



Republic of the Philippines
CIVIL AVIATION AUTHORITY OF THE PHILIPPINES

MEMORANDUM CIRCULAR NO.: 05-18

TO : ALL CONCERNED

FROM : DIRECTOR GENERAL

SUBJECT : AMENDMENT TO PHILIPPINE CIVIL AVIATION REGULATIONS - AIR NAVIGATION SERVICES (CAR-ANS) PART 6 INCORPORATING AMENDMENT 89 TO ICAO ANNEX 10 VOLUME 1

REFERENCE:

1. Philippine Civil Aviation Regulations- Air Navigation Services Part 6, Issue 3 Amendment No. 5
2. ICAO Annex 10 Volume 1; Amendment 89
3. CAAP Regulations Amendment Procedures
4. Board Resolution No. 2012-054 dated 28 September 2012

Pursuant to the powers vested in me under the Republic Act 9497, otherwise known as the Civil Aviation Authority Act of 2008 and in accordance with the Board Resolution No.: 2012-054 dated 28 September 2012, I hereby approve the incorporation of ICAO Annex 10 Volume 1 Amendment No. 89 to the Philippine Civil Aviation Regulations – Air Navigation Services (CAR-ANS) Part 6.

ORIGINAL REGULATION SUBJECT FOR REVIEW AND REVISION:

CAR-ANS Part 6

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6. SPECIFICATIONS FOR RADIO NAVIGATION AIDS

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6.3.7 Requirements for the Global Navigation Satellite System (GNSS)

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6.3.7.3.1 GPS Standard Positioning Service (SPS) (L1)

6.3.7.3.1.1 Space and control segment accuracy

Note.— The following accuracy standards do not include atmospheric or receiver errors as described in Attachment 6D, 4.1.2. They apply under the conditions specified in Appendix 6B, 6.3.1.3.1.1.

6.3.7.3.1.1.1 *Positioning accuracy.* The GPS SPS position errors shall not exceed the following limits

Global average 95% of the time	Worst site 95% of the time
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Horizontal position error ~~43.9~~ m (~~43.30~~ ft) ~~36.17~~ m (~~118.56~~ ft)
 Vertical position error ~~22.15~~ m (~~72.49~~ ft) ~~77.37~~ m (~~253.121~~ ft)

6.3.7.3.1.1.2 *Time transfer accuracy.* The GPS SPS time transfer errors shall not exceed 40 nanoseconds 95 per cent of the time.

6.3.7.3.1.1.3 *Range domain accuracy.* The range domain error shall not exceed the following limits:

- a) range error of any satellite — the larger of: ~~30 m (100 ft) with reliability specified in 3.7.3.1.3;~~ ~~30 m (100 ft);~~ or ~~4.42 times the broadcast user range accuracy (URA), not to exceed 150 m (490 ft);~~
- b) ~~95th percentile~~ range rate error of any satellite — ~~0.02~~ ~~0.006~~ m (~~0.07~~ ~~0.02~~ ft) per second (global average);
- c) ~~95th percentile~~ range acceleration error of any satellite — ~~0.007~~ ~~0.002~~ m (~~0.02~~ ~~0.006~~ ft) per second-squared (global average); and
- d) ~~root-mean-square~~ ~~95th percentile~~ range error over all for any satellites over all time differences between time of data generation and time of use of data — ~~6 m (20 ft)~~ ~~7.8 m (26 ft)~~ (global average).

6.3.7.3.1.2 Availability. The GPS SPS availability shall be as follows:

- ≥99 per cent horizontal service availability, average location (~~36.17~~ m 95 per cent threshold)
- ≥99 per cent vertical service availability, average location (~~77.37~~ m 95 per cent threshold)
- ≥90 per cent horizontal service availability, worst-case location (~~36.17~~ m 95 per cent threshold)
- ≥90 per cent vertical service availability, worst-case location (~~77.37~~ m 95 per cent threshold)

6.3.7.3.1.3 *Reliability.* The GPS SPS reliability shall be within the following limits:

- a) ~~frequency of a major service failure — not more than three per year for the constellation (global average);~~ ba) reliability — at least 99.94 per cent (global average); and
- b) reliability — at least 99.79 per cent (~~worst~~ single point average).

6.3.7.3.1.4 Probability of major service failure. The probability that the user range error (URE) of any satellite will exceed 4.42 times the upper bound on the user range accuracy (URA) broadcast by that satellite without an alert received at the user receiver antenna within 10 seconds shall not exceed 1×10^{-5} per hour.

Note.— The different alert indications are described in U.S. Department of Defense, “Global Positioning System – Standard Positioning Service – Performance Standard”, 4th Edition, September 2008, Section 2.3.4.

6.3.7.3.1.5 Continuity. The probability of losing GPS SPS signal-in-space (SIS) availability from a slot of the nominal 24-slot constellation due to unscheduled interruption shall not exceed 2×10^{-4} per hour.

6.3.7.3.1.4.6 Coverage. The GPS SPS shall cover the surface of the earth up to an altitude of 3 000 kilometres.

Note.— Guidance material on GPS accuracy, availability, reliability and coverage is given in Attachment 6D, 4.1. Renumber paragraphs 6.3.7.3.1.5 – 6.3.7.3.1.8

6.3.7.3.1.5.7 Radio frequency (RF) characteristics

Note.— Detailed RF characteristics are specified in Appendix 6B, 3.1.1.1.

6.3.7.3.1.5.7.1 Carrier frequency. Each GPS satellite shall broadcast an SPS signal at the carrier frequency of 1 575.42 MHz (GPS L1) using code division multiple access (CDMA).

Note.— A new civil frequency will be added to the GPS satellites and will be offered by the United States for critical safety-of-life applications. SARPs for this signal may be developed at a later date.

6.3.7.3.1.5.7.2 Signal spectrum. The GPS SPS signal power shall be contained within a ± 12 MHz band (1 563.42 – 1 587.42 MHz) centred on the L1 frequency.

6.3.7.3.1.5.7.3 Polarization. The transmitted RF signal shall be right-hand (clockwise) circularly polarized.

6.3.7.3.1.5.7.4 Signal power level. Each GPS satellite shall broadcast SPS 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 -160 dBW to -153 dBW for all antenna orientations orthogonal to the direction of propagation.

6.3.7.3.1.5.7.5 Modulation. The SPS L1 signal shall be bipolar phase shift key (BPSK) modulated with a pseudo random noise (PRN) 1.023 MHz coarse/acquisition (C/A) code. The C/A code sequence shall be repeated each millisecond. The transmitted PRN code sequence shall be the Modulo-2 addition of a 50 bits per second navigation message and the C/A code.

6.3.7.3.1.6.8 *GPS time*. GPS time shall be referenced to UTC (as maintained by the U.S. Naval Observatory).

6.3.7.3.1.7.9 *Coordinate system*. The GPS coordinate system shall be WGS-84.

6.3.7.3.1.8.10 *Navigation information*. The navigation data transmitted by the satellites shall include the necessary information to determine:

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APPENDIX 6B. TECHNICAL SPECIFICATIONS FOR THE GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

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3.1.3.1 GNSS (GPS) RECEIVER

3.1.3.1.1 *Satellite exclusion*. The receiver shall exclude any ~~satellite designated~~ marginal or unhealthy ~~satellite by the GPS satellite ephemeris health flag~~.

Note.— Conditions indicating that a satellite is “healthy”, “marginal” or “unhealthy” can be found in U.S. Department of Defense, “Global Positioning System – Standard Positioning Service – Performance Standard”, 4th Edition, September 2008, Section 2.3.2.

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3.5.7.1 GENERAL

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3.5.7.1.3 “Do Not Use”. SBAS shall broadcast a “Do Not Use” message (Type 0 message) when necessary to inform users not to use the SBAS satellite ranging function and its broadcast data.

3.5.7.1.4 The Doppler shift in the GEO satellite signal seen at any fixed location within the GEO footprint for any GEO shall not exceed ± 450 Hz.

Note.— This maximum Doppler shift corresponds approximately to the maximum GEO satellite orbit inclination that can be supported by the coding ranges for Type 9 and Type 17 messages.

~~3.5.7.1.5 SBAS should broadcast almanac data for all SBAS satellites, regardless of the service provider.~~

3.5.7.1.5 *Geostationary orbit (GEO) ranging function parameters*. Each SBAS satellite shall broadcast geostationary orbit (GEO) ranging function parameters (defined in 3.5.4.2).

Note.— It is necessary to broadcast geostationary orbit ranging function parameters even when a ranging function is not provided, so that airborne receivers may implement a positive identification of the broadcasting SBAS satellite. When ranging is not provided, the accuracy of the Type 17 data (and Type 9 data) only needs to support the acquisition of the satellite.

3.5.7.1.5.1 The error in the Doppler shift of a GEO satellite derived from any Type 9 message that has not timed out, with respect to the true GEO Doppler shift seen at any fixed location within the GEO footprint, shall not exceed ± 210 Hz.

3.5.7.1.46 *Almanac data.* Each SBAS satellite shall broadcast almanac data for SBAS satellites (defined in 3.5.4.3) for all SBAS satellites of the same service provider, with error less than 150 km (81 NM) of the true satellite position. Unused almanac slots in Type 17 messages shall be coded with a PRN code number of “0”. The health and status shall indicate satellite status and the service provider as defined in 3.5.4.3.

3.5.7.1.6.1 The error in the estimated position of the satellite derived from any Type 17 message broadcast within the previous 15 minutes, with respect to the true satellite position, shall not exceed 3,000 km.

3.5.7.1.6.2 The separation distance between the estimated position of the satellite derived from any Type 17 message broadcast within the previous 15 minutes and the position of the satellite derived from the GEO ranging parameters in any Type 9 message that has not timed out shall not exceed 200 km.

