Republic of the Philippines
CIVIL AVIATION AUTHORITY OF THE PHILIPPINES

MEMORANDUM CIRCULAR NO.. 04-2021

TO : ALL CONCERNED

FROM : THE DIRECTOR GENERAL

SUBJECT : ADOPTION OF ICAO ANNEX 10 VOLUME 1 AMENDMENT 92 TO CIVIL AVIATION REGULATIONS – AIR NAVIGATION SERVICES PART 6 - AERONAUTICAL TRLECOMMUNICATIONS GOVERNING RADIO NAVIGATION AIDS

REFERENCE:

1. Philippine Civil Aviation Regulations- Air Navigation Service Part 6 Aeronautical Telecommunications Governing Radio Navigational Aids.
2. ICAO Annex 10 Vol I – Aeronautical Telecommunications-Radio Navigational Aids
3. ICAO Annex 10 Volume I, Amendment 92
4. Regulations Amendment Procedures (RAP)
5. 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 Vol I Amendment No. 92 to the Philippine Civil Aviation Regulations-Air Navigation Services (CAR-ANS) Part 6.

ORIGINAL REGULATIONS SUBJECT TO AMENDMENT:

CAR-ANS Part 6- AERONAUTICAL TELECOMMUNICATIONS GOVERNING RADIO NAVIGATION AIDS

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6.2.3 Provision of information on the operational status of radio navigation services

6.2.3.1 Aerodrome control towers and units providing approach control service shall be provided with information on the operational status of radio navigation services essential for approach, landing and take-off at the aerodrome(s) with which they are concerned, on a timely basis consistent with the use of the service(s) involved.

Note.— Guidance material on the application of this Standard in the case of PBN-based operations supported by GNSS is contained in the Performance-based Navigation (PBN) Manual *(Doc 9613).*

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6.3. SPECIFICATIONS FOR RADIO NAVIGATION AIDS

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6.3.1 Specification for ILS

6.3.1.1 Definitions

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Facility Performance Category I — ILS. An ILS which provides guidance information from the coverage limit of the ILS to the point at which the localizer course line intersects the ILS glide path at a height of ~~60~~30 m (~~200~~100 ft) or less above the horizontal plane containing the threshold.

~~*Note.— This definition is not intended to preclude the use of Facility Performance Category I — ILS below the height of 60 m (200 ft), with visual reference where the quality of the guidance provided permits, and where satisfactory operational procedures have been established.*~~

Note.— The lower limit is set to 30 m (100 ft) below the minimum Category I decision height (DH).

Facility Performance Category II — ILS. An ILS which provides guidance information from the coverage limit of the ILS to the point at which the localizer course line intersects the ILS glide path at a height of 15 m (50 ft) or less above the horizontal plane containing the threshold.

Note.— The lower limit is set to 15 m (50 ft) below the minimum Category II decision height (DH).

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6.3.1.2.1.3 Facility Performance Categories I, II and III — ILS shall provide indications at designated remote control points of the operational status of all ILS ground system components, as follows:

a) for all Facility Performance Category II and Category III ILS, the air traffic services unit involved in the control of aircraft on the final approach shall be one of the designated remote control points and shall receive information on the operational status of the ILS, with a delay commensurate with the requirements of the operational environment;

b) for a Facility Performance Category I ILS, if that ILS provides an essential radio navigation service, the air traffic services unit involved in the control of aircraft on the final approach shall be one of the designated remote control points and shall receive information on the operational status of the ILS, with a delay commensurate with the requirements of the operational environment.

Note ~~1.~~— The indications required by this Standard are intended as a tool to support air traffic management functions, and the applicable timeliness requirements are sized accordingly (consistently with 6.2.3.1). ~~*Timeliness requirements applicable to the ILS integrity monitoring functions that protect aircraft from ILS malfunctions are specified in 3.1.3.11.3.1 and 3.1.5.7.3.1.*~~

~~*Note 2.— It is intended that the air traffic system is likely to call for additional provisions which may be found essential for the attainment of full operational Category III capability, e.g. to provide additional lateral and longitudinal guidance during the landing roll-out, and taxiing, and to ensure enhancement of the integrity and reliability of the system.*~~

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6.3.1.2.6 To ensure an adequate level of safety, the ILS shall be so designed and maintained that the probability of operation within the performance requirements specified is of a high value, consistent with the category of operational performance concerned.

6.3.1.2.6.1 For Facility Performance Category II and III localizers and glide paths, the level of integrity and continuity of service shall be at least Level 3, as defined in 6.3.1.3.12.4 (localizer) and 6.3.1.5.8.4 (glide path).

Note.— The specifications for Facility Performance Categories II and III — ILS are intended to achieve the highest degree of system integrity, reliability and stability of operation under the most adverse environmental conditions to be encountered. Guidance material to achieve this objective ~~in Categories II and III operations~~ is given in 2.8 of Attachment 6C.

6.3.1.2.7 At those locations where two separate ILS facilities serve opposite ends of a single runway, and **operationally harmful interference would be present if both facilities were transmitting**, an interlock shall ensure that only the localizer serving the approach direction in use shall radiate~~, except where the localizer in operational use is Facility Performance Category I — ILS and no operationally harmful interference results~~.

~~3.1.2.7.1 **Recommendation.**— *At those locations where two separate ILS facilities serve opposite ends of a single runway and where a Facility Performance Category I — ILS is to be used for auto-coupled approaches and landings in visual conditions an interlock should ensure that only the localizer serving the approach direction in use radiates, providing the other localizer is not required for simultaneous operational use.*~~

Note 1.— While a low height overflight of a transmitting localizer may generate interference within airborne ILS receivers, this interference may only be considered as operationally harmful when it occurs in specific conditions, e.g. without visual cues of the runway, or when the autopilot is engaged. Additional guidance material is contained in 2.1.8 and 2.13 of Attachment 6C.

Note 2.— Interference may also be caused by transmissions from other localizers not serving the opposite end of the same runway (i.e. crossing, parallel or adjacent runways). In such cases, use of interlock to prevent the interference can also be considered.

Note 3.— ~~If both localizers radiate there is a possibility of interference to the localizer signals in the threshold region. Additional guidance material is contained in 2.1.8 of Attachment C.~~ ***An interlock can be provided through hardware, software or an equivalent procedural means.***

6.3.1.2.7.~~2~~1 At locations where ILS facilities serving opposite ends of the same [...].

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6.3.1.2.8 At those locations where an ILS facility and a GBAS facility serve opposite approach directions to the same runway, when the approach direction in use is not the direction served by the ILS, the localizer shall not radiate when GBAS low visibility operations that require GAST D are being conducted, except where it can be demonstrated that the localizer signal supports compliance with the requirements in Appendix 6B, 3.6.8.2.2.5 and 3.6.8.2.2.6 defining the desired to undesired signal ratios and the maximum adjacent channel power tolerable by the GBAS VDB receiver.

Note.— If the localizer is radiating there is a possibility of interference to the GBAS VDB signals in the region where the aircraft overflies the localizer. A means to ensure that the localizer does not radiate can be provided through either hardware or software interlock or a procedural

mitigation. Additional guidance material is contained in Attachment 6C, 2.1.8.1 and Attachment 6D, 7.2.3.3.

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6.3.1.3.3.2.1 For Facility Performance Category I localizers, the minimum field strength on the ILS glide path and within the localizer course sector from a distance of 18.5 km (10 NM) to a height of ~~60~~30 m (~~200~~100 ft) above the horizontal plane containing the threshold shall be not less than 90 microvolts per metre (minus 107 dBW/m^2).

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6.3.1.3.4.2 For Facility Performance Categories II and III localizers, bends in the course line shall not have amplitudes which exceed the following:

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and, for Facility Performance Category III only:

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6.3.1.3.5.3.4 With two-frequency localizer systems, 6.3.1.3.5.3.3 shall apply to each carrier. In addition, the 90 Hz modulating tone of one carrier shall be phase-locked to the 90 Hz modulating tone of the other carrier so that the demodulated wave forms pass through zero in the same direction within:

a) for Facility Performance Categories I and II localizers: 20 degrees; and

b) for Facility Performance Category III localizers: 10 degrees, of phase relative to 90 Hz. Similarly, the 150 Hz tones of the two carriers shall be phase-locked so that the demodulated wave forms pass through zero in the same direction within:

1) for Facility Performance Categories I and II localizers: 20 degrees; and

2) for Facility Performance Category III localizers: 10 degrees,
of phase relative to 150 Hz.

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6.3.1.3.6.2 For Facility Performance Category II localizers, **the mean course line ~~should~~ shall be adjusted and maintained within limits equivalent to plus or minus 4.5 m (15 ft) displacement from runway centre line at the ILS reference datum.**

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Note 2.— It is intended that new Facility Performance Category II installations are to meet the requirements of 6.3.1.3.6.2.

6.3.1.3.7 *Displacement sensitivity*

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6.3.1.3.7.1 The nominal displacement sensitivity within the half course sector shall be the equivalent of 0.00145 DDM/m (0.00044 DDM/ft) at the ILS reference datum except that for Facility Performance Category I localizers, where the specified nominal displacement sensitivity cannot be met, the displacement sensitivity shall be adjusted as near as possible to that value. For Facility Performance Category I localizers on runway codes 1 and 2, the nominal displacement sensitivity shall be achieved at the ILS Point "B". The maximum course sector angle shall not exceed six degrees.

6.3.1.3.8.2 Facility Performance Category III localizers shall not provide such a channel, except where extreme care has been taken in the design and operation of the facility to ensure that there is no possibility of interference with the navigational guidance

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6.3.1.3.11.2 The conditions requiring initiation of monitor action shall be the following:

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Note.— It is important to recognize that a frequency change resulting in a loss of the frequency difference specified in 3.1.3.2.1 may produce a hazardous condition. This problem is of greater operational significance for Facility ***Performance*** *Categories II and III installations. As necessary, this problem can be dealt with through special monitoring provisions or highly reliable circuitry.*

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6.3.1.3.11.3.1 The total period referred to under 6.3.1.3.11.3 shall not exceed under any circumstances:

10 seconds for **Facility Performance** Category I localizers;

5 seconds for **Facility Performance** Category II localizers;

2 seconds for **Facility Performance** Category III localizers.

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6.3.1.3.11.3.2 *Where practicable, the total period under* 6.3.1.3.11.3.1 ~~should~~ **shall** be reduced so as not to exceed two seconds for **Facility Performance** Category II localizers and one second for **Facility Performance** Category III localizers.

6.3.1.3.12 Integrity and continuity of service **levels and** requirements

6.3.1.3.12.1 ~~The probability of not radiating false guidance signals shall not be less than 1 – 0.5 × 10–9 in any one landing for Facility Performance Categories II and III localizers.~~ **A localizer shall be assigned a level of integrity and continuity of service as given in 6.3.1.3.12.2 to 6.3.1.3.12.5.**

Note.— Levels are used to provide the necessary information for the determination of the category of operation and associated minima, which are a function of the Facility Performance Category, the (separate) integrity and continuity of service level, and a number of operational factors (e.g. aircraft and crew qualification, meteorological conditions, and runway features). If a localizer does not meet its required integrity and continuity of service level, some operational use may still be possible, as stated in the* Manual of All-Weather Operations *(Doc 9365), Appendix 6C on ILS facility classification and downgrading. Similarly, if a localizer exceeds the minimum integrity and continuity of service level, more demanding operations may be possible.

6.3.1.3.12.2 The localizer level shall be Level 1 if either:

1) the localizer's integrity of service or its continuity of service, or both, are not demonstrated; or

2) the localizer's integrity of service and its continuity of service are both demonstrated, but at least one of them does not meet the requirements of Level 2.

