAO on **4 March 2011**. Such parts of this amendment as have not been disapproved by more than half of the total number of Contracting States on or before **18 July 2011** will become effective on that date and will become applicable on **17 November 2011** as specified in the Resolution of Adoption. (State letter AN 7/1.1.46-11/23 refers.)

MARCH 2011

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENT 86 TO THE INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

RESOLUTION OF ADOPTION

The Council

Acting in accordance with the Convention on International Civil Aviation, and particularly with the provisions of Articles 37, 54 and 90 thereof,

1. *Hereby adopts* on 4 March 2011 Amendment 86 to the International Standards and Recommended Practices contained in the document entitled *International Standards and Recommended Practices, Aeronautical Telecommunications* which for convenience is designated Annex 10 to the Convention;

2. *Prescribes* 18 July 2011 as the date upon which the said amendment shall become effective, except for any part thereof in respect of which a majority of the Contracting States have registered their disapproval with the Council before that date;

3. *Resolves* that the said amendment or such parts thereof as have become effective shall become applicable on 17 November 2011;

4. *Requests the Secretary General*:

a) to notify each Contracting State immediately of the above action and immediately after 18 July 2011 of those parts of the amendment which have become effective;

b) to request each Contracting State:

1) to notify the Organization (in accordance with the obligation imposed by Article 38 of the Convention) of the differences that will exist on 17 November 2011 between its national regulations or practices and the provisions of the Standards in the Annex as hereby amended, such notification to be made before 17 October 2011, and thereafter to notify the Organization of any further differences that arise;

2) to notify the Organization before 17 October 2011 of the date or dates by which it will have complied with the provisions of the Standards in the Annex as hereby amended;

c) to invite each Contracting State to notify additionally any differences between its own practices and those established by the Recommended Practices, when the notification of such differences is important for the safety of air navigation, following the procedure specified in subparagraph b) above with respect to differences from Standards.

— — — — — — — —

NOTES ON THE PRESENTATION OF THE AMENDMENT TO ANNEX 10, VOLUME I

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

TEXT OF AMENDMENT 86 TO THE
INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

ANNEX 10 — *AERONAUTICAL TELECOMMUNICATIONS*

VOLUME I
(RADIO NAVIGATION AIDS)

. . .

CHAPTER 3. SPECIFICATIONS FOR RADIO NAVIGATION AIDS

. . .

3.7.3.5.2 *Functions*. GBAS shall perform the following functions:

a) provide locally relevant pseudo-range corrections;

b) provide GBAS-related data;

c) provide final approach segment data when supporting precision approach;

d) provide predicted ranging source availability data; and

e) provide integrity monitoring for GNSS ranging sources.

~~*Note.— Additional GBAS SARPs will be developed to provide ground-based ranging function.*~~

. . .

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

. . .

3.6.2 RF CHARACTERISTICS

3.6.2.2 *Bit-to-phase-change encoding*. GBAS messages shall be assembled into symbols, each consisting of 3 consecutive message bits. The end of the message shall be padded by 1 or 2 fill bits if necessary to form the last 3-bit symbol of the message. Symbols shall be converted to D8PSK carrier phase shifts ($\Delta\phi_k$) in accordance with Table B-58.

Note.— The carrier phase for the k^{th} symbol (ϕ_k) is given by: $\phi_k = \phi_{k-1} + \Delta\phi_k$. The D8PSK signal may be produced as shown in Figure B-19 by combining two quadrature RF signals which are independently suppressed-carrier amplitude-modulated by base band filtered impulses. A positive increase in $\Delta\varphi_k$ represents a counter clockwise rotation in the complex I-Q plane of Figure B-19.

. . .

3.6.4 DATA CONTENT

. . .

3.6.4.1 *Message types*. The message types that can be transmitted by GBAS shall be as in Table B-63.

~~*Note.— Currently only 9 of the 256 available message types have been defined, with the intent that future needs can be addressed in the remaining message types.*~~

. . .

Table B-63. GBAS VHF data broadcast messages

Message type identifier	Message name
0	Spare
1	Pseudo-range corrections
2	GBAS-related data
3	Null message ~~Reserved for ground-based ranging source~~
4	Final approach segment (FAS) data
5	Predicted ranging source availability
6	Reserved
7	Reserved for national applications
8	Reserved for test applications
9 to 100	Spare
101	GRAS pseudo-range corrections
102 to 255	Spare

Note.— See 3.6.6 for message formats.

. . .

3.6.4.2.4 The measurement block parameters shall be as follows:

. . .

B_1 through B_4: are the integrity parameters associated with the pseudo-range corrections provided in the same measurement block. For the i^{th} ranging source these parameters correspond to $B_{i,1}$ through $B_{i,4}$ (3.6.5.5.1.2, 3.6.5.5.2.2 and 3.6.7.2.2.4). The indices "1-4" correspond to the same physical reference receiver for every frame transmitted from a given ground subsystem during continuous operation.

Coding: 1000 0000 = Reference receiver was not used to compute the pseudo-range correction.

Note.— Some airborne receivers may expect a static correspondence of the reference receivers to the indices for short-service interruptions. However, the B value indices may be reassigned after the ground subsystem has been out of service for an extended period of time, such as for maintenance.

. . .

3.6.4.3.2 *Additional data blocks*. For additional data blocks other than additional data block 1, the parameters for each data block shall be as follows:

ADDITIONAL DATA BLOCK LENGTH: the number of bytes in the additional data block, including the additional data block length and additional data block number fields.