3.5.7.1.6.3 The error in the Doppler shift of a GEO satellite derived from any Type 17 message broadcast within the previous 15 minutes, with respect to the true GEO Doppler shift seen at any fixed location within the GEO footprint, shall not exceed ± 210 Hz.

3.5.7.1.6.4 SBAS shall not broadcast almanac data for any SBAS satellite from a different service provider for which the position estimated from the almanac data broadcast within the previous 15 minutes would be within 200 km of the position of any of its own GEOs as derived from the GEO ranging parameters from any Type 9 message that has not timed out.

3.5.7.1.6.5 Where the estimated position of a GEO satellite providing a ranging function, derived from the Type 17 message broadcast within the previous 15 minutes, is within 200 km of the position of another GEO satellite of the same service provider, derived from a Type 9 message for this GEO that has not timed out, the GEO UDRE value shall be set sufficiently large to account for the possibility that a user could misidentify the PRN of the GEO providing the ranging function.

3.5.7.1.6.6 The health and status parameter shall indicate the satellite status and the service provider identifier, as defined in 3.5.4.3.

3.5.7.1.6.7 Unused almanac slots in Type 17 messages shall be coded with a PRN code number of “0”.

3.5.7.1.6.8 The service provider shall ensure the correctness of the service provider ID broadcast in any almanac.

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Table B-54. Data broadcast intervals and supported functions

Data type	Maximum broadcast interval	Ranging	GNSS satellite status	Basic differential correction	Precise differential correction	Associated message types
...						
GEO ranging function data	120 s	R	R	R	R	9
...						

Notes.—

1. “R” indicates that the data must be broadcast to support the function.

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3.5.7.3 *GNSS satellite status function.* If an SBAS provides a satellite status function, it shall also comply with the requirements contained in this section.

Note — An SBAS may be able to provide integrity on some GPS satellites that are designated either marginal or unhealthy.

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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 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.

3.5.8.1.1 *GEO satellite acquisition.* The receiver shall be able to acquire and track GEO satellites for which a stationary receiver at the user receiver location would experience a Doppler shift as large as ± 450 Hz.

3.5.8.1.1.2 *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 and all data from that satellite shall be discarded for at least 1 minute. 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. For GLONASS satellites, the receiver shall apply long-term corrections only if the time of reception (t_r) of the GLONASS ephemeris is inside the following IOD validity interval, as defined in 3.5.4.4.1:

$$t_{LT-L-V} \leq t_r \leq t_{LT-L}$$

Note 1.— For SBAS satellites, there is no mechanism that links GEO ranging function data (Type 9 message) and long-term corrections.

Note 2.— This requirement does not imply that the receiver has to stop tracking the SBAS satellite.

3.5.8.1.2.1 *SBAS satellite identification.* Upon acquisition or re-acquisition of an SBAS satellite, the receiver shall not use SBAS satellite data unless the calculated separation between the satellite position derived from its GEO ranging function parameters and the satellite position derived from the almanac message most recently received from the same service provider within the last 15 minutes is less than 200 km.

Note. — This check ensures that a receiver will not mistake one SBAS satellite for another due to cross-correlation during acquisition or re-acquisition.

3.5.8.1.1.2.2 The receiver shall use integrity or correction data only if the IODP associated with that data matches the IODP associated with the PRN mask.

3.5.8.1.1.2.3 The receiver shall use SBAS-provided ionospheric data (IGP vertical delay estimate and GIVE_i) only if the IOD_i associated with that data in a Type 26 message matches the IOD_i associated with the relevant IGP band mask transmitted in a Type 18 message.

3.5.8.1.1.2.4 The receiver shall use the most recently received integrity data for which the IOD_{fj} equals 3 or the IOD_{fj} matches the IOD_{fj} associated with the fast correction data being applied (if corrections are provided).

3.5.8.1.1.2.5 The receiver shall apply any regional degradation to the σ_{2i} , $\delta UDRE$ as defined by a Type 27 service message. If a Type 27 message with a new IODS indicates a higher $\delta UDRE$ for the user location, the higher $\delta UDRE$ shall be applied immediately. A lower $\delta UDRE$ in a new Type 27 message shall not be applied until the complete set of messages with the new IODS has been received.

3.5.8.1.1.2.6 The receiver shall apply satellite-specific degradation to the $\sigma_{i,UDRE 2}$ as defined by a Type 28 clockephemeris covariance matrix message. The $\delta UDRE$ derived from a Type 28 message shall be applied immediately.

3.5.8.1.1.2.7 In the event of a loss of four successive SBAS messages, the receiver shall no longer support SBAS-based precision approach or APV operations.

3.5.8.1.1.2.8 The receiver shall not use a broadcast data parameter after it has timed out as defined in Table B-56.

3.5.8.1.1.2.9 The receiver shall not use a fast correction if Δt for the associated RRC exceeds the time-out interval for fast corrections, or if the age of the RRC exceeds $8\Delta t$.

3.5.8.1.1.2.10 The calculation of the RRC shall be reinitialized if a “Do Not Use” or “Not Monitored” indication is received for that satellite.

3.5.8.1.1.2.11 For SBAS-based precision approach or APV operations, the receiver shall only use satellites with elevation angles at or above 5 degrees.

3.5.8.1.4.1.2.12 The receiver shall no longer support SBAS-based precision approach or APV operation using a particular satellite if the UDREI received is greater than or equal to 12.

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3.5.8.2.4 Almanac data

3.5.8.2.4.1 The almanac data provided by the SBAS shall be used for acquisition.

Note.—Health and status information is provided in the GEO almanac data to support acquisition, but need not be used as a condition for use of that satellite does not override or invalidate data provided in other SBAS messages. The use of bits 0 to 2 by airborne equipment is optional; there are no requirements covering their usage.

3.5.8.3 GNSS satellite status function. The receiver shall exclude satellites from the position solution if they are identified as “Do Not Use” by SBAS. If SBAS-provided integrity is used, the receiver shall not be required to exclude GPS satellites based on the GPS-provided ephemeris health flag as required in 3.1.3.1.1 or to exclude GLONASS satellites based on GLONASS-provided ephemeris health flag as required in 3.2.3.1.1.

Note 1.— In the case of a satellite designated marginal or unhealthy by the core satellite constellation(s) health flag, SBAS may be able to broadcast ephemeris and clock corrections that will allow the user to continue using the satellite.

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3.5.8.4.2 Precision approach and APV operations

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3.5.8.4.2.5 The parameters that define the approach path for a single precision approach or APV shall be contained in the FAS data block.

Note 1.— 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.

Note 2.— 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 6D, 6.6. It differs from the GBAS FAS data block in 3.6.4.5.

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3.5.8.4.2.5.1 FAS data block parameters shall be as follows (see Table B-57A):

Operation type: straight-in approach procedure or other operation types.

Coding: 0 = straight-in approach procedure

1 to 15 = spare

SBAS service provider ID: indicates the service provider associated with this FAS data block.

Coding: See Table B-27.

14 = FAS data block is to be used with GBAS only.

15 = FAS data block can be used with any SBAS service provider.

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

Coding: Each character is coded using the lower 6 bits of its IA-5 representation. For each character, b1 is transmitted first, and 2 zero bits are appended after b6, 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 airport ID, the rightmost (first transmitted) character shall be IA-5 “space”.

Runway number: the runway orientation, point in space final approach course, or SBAS circling only procedure course rounded to the nearest 10 degrees and truncated to two characters. Coding: 01 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.

Runway letter: the one-letter designator used, as necessary, to differentiate between parallel runways.

Coding: 0 = no letter
1 = R (right)
2 = C (centre)
3 = L (left)

Approach performance designator: this field is not used by SBAS.

Table B-57A. 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	01 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 1)	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	8	80 to 143.75 m	0.25 m
ΔLength offset	8	0 to 2 032 m	8 m
Horizontal alert limit (HAL)	8	0 to 51.0 m	0.2 m
Vertical alert limit (VAL) (Note 2)	8	0 to 51.0 m	0.2 m
Final approach segment CRC	32	—	—

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

Note 2.— A VAL of 0 indicates that the vertical deviations cannot be used (i.e., a lateral only approach). This does not preclude providing advisory vertical guidance on such approaches, refer to FAA AC 20-138().

Route indicator: a “blank” or the one-letter identifier used to differentiate between multiple procedures to the same runway end.

Note.— Procedures are considered to be different even if they only differ by the missed approach segment.

Coding: The letter is coded using bits b1 through b5 of its IA-5 representation. Bit b1 is transmitted first. Only upper case letters, excluding “I” and “O”, or IA-5 “space” (blank) are used. Blank indicates that there is only one procedure to the runway end. For multiple procedures to the same runway end the route indicator is coded using a letter starting from Z and moving backward in the alphabet for additional procedures.

Reference path data selector (RPDS): this field is not used by SBAS.

Reference path identifier (RPI): four characters used to uniquely designate the reference path. The four characters consist of three alphanumeric characters plus a blank or four alphanumeric characters.

Note.— The best industry practice matches the 2nd and 3rd character encoding to the encoded runway number. The last character is a letter starting from A or a “blank.”

Coding: Each character is coded using bits b1 through b6 of its IA-5 representation. For each character, b1 is transmitted first, and 2 zero bits are appended after b6 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 reference path identifier, the rightmost (first transmitted) character shall be IA-5 “space”.

Note.— The LTP/FTP is a point over which the FAS path passes at a height above the LTP/FTP height specified by the TCH.

LTP/FTP latitude: the latitude of the LTP/FTP point in arc seconds.

Coding: positive value denotes north latitude.

negative value denotes south latitude.

LTP/FTP longitude: the longitude of the LTP/FTP point in arc seconds.

Coding: positive value denotes east longitude.
negative value denotes west longitude.