6.3.1.3.12.2.1 **The probability of not radiating false guidance signals** ~~should~~ **shall not be less than** $1 - 1.0 \times 10^{-7}$ **in any one landing for** ~~Facility Performance Category I~~ **Level 1 localizers.**

~~3.1.3.12.3 The probability of not losing the radiated guidance signal shall be greater than:~~

~~a) 1 – 2 × 10–6 in any period of 15 seconds for Facility Performance Category II localizers or localizers intended to be used for Category III A operations (equivalent to 2 000 hours mean time~~

between outages); and

b) 1 — 2 × 10-6 in any period of 30 seconds for Facility Performance Category III localizers intended to be used for the full range of Category III operations (equivalent to 4 000 hours mean time between outages).

6.3.1.3.12.42.2 The probability of not losing the radiated guidance signal should shall exceed 1 − 4 × 10^{-6} in any period of 15 seconds for Facility Performance Category I Level 1 localizers (equivalent to 1 000 hours mean time between outages).

Note.— A localizer that meets both Recommended Practices 6.3.1.3.12.2.1 and 6.3.1.3.12.2.2 also meets Standard 6.3.1.3.12.3(Level 2 performance) and is therefore to be identified as Level 2.

6.3.1.3.12.2.3 In the event that the integrity value for a Level 1 localizer is not available or cannot be readily calculated, a detailed analysis should shall be performed to assure proper monitor fail-safe operation.

6.3.1.3.12.3 The localizer level shall be Level 2 if:

a) the probability of not radiating false guidance signals is not less than 1 – 1.0 x 10^{-7} in any one landing; and

b) the probability of not losing the radiated guidance is greater than 1 – 4 × 10^{-6} in any period of 15 seconds (equivalent to 1 000 hours mean time between outages).

6.3.1.3.12.4 The localizer level shall be Level 3 if:

a) the probability of not radiating false guidance signals is not less than 1 – 0.5 × 10^{-9} in any one landing; and

b) the probability of not losing the radiated guidance is greater than 1 – 2 × 10^{-6} in any period of 15 seconds (equivalent to 2 000 hours mean time between outages).

6.3.1.3.12.5 The localizer level shall be Level 4 if:

a) the probability of not radiating false guidance signals is not less than 1 – 0.5 × 10^{-9} in any one landing; and
b) the probability of not losing the radiated guidance is greater than 1 – 2 × 10^{-6} in any period of 30 seconds (equivalent to 4 000 hours mean time between outages).

Note.— Guidance material on ways to achieve integrity and continuity of service is given in Attachment 6C, 2.8.

6.3.1.5.5.3.1 With two-frequency glide path systems, 6.3.1.5.5.3 shall apply to each carrier. In addition, the 90 Hz modulating tone of one carrier shall be phase-locked to the 90 Hz modulating tone of the other carrier so that the demodulated wave forms pass through zero in the same direction within:

a) for Facility Performance Categories I and II — ILS glide paths: 20 degrees;

b) for Facility Performance Category III — ILS glide paths: 10 degrees, of phase relative to 90 Hz. Similarly, the 150 Hz tones of the two carriers shall be phase-locked so that the demodulated wave forms pass through zero in the same direction, within:

1) for Facility Performance Categories I and II — ILS glide paths: 20 degrees;

2) for Facility Performance Category III — ILS glide paths: 10 degrees of phase relative to 150 Hz.

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6.3.1.5.7.1 The automatic monitor system shall provide a warning to the designated control points and cause radiation to cease within the periods specified in 6.3.1.5.7.3.1 if any of the following conditions persist:

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Note.— It is important to recognize that a frequency change resulting in a loss of the frequency difference specified in 6.3.1.5.2.1 may produce a hazardous condition. This problem is of greater operational significance for Facility Performance Categories II and III installations. As necessary, this problem can be dealt with through special monitoring provisions or highly reliable circuitry.

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6.3.1.5.7.3.1 The total period referred to under 6.3.1.5.7.3 shall not exceed under any circumstances:

6 seconds for Facility Performance Category I — ILS glide paths;

2 seconds for Facility Performance Categories II and III — ILS glide paths.

6.3.1.5.7.3.2 Where practicable, the total period specified under 6.3.1.5.7.3.1 for Facility Performance Categories II and III — ILS glide paths ~~should~~ shall not exceed 1 second.

6.3.1.5.8 Integrity and continuity of service levels and requirements

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6.3.1.5.8.1 ~~The probability of not radiating false guidance signals shall not be less than 1 − 0.5 × 10-9 in any one landing for Facility Performance Categories II and III glide paths~~. A glide path shall be assigned a level of integrity and continuity of service as given in 6.3.1.5.8.2 to 6.3.1.5.8.5.

Note.— Levels are used to provide the necessary information for the determination of the category of operation and associated minima, which are a function of the Facility Performance Category, the (separate) integrity and continuity of service level, and a number of operational factors (e.g. aircraft and crew qualification, meteorological conditions, and runway features). If a glide path does not meet its required integrity and continuity of service level, some operational use may still be possible, as stated in the Manual of All-Weather Operations *(Doc 9365), Appendix 6C on ILS facility classification and downgrading. Similarly, if a glide path exceeds the minimum integrity and continuity of service level, more demanding operations may be possible.*

6.3.1.5.8.2 The glide path level shall be Level 1 if either:

1) the glide path's integrity of service or its continuity of service, or both, are not demonstrated; or

2) the glide path's integrity of service and its continuity of service are both demonstrated, but at least one of them does not meet the requirements of Level 2.

6.3.1.5.8.2.1 *The probability of not radiating false guidance signals should shall not be less than 1 − 1.0 × 10^{-7} in any one landing for Facility Performance Category I Level 1 glide paths.* .

~~3.1.5.8.3 The probability of not losing the radiated guidance signal shall be greater than 1 − 2 × 10−6 in any period of 15 seconds for Facility Performance Categories II and III glide paths (equivalent to 2 000 hours mean time between outages).~~

6.3.1.5.8.42.2 The probability of not losing the radiated guidance signal ~~should~~ shall exceed 1 − 4 × 10^{-6} in any period of 15 seconds for Facility Performance Category I Level 1 glide paths (equivalent to 1 000 hours mean time between outages).

Note.— A glide path that meets both Recommended Practices 6.3.1.5.8.2.1 and 6.3.1.5.8.2.2 also meets Standard 6.3.1.5.8.3 (Level 2 performance) and is therefore to be identified as Level 2.

6.3.1.5.8.2.3 *In the event that the integrity value for a Level 1 glide path is not available or cannot be readily calculated, a detailed analysis ~~should~~ shall be performed to assure proper monitor fail-safe operation.*

6.3.1.5.8.3 The glide path level shall be Level 2 if:

a) the probability of not radiating false guidance signals is not less than 1 − 1.0 x 10^{-7} in any one landing; and

b) the probability of not losing the radiated guidance is greater 1 − 4 × 10^{-6} in any period of 15 seconds (equivalent to 1 000 hours mean time between outages).

Note 1.— The requirements for glide path Level 3 and Level 4 are the same. The declaration of the glide path integrity and continuity of service levels ~~should~~ shall match the declaration of the localizer (i.e. the glide path is declared as Level 4 if the localizer is meeting Level 4).

6.3.1.5.8.4 The glide path level shall be Level 3 or 4 if:
a) the probability of not radiating false guidance signals is not less than 1 − 0.5 × 10^{-9} in any one landing; and
b) the probability of not losing the radiated guidance is greater than 1 − 2 × 10^{-6} in any period of 15 seconds (equivalent to 2 000 hours mean time between outages).

Note 1.— The requirements for glide path Level 3 and Level 4 are the same. The declaration of the glide path integrity and continuity of service levels ~~should~~ shall match the declaration of the localizer (i.e. the glide path is declared as Level 4 if the localizer is meeting Level 4).
Note 2. Guidance material on ways to achieve integrity and continuity of service is given in 2.8 of Attachment 6C

~~3.1.5.8.4 **Recommendation.**— The probability of not losing the radiated guidance signal should exceed 1 − 4 × 10−6 in any period of 15 seconds for Facility Performance Category I glide paths (equivalent to 1 000 hours mean time between outages).~~

Note 2. Guidance material on ways to achieve integrity and continuity of service is given in 2.8 of Attachment 6C.

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6.3.7 Requirements for the Global Navigation Satellite System (GNSS)

6.3.7.2.3.2 *Time reference.* The time data provided by the GNSS to the user shall be expressed in a time scale that takes the ~~Universal Time Coordinated~~ **Coordinated Universal Time** (UTC) as reference.

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

1. DEFINITIONS

GBAS/E. A ground-based augmentation system transmitting an elliptically-polarized VHF data broadcast.

GBAS/H. A ground-based augmentation system transmitting a horizontally- polarized VHF data broadcast.

Receiver. A subsystem that receives GNSS signals and includes one or more sensors.

Reserved (bits/words/fields). Bits/words/fields that are not allocated, but which are reserved for a particular GNSS application.

Smax. **Maximum desired VHF data broadcast signal power at the VHF data broadcast receiver input. This power at the receiver input is computed from the maximum RF field strength defined in 6.3, 6.3.7.3.5.4.4 for the desired VHF data broadcast signal as received by an ideal isotropic antenna minus the minimum aircraft implementation loss. It is used to determine the VHF data broadcast interference immunity to adjacent channel signals (3.6.8.2.2.6) and to signals from sources outside the 108.000 – 117.975 MHz band (3.6.8.2.2.8).**

Spare (bits/words/fields). Bits/words/fields that are not allocated or reserved, and which are available for future allocation.

Note.— All spare bits are set to zero.

2. GENERAL

Note.— The following technical specifications supplement the provisions of 6.3, 6.3.7.

3. GNSS ELEMENTS

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3.5 Satellite-based augmentation system (SBAS)

Table B-27. SBAS service provider identifiers

Identifier	Service Provider
0	WAAS
1	EGNOS
2	MSAS
3	GAGAN

4	SDCM
5 ~~to 13~~	~~Spare~~ BDSBAS
6	KASS
7	A-SBAS
8	SPAN
9 to 13	Spare
14, 15	Reserved

Table B-35. UTC standard identifier

UTC standard Identifier	UTC standard
0	**UTC as operated by the Communications Research Laboratory, Tokyo, Japan**
1	**UTC as operated by the U.S. National Institute of Standards and Technology**
2	**UTC as operated by the U.S. Naval Observatory**
3	**UTC as operated by the International Bureau of Weights and Measures**
4	**Reserved for UTC as operated by a European laboratory**
5	**UTC as operated by the National Time Service Center, Chinese Academy of Sciences**
~~5to 6~~	**Spare**
7	**UTC not provided**

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3.5.7.7.2.6 SBAS shall raise an alarm within 8 seconds if any combination of active data and GNSS signals-in-space results in an out-of-tolerance condition for en-route through APV I (3.5.7.4.1).

Note.— The monitoring applies to all failure conditions, including failures in core satellite constellation(s) or SBAS satellites. This monitoring assumes that the aircraft element complies with the requirements of RTCA/DO-229D with Change 1, except as superseded by 3.5.8 and Attachment 6D, 8.11.

3.5.7.7.3 *IOD monitoring.* SBAS shall monitor the GPS IODE values for possible invalid 14 transmissions of values used previously for a different set of ephemeris parameters within the time interval(s) specified in 3.1.1.3.2.2, and take appropriate action to ensure the integrity of its broadcast corrections, if such an invalid use is detected

Note 1.— The IOD uniqueness is granted by design in the case of SBAS augmenting GLONASS satellites.

Note 2.— The GPS IODC (as per section 3.1.1.3.1.4) is not currently used in the processing of GPS L1 navigation messages in an SBAS receiver mode. Therefore, monitoring is not specifically required.

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3.5.7.8 *Robustness to core satellite constellation(s) failures.* Upon occurrence of a core satellite constellation(s) satellite anomaly, SBAS shall continue to operate normally using the available healthy satellite signals that can be tracked.