ADDITIONAL DATA BLOCK NUMBER: the numerical identifier of the type of additional data block.

Coding:	0 to 1	=	reserved
	2	=	additional data block 2, GRAS broadcast stations
	3	=	reserved for future services supporting Category II/III operations
	4	=	additional data block 4, VDB authentication parameters
	~~3~~5 to 255	=	spare

. . .

3.6.4.3.2.2 *VDB authentication parameters*

Additional data block 4 includes information needed to support VDB authentication protocols

Slot group definition: This 8-bit field indicates which of the 8 slots (A-H) are assigned for use by the ground station. The field is transmitted LSB first. The LSB corresponds to slot A, the next bit to slot B, and so on. A "1" in the bit position indicates the slot is assigned to the ground station. A "0" indicates the slot is not assigned to the ground station.

Table B-65C. VDB authentication parameters

Data content	Bits used	Range of values	Resolution
Slot group definition	8	-	-

. . .

3.6.4.4 *TYPE 3 MESSAGE—NULL MESSAGE*

~~*Note.— Type 3 message is intended to provide the information required to use ground-based ranging sources and is reserved for future applications.*~~

3.6.4.4.1 The Type 3 message is a variable length 'null message' which is intended to be used by ground subsystems that support the authentication protocols (see section 3.6.7.4).

3.6.4.4.2 The parameters for the Type 3 message shall be as follows:

Filler: a sequence of bits alternating between "1" and "0" with a length in bytes that is 10 less than the value in the message length field in the message header.

. . .

3.6.4.5.1 *FAS data block.*

. . .

Airport ID: the three- or four-letter designator used to designate an aerodrome.

Coding: Each character is coded using the lower 6 bits of its IA-5 representation. For each character, b_i is transmitted first, and 2 zero bits are appended after b_6, so that 8 bits are transmitted for each character. Only upper case letters, numeric digits and IA-5 "space" are used. The rightmost character is transmitted first. For a three-character ~~GBAS~~ airport ID, the rightmost (first transmitted) character shall be IA-5 "space".

. . .

Approach performance designator: the general information about the approach design.

Coding:	0	=	APV
	1	=	Category I
	2	=	reserved for Category II
	3	=	reserved for Category III
	4 to 7	=	spare

Note.— Some airborne equipment designed for Category I performance is insensitive to the value of the APD. It is intended that airborne equipment designed for Category I performance accepts APD values of at least 1-4 as valid to accommodate future extensions to higher performance types using the same FAS data block.

Route indicator: the one-letter identifier used to differentiate between multiple approaches to the same runway end.

. . .

Reference path identifier (RPI): the three or four alphanumeric characters used to uniquely designate the reference path.

. . .

3.6.5.1 *Measured and carrier smoothed pseudo-range.*

. . .

α = the filter weighting function equal to the sample interval divided by the time constant of 100 seconds, except as specified in 3.6.8.3.5.1 for airborne equipment.

. . .

3.6.6 MESSAGE TABLES

Each GBAS message shall be coded in accordance with the corresponding message format defined in Tables B-70 through B-73.

Note.— Message type structure is defined in 3.6.4.1.

. . .

Table B-70A. Type 101 GRAS pseudo-range corrections message

Data content	Bits used	Range of values	Resolution
Modified Z-count	14	0 to 1 199.9 s	0.1 s
Additional message flag	2	0 to 3	1
Number of measurements (N)	5	0 to 18	1
Measurement type	3	0 to 7	1
Ephemeris decorrelation parameter (P)	8	0 to 1.275×10^{-3} m/m	5×10^{-6} m/m
Ephemeris CRC	16	—	—
Source availability duration	8	0 to 2540 s	10 s
Number of B parameters	1	0 or 4	—
Spare	7	—	—
For N measurement blocks			
Ranging source ID	8	1 to 255	1
Issue of data (IOD)	8	0 to 255	1
Pseudo-range correction (PRC)	16	±327.67 m	0.01 m
Range rate correction (RRC)	16	~~±327.67 m/s~~ ±32.767 m/s	0.001 m/s
$\sigma_{pr\ gnd}$	8	0 to 50.8 m	0.2 m
B parameter block (if provided)			
B_1	8	±25.4 m	0.2 m
B_2	8	±25.4 m	0.2 m
B_3	8	±25.4 m	0.2 m
B_4	8	±25.4 m	0.2 m

. . .

Insert new Table B-71B after Table B-71 and
renumber Table B-71 as B-71A

Table B-71B. Type 3 null message

Data content	Bits used	Range of values	Resolution
Filler	Variable (Note)	N/A	N/A

Note.— The number of bytes in the filler field is 10 less than the message length field in the message header as defined in section 3.6.3.4.

End of new text.

. . .

3.6.7.2.1.2 *Message block identifier*. The MBI shall be set to either normal or test according to the coding given in 3.6.3.4.1.

3.6.7.2.1.3 *VDB authentication*

Note.— This section is reserved for forward compatibility with future authentication functions.

. . .

3.6.7.2.2.9 *Linked pair of Type 1 or Type 101 messages.* If a linked pair of Type 1 or Type 101 messages is transmitted then,

a) the two messages shall have the same modified Z-count;

b) the minimum number of pseudo-range corrections in each message shall be one;

c) the measurement block for a given satellite shall not be broadcast more than once in a linked pair of messages; ~~and~~

d) the two messages shall be broadcast in different time slots~~.~~; and

e) the order of the B values in the two messages shall be the same.

. . .