LTP/FTP height: the height of the LTP/FTP above the WGS-84 ellipsoid.

Coding: This field is coded as an unsigned fixed-point number with an offset of -512 metres. A value of zero in this field places the LTP/FTP 512 metres below the earth ellipsoid.

Note.— *The FPAP is a point at the same height as the LTP/FTP that is used to define the alignment of the approach. The origin of angular deviations in the lateral direction is defined to be 305 metres (1 000 ft) beyond the FPAP along the lateral FAS path. For an approach aligned with the runway, the FPAP is at or beyond the stop end of the runway.*

Δ *FPAP latitude*: the difference of latitude of the runway FPAP from the LTP/FTP in arc seconds.

Coding: Positive value denotes the FPAP latitude north of LTP/FTP latitude.
Negative value denotes the FPAP latitude south of the LTP/FTP latitude.

Δ *FPAP longitude*: the difference of longitude of the runway FPAP from the LTP/FTP in arc seconds.

Coding: Positive value indicates the FPAP longitude east of LTP/FTP longitude.
Negative value indicates the FPAP longitude west of LTP/FTP longitude.

Approach TCH: the height of the FAS path above the LTP/FTP defined in either feet or metres as indicated by the TCH units selector. *Approach TCH units selector*: the units used to describe the TCH.

Coding: 0 = feet
1 = metres

Glide path angle (GPA): the angle of the FAS path with respect to the horizontal plane tangent to the WGS-84 ellipsoid at the LTP/FTP.

Course width: the lateral displacement from the path defined by the FAS at the LTP/FTP at which fullscale deflection of a course deviation indicator is attained.

Coding: This field is coded as an unsigned fixed-point number with an offset of 80 metres. A value of zero in this field indicates a course width of 80 metres at the LTP/FTP.

Δ *Length offset*: the distance from the stop end of the runway to the FPAP.

Coding: 1111 1111 = not provided

HAL: Horizontal alert limit to be used during the approach in meters.

VAL: Vertical alert limit to be used during the approach in meters.

Final approach segment CRC: the 32-bit CRC appended to the end of each FAS data block in order to ensure approach data integrity. The 32-bit final approach segment CRC shall be calculated in accordance with 3.9. The length of the CRC code shall be $k = 32$ bits.

The CRC generator polynomial shall be:

$$G(x) = x^{32} + x^{31} + x^{24} + x^{22} + x^{16} + x^{14} + x^8 + x^7 + x^5 + x^3 + x + 1$$

The CRC information field, $M(x)$, shall be:

$$M(x) = \sum_{i=1}^{288} m_i x^{288-i} = m_1 x^{287} + m_2 x^{286} + \dots + m_{288} x^0$$

$M(x)$ shall be formed from all bits of the associated FAS data block, excluding the CRC. Bits shall be arranged in the order transmitted, such that m_1 corresponds to the LSB of the operation type field, and m_{288} corresponds to the MSB of the Vertical Alert Limit (VAL) field. The CRC shall be ordered such that r_1 is the LSB and r_{32} is the MSB.

3.5.8.4.2.5.2 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.

3.5.8.4.2.5.3 *SBAS FAS data points accuracy*. The survey error of all the FAS data points, relative to WGS-84, shall be less than 0.25 metres vertical and 1 metre horizontal.

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3.6.4.5.1 *FAS data block*

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The CRC information field, $M(x)$, shall be:

$$M(x) = \sum_{i=1}^{272} m_i x^{272-i} = m_1 x^{271} + m_2 x^{270} + \dots + m_{272} x^0$$

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3.6.7.2.4 *Final approach segment data*

3.6.7.2.4.1 *FAS data points accuracy.* The relative survey error between the FAS data points and the GBAS reference point shall be less than 0.25 metres vertical and 0.40 metres horizontal.

~~3.6.7.2.4.2 *SBAS FAS data points accuracy.* For use with SBAS, the survey error of all the FAS data points, relative to WGS 84, shall be less than 0.25 metres vertical and 1 metre horizontal.~~

3.6.7.2.4.3-2 The final approach segment CRC shall be assigned at the time of procedure design, and kept as an integral part of the FAS data block from that time onward.

3.6.7.2.4.4-3 The GBAS shall allow the capability to set the FASVAL and FASLAL for any FAS data block to “1111 1111” to limit the approach to lateral only or to indicate that the approach must not be used, respectively

ATTACHMENT 6D INFORMATION AND MATERIAL FOR GUIDANCE IN THE APPLICATION OF THE GNSS STANDARDS AND RECOMMENDED PRACTICES

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3. Navigation system performance requirements

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3.4 Continuity of service ...

3.4.3.4 For those areas where the system design does not meet the average continuity risk specified in the SARPs, it is still possible to publish procedures. However, specific operational mitigations should be put in place to cope with the reduced continuity expected. For example, flight planning may not be authorized based solely on a GNSS navigation means with such a high average continuity risk.

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4. GNSS core elements

4.1 GPS

Note.— Additional information concerning GPS can be found in the Global Positioning System Standard Positioning Service — Performance Standard, ~~October 2001~~September 2008, and Interface ~~Control Document~~ Specification (ICDIS)-GPS-200E.

4.1.1 The performance standard is based upon the assumption that a representative standard positioning service (SPS) receiver is used. A representative receiver has the following characteristics:

a) designed in accordance with ICDIS-GPS-200E;

b) uses a 5-degree masking angle;

- c) accomplishes satellite position and geometric range computations in the most current realization of the World Geodetic System 1984 (WGS-84) Earth-Centred, Earth-Fixed (ECEF) coordinate system;
- d) generates a position and time solution from data broadcast by all satellites in view;
- e) compensates for dynamic Doppler shift effects on nominal SPS ranging signal carrier phase and C/A code measurements;
- f) excludes GPS marginal and unhealthy satellites from the position solution;
- g) uses up-to-date and internally consistent ephemeris and clock data for all satellites it is using in its position solution; and
- h) loses track in the event that a GPS satellite stops transmitting a trackable signal.

The time transfer accuracy applies to a stationary receiver operating at a surveyed location the data in the broadcast navigation message, which relates GPS SPS time to UTC as maintained by the United States Naval Observatory. A 12-channel receiver will meet performance requirements specified in Chapter 6.3, 6.3.7.3.1.1.1 and 6.3.7.3.1.2. A receiver that is able to track four satellites only (Appendix 6B, 3.1.3.1.2) will not get the full accuracy and availability performance.

Note.—Conditions indicating that a satellite is “healthy”, “marginal” or “unhealthy” can be found in U.S. Department of Defense, “Global Positioning System – Standard Positioning Service – Performance Standard”, 4th Edition, September 2008, Section 2.3.2.

4.1.2 *Position domain Accuracy.* The position domain accuracy is measured with a representative receiver and a measurement interval of 24 hours for any point within the coverage area. The positioning and timing accuracy are for the signal-in-space (SIS) only and do not include such error sources as: ionosphere, troposphere, interference, receiver noise or multipath. The accuracy is derived based on the worst two of 24 satellites being removed from the constellation and a 6-metre constellation RMS SIS user range error (URE).

4.1.3 *Range domain accuracy.* The range domain accuracy standard applies to normal operations, which implies that updated navigation data is uplinked to the satellites on regular basis. Range domain accuracy is conditioned by the satellite indicating a healthy status and transmitting C/A code and does not account for satellite failures outside of the normal operating characteristics. Range domain accuracy limits can be exceeded during satellite failures or anomalies while uploading data to the satellite. Exceedance of the range error limit constitutes a major service failure as described in 4.1.6. The range rate error limit is the maximum for any satellite measured over any 3-second interval for any point within the coverage area. The range acceleration error limit is the maximum for any satellite measured over any 3-second interval for any point within the coverage area. The root-mean-square range error accuracy is the average of the RMS URE of all satellites over any 24 hour interval for any point within the coverage area. Under nominal conditions, all satellites are maintained to the same standards, so it is appropriate for availability modelling purposes to assume that all satellites have a 64-metre RMS SIS user range error (URE). The standards are restricted to range domain errors allocated to space and control segments.

4.1.4 *Availability*. The availability standard applies to normal operations, which implies that updated navigation data is uplinked to the satellites on regular basis. Availability is the percentage of time over any 24-hour interval that the predicted 95 per cent positioning error (due to space and control segment errors) is less than its threshold, for any point within the coverage area. It is based on a 3617- metre horizontal 95 per cent threshold; a 7737-metre vertical 95 per cent threshold; using a representative receiver; and operating within the coverage area over any 24-hour interval. The service availability assumes the worst combination of two satellites out of service a constellation that meets the criteria in 4.1.4.2.

4.1.4.1 *Relationship to augmentation availability*. The availability of ABAS, GBAS and SBAS does not directly relate to the GPS availability defined in Chapter 6.3, 6.3.7.3.1.2. States and operators must evaluate the availability of the augmented system by comparing the augmented performance to the requirements. Availability analysis is based on an assumed satellite constellation and the probability of having a given number of satellites.

4.1.4.2 *Satellite/constellation availability*. Twenty-four operational satellites are available will be maintained on orbit with 0.95 probability (averaged over any day), where a satellite is defined to be operational if it is capable of, but is not necessarily transmitting, a usable ranging signal. At least 21 satellites in the 24 nominal 24 plane/slot positions must be set healthy and must be transmitting a navigation signal with 0.98 probability (yearly averaged/normalized annually). At least 20 satellites in the nominal 24 slot positions must be set healthy and must be transmitting a navigation signal with 0.99999 probability (normalized annually).

4.1.5 *Reliability*. Reliability is the percentage of time over a specified time interval that the instantaneous SPS SIS URE is maintained within the range error limit, at any given point within the coverage area, for all healthy GPS satellites. The reliability standard is based on a measurement interval of one year and the average of daily values within the coverage area. The worst single point average reliability assumes that the total service failure time of 18 hours will be over that particular point (3 failures each lasting 6 hours).