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3.6.7.2.2.2 *Low-frequency data.* Except during an ephemeris change, the first ranging source in the Type 1, Type 11 or Type 101 message shall sequence so that the ~~ephemeris decorrelation parameter, ephemeris CRC and source availability duration~~ **low-frequency data (as defined in 3.6.4.2.1 for Type 1 message, 3.6.4.11.1 for Type 11 message and 3.6.4.10.1 for Type 101 message)** for each core satellite constellation's ranging source are transmitted at least once every 10 seconds. During an ephemeris change, the first ranging source shall sequence so that the ~~ephemeris decorrelation parameter, ephemeris CRC and source availability duration~~ **low-frequency data** for each core satellite constellation's ranging source are transmitted at least once every 27 seconds. [...]

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3.6.7.3.1.1 *VHF data broadcast monitoring.* The data broadcast transmissions shall be monitored. The transmission of the data shall cease within 0.5 seconds in case of continuous disagreement during any 3-second period between the transmitted application data and the application data derived or stored by the monitoring system prior to transmission. For FAST D ground subsystems, the transmission of ~~the data~~ **Type 11 messages** shall cease within 0.5 seconds in case of continuous disagreement during any 1-second period between the transmitted application data and the application data derived or stored by the monitoring system prior to transmission

*Note.— For ground subsystems that support authentication, ceasing the transmission of data means ceasing the transmission of Type 1 messages and/or Type 11 messages if applicable or ceasing the transmission of Type 101 messages. In accordance with 3.6.7.4.1.3, the ground **subsystem must still transmit messages such that the defined percentage or more of every assigned slot is occupied. This can be accomplished by transmitting Type 2, Type 3, Type 4 and/or Type 5 messages.***

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3.6.8 AIRCRAFT ELEMENTS

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3.6.8.2.2 *VHF data broadcast receiver performance*

3.6.8.2.2.3 *VHF data broadcast message failure rate.* The VHF data broadcast receiver shall achieve a message failure rate less than or equal to one failed message per 1 000 full-length (222 bytes) application data messages, within the range of the RF field strength defined in Chapter 3, 3.7.3.5.4.4 as received by the airborne antenna.~~, provided that~~ **This requirement shall apply when** the variation in the average received signal power between successive bursts in a given time slot does not exceed 40 dB. Failed messages include those lost by the VHF data broadcast receiver system or which do not pass the CRC after application of **the** FEC.

3.6.8.2.2.5 *Co-channel rejection*

3.6.8.2.2.5.3 *ILS localizer as the undesired signal.* The VHF data broadcast receiver shall meet the requirements specified in 3.6.8.2.2.3 in the presence of an undesired co-channel ILS localizer signal that is 26 dB below the desired VHF data broadcast signal power at the receiver input.

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3.6.8.2.2.6 *Adjacent channel rejection.* The level of ILS localizer or VOR undesired signals shall be measured as the power in the RF carrier.

Note.— Even though S_{max} is the maximum desired VHF data broadcast signal power, it is also used to limit the maximum adjacent channel undesired signal power at the receiver input.

3.6.8.2.2.6.1 *First adjacent 25 kHz channels (±25 kHz).* The VHF data broadcast receiver shall meet the requirements specified in 3.6.8.2.2.3 in the presence of an ~~transmitted~~ undesired signal with power levels at the receiver input up to S_{max} offset by 25 kHz on either side of the desired channel that is either:

a) 18 dB above the desired signal power at the receiver input when the undesired signal is another VHF data broadcast signal assigned to the same time slot(s); or

b) equal in power at the receiver input when the undesired signal is VOR; or.

c) equal in power at the receiver input when the undesired signal is ILS localizer.

3.6.8.2.2.6.2 *Second adjacent 25 kHz channels (±50 kHz).* The VHF data broadcast receiver shall meet the requirements specified in 3.6.8.2.2.3 in the presence of an ~~transmitted~~ undesired signal with power levels at the receiver input up to Smax offset by 50 kHz on either side of the desired channel that is either:

a) 43 dB above the desired signal power at the receiver input when the undesired signal is another VHF data broadcast source assigned to the same time slot(s); or

b) 34 dB above the desired signal power at the receiver input when the undesired signal is VOR; or.

c) 34 dB above the desired signal power at the receiver input when the undesired signal is ILS localizer.

3.6.8.2.2.6.3 *Third up to thirty-ninth ~~and beyond~~ adjacent 25 kHz channels (±75 kHz to ±975 kHz ~~or more~~).* The VHF data broadcast receiver shall meet the requirements specified in 3.6.8.2.2.3 in the presence of an ~~transmitted~~ undesired signal with power levels at the receiver input up to S_{max} offset by 75 kHz to 975 kHz ~~or more~~ on either side of the desired channel that is either:

a) 46 dB above the desired signal power at the receiver input when the undesired signal is another VHF data broadcast signal assigned to the same time slot(s); or

b) 46 dB above the desired signal power at the receiver input when the undesired signal is VOR; or.

c) 46 dB above the desired signal power at the receiver input when the undesired signal is ILS localizer.

3.6.8.2.2.6.4 *Fortieth and beyond adjacent 25 kHz channels (±1 MHz or more).* The VHF data broadcast receiver shall meet the requirements specified in 3.6.8.2.2.3 in the presence of an undesired signal offset by 1 MHz or more on either side of the desired channel that is either:

a) 46 dB above the desired signal power at the receiver input when the undesired signal with power levels at the receiver input up to Smax is another VHF data broadcast signal assigned to the same time slot(s); or

b) 46 + ΔP dB above the desired signal power at the receiver input when the undesired signal is a VOR with power levels at the receiver input up to Smax – ΔP dB and ΔP ranges from 0 to 14 dB; or

c) 46 + ΔP dB above the desired signal power at the receiver input when the undesired signal is an ILS localizer with power levels at the receiver input up to S_{max} – ΔP dB and ΔP ranges from 0 to 14 dB.

Note 1.— ΔP equals S_{max} minus the undesired signal power at the receiver input with the following two constraints. ΔP equals 0 dB when the undesired power reaches Smax. ΔP equals 14 dB when the undesired power is 14 dB or more below S_{max}.

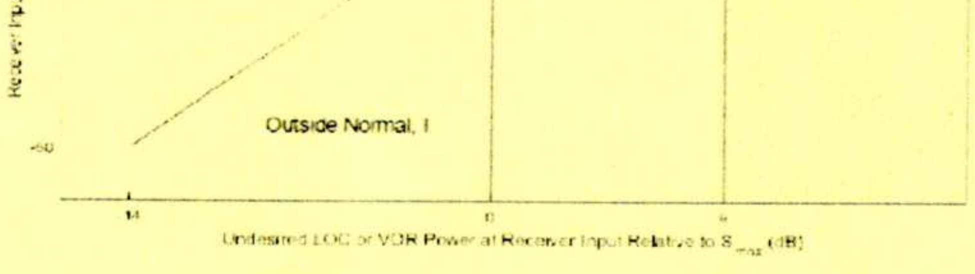
Note 2.— The requirements in items b) and c) accommodate a third order intermodulation between the undesired signal and the local oscillator in the first mixer of the RF front-end of the VDB receiver; it is similar to the FM intermodulation immunity in 3.6.8.2.2.8.3 where N1 is the undesired signal and N2 is the local oscillator.

3.6.8.2.2.6.5 *Receiver recovery from short-term excess undesired signal power.* The VHF data broadcast receiver shall meet the requirements specified in 3.6.8.2.2.3 within 187.5 milliseconds (equivalent duration of three VDB slots) after encountering an adjacent channel interference signal (ILS localizer or VOR) whose power is above S_{max} for no more than 2.5 seconds and by no more than 9 dB at the receiver input.

Note 1.— This requirement supports brief excessive power received during ILS localizer and VOR overflight. The duration of the excess power is limited by the continuity of the operation, e.g. the opportunity to receive three Type 1 messages in every 3.5 second window (refer to 3.6.8.3.4.1) without excess power for GAST C. For GAST D, no excess power is allowed when the timeout is 1.5 seconds (refer to 3.6.8.3.4.3). A VDB undesired signal never exceeds the maximum allowed field strength of the desired VDB signal within the service volume.

Note 2.— Figure B-20 shows a graphical representation of the VDB receiver regions of operation ***in the presence of an undesired ILS localizer or VOR signal in the fortieth or beyond adjacent 25 kHz channel, as a function of D/U and undesired signal power.***

. . .



Note.— The region of the figure labelled "Normal Operation" is the one in which 3.6.8.2.2.6.4 applies, and consequently 3.6.8.2.2.3 is met (MFR <= 0.001). The lower boundary of the region is the line plotting the minimum acceptable D/U ratio specified in 3.6.8.2.2.6.4 as a function of the undesired power, for values of the undesired power up to S_{max}.

In the other three regions of the figure, 3.6.8.2.2.6.4 does not apply. Consequently, 3.6.8.2.2.3 may not be met, and MFR may be as high as 1.

The region labelled "Outside Normal, I" is the one in which the D/U ratio is lower than the minimum acceptable value defined in 3.6.8.2.2.6.4 and the undesired power is lower or equal to S_{max}.

The region labelled "Outside Normal, II" is the one in which the undesired power is higher than Smax but lower than S_{max} *+ 9 dB. The requirement for receiver recovery from short-term excess undesired signal power specified in 3.6.8.2.2.6.5 applies in this region.*

The region labelled "Outside Normal, III" is the one in which the undesired power is higher than S_{max} *+ 9 dB. Because this region is outside the expected operational environment, no receiver performance requirements apply.*

Figure B-20. GBAS VDB receiver regions of operation in the presence of an undesired signal in the fortieth or beyond adjacent 25 kHz channel

ATTACHMENT 6C. INFORMATION AND MATERIAL FOR GUIDANCE IN THE APPLICATION OF THE STANDARDS AND RECOMMENDED PRACTICES FOR ILS, VOR, PAR, 75 MHz MARKER BEACONS (EN-ROUTE), NDB AND DME

2. Material concerning ILS installations

2.1 Operational objectives, design and maintenance objectives, and definition of course structure for Facility Performance Categories

2.1.1 The Facility Performance Categories defined in ~~Chapter~~ 6.3, 6.3.1.1 have operational objectives as ~~follows~~: **defined by Category I, II or III operations. Definitions of such operations are given in Annex 6.**

~~*Category I operation:* **A precision instrument approach and landing with a decision height not lower than 60 m (200 ft) and with either a visibility not less than 800 m or a runway visual range not less than 550 m.**~~

~~*Category II operation:* **A precision instrument approach and landing with a decision height lower than 60 m (200 ft) but not lower than 30 m (100 ft), and a runway visual range not less than 300 m.**~~

~~*Category IIIA operation: A precision instrument approach and landing with:*~~
~~**a) a decision height lower than 30 m (100 ft), or no decision height; and**~~
~~**b) a runway visual range not less than 175 m.**~~

~~*Category IIIB operation:* **A precision instrument approach and landing with:**~~
~~**a) a decision height lower than 15 m (50 ft), or no decision height; and**~~
~~**b) a runway visual range less than 175 m but not less than 50 m.**~~

~~*Category IIIC operation:* A precision instrument approach and landing with no decision height and no runway visual range limitations.~~

. . .

2.1.3 *Course bends.* Localizer course bends ~~should~~ **shall** be evaluated in terms of the course structure specified in ~~Chapter~~ **6.3,** 6.3.1.3.4. With regard to landing and roll-out ~~in Category III conditions~~, this course structure is based on the desire to provide adequate guidance for manual and/or automatic operations along the runway in low visibility conditions. With regard to **Facility Performance** Category I ~~performance~~ in the approach phase, this course structure is based on the desire to restrict aircraft deviations, due to course bends (95 per cent probability basis) at the 30 m (100 ft) height, to lateral displacement of less than 10 m (30 ft). With regard to **Facility Performance** Categories II and III ~~performance~~ in the approach phase, this course structure is based on the desire to restrict aircraft deviations due to course bends (95 per cent probability basis) in the region between ILS Point B and the ILS reference datum (**Facility Performance** Category II ~~facilities~~) or Point D (**Facility Performance** Category III ~~facilities~~), to less than 2 degrees of roll and pitch attitude and to lateral displacement of less than 5 m (15 ft).