~~3.6.7.4 *GROUND-BASED RANGING SOURCES*~~

~~*Note. — Ground-based ranging systems are expected to use a portion of the 1 559 – 1 610 MHz band, which will be classified by the ITU as providing RNSS-ARNS service, and are expected to require up to ±10 MHz around their centre frequency. As augmentations to GPS and/or GLONASS, they will constitute components of GNSS and will have associated avionics receivers. Their interference protection level must be consistent with the interference environment of GNSS receivers.*~~

Insert new text as follows:

3.6.7.4 *Functional requirements for authentication protocols*

3.6.7.4.1 *Functional requirements for ground subsystems that support authentication*

3.6.7.4.1.1 The ground system shall broadcast the additional data block 4 with the Type 2 message with the slot group definition field coded to indicate which slots are assigned to the ground station.

3.6.7.4.1.2 The ground subsystem shall broadcast every Type 2 message in the slot that corresponds to the SSID coding for the ground subsystem. Slot A is represented by SSID=0, B by 1, C by 2, and H by 7.

3.6.7.4.1.3 *Assigned slot occupancy*. The ground subsystem shall transmit messages such that 87 per cent or more of every assigned slot is occupied. If necessary, Type 3 messages will be used to fill unused space in any assigned time slot.

3.6.7.4.1.4 *Reference path identifier coding*. Every reference path identifier included in every final approach segment data block broadcast by the ground station via the Type 4 messages shall have the first letter selected to indicate the SSID of the ground station in accordance with the following coding.

Coding:	A	=	SSID of 0
	X	=	SSID of 1
	Z	=	SSID of 2
	J	=	SSID of 3
	C	=	SSID of 4
	V	=	SSID of 5
	P	=	SSID of 6
	T	=	SSID of 7

3.6.7.4.2 *Functional requirements for ground subsystems that do not support authentication*

3.6.7.4.2.1 *Reference path indicator coding*. Characters in this set: {A X Z J C V P T} shall not be used as the first character of the reference path identifier included in any FAS block broadcast by the ground station via the Type 4 messages.

End of new text.

. . .

3.6.8 AIRCRAFT ELEMENTS

3.6.8.1 *GNSS receiver*. The GBAS-capable GNSS receiver shall process signals of GBAS in accordance with the requirements specified in this section as well as with requirements in 3.1.3.1 and/or 3.2.3.1 and/or 3.5.8.1.

~~*Note. — A GBAS-capable GNSS receiver may be implemented without the capability to process the Type 101 message, the Type 2 message additional data block 2, or data specific to an approach performance designator value of 0.*~~

. . .

3.6.8.3 *AIRCRAFT FUNCTIONAL REQUIREMENTS*

. . .

3.6.8.3.1.2 The receiver shall use message data only if the message block identifier is set to the bit pattern “1010 1010”.

Insert new text as follows:

3.6.8.3.1.2.1 *GBAS message processing capability*. The GBAS receiver shall at a minimum process GBAS message types in accordance with Table B-82.

3.6.8.3.1.2.2 *Airborne processing for forward compatibility*

Note.— Provisions have been made to enable future expansion of the GBAS Standards to support new capabilities. New message types may be defined, new additional data blocks for message Type 2 may be defined and new data blocks defining reference paths for inclusion within message Type 4 may be defined. To facilitate these future expansions, all equipment should be designed to properly ignore all data types that are not recognized.

3.6.8.3.1.2.2.1 *Processing of unknown message types.* The existence of messages unknown to the airborne receiver shall not prevent correct processing of the required messages.

3.6.8.3.1.2.2.2 *Processing of unknown Type 2 extended data blocks.* The existence of message Type 2 additional data blocks unknown to the airborne receiver shall not prevent correct processing of the required messages.

3.6.8.3.1.2.2.3 *Processing of unknown Type 4 data blocks.* The existence of message Type 4 data blocks unknown to the airborne receiver shall not prevent correct processing of the required messages.

Note.— While the current SARPs include only one definition of a data block for inclusion within a Type 4 message, future GBAS Standards may include other reference path definitions.

End of new text.

. . .

Insert new Table B-82 as follows and *renumber* existing Tables B-82 to B-87 including their corresponding references:

Table B-82. Airborne equipment message type processing

Airborne equipment designed performance	Minimum message types processed
APV-I	MT 1 or 101, MT 2 (including ADB 1 and 2 if provided)
APV-II	MT 1, MT 2 (including ADB 1 and 2 if provided), MT 4
Category I	MT 1, MT 2 (including ADB 1 if provided), MT 4

End of new text.

. . .

3.6.8.3.5 *Airborne pseudo-range measurements*. ~~Pseudo-range measurement for each satellite shall be smoothed using the carrier measurement and a smoothing filter which deviates less than 0.1 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 metre per second.~~

3.6.8.3.5.1 *Carrier smoothing for airborne equipment.* Airborne equipment shall utilize the standard 100 second carrier smoothing of code phase measurements defined in 3.6.5.1. During the first 100 seconds after filter start up, the value of α shall be either:

1) a constant equal to the sample interval divided by 100 seconds or,

2) a variable quantity defined by the sample interval divided by the time in seconds since filter start-up.

. . .