4.1.6 *Major service failure*. A major service failure is defined to be a condition over a time interval during which a healthy GPS satellite's ranging signal error (excluding atmospheric and receiver errors) exceeds the range error limit of 4.42 times the upper bound on the user range accuracy (URA) broadcast by a satellite for longer than the allowable time to alert (10 seconds). As defined in Chapter 3, 3.7.3.1.1.3 a), the range error limit is the larger of: a) 30 m; or b) 4.42 times the URA, not to exceed 150 m. The probability of 1×10^{-5} in Chapter 6.3, 6.3.7.3.1.4 corresponds to a maximum of 3 major service failures for the entire constellation per year assuming a maximum constellation of 32 satellites.

4.1.7 *Continuity*. Continuity for a healthy GPS satellite is the probability that the SPS SIS will continue to be healthy without unscheduled interruption over a specified time interval. Scheduled interruptions which are announced at least 48 hours in advance do not contribute to a loss of continuity.

4.1.7.8 *Coverage*. The SPS supports the terrestrial coverage area, which is from the surface of the earth up to an altitude of 3 000 km.

...

6.6 SBAS final approach segment (FAS) data block

6.6.1 The SBAS final approach segment (FAS) data block for a particular approach procedure is as shown in ~~Table D-1 Appendix 6B, 3.5.8.4.2.5.1 and Table B-57A.~~ It is the same as the GBAS FAS data block defined in Appendix 6B, section 3.6.4.5.1 and Table B-66, with the following exceptions. ~~that the SBAS FAS data block also contains the HAL and VAL to be used for the approach procedure as described in 6.3.4. SBAS user equipment interprets certain fields differently from GBAS user equipment~~

6.6.2 FAS data blocks for SBAS and some GBAS approaches are held within a common on-board database supporting both SBAS and GBAS. Within this database, channel assignments must be unique for each approach and coordinated with civil authorities. States are responsible for providing the FAS data for incorporation into the database. ~~The FAS block for a particular approach procedure is described in Appendix B, 3.6.4.5.1 and Table B-66.~~

6.6.3 An example of the coding of FAS data block for SBAS is provided in Table D-1. This example illustrates the coding of the various application parameters, including the cyclic redundancy check (CRC). The engineering values for the message parameters in the table illustrate the message coding process.

Table D-1. Example of an 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	6	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 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	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 2)	8	0 to 50.8 m	0.2 m
Final approach segment CRC	32	—	—

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

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

DATA CONTENT DESCRIPTION	BITS USED	RANGE OF VALUES	RESOLUTION	CODING RULES (Note 5)	PROCEDURE DESIGN VALUE PROVIDED	FAS DB VALUES USED	BINARY DEFINITION	BINARY REPRESENTATION (Note 1)	HEXADECIMAL REPRESENTATION
Operation Type	4	[0..15]	1	0: Straight-in approach procedure 1..15 : Spare	Straight-In	0	m4..m1	0000	08
SBAS service provider ID	4	[0..15]	1	0 : WAAS 1 : EGNOS 2 : MSAS 3..13 : Spare 14 : GBAS only 15: Any SBAS provider	EGNOS	1	m8..m5	0001	
Airport ID	32	$\alpha_1\alpha_2\alpha_3\alpha_4$	-	$\alpha_1, \alpha_2, \alpha_3 = [0..9, A..Z]$ $\alpha_4 = [<space>, 0..9, A..Z]$ DOUT = ASCII value & 3F	LFBO	LFBO	m40..m33 m32..m25 m24..m17 m16..m9	'L' 00 001100 'F' 00 000110 'B' 00 000010 'O' 00 001111 (Note 2)	F0 40 60 30
Runway number	6	[01..36]	1		14	14	m46..m41	001110	72
Runway letter	2	[0..3]	1	0 : No letter 1 : Right (R) 2 : Centre (C) 3 : Left (L)	R	1	m48m47	01	
Approach performance designator	3	[0..7]	1	Not used by SBAS	0 (default value)	0	m51..m49	000	0B
Route indicator	5	α	-	$\alpha = [<space>, A..Z]$ $\alpha \neq 1$ and $\alpha \neq O$	Z	Z	m56..m52	11010	
Reference path data Selector	8	[0..48]	-	Not used by SBAS	0 (default value)	0	m64..m57	00000000	00
Reference path identifier	32	$\alpha_1\alpha_2\alpha_3\alpha_4$	-	$\alpha_1 = [E, M, W]$ $\alpha_2, \alpha_3 = [0..9]$ $\alpha_4 = [<space>, A, B, D..K, M..Q, S..Z]$	E14A	E14A	m96..m89 m88..m81 m80..m73 m72..m65	'E' 00 000101 '1' 00 110001 '4' 00 110100 'A' 00000001 (Note 2)	80 2C 8C A0
LTP/FTP latitude	32	[-90.0°..90.0°]	0.0005 arcsec	DCONV1 = DIN-> rounding method (Note 3) DCONV2 = DCONV1-> decimal (sec) DOUT = DCONV2 x 2000 N : DOUT S : Two's complement(DOUT)	DIN = 43°38'38.8103"N	DCONV1 = 43°38'38.8105 N DCONV2 = 157118.8105 sec DOUT = 314237621	m128..m121 m120..m113 m112..m105	00010010 10111010 11100010	AD 47 5D 48
LTP/FTP longitude	32	[-180.0°..180.0°]	0.0005 arcsec	DCONV1 = DIN-> rounding method(Note 3) DCONV2 x 2000 E : DOUT W : Two's complement(DOUT)	DIN = 001°20'45.3591" E	DCONV1 = 001°20'45.3590" E DCONV2 = 4845.359 sec DOUT = 9690718	m160..m153 m152..m145 m144..m137 m136..m129	00000000 10010011 11011110 01011110	7A 7B C9 00
LTP/FTP height	16	[-512..6041.5]	0.1m	DCONV = round (DIN, resolution) DOUT = (DIN + 512) x 10	DIN = 148.74m	DCONV = 148.7 DOUT =	m176..m169 m176..m169	00011001 11001111	F3 98

						6607			
Δ FPAP latitude	24	[-1.0°..1.0°]	0.0005 arcsec	DCONV1 = DiN-> rounding method(Note 3) DCONV2 = DCONV1-> decimal (sec) DOUT = DCONV2 x 2000 + ; DOUT - : Two's complement(DOUT)	DIN = 0°01'37.8973"	DCONV1 = 00°01'37.8 975" DCONV2 =-97.8975" DOUT = Two's compleme nt (195795) DOUT =16581421	m192..m185 m192..m185 m184..m177	11111101 00000011	B4 C0 BF
Δ FPAP longitude	24	[-1.0°..1.0°]	0.0005 arcsec	DCONV1 = DIN-> rounding method(Note 3) DCONV2 = DCONV1-> decimal (sec) DOUT = DCONV2 x 2000 + ; DOUT - : Two's complement(DOUT)	DIN = 0°01'41.9329"	DCONV1 = 0°01'41.93 30" DCONV2 = 101.9330" DOUT =203866	m224..m217 m216..m209 m208..m201	00000011 00011100 01011010	5A 38 C0
Approach TCH	15	[0..1638.35m]	[0..3276.7ft]	0.05m 0.1ft DCONV = round(DIN, resolution) m : DOUT = DIN x 20 ft; DOUT = DIN x 10	DIN = 15.00m	DCONV = 15.00m DOUT = 300	m239..m233 m232..m225	0000001 00101100	34 81
Approach TCH Units Selector	1	[0,1]	-	0 : feet1 : meters	m	1	m240	1	
Glide path angle (GPA)	16	[0..90.00°]	0.01°	DCONV = round(DIN, resolution) DOUT = DIN x 100	DIN = 3.00°	DCONV = 3.00° DOUT =300	m256..m249 m248..m241	00000001 00101100	34 80
Course width	8	[80.00m..143. 75m]	0.25m	DCONV = round (DIN, resolution) DOUT = (DCONV - 80) x 4	DIN =105.00m	DCONV = 105.00m DOUT = 100	m264..m257	01100100	26
Δ Length offset	8	[0..2032m]	8m	DCONV = Round (DIN, resolution) DOUT = (integer division of DCONV by 8) + 1 DOUT= 255 : not provided value	DIN =284.86m	DCONV =288m DOUT = 36	m272..m265	00100100	24
Horizontal alert limit (HAL)	8	[0..50.8m]	0.2m	DCONV = round (DIN, resolution) DOUT = DIN * 5	DIN = 40.0m	DCONV =40.0m DOUT = 200	m280..m273	11001000	13
Vertical alert limit (VAL)	8	[0..50.8m]	0.2m	DCONV = round (DIN, resolution) DOUT = Value * 5 DOUT = 0 : vertical deviations cannot be used	DIN = 50.0m	DCONV = 50.0m DOUT = 250	m288..m281	11111010	5F
Final approach segment CRC	32	[0..232-1]		DOUT = remainder(P(x) / Q(x))	-	-	r32..r25 r24..r17 r16..r9 r8..r1	10101110 11000011 0110010 10001111	75 C3 26 F1 (Note 4)

Notes.

1. The rightmost bit is the LSB of the binary parameter value and is the first bit transmitted to the CRC calculator.

2. The two most significant bits of each byte are set to 0 (see bold characters).

3. The rounding methodology is provided in the PANS-OPS (Doc 8168) Volume II.

4. The FAS CRC value is displayed in the order $r_{25}..r_{32}$, $r_{17}..r_{24}$, $r_{9}..r_{16}$, $r_{1}..r_{8}$ where r_i is the i th coefficient of the remainder $R(x)$ as defined in Appendix 6B, 3.9.