2.1.4 *ILS glide path bends.* Bends ~~should~~ **shall** be evaluated in terms of the ILS glide path structure specified in ~~Chapter~~ **6.3,** 6.3.1.5.4. With regard to **Facility Performance** Category I ~~performance~~, this glide path structure is based on the desire to restrict aircraft deviations due to glide path bends (95 per cent probability basis) at the 30 m (100 ft) height, to vertical displacements of less than 3 m (10 ft). With regard to **Facility Performance** Categories II and III ~~performance~~, this glide path structure is based on the desire to restrict aircraft deviations due to path bends (95 per cent probability basis) at the 15 m (50 ft) height, to less than 2 degrees of roll and pitch attitude and to vertical displacements of less than 1.2 m (4 ft).

. . .

2.1.5 *Application of localizer course glide path bend amplitude Standard.* In applying the specification for localizer course structure (**6.3,** 6.3.1.3.4) and ILS glide path structure (**6.3,** 6.3.1.5.4), the following criteria ~~should~~ **shall** be employed:

— Figure C-1 shows the relationship between the maximum (95 per cent probability) localizer course/glide path bend amplitudes and distances from the runway threshold that have been specified for **Facility Performance** Categories I, II and III ILS ~~Performance.~~

. . .

2.1.8 *Radiation by ILS localizers not in operational use.* Severe interference with operational ILS localizer signals has been experienced in aircraft carrying out approaches to low levels at runways equipped with localizer facilities serving the reciprocal direction to the approach. Interference in aircraft overflying this localizer antenna system is caused by cross modulation due to signals radiated from the reciprocal approach localizer. Such interference, in the case of low level operations, could seriously affect approach or landing, and may prejudice safety. **6.3,** 6.3.1.2.7~~,~~ **and** 6.3.1.2.7.1 ~~and 6.3.1.2.7.2~~ specify the conditions under which radiation by localizers not in operational use may be permitted.

2.1.8.1 At those locations where an ILS facility and a GBAS facility serve opposite approach directions to the same runway, there is a possibility of interference to the reception of the GBAS VDB signals in the region where the aircraft overflies the localizer. Localizer signals that do not support compliance with the requirements in Appendix 6B, 3.6.8.2.2.5 and 3.6.8.2.2.6 defining the desired to undesired signal ratios and the maximum adjacent channel power tolerable by the GBAS VDB receiver, can result in excessive missed messages and cause a loss of continuity of GBAS guidance. The interference is likely to be higher when the localizer is sited close to the runway threshold. 6.3, 6.3.1.2.8 specifies the conditions under which radiation by localizers not in operational use ~~should~~ shall not be allowed. Additional information is contained in Attachment 6D, 7.2.3.3.

. . .

2.1.9.4 *Technical determination of critical and sensitive area dimensions.* Critical and sensitive areas are normally calculated in the planning stage, prior to ILS installation, using computer simulation. A similar process is used when there are changes to the installation or to the environment. When using computer simulations, it is necessary to allocate the protection of individual parts of the approach to either the critical or sensitive area. It is desirable to ensure that the combined critical and sensitive areas protect the entire approach. However, this may not be possible in all cases. Furthermore, if the logic described in 2.1.9.3 is used, this may lead to restrictively large critical areas. Some States have found that a reasonable compromise can be achieved using a different logic, whereby the critical area protects the segment from the edge of coverage down to 2 NM from the runway threshold, while the sensitive area protects the approach from 2 NM down to the runway. In this case, a ~~Category I~~ sensitive area **for Category I operations** will exist and may require operational mitigation. [...]

2.1.9.9 *Typical examples of critical and sensitive areas.* Figures C-3 and C-4 (including associated Tables C-1, C-2-A and C-2-B)) show examples of critical and sensitive areas **for the different categories of operations and** for different classes of vehicle/aircraft heights and several localizer and glide path antenna types. [...]

Editorial Note.— Modify Note 2 of Table C-2B. Example of glide path critical and sensitive area dimensions for other orientation as follows:

Notes:

. . .

2. The ground vehicle category also applies to small aircraft. Simulations have approximated these aircraft or large ground vehicles using a rectangular box (4 m high x 12 m long x 3 m wide). Depending on local conditions, it may be possible to reduce especially Category I critical area dimensions such that taxiing or driving on the taxiway directly in front of the glide path antenna may be allowed.

. . .

2.4.8 To reduce multipath interference to **Facility Performance** Category III glide paths and to reduce siting requirements and sensitive areas at these sites, it is desirable that the signals forming the horizontal radiation pattern from the **Facility Performance** Category III — ILS glide path antenna system be reduced to as low a value as practicable outside the azimuth coverage limits specified in 6.3, 6.3.1.5.3. Another acceptable method is to rotate in azimuth the glide path antennas away from multipath sources thus reducing the amount of radiated signals at specific angles while still maintaining the azimuth coverage limits.

2.5 Diagrams

(Figures C-6 to C-12 illustrate certain of the Standards contained in 6.3)
Editorial Note. Modify the last sentence of the caption of Figure C-6 as follows:

For **Facility Performance** Categories I and II ILS the ratio ~~should~~ **shall** be greater than 0.903 and for **Facility Performance** Category III the ratio should be greater than 0.951.

. . .

2.8.2.4 A design analysis can be used to calculate the level of integrity of the system in any one landing. [...]

. . .

M_2 = MTBF of the monitoring and associated control system

$\frac{1}{\alpha_1}$ = ratio of the rate of failure in the transmitter resulting in the radiation of an erroneous signal to the rate of all transmitter failures

~~$\frac{1}{\alpha_1}$ = ratio of the rate of failure in the transmitter resulting in the radiation of an erroneous signal to the rate of all transmitter failures~~

$\frac{1}{\alpha_2}$ = ratio of the rate of failure in the monitoring and associated control system resulting in inability to detect an erroneous signal to the rate of all monitoring and associated control system failures

2.8.3.1 A design analysis ~~should~~ **shall** be used to predict the MTBF and continuity of service of the ILS equipment. Before assignment of a level of continuity of service and introduction into ~~Category II or III~~ service, ~~however,~~ the mean time between outages (MTBO) of the **Level 2, 3 or 4** ILS ~~should~~ **shall** be confirmed by evaluation in an operational environment. [...]

...

2.8.3.3 *Additional detailed guidance.* Several States have published continuity of service policies and procedures. The following documents may be consulted for additional guidance and details:

...

b) *Instrument Landing System Continuity of Service Requirements and Procedures*, Order 6750.57A, United States Federal Aviation Administration.

2.14 ILS classification — supplementary ILS description method with objective to facilitate operational utilization

2.14.1 The classification system given below, in conjunction with the current facility performance categories, is intended to provide a more comprehensive method of describing an ILS.

2.14.2 The ILS **localizer** classification is defined by using three characters as follows:

a) I, II or III: this character indicates conformance to Facility Performance Category in ~~Chapter~~ 6.3, 6.3.1.3 ~~and 3.1.5.~~

b) A, B, C, T, D or E: this character defines the ILS points to which the localizer structure conforms to the course structure given at ~~Chapter~~ 6.3, 6.3.1.3.4.2, except the letter T, which designates the runway threshold. The points are defined in ~~Chapter~~ 6.3, 6.3.1.1.

c) 1, 2, 3 or 4: this number indicates the level of integrity and continuity of service of **the localizer as defined in** ~~Chapter~~ 6.3, 6.3.1.3.12 and summarized ~~given~~ in Table C-4.

~~*Note.— In relation to specific ILS operations it is intended that the level of integrity and continuity of service would typically be associated as follows:*~~

~~*1) Level 2 is the performance objective for ILS equipment used to support low visibility operations when ILS guidance for position information in the landing phase is supplemented by visual cues. This level is a recommended objective for equipment supporting Category I operations;*~~

~~*2) Level 3 is the performance objective for ILS equipment used to support operations which place a high degree of reliance on ILS guidance for positioning through touchdown. This level is a required objective for equipment supporting Category II and IIIA operations; and*~~

~~*3) Level 4 is the performance objective for ILS equipment used to support operations which place a high degree of reliance on ILS guidance throughout touchdown and rollout. This level basically relates to the needs of the full range of Category III operations.*~~

2.14.3 The ILS glide path classification is defined by using three characters as follows:

a) I, II or III: this character indicates conformance to Facility Performance Category in ~~Chapter~~ 6.3, 6.3.1.3 and 6.3.1.5.

b) A, B, C or T: this character defines the ILS points to which the glide path structure conforms to the path structure given at ~~Chapter~~ 6.3, 6.3.1.5.4.2, except the letter T, which designates the runway threshold. The points are defined in ~~Chapter~~ 6.3, 6.3.1.1.

c) 1, 2, 3 or 4: this number indicates the level of integrity and continuity of service of the glide path as defined in ~~Chapter~~ 6.3, 6.3.1.5.8 and summarized in Table C-4.

2.14.4 *Examples*

2.14.~~3~~4.1 As an example, a Facility Performance Category II — localizer ~~ILS~~ which meets the localizer course structure criteria appropriate to a Facility Performance Category III — localizer ~~ILS~~ down to ILS point "D" and conforms to the integrity and continuity of service objectives of Level 3 would be described as class II/D/3....

2.14.4.2 As an example, a Facility Performance Category I — glide path which meets the glide path structure criteria appropriate to a Facility Performance Category III — glide path down to ILS point "T" and conforms to the integrity and continuity of service objectives of Level 3 would be described as class I/T/3.

2.14.~~4~~5 ILS classes are appropriate only to the ground ILS element. Consideration of operational categories must also include additional factors such as operator capability, critical and sensitive area protection, procedural criteria and ancillary aids, such as transmissometers and lights.

...

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

...

3.1.2 Two types of approach and landing operations with vertical guidance (APV), APV-I and APV-II, use vertical guidance relative to a glide path, but the facility or navigation system may not satisfy all of the requirements associated with precision approach. These operations combine the lateral performance equal to that of an Facility Performance ~~ILS~~ Category I localizer with different levels of vertical guidance. [...]

...

3.3.6 Alert limits for typical operations are provided in Note 2 to Table 3.7.2.4-1. A range of vertical alert limits (VAL) from 10 m (33 ft) to 35 m (115 ft) is specified for Category I precision approach operations, reflecting potential differences in system design that may affect the operation. The derivation of the range values is explained in 3.3.7 and 3.3.8. When using a VAL greater than 10 m (33 ft), a system-specific analysis must determine which value in the 10 m (33 ft) to 35 m (115 ft) range is appropriate to ensure suitable guidance quality. The analysis must take into account the system monitor design and other factors relevant to system implementation (i.e. additional mechanisms which prevent exposure to significant vertical biases). In the case of SBAS, this analysis is normally done by the augmentation system service provider, supported by the system designer and accepted by the appropriate safety oversight authority. Additionally, regardless of the VAL used, local implementation- and procedure-specific safety cases are normally conducted separately from the system-specific safety case. These are conducted by the local air navigation service provider, taking into account information provided by the augmentation system service provider (see 3.3.9 and 3.3.10).