Insert, after Figure B-18, the following new figure:

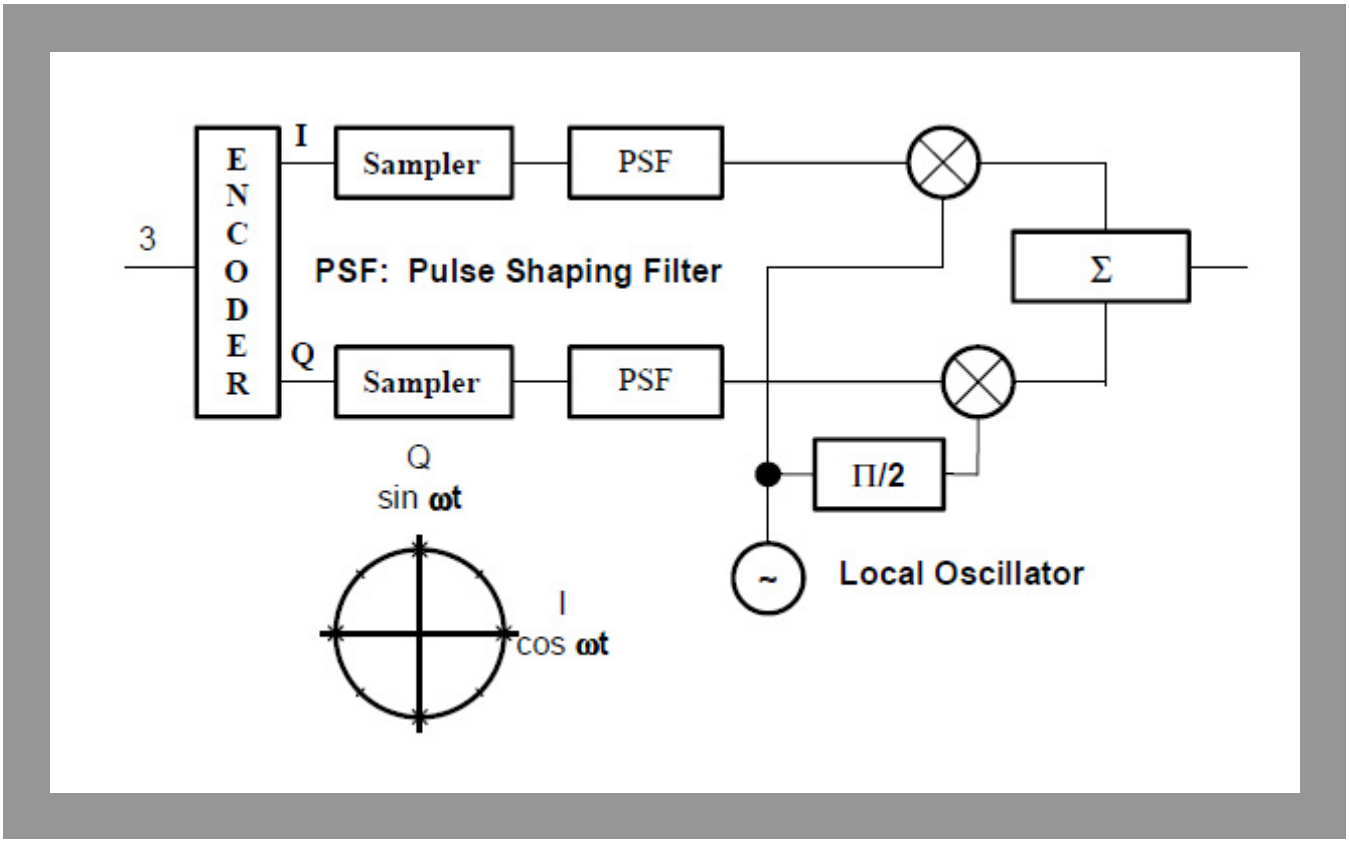


Figure B-19. Example data modulation

End of new text.

. . .

3.7.2.2.2

. . .

Table B-83. Interference threshold for GLONASS receivers

Frequency range f_i of the interference signal	Interference thresholds for receivers used for precision approach phase of flight
…	
1 562.15625 MHz < $f_i \leq$ 1 583.65625 MHz	Linearly decreasing from –42 dBW to –80 dBW
…	

. . .

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

. . .

3.4.3 *Approach and landing*

3.4.3.1 For approach and landing operations, continuity of service relates to the capability of the navigation system to provide a navigation output with the specified accuracy and integrity during the approach and landing, given that it was available at the start of the operation. In particular, this means that loss of continuity events that can be predicted and for which NOTAMs have been issued do not have to be taken into account when establishing compliance of a given system design against the SARPs continuity requirement. The occurrence of navigation system alerts, either due to rare fault-free performance or to failures, constitute a loss of continuity event ~~failures~~. In this case, the continuity requirement is stated as a probability for a short exposure time.

. . .

7.1 System description

. . .

7.1.5 *GRAS configurations*. From a user perspective, a GRAS ground subsystem consists of one or more GBAS ground subsystems (as described in 7.1.1 through 7.1.4), each with a unique GBAS identification, providing the positioning service and APV where required. By using multiple GBAS broadcast stations, and by broadcasting the Type 101 message, GRAS is able to support en-route operations via the GBAS positioning service, while also supporting terminal, departure, and APV operations over a larger coverage region than that typically supported by GBAS. In some GRAS applications, the corrections broadcast in the Type 101 message may be computed using data obtained from a network of reference receivers distributed in the coverage region. This permits detection and mitigation of measurement errors and receiver faults.

7.1.6 *VDB transmission path diversity*. All broadcast stations of a GBAS ground subsystem broadcast identical data with the same GBAS identification on a common frequency. The airborne receiver need not and cannot distinguish between messages received from different broadcast stations of the same GBAS ground subsystem. When within coverage of two such broadcast stations, the receiver will receive and process duplicate copies of messages in different time division multiple access (TDMA) time slots.