5. DIN : raw data value, $DCONV$: converted data value according to coding rules, $DOUT$: coded data value

...

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 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.

...

Table D-13B. GPS tracking constraints for GBAS 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	$(-50x X) + 12 < BW \leq 7 \text{ MHz}$ $24 < BW \leq 7 \text{ MHz}$	$0.1 - \mathbf{0.20} .16$ $0.16 - 0.6$	$0.09 - \mathbf{0.22} .18$ $0.18 - 0.65$	$\leq 600 \text{ ns}$
2	$(-50x X) + 12 < BW \leq (133.33x X) + 2.667 \text{ MHz}$ $(-50x X) + 12 < BW \leq 14 \text{ MHz}$ $7 < BW \leq 14 \text{ MHz}$	$0.07 - 0.085$ $0.085 - 0.1$ $0.1 - 0.24$	$0.63 - 0.094$ $0.077 - 0.11$ $0.09 - 0.26$	$\leq 150 \text{ ns}$
3	$14 < BW \leq 16 \text{ MHz}$ $(133.33x X) + 2.667 < BW \leq 16 \text{ MHz}$ $14 < BW \leq (133.33x X) + 2.667 \text{ MHz}$	$0.1 - 0.24$ $0.085 - 0.1$	$0.09 - 0.26$ $0.077 - 0.11$	$\leq 150 \text{ ns}$

...

— END —

AMENDED REGULATION AFTER REVISION:

CAR-ANS PART 6:

...

6. SPECIFICATIONS FOR RADIO NAVIGATION AIDS

...

6.3.7 Requirements for the Global Navigation Satellite System (GNSS)

...

6.3.7.3.1 GPS Standard Positioning Service (SPS) (L1)

6.3.7.3.1.1 Space and control segment accuracy

Note.— The following accuracy standards do not include atmospheric or receiver errors as described in Attachment 6D, 4.1.2. They apply under the conditions specified in Appendix 6B, 6.3.1.3.1.1.

6.3.7.3.1.1.1 Positioning accuracy. The GPS SPS position errors shall not exceed the following limits

	Global average 95% of the time	Worst site 95% of the time
Horizontal position error	9 m (30 ft)	17 m (56 ft)
Vertical position error	15 m (49 ft)	37 m (121 ft)

6.3.7.3.1.1.2 Time transfer accuracy. The GPS SPS time transfer errors shall not exceed 40 nanoseconds 95 per cent of the time.

6.3.7.3.1.1.3 Range domain accuracy. The range domain error shall not exceed the following limits:

- a) range error of any satellite 30 m (100 ft) with reliability specified in 6.3.7.3.1.3;
- b) 95th percentile range rate error of any satellite —0.006 m (0.02 ft) per second (global average);
- c) 95th percentile range acceleration error of any satellite —0.002 m (0.006 ft) per second-squared (global average); and
- d) 95th percentile range error for any satellites over all time differences between time of data generation and time of use of data — 7.8 m (26 ft) (global average).

6.3.7.3.1.2 Availability. The GPS SPS availability shall be as follows:

≥99 per cent horizontal service availability, average location (17 m 95 per cent threshold)
≥99 per cent vertical service availability, average location (37 m 95 per cent threshold)
≥90 per cent horizontal service availability, worst-case location (17 m 95 per cent threshold)
≥90 per cent vertical service availability, worst-case location (37 m 95 per cent threshold)

6.3.7.3.1.3 *Reliability.* The GPS SPS reliability shall be within the following limits:

- a) reliability — at least 99.94 per cent (global average); and
- b) reliability — at least 99.79 per cent (worst single point average).

6.3.7.3.1.4 *Probability of major service failure.* The probability that the user range error (URE) of any satellite will exceed 4.42 times the upper bound on the user range accuracy (URA) broadcast by that satellite without an alert received at the user receiver antenna within 10 seconds shall not exceed 1×10^{-5} per hour.

Note.— The different alert indications are described in U.S. Department of Defense, “Global Positioning System – Standard Positioning Service – Performance Standard”, 4th Edition, September 2008, Section 2.3.4.

6.3.7.3.1.5 *Continuity.* The probability of losing GPS SPS signal-in-space (SIS) availability from a slot of the nominal 24-slot constellation due to unscheduled interruption shall not exceed 2×10^{-4} per hour.

6.3.7.3.1.6 *Coverage.* The GPS SPS shall cover the surface of the earth up to an altitude of 3 000 kilometres.

Note.— Guidance material on GPS accuracy, availability, reliability and coverage is given in Attachment 6D, 4.1.

6.3.7.3.1.7 *Radio frequency (RF) characteristics*

Note.— Detailed RF characteristics are specified in Appendix 6B, 3.1.1.1.

6.3.7.3.1.7.1 *Carrier frequency.* Each GPS satellite shall broadcast an SPS signal at the carrier frequency of 1 575.42 MHz (GPS L1) using code division multiple access (CDMA).

Note.— A new civil frequency will be added to the GPS satellites and will be offered by the United States for critical safety-of-life applications. SARPs for this signal may be developed at a later date.

6.3.7.3.1.7.2 *Signal spectrum.* The GPS SPS signal power shall be contained within a ± 12 MHz band (1 563.42 –1 587.42 MHz) centred on the L1 frequency.

6.3.7.3.1.7.3 *Polarization.* The transmitted RF signal shall be right-hand (clockwise) circularly polarized.

6.3.7.3.1.7.4 *Signal power level.* Each GPS satellite shall broadcast SPS 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 –160 dBW to –153 dBW for all antenna orientations orthogonal to the direction of propagation.

6.37.3.1.7.5 *Modulation.* The SPS L1 signal shall be bipolar phase shift key (BPSK) modulated with a pseudo random noise (PRN) 1.023 MHz coarse/acquisition (C/A) code. The C/A code sequence shall be repeated each millisecond. The transmitted PRN code sequence shall be the Modulo-2 addition of a 50 bits per second navigation message and the C/A code.

6.3.7.3.1.8 *GPS time.* GPS time shall be referenced to UTC (as maintained by the U.S. Naval Observatory).

6.3.7.3.1.9 *Coordinate system.* The GPS coordinate system shall be WGS-84.

6.3.7.3.1.10 *Navigation information.* The navigation data transmitted by the satellites shall include the necessary information to determine:

...
APPENDIX 6B. TECHNICAL SPECIFICATIONS FOR THE GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)
...

3.1.3.1 *GNSS (GPS) RECEIVER*

3.1.3.1.1 *Satellite exclusion.* The receiver shall exclude any marginal or unhealthy satellite.

Note.— Conditions indicating that a satellite is “healthy”, “marginal” or “unhealthy” can be found in U.S. Department of Defense, “Global Positioning System – Standard Positioning Service – Performance Standard”, 4th Edition, September 2008, Section 2.3.2.

...
3.5.7.1 *GENERAL*

...
3.5.7.1.3 *“Do Not Use”.* SBAS shall broadcast a “Do Not Use” message (Type 0 message) when necessary to inform users not to use the SBAS satellite ranging function and its broadcast data.

3.5.7.1.4 The Doppler shift in the GEO satellite signal seen at any fixed location within the GEO footprint for any GEO shall not exceed ± 450 Hz.

Note .— This maximum Doppler shift corresponds approximately to the maximum GEO satellite orbit inclination that can be supported by the coding ranges for Type 9 and Type 17 messages

3.5.7.1.5 *Geostationary orbit (GEO) ranging function parameters.* Each SBAS satellite shall broadcast geostationary orbit (GEO) ranging function parameters (defined in 3.5.4.2).

Note — It is necessary to broadcast geostationary orbit ranging function parameters even when a ranging function is not provided, so that airborne receivers may implement a positive identification of the broadcasting SBAS satellite. When ranging is not provided, the accuracy of the Type 17 data (and Type 9 data) only needs to support the acquisition of the satellite.

3.5.7.1.5.1 The error in the Doppler shift of a GEO satellite derived from any Type 9 message that has not timed out, with respect to the true GEO Doppler shift seen at any fixed location within the GEO footprint, shall not exceed ± 210 Hz.

3.5.7.1.6 *Almanac data.* Each SBAS satellite shall broadcast almanac data (defined in 3.5.4.3) for all SBAS satellites of the same service provider-

3.5.7.1.6.1 The error in the estimated position of the satellite derived from any Type 17 message broadcast within the previous 15 minutes, with respect to the true satellite position, shall not exceed 3,000 km.

3.5.7.1.6.2 The separation distance between the estimated position of the satellite derived from any Type 17 message broadcast within the previous 15 minutes and the position of the satellite derived from the GEO ranging parameters in any Type 9 message that has not timed out shall not exceed 200 km.

3.5.7.1.6.3 The error in the Doppler shift of a GEO satellite derived from any Type 17 message broadcast within the previous 15 minutes, with respect to the true GEO Doppler shift seen at any fixed location within the GEO footprint, shall not exceed ± 210 Hz.

3.5.7.1.6.4 SBAS shall not broadcast almanac data for any SBAS satellite from a different service provider for which the position estimated from the almanac data broadcast within the previous 15 minutes would be within 200 km of the position of any of its own GEOs as derived from the GEO ranging parameters from any Type 9 message that has not timed out

3.5.7.1.6.5 Where the estimated position of a GEO satellite providing a ranging function, derived from the Type 17 message broadcast within the previous 15 minutes, is within 200 km of the position of another GEO satellite of the same service provider, derived from a Type 9 message for this GEO that has not timed out, the GEO UDRE value shall be set sufficiently large to account for the possibility that a user could misidentify the PRN of the GEO providing the ranging function.

3.5.7.1.6.6 The health and status parameter shall indicate the satellite status and the service provider identifier, as defined in 3.5.4.3.