3.3.7 The range of values for VAL reflects the different characteristics of GNSS integrity monitoring as compared to ILS integrity monitoring. In ILS, monitor thresholds for key signal parameters are standardized, and the monitors themselves have very low measurement ~~noise~~ uncertainty on the parameter that is being monitored. With differential GNSS, some system monitors have comparably large measurement noise uncertainty whose impact must be considered on the intended operation. In all cases, the effect of the alert limit is to restrict the satellite-user geometry to one where the monitor performance (typically in the pseudo-range domain) is acceptable when translated into the position domain. ~~3.3.7~~ The smallest (most stringent) precision approach vertical alert limit (VAL) value (10 m (33 ft)) was derived based on the monitor performance of ILS as it could affect the glide slope at a nominal decision altitude of 60 m (200 ft) above the runway threshold, without taking into account the specific characteristics of GNSS integrity monitoring which could potentially enable the use of a less stringent VAL. By applying ~~this alert limit~~ the 10 m (33 ft) VAL, the GNSS error, under faulted conditions, can be directly compared to an ILS error under faulted conditions, such that the GNSS errors are less than or equal to the ILS errors. For those faulted conditions with comparably large measurement ~~noise~~ uncertainty in GNSS, this results in monitor thresholds which are more stringent than ILS. When using a 10 m (33 ft) VAL no further analysis of navigation system error distribution is required.

3.3.8 The largest precision approach VAL value (35 m (115 ft)) was derived to ensure obstacle clearance equivalent to ILS for those error conditions which can be modelled as a bias during the final approach, taking into account that the aircraft decision altitude is independently derived from barometric pressure. An assessment has been conducted of the worst-case effect of a latent bias error equal to the alert limit of 35 m (115 ft), concluding that adequate obstacle clearance protection is provided on the approach and missed approach (considering the decision altitude would be reached early or late, using an independent barometric altimeter). It is important to recognize that this assessment only addressed obstacle clearance and is limited to those error conditions which can be modelled as bias errors. Analysis has shown 35 m (115 ft) bias high and low conditions can be tolerated up to the approach speed category (Categories A through D) glide path angle limits in the *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS, Doc 8168) without impinging on the ILS obstacle clearance surfaces during the instrument segment of the approach. However, it is important to note that GNSS systems using a VAL greater than 10 m (33 ft) will not produce sustained bias errors of such magnitude. Instead, the increased VAL is used in conjunction with additional system monitors to produce guidance quality equivalent to or better than ILS. When using a VAL greater than 10 m (33 ft), additional characterization of navigation system error distribution is required to ensure that position errors, in both the instrument and visual segments of the approach, are sufficiently small to ensure obstacle clearance and acceptable touchdown performance.

3.3.9 ~~Since the analysis of a 35 m (115 ft) VAL is limited in scope, a system-level safety analysis should be completed before using any value greater than 10 m (33 ft) for a specific system design. The safety analysis should consider obstacle clearance criteria and risk of collision due to~~

~~navigation error, and the risk of unsafe landing due to navigation error, given the system design characteristics and operational environment (such as the type of aircraft conducting the approach and the supporting airport infrastructure). With respect to the collision risk, it is sufficient to confirm that the assumptions identified in 3.3.8 are valid for the use of a 35 m (115 ft) VAL. With respect to an unsafe landing, the principal mitigation for a navigation error is pilot intervention during the visual segment. Limited operational trials, in conjunction with operational expertise, have indicated that navigation errors of less than 15 m (50 ft) consistently result in acceptable touchdown performance. For errors larger than 15 m (50 ft), there can be a significant increase in the flight crew workload and potentially a significant reduction in the safety margin, particularly for errors that shift the point where the aircraft reaches the decision altitude closer to the runway threshold where the flight crew may attempt to land with an unusually high rate of descent. The hazard severity of this event is major (see the Safety Management Manual (SMM) (Doc 9859)).~~ When conducting the system-specific safety assessment to support the use of a VAL greater than 10 m (33 ft), the factors discussed below ~~should~~ shall be considered.

3.3.9.1 When a visual contact with approach/runway lighting or marking is established and the pilot takes a decision to land, the instrument phase ends and the flight continues with a visual reference. In the presence of a vertical navigation system error (VNSE), pilots may not be able to recognize a navigation error during the transition from the instrument to the visual segment. As a consequence of the VNSE, the decision altitude may be reached either above or below the nominal flight path, such that there might be a necessity to manually align the aircraft with reference to visual cues in order to cross the runway threshold at a height suitable for landing. Such actions, in a very late phase of flight, could lead to a destabilization of the approach or a go-around from inside the visual segment. Although possible consequences of the exposure to a VNSE depend on various contributors, such as flight technical error (FTE), aircraft velocity, wind speed, glide path angle, visibility, runway lighting and human performance, the magnitude of the VNSE is the most relevant factor for assessing the safety of the navigation system.

3.3.9.2 The following values of the VNSE ~~should~~ shall be considered in the design of the augmentation system:

a) VNSE of 4 m (13 ft) or less. This is considered as an equivalent to ILS Category I with acceptable touchdown performance and a standard number of missed approaches due to visibility conditions.

b) VNSE higher than 4 m (13 ft) but not higher than 10 m (33 ft). Either a safe landing with an acceptable touchdown performance or a go-around can be expected.

c) VNSE higher than 10 m (33 ft) but not higher than 15 m (50 ft). The touchdown performance may be affected and flight crew workload may be increased.

d) VNSE higher than 15 m (50 ft). The safety margin would be significantly reduced under some operational configurations.

3.3.9.3 In considering the values above, ~~O~~one acceptable means to manage the risks in the visual segment is for the system to comply with the following criteria:

a) the fault-free accuracy is equivalent to ILS at ILS point B. This includes system 95 per cent VNSE ~~vertical navigation system error (NSE) less~~ than 4 m (13 ft), and a fault-free system ~~vertical NSE~~ VNSE exceeding 10 m (33 ft) with a probability less than 10-7 per approach for each location where the operation is to be approved. This assessment is performed over all environmental and operational conditions under which the service is declared available;

b) under system failure conditions, the system design is such that the probability of an error greater than 15 m (50 ft) is lower than 10^{-5}, so that the likelihood of occurrence is remote. The fault conditions to be taken into account are those affecting either the core constellations or the GNSS augmentation under consideration. This probability is to be understood as the combination of the occurrence probability of a given failure with the probability of detection for applicable monitor(s). Typically, the probability of a single fault is large enough that a monitor is required to satisfy this condition.

3.3.9.4 In case these criteria are applied, the service provider could declare the Category I service area considering where Category I integrity is available, for a given VAL in the 10 m (33 ft) to 35 m (115 ft) range, in accordance with the system analysis showing where the additional conditions a) and b) described above are met.

Note.— Further guidance on the technical interpretation of these requirements is given in the **GNSS Manual** *(Doc 9849, SBAS Operations, 4.3.3.3).*

3.3.10 For GBAS, a technical provision has been made to broadcast the alert limit to aircraft. For SBAS, technical provisions have been made to specify the alert limit through an updatable database (see Attachment 6C).

6.2.2 Satellite-based augmentation services are provided by the Wide Area Augmentation System (WAAS) (North America), the European Geostationary Navigation Overlay Service (EGNOS) (Europe and Africa), the **Michibiki** ~~Multifunction Transport Satellite (MTSAT)~~ Satellite-based Augmentation **Service** ~~System~~ (MSAS) (Japan) and the GPS-aided Geo-augmented Navigation (GAGAN) (India). The System of Differential Correction and Monitoring (SDCM) (Russia), **the BeiDou SBAS (BDSBAS) (China), the Korea Augmentation Satellite System (KASS) (Republic of Korea), the SBAS for Africa and Indian Ocean (A-SBAS) (ASECNA) and the Southern Positioning Augmentation Network (SPAN) (Australia and New Zealand)** ~~and other SBAS systems~~ are also under development to provide these services.

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7. GROUND-BASED AUGMENTATION SYSTEM (GBAS) AND GROUND-BASED REGIONAL AUGMENTATION SYSTEM (GRAS)

7.2 RF characteristics

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7.2.1.4.2 The geographic separation for co-channel, co-slot GBAS VDB assignments is obtained by determining the distance at which the transmission loss equals 145 dB for receiver altitude of 3 000 m (10 000 ft) above that of the GBAS VDB transmitter antenna. This distance is 318 km (172 NM) using the free-space attenuation approximation and assuming a negligible transmitter antenna height. The minimum required geographical separation can then be determined by adding this distance to the nominal distance between the edge of ~~VDB coverage~~ **the service volume** and the ~~GBAS~~ VDB transmitter **antenna**. **For example, using a service volume extending to** 43 km (23 NM) **from the VDB transmitter antenna**. Results in a co-channel, co-slot reuse distance of 361 km (195 NM).

7.2.1.5 *Guidelines on GBAS/GBAS geographical separation criteria.* Using the methodology described above, typical geographic separation criteria can be defined for GBAS to GBAS and GBAS to VOR. The resulting GBAS/GBAS minimum required geographical separation criteria are summarized in Table D-4.

Note.— Geographical separation criteria between the ~~GBAS~~ VDB transmitters ***antennas*** *providing the GBAS positioning service are under development. A conservative value corresponding to the radio horizon may be used as an interim value for separation between co-frequency, adjacent time slot transmitters to ensure time slots do not overlap.*

. . .

7.2.3.2 *Same-airport compatibility*. To analyse the constraints for the deployment of a GBAS ground station at the same airport as ILS, it is necessary to consider ILS and VDB compatibility in detail taking into account information such as the actual desired service field strength and actual undesired service transmit antenna radiation patterns. For GBAS equipment with transmitter power such that the maximum field strength of 0.879 volts per metre (−27 dBW/m2) for the horizontally polarized signal component is not exceeded in the ILS coverage volume, the 16th channel (and beyond) will be below −100.5 dBm in a 25 kHz bandwidth at a distance of 80 m from the VDB transmitter antenna, including allowance for a +5 dB increase due to constructive multipath. This −100.5 dBm in a 25 kHz bandwidth translates to a signal-to-noise ratio of 21.5 dB (above the assumed minimum signal-to-noise ratio of 20 dB) for a −79 dBm localizer signal which corresponds to an ILS localizer field strength of 90 microvolts per metre (−107 dBW/m2).

7.2.3.3 At those locations where an ILS facility and a GBAS facility serve opposite approach directions to the same runway, there is a possibility of interference to the GBAS VDB signals in the region where the aircraft overflies the localizer. The interference can result in exceedance of the message failure rate requirement (Appendix 6B, 3.6.8.2.2.3) and cause a loss of continuity of GBAS guidance. The condition of unacceptable interference is when the ILS localizer signal does not support compliance with the requirements in Appendix 6B, 3.6.8.2.2.5 and 3.6.8.2.2.6, defining the desired to undesired signal ratios and the maximum adjacent channel power tolerable by the GBAS VDB receiver. The interference is likely to be higher when the localizer is sited close to the runway threshold. ~~Chapter~~ 6.3, 6.3.1.2.8 specifies the conditions under which radiation by localizers not in operational use ~~should~~ shall not be allowed. Compliance with 6.3.1.2.8 will ensure there is no interference by the ILS localizer to GBAS during low visibility operations that require GAST D. Generally, this ~~should~~ shall not be an issue for GAST C operations due to the 3.5 seconds window allowed to receive three Type 1 messages, when the aircraft overflies the localizer. However, there may be conditions during GAST C operations where the VDB signal power does not support the D/U, or the maximum ILS localizer power is incompatible with recovery from short-term excess undesired signal power (Appendix 6B, 3.6.8.2.2.6.5), and that would require the localizer to be turned off.