. . .

7.2 RF characteristics

7.2.1 *Frequency ~~and time slot planning~~ coordination*

7.2.1.1 *Performance factors*

7.2.1.1.1 The geographical separation between a candidate GBAS station, a candidate VOR station and existing VOR or GBAS installations must consider the following factors:

a) the coverage volume, minimum field strength and effective radiated power (ERP) of the candidate GBAS including the GBAS positioning service, if provided. The minimum requirements for coverage and field strength are found in Chapter 3, 3.7.3.5.3 and 3.7.3.5.4.4, respectively. The ERP is determined from these requirements;

b) the coverage volume, minimum field strength and ERP of the surrounding VOR and GBAS stations including the GBAS positioning service, if provided. Specifications for coverage and field strength for VOR are found in Chapter 3, 3.3, and respective guidance material is provided in Attachment C;

c) the performance of VDB receivers, including co-channel and adjacent channel rejection, and immunity to desensitization and intermodulation products from FM broadcast signals. These requirements are found in Appendix B, 3.6.8.2.2;

d) the performance of VOR receivers, including co-channel and adjacent channel rejection of VDB signals. Since existing VOR receivers were not specifically designed to reject VDB transmissions, desired-to-undesired (D/U) signal ratios for co-channel and adjacent channel rejection of the VDB were determined empirically. Table D-2 summarizes the assumed signal ratios based upon empirical performance of numerous VOR receivers designed for 50 kHz channel spacing;

e) for areas/regions of frequency congestion, a precise determination of separation may be required using the appropriate criteria;~~.~~

f) that between GBAS installations RPDS and RSDS numbers are assigned only once on a given frequency within radio range of a particular GBAS ground subsystem. The requirement is found in Appendix B, 3.6.4.3.1;

g) that between GBAS installations within radio range of a particular GBAS ground subsystem the reference path identifier is assigned to be unique. The requirement is found in Appendix B, 3.6.4.5.1; and

h) the four-character GBAS ID to differentiate between GBAS ground subsystems. The GBAS ID is normally identical to the location indicator at the nearest aerodrome. The requirement is found in Appendix B, 3.6.3.4.1.

7.2.1.1.2 ~~The nominal~~ Nominal link ~~budget~~ budgets for VDB ~~is~~ are shown in Table D-3. The ~~figures~~ first example in ~~the table~~ Table D-3 ~~assume~~ assumes a user receiver height of 3 000 m (10 000 ft) MSL and a transmit antenna designed to suppress ground illumination in order to limit the fading losses to a maximum of 10 dB at coverage edge. In the case of GBAS/E equipment, the 10 dB also includes any effects of signal loss due to interference between the horizontal and vertical components. The second example in Table D-3 provides a link budget for longer range positioning service. It is for a user receiver height sufficient to maintain radio line-of-sight with a multi-path limiting transmitting antenna. No margin is given for fading as it is assumed that the receiver is at low elevation angles of radiation and generally free from significant null for the distances shown in the table (greater than 50 NM).

. . .

Table D-3. Nominal VDB link budget

VDB link elements	~~Vertical component link budget at coverage edge~~	~~Horizontal component link budget at coverage edge~~
For approach service	Vertical component at coverage edge	Horizontal component at coverage edge
Required receiver sensitivity (dBm)	–87	–87
Maximum aircraft implementation loss (dB)	11	15
Power level after aircraft antenna (dBm)	–76	–72
Operating margin (dB)	3	3
Fade margin (dB)	10	10
Free space path loss (dB) at 43 km (23 NM)	106	106
Nominal effective radiated power (ERP) (dBm)	43	47
For longer range and low radiation angle associated with positioning service	Vertical component	Horizontal component
Required receiver sensitivity (dBm)	–87	–87
Maximum aircraft implementation loss (dB)	11	15
Power level after aircraft antenna (dBm)	–76	–72
Operating margin (dB)	3	3
Fade margin (dB)	0	0
Nominal ERP (dBm)		

Range (km (NM))	Free space loss (dB)	ERP (dBm)	ERP (W)	ERP (dBm)	ERP (W)
93 (50)	113	39.9	10	43.9	25
185 (100)	119	45.9	39	49.9	98
278 (150)	122	49.4	87	53.4	219
390 (200)	125	51.9	155	55.9	389

Note 1.— In this table ERP is referenced to an isotropic antenna model.
Note 2.— It is possible, with an appropriately sited multipath limiting VDB transmitting antenna with an ERP sufficient to meet the field strength requirements for approach service and considering local topographical limitations, to also satisfy the field strength requirements such that positioning service can be supported at the ranges in the table above.
Note 3.— Actual aircraft implementation loss (including antenna gain, mismatch loss, cable loss, etc.) and actual receiver sensitivity may be balanced to achieve the expected link budget. For example, if the aircraft implementation loss for the horizontal component is 19 dB, the receiver sensitivity must exceed the minimum requirement and achieve -91 dBm to satisfy the nominal link budget.

. . .