3.5.7.1.6.7 Unused almanac slots in Type 17 messages shall be coded with a PRN code number of "0".

3.5.7.1.6.8 The service provider shall ensure the correctness of the service provider ID broadcast in any almanac. ...

...

Table B-54. Data broadcast intervals and supported functions

Data type	Maximum broadcast interval	Ranging	GNSS satellite status	Basic differential correction	Precise differential correction	Associated message types
...						
GEO ranging function data	120 s	R	R	R	R	9
...						

Notes.— 1. “R” indicates that the data must be broadcast to support the function

...

3.5.7.3 *GNSS satellite status function*. If an SBAS provides a satellite status function, it shall also comply with the requirements contained in this section.

Note — An SBAS may be able to provide integrity on some GPS satellites that are designated either marginal or unhealthy.

...

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 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.

3.5.8.1.1 *GEO satellite acquisition*. The receiver shall be able to acquire and track GEO satellites for which a stationary receiver at the user receiver location would experience a Doppler shift as large as ± 450 Hz.

3.5.8.1.2 *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 and all data from that satellite shall be discarded for at least 1 minute. 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. For GLONASS satellites, the receiver shall apply long-term corrections only if the time of reception (t_r) of the GLONASS ephemeris is inside the following IOD validity interval, as defined in 3.5.4.4.1:

$$t_{LT} - L - V \leq t_r \leq t_{LT} - L$$

Note 1.— For SBAS satellites, there is no mechanism that links GEO ranging function data (Type 9 message) and long-term corrections.

Note 2.— This requirement does not imply that the receiver has to stop tracking the SBAS satellite.

3.5.8.1.2.1 *SBAS satellite identification*. Upon acquisition or re-acquisition of an SBAS satellite, the receiver shall not use SBAS satellite data unless the calculated separation between the satellite position derived from its GEO ranging function parameters and the satellite position derived from the almanac message most recently received from the same service provider within the last 15 minutes is less than 200 km.

Note. — This check ensures that a receiver will not mistake one SBAS satellite for another due to cross-correlation during acquisition or re-acquisition.

3.5.8.1.2.2 The receiver shall use integrity or correction data only if the IODP associated with that data matches the IODP associated with the PRN mask.

3.5.8.1.2.3 The receiver shall use SBAS-provided ionospheric data (IGP vertical delay estimate and GIVEIi) only if the IODik associated with that data in a Type 26 message

matches the IODIk associated with the relevant IGP band mask transmitted in a Type 18 message.

3.5.8.1.2.4 The receiver shall use the most recently received integrity data for which the IODFj equals 3 or the IODFj matches the IODFj associated with the fast correction data being applied (if corrections are provided).

3.5.8.1.2.5 The receiver shall apply any regional degradation to the σ_{2i} , $\delta UDRE$ as defined by a Type 27 service message. If a Type 27 message with a new IODS indicates a higher $\delta UDRE$ for the user location, the higher $\delta UDRE$ shall be applied immediately. A lower $\delta UDRE$ in a new Type 27 message shall not be applied until the complete set of messages with the new IODS has been received.

3.5.8.1.2.6 The receiver shall apply satellite-specific degradation to the $\sigma_{i, UDRE 2}$ as defined by a Type 28 clockephemeris covariance matrix message. The $\delta UDRE$ derived from a Type 28 message shall be applied immediately.

3.5.8.1.2.7 In the event of a loss of four successive SBAS messages, the receiver shall no longer support SBAS-based precision approach or APV operations.

3.5.8.1.2.8 The receiver shall not use a broadcast data parameter after it has timed out as defined in Table B-56.

3.5.8.1.2.9 The receiver shall not use a fast correction if Δt for the associated RRC exceeds the time-out interval for fast corrections, or if the age of the RRC exceeds $8\Delta t$.

3.5.8.1.2.10 The calculation of the RRC shall be reinitialized if a “Do Not Use” or “Not Monitored” indication is received for that satellite.

3.5.8.1.2.11 For SBAS-based precision approach or APV operations, the receiver shall only use satellites with elevation angles at or above 5 degrees.

3.5.8.1.2.12 The receiver shall no longer support SBAS-based precision approach or APV operation using a particular satellite if the $UDRE_{Li}$ received is greater than or equal to 12.

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3.5.8.2.4 *Almanac data*

3.5.8.2.4.1 The almanac data provided by the SBAS shall be used for acquisition.

Note.— Health and status information is provided in the GEO almanac data does not override or invalidate data provided in other SBAS messages. The use of bits 0 to 2 by airborne equipment is optional; there are no requirements covering their usage.

3.5.8.3 *GNSS satellite status function.* The receiver shall exclude satellites from the position solution if they are identified as “Do Not Use” by SBAS. If SBAS-provided integrity is used, the receiver shall not be required to exclude GPS satellites based on the GPS-provided ephemeris health flag as required in 3.1.3.1.1 or to exclude GLONASS satellites based on GLONASS-provided ephemeris health flag as required in 3.2.3.1.1.

Note 1.— In the case of a satellite designated marginal or unhealthy by the core satellite constellation(s) health flag, SBAS may be able to broadcast ephemeris and clock corrections that will allow the user to continue using the satellite.

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3.5.8.4.2 Precision approach and APV operations

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3.5.8.4.2.5 The parameters that define the approach path for a single precision approach or APV shall be contained in the FAS data block.

Note 1.— 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.

Note 2.— 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 6D, 6.6. It differs from the GBAS FAS data block in 3.6.4.5.

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3.5.8.4.2.5.1 FAS data block parameters shall be as follows (see Table B-57A):

Operation type: straight-in approach procedure or other operation types.

Coding: 0 = straight-in approach procedure
1 to 15 = spare

SBAS service provider ID: indicates the service provider associated with this FAS data block.

Coding: See Table B-27.

14 = FAS data block is to be used with GBAS only.

15 = FAS data block can be used with any SBAS service provider.

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

Coding: Each character is coded using the lower 6 bits of its IA-5 representation. For each character, b1 is transmitted first, and 2 zero bits are appended after b6, 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 airport ID, the rightmost (first transmitted) character shall be IA-5 “space”.

Runway number: the runway orientation, point in space final approach course, or SBAS circling only procedure course rounded to the nearest 10 degrees and truncated to two characters. *Coding:* 01 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.

Runway letter: the one-letter designator used, as necessary, to differentiate between parallel runways.

Coding: 0 = no letter
 1 = R (right)
 2 = C (centre)
 3 = L (left)

Approach performance designator: this field is not used by SBAS.

Table B-57A. 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	01 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 1)	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	8	80 to 143.75 m	0.25 m
ΔLength offset	8	0 to 2 032 m	8 m
Horizontal alert limit (HAL)	8	0 to 51.0 m	0.2 m
Vertical alert limit (VAL) (Note 2)	8	0 to 51.0 m	0.2 m
Final approach segment CRC	32	—	—

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

Note 2.— A VAL of 0 indicates that the vertical deviations cannot be used (i.e., a lateral only approach). This does not preclude providing advisory vertical guidance on such approaches, refer to FAA AC 20-138().

Route indicator: a “blank” or the one-letter identifier used to differentiate between multiple procedures to the same runway end.

Note.— Procedures are considered to be different even if they only differ by the missed approach segment.

Coding: The letter is coded using bits b1 through b5 of its IA-5 representation. Bit b1 is transmitted first. Only upper case letters, excluding “I” and “O”, or IA-5 “space” (blank) are used. Blank indicates that there is only one procedure to the runway end. For multiple procedures to the same runway end the route indicator is coded using a letter starting from Z and moving backward in the alphabet for additional procedures.

Reference path data selector (RPDS): this field is not used by SBAS.

Reference path identifier (RPI): four characters used to uniquely designate the reference path. The four characters consist of three alphanumeric characters plus a blank or four alphanumeric characters.

Note.— The best industry practice matches the 2nd and 3rd character encoding to the encoded runway number. The last character is a letter starting from A or a “blank.”

Coding: Each character is coded using bits b1 through b6 of its IA-5 representation. For each character, b1 is transmitted first, and 2 zero bits are appended after b6 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 reference path identifier, the rightmost (first transmitted) character shall be IA-5 “space”.

Note.— The LTP/FTP is a point over which the FAS path passes at a height above the LTP/FTP height specified by the TCH.

LTP/FTP latitude: the latitude of the LTP/FTP point in arc seconds.

Coding: positive value denotes north latitude.
negative value denotes south latitude.

LTP/FTP longitude: the longitude of the LTP/FTP point in arc seconds.

Coding: positive value denotes east longitude.
negative value denotes west longitude.

LTP/FTP height: the height of the LTP/FTP above the WGS-84 ellipsoid.

Coding: This field is coded as an unsigned fixed-point number with an offset of –512 metres. A value of zero in this field places the LTP/FTP 512 metres below the earth ellipsoid.

Note.— The FPAP is a point at the same height as the LTP/FTP that is used to define the alignment of the approach. The origin of angular deviations in the lateral direction is defined to be 305 metres (1 000 ft) beyond the FPAP along the lateral FAS path. For an approach aligned with the runway, the FPAP is at or beyond the stop end of the runway.

ΔFPAP latitude: the difference of latitude of the runway FPAP from the LTP/FTP in arc seconds.

Coding: Positive value denotes the FPAP latitude north of LTP/FTP latitude.

Negative value denotes the FPAP latitude south of the LTP/FTP latitude.

ΔFPAP longitude: the difference of longitude of the runway FPAP from the LTP/FTP in arc seconds.

Coding: Positive value indicates the FPAP longitude east of LTP/FTP longitude.
Negative value indicates the FPAP longitude west of LTP/FTP longitude.

Approach TCH: the height of the FAS path above the LTP/FTP defined in either feet or metres as indicated by the TCH units selector. *Approach TCH units selector*: the units used to describe the TCH.