7.2.4 *Compatibility with VHF communications*. For GBAS VDB assignments above 116.400 MHz, it is necessary to consider VHF communications and GBAS VDB compatibility. Considerations for assignment of these VDB channels include the frequency separation between the VHF communication and the VDB, the distance separation between the transmitters **antennas** and coverage areas, the field strengths, the polarization of the VDB signal, and the VDB and VHF communication receiver sensitivity. Both aircraft and ground VHF communication equipment are to be considered. For GBAS/E equipment with a transmitter maximum power of up to 150 W (100 W for horizontal **component and** 50 W **for vertical component), the** 64th channel (and beyond) will be below −112 dBm in a 25 kHz bandwidth at a distance of 80 m from the VDB transmitter **antenna** including an allowance of +5 dB increase due to constructive multipath. For GBAS/H equipment with a transmitter maximum power of 100 W, the 32nd channel (and beyond) will be below −112 dBm in a 25 kHz bandwidth at a distance of 80 m from the VDB transmitter **antenna** including an allowance of +5 dB increase due to constructive multipath, and a 10 dB polarization isolation. It must be noted that due to differences in the GBAS VDB and VDL transmitter masks, separate analysis must be performed to ensure VDL does not interfere with the GBAS VDB.

. . .

7.3.2.3 Simplified analysis method.
In order to apply this method, it is assumed the following:

o VDB transmitters **antennas** are installed above a planar ground with line-of-sight to runways in the desired GBAS service volume as mentioned in 7.12.3.

. . .

To estimate the power *PhdBm* (in dBm) at a height *h* (in metres) from the power *Ph0dBm* at a height h0 (in metres), one can use the following expression:

$$P_{hdBm} = P_{h_0 dBm} + 20\log\left(\sin\left(\frac{2\pi h h_a}{\lambda d}\right)\right) - 20\log\left(\sin\left(\frac{2\pi h_0 h_a}{\lambda d}\right)\right)$$

Where

- d is the **horizontal** distance to the transmitter antenna in metres
- h_a is the height of the transmitter antenna phase centre in metres
- $\lambda = c / f$ is the wavelength in metres
- f is the frequency in Hertz
- c is the speed of light

...

The applicability of the above-mentioned formula at different heights above the runway surface may vary with the distance between the VDB transmitter antenna and the intended path on the runway surface, and the VDB transmitter **antenna** height. Some siting constraints may be needed to verify the minimum signal strength is met in the service volume above the runway surface.

...

7.12.3 *Locating the VDB **transmitter** antenna.* The VDB **transmitter** antenna must be located to comply with the minimum and maximum field strength requirements within the service volume(s) as defined in ~~Chapter~~ 6.3, 6.3.7.3.5.4.4. Compliance with the minimum field strength for approach services can generally be met if the VDB **transmitter** antenna is located so that an unobstructed line-of-sight exists from the antenna to any point within the service volume for each supported FAS. Consideration ~~should~~ shall also be given to ensuring the minimum **VDB** transmitter **antenna**-to-~~receiver~~ **aircraft antenna** separation so that the **maximum field strength is not exceeded**. [...]

7.12.3.1 In order to ensure that the maximum field strength requirements defined in ~~Chapter~~ 6.3, **6**.3.7.3.5.4.4 are not violated, VDB transmitters **antennas** ~~should~~ **shall** not be located any closer than 80 m to where aircraft are approved to operate based on published procedures using GBAS or ILS guidance information. This applies to aircraft on final approach, departure, and on runways. The 80-metre separation applies to the slant range distance between VDB transmitter antennas and the aircraft antenna position. [...]

...

NEW AMENDED REGULATIONS :

6.2.3 Provision of information on the operational status of radio navigation services

6.2.3.1 Aerodrome control towers and units providing approach control service shall be provided with information on the operational status of radio navigation services essential for approach, landing and take-off at the aerodrome(s) with which they are concerned, on a timely basis consistent with the use of the service(s) involved.

Note.— Guidance material on the application of this Standard in the case of PBN-based operations supported by GNSS is contained in the Performance-based Navigation (PBN) Manual *(Doc 9613).*

...

6.3. SPECIFICATIONS FOR RADIO NAVIGATION AIDS

. . .

6.3.1 Specification for ILS

6.3.1.1 Definitions

. . .

Facility Performance Category I — ILS. An ILS which provides guidance information from the coverage limit of the ILS to the point at which the localizer course line intersects the ILS glide path at a height of 30 m (100 ft) or less above the horizontal plane containing the threshold.

Note.— The lower limit is set to 30 m (100 ft) below the minimum Category I decision height (DH).

Facility Performance Category II — ILS. An ILS which provides guidance information from the coverage limit of the ILS to the point at which the localizer course line intersects the ILS glide path at a height of 15 m (50 ft) or less above the horizontal plane containing the threshold.

Note.— The lower limit is set to 15 m (50 ft) below the minimum Category II decision height (DH).

. . .

6.3.1.2.1.3 Facility Performance Categories I, II and III — ILS shall provide indications at designated remote control points of the operational status of all ILS ground system components, as follows:

a) for all Facility Performance Category II and Category III ILS, the air traffic services unit involved in the control of aircraft on the final approach shall be one of the designated remote control points and shall receive information on the operational status of the ILS, with a delay commensurate with the requirements of the operational environment;

b) for a Facility Performance Category I ILS, if that ILS provides an essential radio navigation service, the air traffic services unit involved in the control of aircraft on the final approach shall be one of the designated remote control points and shall receive information on the operational status of the ILS, with a delay commensurate with the requirements of the operational environment.

Note - The indications required by this Standard are intended as a tool to support air traffic management functions, and the applicable timeliness requirements are sized accordingly (consistently with 6.2.3.1).

. . .

6.3.1.2.6 To ensure an adequate level of safety, the ILS shall be so designed and maintained that the probability of operation within the performance requirements specified is of a high value, consistent with the category of operational performance concerned

6.3.1.2.6.1 For Facility Performance Category II and III localizers and glide paths, the level of integrity and continuity of service shall be at least Level 3, as defined in 6.3.1.3.12.4 (localizer) and 6.3.1.5.8.4 (glide path).

Note.— The specifications for Facility Performance Categories II and III — ILS are intended to achieve the highest degree of system integrity, reliability and stability of operation under the most adverse environmental conditions to be encountered. Guidance material to achieve this objective is given in 2.8 of Attachment 6C.

6.3.1.2.7 At those locations where two separate ILS facilities serve opposite ends of a single runway, and operationally harmful interference would be present if both facilities were transmitting, an interlock shall ensure that only the localizer serving the approach direction in use shall radiate.

Note 1.— While a low height overflight of a transmitting localizer may generate interference within airborne ILS receivers, this interference may only be considered as operationally harmful when it occurs in specific conditions, e.g. without visual cues of the runway, or when the autopilot is engaged. Additional guidance material is contained in 2.1.8 and 2.13 of Attachment 6C.

Note 2.— Interference may also be caused by transmissions from other localizers not serving the opposite end of the same runway (i.e. crossing, parallel or adjacent runways). In such cases, use of interlock to prevent the interference can also be considered.

Note 3 An interlock can be provided through hardware, software or an equivalent procedural means.

6.3.1.2.7. 1 At locations where ILS facilities serving opposite ends of the same [...].

...

6.3.1.2.8 At those locations where an ILS facility and a GBAS facility serve opposite approach directions to the same runway, when the approach direction in use is not the direction served by the ILS, the localizer shall not radiate when GBAS low visibility operations that require GAST D are being conducted, except where it can be demonstrated that the localizer signal supports compliance with the requirements in Appendix 6B, 3.6.8.2.2.5 and 3.6.8.2.2.6 defining the desired to undesired signal ratios and the maximum adjacent channel power tolerable by the GBAS VDB receiver.

Note.— If the localizer is radiating there is a possibility of interference to the GBAS VDB signals in the region where the aircraft overflies the localizer. A means to ensure that the localizer does not radiate can be provided through either hardware or software interlock or a procedural mitigation. Additional guidance material is contained in Attachment 6C, 2.1.8.1 and Attachment 6D 7.2.3.3.

6.3.1.3.3.2.1 For Facility Performance Category I localizers, the minimum field strength on the ILS glide path and within the localizer course sector from a distance of 18.5 km (10 NM) to a height of 30 m (100 ft) above the horizontal plane containing the threshold shall be not less than 90 microvolts per metre (minus 107 dBW/m^2).

...

6.3.1.3.4.2 For Facility Performance Categories II and III localizers, bends in the course line shall not have amplitudes which exceed the following:

...

and, for Facility Performance Category III only:

...

6.3.1.3.5.3.4 With two-frequency localizer systems, 6.3.1.3.5.3.3 shall apply to each carrier. In addition, the 90 Hz modulating tone of one carrier shall be phase-locked to the 90 Hz modulating tone of the other carrier so that the demodulated wave forms pass through zero in the same direction within:

a) for Facility Performance Categories I and II localizers: 20 degrees; and
b) for Facility Performance Category III localizers: 10 degrees,

of phase relative to 90 Hz. Similarly, the 150 Hz tones of the two carriers shall be phase-locked so that the demodulated wave forms pass through zero in the same direction within:

1) for Facility Performance Categories I and II localizers: 20 degrees; and

2) for Facility Performance Category III localizers: 10 degrees,
of phase relative to 150 Hz.

6.3.1.3.6.2 For Facility Performance Category II localizers, the mean course line shall be adjusted and maintained within limits equivalent to plus or minus 4.5 m (15 ft) displacement from runway centre line at the ILS reference datum.

...

Note 2.— It is intended that new Facility Performance Category II installations are to meet the requirements of 6.3.1.3.6.2.

...

6.3.1.3.7 *Displacement sensitivity*

6.3.1.3.7.1 The nominal displacement sensitivity within the half course sector shall be the equivalent of 0.00145 DDM/m (0.00044 DDM/ft) at the ILS reference datum except that for Facility Performance Category I localizers, where the specified nominal displacement sensitivity cannot be met, the displacement sensitivity shall be adjusted as near as possible to that value. For Facility Performance Category I localizers on runway codes 1 and 2, the nominal displacement sensitivity shall be achieved at the ILS Point "B". The maximum course sector angle shall not exceed six degrees.

6.3.1.3.8.2 Facility Performance Category III localizers shall not provide such a channel, except where extreme care has been taken in the design and operation of the facility to ensure that there is no possibility of interference with the navigational guidance

6.3.1.3.11.2 The conditions requiring initiation of monitor action shall be the following:

...

Note.— It is important to recognize that a frequency change resulting in a loss of the frequency difference specified in 6.3.1.3.2.1 may produce a hazardous condition. This problem is of greater operational significance for Facility Performance Categories II and III installations. As necessary, this problem can be dealt with through special monitoring provisions or highly reliable circuitry.

...

6.3.1.3.11.3.1 The total period referred to under 6.3.1.3.11.3 shall not exceed under any circumstances:

10 seconds for Facility Performance Category I localizers;

5 seconds for Facility Performance Category II localizers;

2 seconds for Facility Performance Category III localizers.

...

6.3.1.3.11.3.2 Where practicable, the total period under 6.3.1.3.11.3.1 shall be reduced so as not to exceed two seconds for Facility Performance Category II localizers and one second for Facility Performance Category III localizers.

6.3.1.3.12 Integrity and continuity of service levels and requirements

6.3.1.3.12.1 A localizer shall be assigned a level of integrity and continuity of service as given in 6.3.1.3.12.2 to 6.3.1.3.12.5.

Note.— Levels are used to provide the necessary information for the determination of the category of operation and associated minima, which are a function of the Facility Performance Category, the (separate) integrity and continuity of service level, and a number of operational factors (e.g. aircraft and crew qualification, meteorological conditions, and runway features). If a localizer does not meet its required integrity and continuity of service level, some operational use may still be possible, as stated in the Manual of All-Weather Operations *(Doc 9365), Appendix 6C on ILS facility classification and downgrading. Similarly, if a localizer exceeds the minimum integrity and continuity of service level, more demanding operations may be possible.*

6.3.1.3.12.2 The localizer level shall be Level 1 if either:

a) the localizer's integrity of service or its continuity of service, or both, are not demonstrated; or

b) the localizer's integrity of service and its continuity of service are both demonstrated, but at least one of them does not meet the requirements of Level 2.