7.6.2 *Ground subsystem continuity of service*. GBAS ground subsystems are required to meet the continuity specified in Appendix B to Chapter 3, 3.6.7.1.3 in order to support Category I precision approach and APV. GBAS ground subsystems that are also intended to support other operations through the use of the GBAS positioning service should support the minimum continuity required for terminal area operations, which is $1–10^{-4}$/hour (Chapter 3, Table 3.7.2.4-1). When the Category I precision approach or APV required continuity ($1-3.38 \times 10^{-6}$/15 seconds) is converted to a per hour value it does not meet the $1–10^{-4}$/hour minimum continuity requirement. Therefore, additional measures are necessary to meet the continuity required for other operations. One method of showing compliance with this requirement is to assume that airborne implementation uses both GBAS and ABAS to provide redundancy and that ABAS provides sufficient accuracy for the intended operation.

. . .

7.11.3 *"ILS look-alike" deviation computations*. For compatibility with existing aircraft designs, it is desirable for aircraft equipment to output guidance information in the form of deviations relative to a desired flight path defined by the FAS path. The Type 4 message includes parameters that support the computation of deviations that are consistent with typical ILS ~~requirements~~ installations.

7.11.3.1 *Lateral deviation definition.* Figure D-6 illustrates the relationship between the FPAP and the origin of the lateral angular deviations. The course width parameter and FPAP are used to define the origin and sensitivity of the lateral deviations. By adjusting the location of the FPAP and the value of the course width, the course width and sensitivity of a GBAS can be set to the desired values. They may be set to match the course width and sensitivity of an existing ILS or MLS. This may be necessary, for example, for compatibility with existing visual landing aids.

. . .

7.11.3.2 *Vertical deviations.* Vertical deviations are computed by the aircraft equipment with respect to a GBAS elevation reference point (GERP). The GERP may be at the GPIP or laterally offset from the GPIP by a fixed GERP offset value of 150 m. Use of the offset GERP allows the glide path deviations to produce the same hyperbolic effects that are normal characteristics of ILS and MLS (below 200 ft). The decision to offset the GERP or not is made by the aircraft equipment in accordance with requirements driven by compatibility with existing aircraft systems. Service providers should be aware that users may compute vertical deviations using a GERP which is placed at either location. Sensitivity of vertical deviations is set automatically in the aircraft equipment as a function of the GPA. The specified relationship between GPA and the full scale deflection (FSD) of the vertical deviation sensitivity is: FSD=0.25*GPA. The value 0.25 is the same as for MLS (Attachment G, 7.4.1.2) and differs slightly from the nominal value of 0.24 recommended for ILS (Chapter 3, section 3.1.5.6.2). However, the value specified is well within the tolerances recommended for ILS (0.2 to 0.28). Therefore the resulting sensitivity is equivalent to the glide path displacement sensitivity provided by a typical ILS.

. . .

7.11.6 *Approach identifier*. The service provider is responsible for assigning the approach identifier for each approach. The approach identification should be unique within a large geographical area. Approach identifications for multiple runways at a given aerodrome should be chosen to reduce the potential for confusion and misidentification. The approach identification should appear on the published charts that describe the approach. The first letter of the approach identifier is used in the authentication protocols for GBAS. Ground stations that support the authentication protocols must encode the first character of the identifier for all approaches supported from the set of letters {A X Z J C V P T} as described in Appendix B, section 3.6.7.4.1.4. This enables airborne equipment (that supports the authentication protocols) to determine which slots are assigned to the ground station and therefore to subsequently ignore reception of data broadcast in slots not assigned to the selected ground station. For ground stations that do not support the authentication protocols, the first character of the approach identifier may be assigned any character except those in the set {A X Z J C V P T}.

. . .

7.15.4 Table D-8 provides examples of a Type 1 VDB message and a Type 2 VDB message coded within a single burst (i.e. two messages to be broadcast within a single transmission slot). The additional message flag field of the Type 1 message is coded to indicate that it is the second of two Type 1 messages to be broadcast within the same frame. The Type 2 message includes additional data block 1. Table D-8A provides an example of Type 1 and Type 2 messages with additional data blocks 1 and 2.

7.15.4.1 Table D-8B provides an example of Type 2 messages with additional data blocks 1 and 4 coded within a single burst with a Type 3 message that is used to fill the rest of the time slot.

. . .

7.17 Type 2 message additional data blocks ~~block 2~~

7.17.1 The Type 2 message contains data related to the GBAS facility such as the GBAS reference point location, the GBAS continuity and integrity designator (GCID) and other pertinent configuration information. A method for adding new data to the Type 2 message has been devised to allow GBAS to evolve to support additional service types. The method is through the definition of new additional data blocks that are appended to the Type 2 message. In the future, more additional data blocks may be defined. Data blocks 2 through 255 have variable length and may be appended to the message after additional data block 1 in any order.

7.17.2 Type 2 message additional data block 1 contains information related to spatial decorrelation of errors and information needed to support selection of the GBAS positioning service (when provided by a given ground station).

7.17.3 Type 2 message additional data block 2 data may be used in GRAS to enable the GRAS airborne subsystem to switch between GBAS broadcast stations, particularly if the GBAS broadcast stations utilize different frequencies. Additional data block 2 identifies the channel numbers and locations of the GBAS broadcast station currently being received and other adjacent or nearby GBAS broadcast stations.

7.17.4 Type 2 message additional data block 3 is reserved for future use.

7.17.5 Type 2 message additional data block 4 contains information necessary for a ground station that supports the authentication protocols. It includes a single parameter which indicates which slots are assigned to the ground station for VDB transmissions. Airborne equipment that supports the authentication protocols will not use data unless it is transmitted in the slots indicated by the slot group definition field in the MT 2 ADB 4.

. . .