Coding: 0 = feet
1 = metres

Glide path angle (GPA): the angle of the FAS path with respect to the horizontal plane tangent to the WGS-84 ellipsoid at the LTP/FTP.

Course width: the lateral displacement from the path defined by the FAS at the LTP/FTP at which fullscale deflection of a course deviation indicator is attained.

Coding: This field is coded as an unsigned fixed-point number with an offset of 80 metres. A value of zero in this field indicates a course width of 80 metres at the LTP/FTP.

ΔLength offset: the distance from the stop end of the runway to the FPAP.

Coding: 1111 1111 = not provided

HAL: Horizontal alert limit to be used during the approach in meters.

VAL: Vertical alert limit to be used during the approach in meters.

Final approach segment CRC: the 32-bit CRC appended to the end of each FAS data block in order to ensure approach data integrity. The 32-bit final approach segment CRC shall be calculated in accordance with 3.9. The length of the CRC code shall be $k = 32$ bits.

The CRC generator polynomial shall be:

$$G(x) = x^{32} + x^{31} + x^{24} + x^{22} + x^{16} + x^{14} + x^8 + x^7 + x^5 + x^3 + x + 1$$

The CRC information field, $M(x)$, shall be:

$$M(x) = \sum_{i=1}^{288} m_i x^{288-i} = m_1 x^{287} + m_2 x^{286} + \dots + m_{288} x^0$$

$M(x)$ shall be formed from all bits of the associated FAS data block, excluding the CRC. Bits shall be arranged in the order transmitted, such that m_1 corresponds to the LSB of the operation type field, and m_{288} corresponds to the MSB of the Vertical Alert Limit (VAL) field. The CRC shall be ordered such that r_1 is the LSB and r_{32} is the MSB.

3.5.8.4.2.5.2 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. 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.

3.5.8.4.2.5.3 *SBAS FAS data points accuracy.* The survey error of all the FAS data points, relative to WGS-84, shall be less than 0.25 metres vertical and 1 metre horizontal.

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3.6.4.5.1 *FAS data block*

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The CRC information field, $M(x)$, shall be:

$$M(x) = \sum_{i=1}^{272} m_i x^{272-i} = m_1 x^{271} + m_2 x^{270} + \dots + m_{272} x^0$$

...

3.6.7.2.4 *Final approach segment data*

3.6.7.2.4.1 *FAS data points accuracy.* The relative survey error between the FAS data points and the GBAS reference point shall be less than 0.25 metres vertical and 0.40 metres horizontal.

3.6.7.2.4.2 The final approach segment CRC shall be assigned at the time of procedure design, and kept as an integral part of the FAS data block from that time onward.

3.6.7.2.4.3 The GBAS shall allow the capability to set the FASVAL and FASLAL for any FAS data block to “1111 1111” to limit the approach to lateral only or to indicate that the approach must not be used, respectively

ATTACHMENT 6D .INFORMATION AND MATERIAL FOR GUIDANCE IN THE APPLICATION OF THE GNSS STANDARDS AND RECOMMENDED PRACTICES

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3. Navigation system performance requirements

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3.4 Continuity of service ...

3.4.3.4 For those areas where the system design does not meet the average continuity risk specified in the SARPs, it is still possible to publish procedures. However, specific operational mitigations should be put in place to cope with the reduced continuity expected. For example, flight planning may not be authorized based solely on a GNSS navigation means with such a high average continuity risk.

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4. GNSS core elements

4.1 GPS

Note.— Additional information concerning GPS can be found in the Global Positioning System Standard Positioning Service — Performance Standard, September 2008, and Interface Specification (S)-GPS-200E.

4.1.1 The performance standard is based upon the assumption that a representative standard positioning service (SPS) receiver is used. A representative receiver has the following characteristics:

- a) designed in accordance with IS-GPS-200E;
- b) uses a 5-degree masking angle;
- c) accomplishes satellite position and geometric range computations in the most current realization of the World Geodetic System 1984 (WGS-84) Earth-Centred, Earth-Fixed (ECEF) coordinate system;
- d) generates a position and time solution from data broadcast by all satellites in view;
- e) compensates for dynamic Doppler shift effects on nominal SPS ranging signal carrier phase and C/A code measurements;
- f) excludes marginal and unhealthy satellites from the position solution;
- g) uses up-to-date and internally consistent ephemeris and clock data for all satellites it is using in its position solution; and
- h) loses track in the event that a GPS satellite stops transmitting a trackable signal.

The time transfer accuracy applies to data in the broadcast navigation message, which relates GPS SPS time to UTC as maintained by the United States Naval Observatory. A 12-channel receiver will meet performance requirements specified in Chapter 6.3, 6.3.7.3.1.1.1 and 6.3.7.3.1.2. A receiver that is able to track four satellites only (Appendix 6B, 3.1.3.1.2) will not get the full accuracy and availability performance.

Note.— Conditions indicating that a satellite is “healthy”, “marginal” or “unhealthy” can be found in U.S. Department of Defense, “Global Positioning System – Standard Positioning Service – Performance Standard”, 4th Edition, September 2008, Section 2.3.2.

4.1.2 *Position domain accuracy.* The position domain accuracy is measured with a representative receiver and a measurement interval of 24 hours for any point within the coverage area. The positioning and timing accuracy are for the signal-in-space (SIS) only and do not include such error sources as: ionosphere, troposphere, interference, receiver noise or multipath.

4.1.3 *Range domain accuracy.* The range domain accuracy standard applies to normal operations, which implies that updated navigation data is uplinked to the satellites on regular basis. Range domain accuracy is conditioned by the satellite indicating a healthy status and transmitting C/A code and does not account for satellite failures outside of the normal operating characteristics. Range domain accuracy limits can be exceeded during satellite

failures or anomalies while uploading data to the satellite. The range rate error limit is the maximum for any satellite measured over any 3-second interval for any point within the coverage area. The range acceleration error limit is the maximum for any satellite measured over any 3-second interval for any point within the coverage area. Under nominal conditions, all satellites are maintained to the same standards, so it is appropriate for availability modelling purposes to assume that all satellites have a 4-metre RMS SIS user range error (URE). The standards are restricted to range domain errors allocated to space and control segments.

4.1.4 *Availability*. The availability standard applies to normal operations, which implies that updated navigation data is uplinked to the satellites on regular basis. Availability is the percentage of time over any 24-hour interval that the predicted 95 per cent positioning error (due to space and control segment errors) is less than its threshold, for any point within the coverage area. It is based on a 3617-metre horizontal 95 per cent threshold; a 37-metre vertical 95 per cent threshold; using a representative receiver; and operating within the coverage area over any 24-hour interval. The service availability assumes service a constellation that meets the criteria in 4.1.4.2.

4.1.4.1 *Relationship to augmentation availability*. The availability of ABAS, GBAS and SBAS does not directly relate to the GPS availability defined in Chapter 6.3, 6.3.7.3.1.2. States and operators must evaluate the availability of the augmented system by comparing the augmented performance to the requirements. Availability analysis is based on an assumed satellite constellation and the probability of having a given number of satellites.

4.1.4.2 *Satellite/constellation availability*. Twenty-four operational satellites are available will be maintained on orbit with 0.95 probability (averaged over any day), where a satellite is defined to be operational if it is capable of, but is not necessarily transmitting, a usable ranging signal. At least 21 satellites in the nominal 24 slot positions must be set healthy and must be transmitting a navigation signal with 0.98 probability (annually). At least 20 satellites in the nominal 24 slot positions must be set healthy and must be transmitting a navigation signal with 0.99999 probability (normalized annually).

4.1.5 *Reliability*. Reliability is the percentage of time over a specified time interval that the instantaneous SPS SIS URE is maintained within the range error limit, at any given point within the coverage area, for all healthy GPS satellites. The reliability standard is based on a measurement interval of one year and the average of daily values within the coverage area. The worst single point average reliability assumes that the total service failure time of 18 hours will be over that particular point (3 failures each lasting 6 hours).

4.1.6 *Major service failure*. A major service failure is defined to be a condition over a time interval during which a healthy GPS satellite's ranging signal error (excluding atmospheric and receiver errors) exceeds the range error limit of 4.42 times the upper bound on the user range accuracy (URA) broadcast by a satellite for longer than the allowable time to alert (10 seconds). The probability of 1×10^{-5} in Chapter 6.3, 6.3.7.3.1.4 corresponds to a maximum of 3 major service failures for the entire constellation per year assuming a maximum constellation of 32 satellites.

4.1.7 *Continuity*. Continuity for a healthy GPS satellite is the probability that the SPS SIS will continue to be healthy without unscheduled interruption over a specified time interval. Scheduled interruptions which are announced at least 48 hours in advance do not contribute to a loss of continuity.

4.1.8 *Coverage*. The SPS supports the terrestrial coverage area, which is from the surface of the earth up to an altitude of 3 000 km.

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6.6 SBAS final approach segment (FAS) data block

6.6.1 The SBAS final approach segment (FAS) data block for a particular approach procedure is as shown in Appendix 6B, 3.5.8.4.2.5.1 and Table B-57A. It is the same as the GBAS FAS data block defined in Appendix 6B, section 3.6.4.5.1 and Table B-66, with the following exceptions. The SBAS FAS data block also contains the HAL and VAL to be used for the approach procedure as described in 6.3.4. SBAS user equipment interprets certain fields differently from GBAS user equipment

6.6.2 FAS data blocks for SBAS and some GBAS approaches are held within a common on-board database supporting both SBAS and GBAS. Within this database, channel assignments must be unique for each approach and coordinated with civil authorities. States are responsible for providing the FAS data for incorporation into the database.

6.6.3 An example of the coding of FAS data block for SBAS is provided in Table D-1. This example illustrates the coding of the various application parameters, including the cyclic redundancy check (CRC). The engineering values for the message parameters in the table illustrate the message coding process.