6.3.1.3.12.2.1 The probability of not radiating false guidance signals shall not be less than $1 - 1.0 \times 10^{-7}$ in any one landing for Level 1 localizers.

6.3.1.3.12.2.2 The probability of not losing the radiated guidance signal shall exceed $1 - 4 \times 10^{-6}$ in any period of 15 seconds for Level 1 localizers (equivalent to 1 000 hours mean time between outages).

Note.— A localizer that meets both Recommended Practices 6.3.1.3.12.2.1 and 6.3.1.3.12.2.2 also meets Standard 6.3.1.3.12.3 (Level 2 performance) and is therefore to be identified as Level 2.

6.3.1.3.12.2.3 In the event that the integrity value for a Level 1 localizer is not available or cannot be readily calculated, a detailed analysis shall be performed to assure proper monitor fail-safe operation.

6.3.1.3.12.3 The localizer level shall be Level 2 if:

a) the probability of not radiating false guidance signals is not less than $1 - 1.0 \times 10^{-7}$ in any one landing; and

b) the probability of not losing the radiated guidance is greater than $1 - 4 \times 10^{-6}$ in any period of 15 seconds (equivalent to 1 000 hours mean time between outages).

6.3.1.3.12.4 The localizer level shall be Level 3 if:

a) the probability of not radiating false guidance signals is not less than $1 - 0.5 \times 10^{-9}$ in any one landing; and

b) the probability of not losing the radiated guidance is greater than $1 - 2 \times 10^{-6}$ in any period of 15 seconds (equivalent to 2 000 hours mean time between outages).

6.3.1.3.12.5 The localizer level shall be Level 4 if:

a) the probability of not radiating false guidance signals is not less than $1 - 0.5 \times 10^{-9}$ in any one landing; and

b) the probability of not losing the radiated guidance is greater than $1 - 2 \times 10^{-6}$ in any period of 30 seconds (equivalent to 4 000 hours mean time between outages).

Note.— Guidance material on ways to achieve integrity and continuity of service is given in Attachment 6C, 2.8.

. . .

6.3.1.5.5.3.1 With two-frequency glide path systems, 6.3.1.5.5.3 shall apply to each carrier. In addition, the 90 Hz modulating tone of one carrier shall be phase-locked to the 90 Hz modulating tone of the other carrier so that the demodulated wave forms pass through zero in the same direction within:

a) for Facility Performance Categories I and II — ILS glide paths: 20 degrees;

b) for Facility Performance Category III — ILS glide paths: 10 degrees,

of phase relative to 90 Hz. Similarly, the 150 Hz tones of the two carriers shall be phase-locked so that the demodulated wave forms pass through zero in the same direction, within:

1) for Facility Performance Categories I and II — ILS glide paths: 20 degrees;

2) for Facility Performance Category III — ILS glide paths: 10 degrees,
of phase relative to 150 Hz.

. . .

6.3.1.5.7.1 The automatic monitor system shall provide a warning to the designated control points and cause radiation to cease within the periods specified in 6.3.1.5.7.3.1 if any of the following conditions persist:

. . .

Note.— It is important to recognize that a frequency change resulting in a loss of the frequency difference specified in 6.3.1.5.2.1 may produce a hazardous condition. This problem is of greater operational significance for Facility Performance Categories II and III installations. As necessary, this problem can be dealt with through special monitoring provisions or highly reliable circuitry.

. . .

6.3.1.5.7.3.1 The total period referred to under 6.3.1.5.7.3 shall not exceed under any circumstances:

6 seconds for Facility Performance Category I — ILS glide paths;

2 seconds for Facility Performance Categories II and III — ILS glide paths.

. . .

6.3.1.5.7.3.2 Where practicable, the total period specified under 6.3.1.5.7.3.1 for Facility Performance Categories II and III — ILS glide paths shall not exceed 1 second.

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6.3.1.5.8 Integrity and continuity of service levels and requirements

6.3.1.5.8.1 . A glide path shall be assigned a level of integrity and continuity of service as given in 6.3.1.5.8.2 to 6.3.1.5.8.5.

Note.— Levels are used to provide the necessary information for the determination of the category of operation and associated minima, which are a function of the Facility Performance Category, *the (separate) integrity and continuity of service level, and a number of operational factors (e.g. aircraft and crew qualification, meteorological conditions, and runway features). If a glide path does not meet its required integrity and continuity of service level, some operational use may still be possible, as stated in the* Manual of All-Weather Operations *(Doc 9365), Appendix 6C on ILS facility classification and downgrading. Similarly, if a glide path exceeds the minimum integrity and continuity of service level, more demanding operations may be possible.*

6.3.1.5.8.2 The glide path level shall be Level 1 if either:

a) the glide path's integrity of service or its continuity of service, or both, are not demonstrated; or

b) the glide path's integrity of service and its continuity of service are both demonstrated, but at least one of them does not meet the requirements of Level 2.

6.3.1.5.8.2.1 The probability of not radiating false guidance signals shall not be less than $1 - 1.0 \times 10^{-7}$ in any one landing for Level 1 glide paths

6.3.1.5.8.2.2 The probability of not losing the radiated guidance signal shall exceed $1 - 4 \times 10^{-6}$ in any period of 15 seconds for Facility Performance Category I Level 1 glide paths (equivalent to 1 000 hours mean time between outages).

Note.— A glide path that meets both Recommended Practices 6.3.1.5.8.2.1 and 6.3.1.5.8.2.2 also meets Standard 6.3.1.5.8.3 (Level 2 performance) and is therefore to be identified as Level 2.

6.3.1.5.8.2.3 In the event that the integrity value for a Level 1 glide path is not available or cannot be readily calculated, a detailed analysis shall be performed to assure proper monitor fail-safe operation.

6.3.1.5.8.3 The glide path level shall be Level 2 if:

a) the probability of not radiating false guidance signals is not less than $1 - 1.0 \times 10^{-7}$ in any one landing; and

b) the probability of not losing the radiated guidance is greater $1 - 4 \times 10^{-6}$ in any period of 15 seconds (equivalent to 1 000 hours mean time between outages).

6.3.1.5.8.4 The glide path level shall be Level 3 or 4 if:

a) the probability of not radiating false guidance signals is not less than $1 - 0.5 \times 10^{-9}$ in any one landing; and
b) the probability of not losing the radiated guidance is greater than $1 - 2 \times 10^{-6}$ in any period of 15 seconds (equivalent to 2 000 hours mean time between outages).

Note 1.— The requirements for glide path Level 3 and Level 4 are the same. The declaration of the glide path integrity and continuity of service levels shall match the declaration of the localizer (i.e. the glide path is declared as Level 4 if the localizer is meeting Level 4).

Note 2.— Guidance material on ways to achieve integrity and continuity of service is given in 2.8 of Attachment 6C

6.3.7 Requirements for the Global Navigation Satellite System (GNSS)

6.3.7.2.3.2 *Time reference.* The time data provided by the GNSS to the user shall be expressed in a time scale that takes the Coordinated Universal Time (UTC) as reference.

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

1. DEFINITIONS

GBAS/E. A ground-based augmentation system transmitting an elliptically-polarized VHF data broadcast.

GBAS/H. A ground-based augmentation system transmitting a horizontally-polarized VHF data broadcast.

Receiver. A subsystem that receives GNSS signals and includes one or more sensors.

Reserved (bits/words/fields). Bits/words/fields that are not allocated, but which are reserved for a particular GNSS application.

S_{max}. Maximum desired VHF data broadcast signal power at the VHF data broadcast receiver input. This power at the receiver input is computed from the maximum RF field strength defined in 6.3, 6.3.7.3.5.4.4 for the desired VHF data broadcast signal as received by an ideal isotropic antenna minus the minimum aircraft implementation loss. It is used to determine the VHF data broadcast interference immunity to adjacent channel signals (3.6.8.2.2.6) and to signals from sources outside the 108.000 – 117.975 MHz band (3.6.8.2.2.8).

Spare (bits/words/fields). Bits/words/fields that are not allocated or reserved, and which are available for future allocation.

Note.— All spare bits are set to zero.

2. GENERAL

Note.— The following technical specifications supplement the provisions of 6. 3, 6.3.7.

3. GNSS ELEMENTS

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3.5 Satellite-based augmentation system (SBAS)

Table B-27. SBAS service provider Identifiers

Identifier	Service provider
0	WAAS
1	EGNOS
2	MSAS
3	GAGAN
4	SDCM
5	BDSBAS
6	KASS
7	A-SBAS

8	SPAN
9 to 13	Spare
14, 15	Reserved

Table B-35. UTC standard identifier

UTC standard Identifier	UTC standard
0	UTC as operated by the Communications Research Laboratory, Tokyo, Japan
1	UTC as operated by the U.S. National Institute of Standards and Technology
2	UTC as operated by the U.S. Naval Observatory
3	UTC as operated by the International Bureau of Weights and Measures
4	Reserved for UTC as operated by a European laboratory
5	UTC as operated by the National Time Service Center, Chinese Academy of Sciences
6	Spare
7	UTC not provided

3.5.7.7.2.6 SBAS shall raise an alarm within 8 seconds if any combination of active data and GNSS signals-in-space results in an out-of-tolerance condition for en-route through APV I (3.5.7.4.1).

Note. — The monitoring applies to all failure conditions, including failures in core satellite constellation(s) or SBAS satellites. This monitoring assumes that the aircraft element complies with the requirements of RTCA DO-229D with Change 1, except as superseded by 3.5.8 and Attachment 6D, 8.11.

3.5.7.7.3 IOD monitoring. SBAS shall monitor the GPS IODE values for possible invalid 14 transmissions of values used previously for a different set of ephemeris parameters within the time interval(s) specified in 3.1.1.3.2.2, and take appropriate action to ensure the integrity of its broadcast corrections, if such an invalid use is detected

Note 1. — The IOD uniqueness is granted by design in the case of SBAS augmenting GLONASS satellites.

Note 2. — The GPS IODC (as per section 3.1.1.3.1.4) is not currently used in the processing of GPS L1 navigation messages in an SBAS receiver mode. Therefore, monitoring is not specifically required.

3.5.7.8 *Robustness to core satellite constellation(s) failures.* Upon occurrence of a core satellite constellation(s) satellite anomaly, SBAS shall continue to operate normally using the available healthy satellite signals that can be tracked.

. . .

3.6.7.2.2.2 *Low-frequency data.* Except during an ephemeris change, the first ranging source in the Type 1, Type 11 or Type 101 message shall sequence so that the low-frequency data (as defined in 3.6.4.2.1 for Type 1 message, 3.6.4.11.1 for Type 11 message and 3.6.4.10.1 for Type 101 message) for each core satellite constellation's ranging source are transmitted at least once every 10 seconds. During an ephemeris change, the first ranging source shall sequence so that the low-frequency data for each core satellite constellation's ranging source are transmitted at least once every 27 seconds. [...]

. . .

3.6.7.3.1.1 VHF data broadcast monitoring. The data broadcast transmissions shall be monitored. The transmission of the data shall cease within 0.5 seconds in case of continuous disagreement during any 3-second period between the transmitted application data and the application data derived or stored by the monitoring system prior to transmission. For FAST D ground subsystems, the transmission of Type 11 messages shall cease within 0.5 seconds in case of continuous disagreement during any 1-second period between the transmitted application data and the application data derived or stored by the monitoring system prior to transmission.

Note.— For ground subsystems that support authentication, ceasing the transmission of data means ceasing the transmission of Type 1 messages and/or Type 11 messages if applicable or ceasing the transmission of Type 101 messages. In accordance with 3.6.7.4.1.3, the ground subsystem must still transmit messages such that the defined percentage or more of every assigned slot is occupied. This can be accomplished by transmitting Type 2, Type 3, Type 4 and/or Type 5 messages.