Insert new Table D-8B following Table D-8A:

Table D-8B. Example of Type 2 Message Containing Data Blocks 1 and 4

DATA CONTENT DESCRIPTION	BITS USED	RANGE OF VALUES	RESOLUTION	VALUES	BINARY REPRESENTATION (NOTE 1)
BURST DATA CONTENT					
Power ramp-up and settling	15	-	-	-	000 0000 0000 0000
Synchronization and ambiguity resolution	48	-	-	-	0100 0111 1101 1111 1000 1100 0111 0110 0000 0111 1001 0000
SCRAMBLED DATA					
Station Slot Identifier	3	-	-	E	100
Transmission Length	17	0 – 1824 bits	1 bit	1704	0 0000 0110 1010 1000
Training Sequence FEC	5	-	-	-	01000
APPLICATION DATA					
Message Block 1 (Type 2 Message)					
Message Block Header					
Message Block Identifier	8	-	-	Normal	1010 1010
GBAS ID	24	-	-	BELL	000010 000101 001100 001100
Message Type Identifier	8	1 – 101	1	2	0000 0010
Message Length	8	10 – 222 bytes	1 byte	37	0010 0101
Message (Type 2 Example)					
GBAS reference receivers	2	2 - 4	1	3	01
Ground accuracy designator letter	2	-	-	B	01
Spare	1	-	-	-	0
GBAS continuity/integrity designator	3	0 – 7	1	2	010
Local magnetic variation	11	± 180°	0.25°	E58.0°	000 1110 1000
Spare	5	-	-	-	0000 0
$\sigma_{vert\_iono\_gradient}$	8	0 - 25.5 x10^{-6} m/m	0.1 x10^{-6} m/m	4x10^{-6}	0010 1000
Refractivity index	8	16 to 781	3	379	1111 1001
Scale height	8	0 – 25,500 m	100 m	100 m	0000 0001
Refractivity uncertainty	8	0 – 255	1	20	0001 0100
Latitude	32	± 90.0°	0.0005 arcsec	N45° 40' 32" (+164432")	0001 0011 1001 1010 0001 0001 0000 0000
Longitude	32	± 180.0°	0.0005 arcsec	W93° 25' 13" (-336313")	1101 0111 1110 1000 1000 1010 1011 0000
Ellipsoid height	24	± 83,886.07 m	0.01 m	892.55 m	0000 0001 0101 1100 1010 0111
Additional Data Block 1					
Reference Station Data Selector	8	0 – 48	1	5	0000 0101
Maximum Use Distance (D_{max})	8	2 – 510 km	2 km	50 km	0001 1001
$K_{md\_e\_POS,GPS}$	8	0 – 12.75	0.05	6	0111 1000
$K_{md\_e\ C,GPS}$	8	0 – 12.75	0.05	5	0110 0100
$K_{md\_e\_POS,GLONASS}$	8	0 – 12.75	0.05	0	0000 0000
$K_{md\_e\ C,GLONASS}$	8	0 – 12.75	0.05	0	0000 0000
Additional Data Block 4					
Additional Data Block Length	8	3	1 byte	3	0000 0011
Additional Data Block Number	8	4	1	4	0000 0100
Slot Group Definition	8	-	-	E	0011 0000
Message Block 1 CRC	32	-	-	-	1100 0101 1110 0000 0010 0110 1100 1011
Message Block 2 (Type 3 Message)					
Message Block Header					
Message block identifier	8	-	-	Normal	1010 1010
GBAS ID	24	-	-	BELL	000010 000101 001100 001100
Message type identifier	8	1 - 101	1	3	0000 0011
Message length	8	N/A	1 byte	170	1010 1010
Message (Type 3 example)					
Filler	1280	-	-	-	1010 1010 ..... 1010 1010
Message Block 2 CRC	32	-	-	-	1001 0000 1110 1100 1101 1001 1011 1010
Application FEC	48	-	-	-	0000 1000 0010 0011 1100 1011 1101 0000 1101 0110 1011 0101

DATA CONTENT DESCRIPTION	BITS USED	RANGE OF VALUES	RESOLUTION	VALUES	BINARY REPRESENTATION (NOTE 1)
Input to Bit Scrambling (Note 2)	0 45 58 02 55 30 CA 10 40 A4 A2 17 00 14 9F 80 28 00 88 59 C8 0D 51 17 EB E5 3A 80 A0 98 1E 26 00 00 C0 20 0C D3 64 07 A3 55 30 CA 10 C0 55 5D 9B 37 09 AD 6B 0B D3 C4 10				
Output from the bit scrambling (Note 3)	0 63 6F 8A 1F 2F D2 3B 9F 3E 77 CE 32 C8 D9 50 DE C1 C1 5A D4 09 7E E7 81 5A 5C D4 28 56 00 CE 29 60 A3 5F 77 87 C0 C9 D2 42 73 01 15 DB A6 8F EF 8C F3 88 DC 78 B6 C7 D0 93 58 5D 46 B5 6F D5 0C AA 77 FE D3 30 A2 27 E1 EC E4 F7 17 2D AD F4 0B 29 82 04 61 96 E4 50 E9 58 FA B8 C0 38 99 C7 BB 6C 3D 09 CA 7B 7E C2 CF 60 8D 18 75 B9 2B C5 FC 94 C8 57 79 52 C5 5F 6A B2 FF DF 33 4D DD 74 B5 28 2A 06 01 91 9B A4 43 E9 63 05 1D 95 B4 54 29 56 05 51 95 5B AA BC 00 36 66 2E EE 0F 0E 72 71 21 25 E5 EB 14 FD A8 CB F8 83 38 62 39 1E 3A 4E 3E 8E 30 71 D9 24 BA 17 C1 AC 9B F7 BC D3 C8 A3 78 1D 39 B5 C4 2B 69 FD 04 CA 68 81 07 9A 64 8F 6B 39 7D 2A 34 D0 6F EA				
Fill Bits	0 to 2	-	-	2	00
Power ramp-down	9	-	-	-	000 000 000
D8PSK Symbols (Note 4)	00000035 11204546 31650102 46331130 13067746 52605627 35467122 62533573 77100603 75554273 01666461 41203311 42111340 14733657 27302663 77076361 44301001 17175104 35263707 43007132 40135774 07012022 52546153 57425454 25413051 54022547 01622754 12302141 24615265 50476225 56622615 23311312 51275055 11132570 45242065 63665236 04052447 35155017 73303745 61650521 06765616 04756006 16264736 30530735 02426407 53610061 12111501 04147002 72512117 74672621 42254251 12533720 37475054 44460104 57516674 46523401 22503075 25125742 03431633 22607072 37230050 35463673 43300570 12353363 77140357 42715724 03470633 30354042 67720645 27225703 50111005 40736127 14021742 36572477 13042222 2				