Table D-1. Example of an SBAS FAS data block

DATA CONTENT DESCRIPTION	BITS USED	RANGE OF VALUES	RESOLUTION	CODING RULES (Note 5)	PROCEDURE DESIGN VALUE PROVIDED	FAS DB VALUES USED	BINARY DEFINITION	BINARY REPRESENTATION (Note 1)	HEXADECIMAL REPRESENTATION
Operation Type	4	[0..15]	1	0: Straight-in approach procedure 1..15 : Spare	Straight-In	0	m4..m1	0000	08
SBAS service provider ID	4	[0..15]	1	0 : WAAS 1 : EGNOS 2 : MSAS 3..13 : Spare 14 : GBAS only 15: Any SBAS provider	EGNOS	1	m8..m5	0001	
Airport ID	32	$\alpha_1\alpha_2\alpha_3\alpha_4$	-	$\alpha_1, \alpha_2, \alpha_3 = [0..9, A..Z]$ $\alpha_4 = [<space>, 0..9, A..Z]$ DOUT = ASCII value & 3F	LFBO	LFBO	m40..m33 m32..m25 m24..m17 m16..m9	'L' 00 001100 'F' 00 000110 'B' 00 000010 'O' 00 001111 (Note 2)	F0 40 60 30
Runway number	6	[01..36]	1	—	14	14	m46..m41	001110	72
Runway letter	2	[0..3]	1	0 : No letter 1 : Right (R) 2 : Centre (C) 3 : Left (L)	R	1	m48m47	01	
Approach performance designator	3	[0..7]	1	Not used by SBAS	0 (default value)	0	m51..m49	000	0B
Route indicator	5	α	-	$\alpha = [<space>, A..Z]$ $\alpha \neq 1$ and $\alpha \neq 0$	Z	Z	m56..m52	11010	
Reference path data Selector	8	[0..48]	-	Not used by SBAS	0 (default value)	0	m64..m57	00000000	00
Reference path identifier	32	$\alpha_1\alpha_2\alpha_3\alpha_4$	-	$\alpha_1 = [E, M, W]$ $\alpha_2, \alpha_3 = [0..9]$	E14A	E14A	m96..m89 m88..m81	'E' 00 000101 '1' 00 110001	80 2C 8C A0

				$\alpha 4 = [\text{<space>, A, B, D..K, M..Q, S..Z}]$			m80..m73 m72..m65	'4' 00 110100 'A' 00000001 (Note 2)	
LTP/FTP latitude	32	[-90.0°..90.0°]	0.0005 arcsec	DCONV1 = DIN-> rounding method (Note 3) DCONV2 = DCONV1-> decimal (sec) DOUT = DCONV2 x 2000 N : DOUT S : Two's complement(DOUT)	DIN = 43°38'38.8103"N	DCONV1 = 43°38'38.8 105 N DCONV2 = 157118.81 05 sec DOUT = 314237621	m128..m121 m120..m113 m112..m105	00010010 10111010 11100010	AD 47 5D 48
LTP/FTP longitude	32	[-180.0°..180.0°]	0.0005 arcsec	DCONV1 = DIN-> rounding method(Note 3) DCONV2 x 2000 E : DOUT W : Two's complement(DOUT)	DIN =001°20'45.3591" E	DCONV1 = 001°20' 45.3590" E DCONV2 = 4845.359 sec DOUT = 9690718	m160..m153 m152..m145 m144..m137 m136..m129	00000000 10010011 11011110 01011110	7A 7B C9 00
LTP/FTP height	16	[-512..6041.5]	0.1m	DCONV = round (DIN, resolution) DOUT = (DIN + 512) x 10	DIN =148.74m	DCONV = 148.7 DOUT = 6607	m176..m169 m176..m169	00011001 11001111	F3 98
ΔFPAP latitude	24	[-1.0°..1.0°]	0.0005 arcsec	DCONV1 = DiN-> rounding method(Note 3) DCONV2 = DCONV1-> decimal (sec) DOUT = DCONV2 x 2000 + : DOUT - : Two's complement(DOUT)	DIN =- 0°01'37.8973"	DCONV1 = - 00°01'37.8 975" DCONV2 =-97.8975" DOUT = Two's compleme nt (195795) DOUT =16581421	m192..m185 m192..m185 m184..m177	11111101 00000011	B4 C0 BF
ΔFPAP longitude	24	[-1.0°..1.0°]	0.0005 arcsec	DCONV1 = DIN-> rounding method(Note 3) DCONV2 = DCONV1-> decimal (sec) DOUT = DCONV2 x 2000 + : DOUT - : Two's complement(DOUT)	DIN = 0°01'41.9329"	DCONV1 = 0°01'41.93 30" DCONV2 = 101.9330" DOUT =203866	m224..m217 m216..m209 m208..m201	00000011 00011100 01011010	5A 38 C0
Approach TCH	15	[0..1638.35m]	[0..3276.7ft]	0.05m 0.1ft DCONV = round(DIN, resolution) m : DOUT = DIN x 20 ft: DOUT = DIN x 10	DIN = 15.00m	DCONV = 15.00m DOUT = 300	m239..m233 m232..m225	0000001 00101100	34 81
Approach TCH Units Selector	1	[0,1]	-	0 : feet1 : meters	m	1	m240	1	
Glide path angle (GPA)	16	[0..90.00°]	0.01°	DCONV = round(DIN, resolution) DOUT = DIN x 100	DIN = 3.00°	DCONV = 3.00° DOUT =300	m256..m249 m248..m241	00000001 00101100	34 80
Course width	8	[80.00m..143. 75m]	0.25m	DCONV = round (DIN, resolution) DOUT = (DCONV - 80) x 4	DIN =105.00m	DCONV = 105.00m DOUT =	m264..m257	01100100	26

						100			
ΔLength offset	8	[0..2032m]	8m	DCONV = Round (DIN, resolution) DOUT = (integer division of DCONV by 8) + 1 DOUT= 255 : not provided value	DIN =284.86m	DCONV =288m DOUT = 36	m272..m265	00100100	24
Horizontal alert limit (HAL)	8	[0..50.8m]	0.2m	DCONV = round (DIN, resolution) DOUT = DIN * 5	DIN = 40.0m	DCONV =40.0m DOUT = 200	m280..m273	11001000	13
Vertical alert limit (VAL)	8	[0..50.8m]	0.2m	DCONV = round (DIN, resolution) DOUT = Value * 5 DOUT = 0 : vertical deviations cannot be used	DIN = 50.0m	DCONV = 50.0m DOUT = 250	m288..m281	11111010	5F
Final approach segment CRC	32	[0..232-1]		DOUT = remainder(P(x) / Q(x))	-	-	r32..r25 r24..r17 r16..r9 r8..r1	10101110 11000011 0110010 10001111	75 C3 26 F1 (Note 4)

Notes.

1. The rightmost bit is the LSB of the binary parameter value and is the first bit transmitted to the CRC calculator.
2. The two most significant bits of each byte are set to 0 (see bold characters).
3. The rounding methodology is provided in the PANS-OPS (Doc 8168) Volume II.
4. The FAS CRC value is displayed in the order r25..r32, r17..r24, r9..r16, r1..r8 where ri is the ith coefficient of the remainder R(x) as defined in Appendix 6B, 3.9.
5. DIN : raw data value, DCONV : converted data value according to coding rules, DOUT : coded data value.

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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 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.

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Table D-13B. GPS tracking constraints for GBAS 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	$(-50x X) + 12 < BW \leq 7 \text{ MHz}$ $4 < BW \leq 7 \text{ MHz}$	0.1 – 0.16 0.16 – 0.6	0.09 – 0.18 0.14 – 0.65	$\leq 600 \text{ ns}$
2	$(-50x X) + 12 < BW \leq (133.33x X) + 2.667 \text{ MHz}$ $(-50x X) + 12 < BW \leq 14 \text{ MHz}$ $7 < BW \leq 14 \text{ MHz}$	0.07 – 0.085 0.085 – 0.1 0.1 – 0.24	0.063 – 0.094 0.077 – 0.11 0.09 – 0.26	$\leq 150 \text{ ns}$
3	$14 < BW \leq 16 \text{ MHz}$ $14 < BW \leq (133.33x X) + 2.667 \text{ MHz}$	0.1 – 0.24 0.085 – 0.1	0.09 – 0.26 0.077 – 0.11	$\leq 150 \text{ ns}$

— END —

- i. **Separability Clause.** - If, for any reason, any provision of this Memorandum Circular is declared invalid or unconstitutional, the other part or parts thereof which are not affected thereby shall continue to be in full force and effect.
- ii. **Repealing Clause.** - All orders, rules, regulations and issuances, or parts thereof which are inconsistent with this Memorandum Circular are hereby repealed, superseded or modified accordingly.
- iii. **Determination of changes.** – To highlight the amendments and/or revisions in the Memorandum Circular, the deleted text shall be shown with strikethrough and the new inserted text shall be highlighted with grey shading, as illustrated below:
 1. Text deleted: ~~Text to be deleted is shown with a line through it.~~
 2. New text inserted: New text is highlighted with grey shading.
 3. New text replacing existing text: ~~Text to be deleted is shown with a line through it~~ followed by the replacement text which is highlighted with grey shading.
- iv. **Effectivity Clause.** - This Memorandum Circular shall take effect fifteen (15) days after publication in a requisite single newspaper of general circulation or the Official Gazette and a copy filed with the U.P. Law Center - Office of the National Administrative Register.

So Ordered. Signed this 22 day of January 2017, at the Civil Aviation Authority of the Philippines, MIA Road, Pasay City, Metro Manila, 1301.


CAPTAIN JIM C. SYDIONGCO