Notes.—

1. *The rightmost bit is the LSB of the binary parameter value and is the first bit transmitted or sent to the bit scrambler. All data fields are sent in the order specified in the table.*
2. *This field is coded in hexadecimal with the first bit to be sent to the bit scrambler as its MSB. The first character represents a single bit.*
3. *In this example, fill bits are not scrambled.*
4. *This field represents the phase, in units of π/4 (e.g. a value of 5 represents a phase of 5π/4 radians), relative to the phase of the first symbol.*

End of new text.

. . .

8. Signal quality monitor (SQM) design

. . .

8.5 Threat Model B introduces amplitude modulation and models degradations in the analog section of the GPS or GLONASS satellite. More specifically, it consists of the output from a second order system when the nominal C/A code baseband signal is the input. Threat Model B assumes that the degraded satellite subsystem can be described as a linear system dominated by a pair of complex conjugate poles. These poles are located at $\sigma \pm j2\pi f_d$, where σ is the damping factor in 10^6 nepers/second and f_d is the resonant frequency with units of 10^6 cycles/second.

. . .

8.10.2 Mean values $\mu_{D,test}$ and $\mu_{R,test}$, on the other hand, are determined in a relatively error-free environment, such as through the use of GPS and GLONASS signal simulator as input. These mean values model the nominal SQM receiver's filter distortion of the autocorrelation peak, including the effects of distortion due to adjacent minor autocorrelation peaks. The mean values can differ for the various PRNs based on these properties.

8.10.3 The presence of nominal signal deformation biases may cause the distribution of the monitor detectors to have non-zero mean. These biases can be observed by averaging measurements taken from a real-world data collection. Note that the nominal biases may depend on elevation and they typically change slowly over time.

. . .

8.11.2 For double-delta correlators, the precorrelation filter rolls off by at least 30 dB per octave in the transition band. For GBAS receivers, the resulting attenuation in the stop band is required to be greater than or equal to 50 dB (relative to the peak gain in the pass band).

. . .

8.11.6 For aircraft receivers using double-delta 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~~ Tables D-13A and D-13B.

. . .

Table D-13A. GPS tracking constraints for GRAS and SBAS airborne receivers with double-delta correlators

Region	3 dB precorrelation bandwidth, BW	Average correlator spacing ~~range~~ (X) (chips)	Instantaneous correlator spacing ~~range~~ (chips)	Differential group delay
1	$(-50 \times X) + 12 < BW \leq 7$ MHz	0.1 – 0.2	0.09 – 0.22	≤ 600 ns
	$2 < BW \leq 7$ MHz	0.2 – 0.6	0.18 – 0.65	
2	$(-50 \times X) + 12 < BW \leq (40 \times X) + 11.2$ MHz	0.045 – 0.07	0.04 – 0.077	≤ 150 ns
	$(-50 \times X) + 12 < BW \leq 14$ MHz	0.07 – 0.1	0.062 – 0.11	
	$7 < BW \leq 14$ MHz	0.1 – 0.24	0.09 – 0.26	
3	$14 < BW \leq 16$ MHz	0.07 – 0.24	0.06 – 0.26	≤ 150 ns

Insert new Table D-13B as follows:

Table D-13B. GPS tracking constraints for GBAS airborne receivers with double-delta correlators

Region	3 dB precorrelation bandwidth, BW	Average correlator spacing (X) (chips)	Instantaneous correlator spacing (chips)	Differential group delay
1	$(-50 \times X)+12 < BW \leq 7$ MHz $2 < BW \leq 7$ MHz	0.1 – 0.2 0.2 – 0.6	0.09 – 0.22 0.18 – 0.65	≤ 600 ns
2	$(-50 \times X)+12 < BW \leq (133.33 \times X)+2.667$ MHz $(-50 \times X)+12 < BW \leq 14$ MHz $7 < BW \leq 14$ MHz	0.07 – 0.085 0.085 – 0.1 0.1 – 0.24	0.063 – 0.094 0.077 – 0.11 0.09 – 0.26	≤ 150 ns
3	$14 < BW \leq 16$ MHz $(133.33 \times X)+2.667 < BW \leq 16$ MHz	0.1 – 0.24 0.085 – 0.1	0.09 – 0.26 0.077 – 0.11	≤ 150 ns

End of new text.

. . .

— END —