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3.6.8 AIRCRAFT ELEMENTS

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3.6.8.2.2 *VHF data broadcast receiver performance*

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3.6.8.2.2.3 *VHF data broadcast message failure rate.* The VHF data broadcast receiver shall achieve a message failure rate less than or equal to one failed message per 1 000 full-length (222 bytes) application data messages, within the range of the RF field strength defined in Chapter 3, 3.7.3.5.4.4 as received by the airborne antenna., This requirement shall apply when the variation in the average received signal power between successive bursts in a given time slot does not exceed 40 dB. Failed messages include those lost by the VHF data broadcast receiver system or which do not pass the CRC after application of the FEC.

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3.6.8.2.2.5 *Co-channel rejection*

3.6.8.2.2.5.3 *ILS localizer as the undesired signal.* The VHF data broadcast receiver shall meet the requirements specified in 3.6.8.2.2.3 in the presence of an undesired co-channel ILS localizer signal that is 26 dB below the desired VHF data broadcast signal power at the receiver input.

3.6.8.2.2.6 *Adjacent channel rejection.* The level of ILS localizer or VOR undesired signals shall be measured as the power in the RF carrier.

Note.— Even though S_{max} is the maximum desired VHF data broadcast signal power, it is also used to limit the maximum adjacent channel undesired signal power at the receiver input.

3.6.8.2.2.6.1 First adjacent 25 kHz channels (±25 kHz). The VHF data broadcast receiver shall meet the requirements specified in 3.6.8.2.2.3 in the presence of an undesired signal with power levels at the receiver input up to S_{max} offset by 25 kHz on either side of the desired channel that is either:

a) 18 dB above the desired signal power at the receiver input when the undesired signal is another VHF data broadcast signal assigned to the same time slot(s); or

b) equal in power at the receiver input when the undesired signal is VOR; or.

c) equal in power at the receiver input when the undesired signal is ILS localizer.

3.6.8.2.2.6.2 Second adjacent 25 kHz channels (±50 kHz). The VHF data broadcast receiver shall meet the requirements specified in 3.6.8.2.2.3 in the presence of an undesired signal with power levels at the receiver input up to S_{max} offset by 50 kHz on either side of the desired channel that is either:

a) 43 dB above the desired signal power at the receiver input when the undesired signal is another VHF data broadcast source assigned to the same time slot(s); or

b) 34 dB above the desired signal power at the receiver input when the undesired signal is VOR; or.

c) 34 dB above the desired signal power at the receiver input when the undesired signal is ILS localizer.

3.6.8.2.2.6.3 *Third up to thirty-ninth adjacent 25 kHz channels (±75 kHz to ±975 kHzor more).* The VHF data broadcast receiver shall meet the requirements specified in 3.6.8.2.2.3 in the presence of an transmitted undesired signal with power levels at the receiver input up to Smax offset by 75 kHz to 975 kHz or more on either side of the desired channel that is either:

a) 46 dB above the desired signal power at the receiver input when the undesired signal is another VHF data broadcast signal assigned to the same time slot(s); or

b) 46 dB above the desired signal power at the receiver input when the undesired signal is VOR; or

c) 46 dB above the desired signal power at the receiver input when the undesired signal is ILS localizer.

3.6.8.2.2.6.4 *Fortieth and beyond adjacent 25 kHz channels (±1 MHz or more).* The VHF data broadcast receiver shall meet the requirements specified in 3.6.8.2.2.3 in the presence of an undesired signal offset by 1 MHz or more on either side of the desired channel that is either:

a) 46 dB above the desired signal power at the receiver input when the undesired signal with power levels at the receiver input up to S_{max} is another VHF data broadcast signal assigned to the same time slot(s); or

b) 46 + ΔP dB above the desired signal power at the receiver input when the undesired signal is a VOR with power levels at the receiver input up to S_{max} – ΔP dB and ΔP ranges from 0 to 14 dB; or

c) 46 + ΔP dB above the desired signal power at the receiver input when the undesired signal is an ILS localizer with power levels at the receiver input up to S_{max} – ΔP dB and ΔP ranges from 0 to 14 dB.

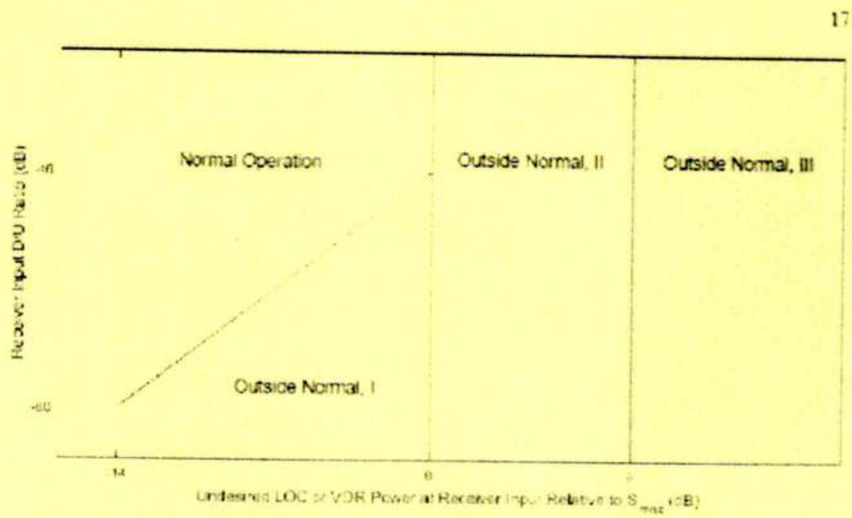
Note 1. – ΔP equals S_{max} minus the undesired signal power at the receiver input with the following two constraints. ΔP equals 0 dB when the undesired power reaches S_{max}. ΔP equals 14 dB when the undesired power is 14 dB or more below S_{max}.

Note 2. – The requirements in items b) and c) accommodate a third order intermodulation between the undesired signal and the local oscillator in the first mixer of the RF front-end of the VDB receiver; it is similar to the FM intermodulation immunity in 3.6.8.2.2.8.3 where N1 is the undesired signal and N2 is the local oscillator.

3.6.8.2.2.6.5 Receiver recovery from short-term excess undesired signal power. The VHF data broadcast receiver shall meet the requirements specified in 3.6.8.2.2.3 within 187.5 milliseconds (equivalent duration of three VDB slots) after encountering an adjacent channel interference signal (ILS localizer or VOR) whose power is above S_{max} for no more than 2.5 seconds and by no more than 9 dB at the receiver input.

Note 1. – This requirement supports brief excessive power received during ILS localizer and VOR overflight. The duration of the excess power is limited by the continuity of the operation, e.g. the opportunity to receive three Type 1 messages in every 3.5 second window (refer to 3.6.8.3.4.1) without excess power for GAST C. For GAST D, no excess power is allowed when the timeout is 1.5 seconds (refer to 3.6.8.3.4.3). A VDB undesired signal never exceeds the maximum allowed field strength of the desired VDB signal within the service volume.

Note 2. Figure B-20 shows a graphical representation of the VDB receiver regions of operation in the presence of an undesired ILS localizer or VOR signal in the fortieth or beyond adjacent 25 kHz channel, as a function of D/U and undesired signal power.



Note.:

1. The region of the figure labelled "Normal Operation" is the one in which 3.6.8.2.2.6.4 applies, and consequently 3.6.8.2.2.3 is met (MFR <= 0.001). The lower boundary of the region is the line plotting the minimum acceptable D/U ratio specified in 3.6.8.2.2.6.4 as a function of the undesired power, for values of the undesired power up to S_{max}.

2. In the other three regions of the figure, 3.6.8.2.2.6.4 does not apply. Consequently, 3.6.8.2.2.3 may not be met, and MFR may be as high as 1.

3. The region labelled "Outside Normal, I" is the one in which the D/U ratio is lower than the minimum acceptable value defined in 3.6.8.2.2.6.4 and the undesired power is lower or equal to S_{max}.

4. The region labelled "Outside Normal, II" is the one in which the undesired power is higher than S_{max} but lower than S_{max} + 9 dB. The requirement for receiver recovery from short-term excess undesired signal power specified in 3.6.8.2.2.6.5 applies in this region.

5. The region labelled "Outside Normal, III" is the one in which the undesired power is higher than S_{max} + 9 dB. Because this region is outside the expected operational environment, no receiver performance requirements apply.

Figure B-20. GBAS VDB receiver regions of operation in the presence of an undesired signal in the fortieth or beyond adjacent 25 kHz channel

ATTACHMENT 6C. INFORMATION AND MATERIAL FOR GUIDANCE IN THE APPLICATION OF THE STANDARDS AND RECOMMENDED PRACTICES FOR ILS, VOR, PAR, 75 MHz MARKER BEACONS (EN-ROUTE), NDB AND DME

2. Material concerning ILS installations

2.1 Operational objectives, design and maintenance objectives, and definition of course structure for Facility Performance Categories

2.1.1 The Facility Performance Categories defined in 6. 3, 6. 3.1.1 have operational objectives as: defined by Category I, II or III operations. Definitions of such operations are given in Annex 6.

2.1.3 Course bends. Localizer course bends shall be evaluated in terms of the course structure specified in 6.3, 6.3.1.3.4. With regard to landing and roll-out , this course structure is based on the desire to provide adequate guidance for manual and/or automatic operations along the runway in low visibility conditions. With regard to Facility Performance Category I in the approach phase, this course structure is based on the desire to restrict aircraft deviations, due to course bends (95 per cent probability basis) at the 30 m (100 ft) height, to lateral displacement of less than 10 m (30 ft). With regard to Facility Performance Categories II and III in the approach phase, this course structure is based on the desire to restrict aircraft deviations due to course bends (95 per cent probability basis) in the region between ILS Point B and the ILS reference datum (Facility Performance Category II) or Point D (Facility Performance Category III), to less than 2 degrees of roll and pitch attitude and to lateral displacement of less than 5 m (15 ft).

2.1.4 ILS glide path bends. Bends shall be evaluated in terms of the ILS glide path structure specified in 6.3, 6.3.1.5.4. With regard to Facility Performance Category I , this glide path structure is based on the desire to restrict aircraft deviations due to glide path bends (95 per cent probability basis) at the 30 m (100 ft) height, to vertical displacements of less than 3 m (10 ft). With regard to Facility Performance Categories II and III , this glide path structure is based on the desire to restrict aircraft deviations due to path bends (95 per cent probability basis) at the 15 m (50 ft) height, to less than 2 degrees of roll and pitch attitude and to vertical displacements of less than 1.2 m (4 ft).

. . .

2.1.5 Application of localizer course/glide path bend amplitude Standard. In applying the specification for localizer course structure (6.3, 6.3.1.3.4) and ILS glide path structure (6.3, 6.3.1.5.4), the following criteria shall be employed:

— Figure C-1 shows the relationship between the maximum (95 per cent probability) localizer course/glide path bend amplitudes and distances from the runway threshold that have been specified for Facility Performance Categories I, II and III ILS.

. . .

2.1.8 *Radiation by ILS localizers not in operational use.* Severe interference with operational ILS localizer signals has been experienced in aircraft carrying out approaches to low levels at runways equipped with localizer facilities serving the reciprocal direction to the approach. Interference in aircraft overflying this localizer antenna system is caused by cross modulation due to signals radiated from the reciprocal approach localizer. Such interference, in the case of low level operations, could seriously affect approach or landing, and may prejudice safety. 6.3, 6.3.1.2.7, and 6.3.1.2.7.1 specify the conditions under which radiation by localizers not in operational use may be permitted.

2.1.8.1 At those locations where an ILS facility and a GBAS facility serve opposite approach directions to the same runway, there is a possibility of interference to the reception of the GBAS VDB signals in the region where the aircraft overflies the localizer. Localizer signals that do not support compliance with the requirements in Appendix 6B, 3.6.8.2.2.5 and 3.6.8.2.2.6 defining the desired to undesired signal ratios and the maximum adjacent channel power tolerable by the GBAS VDB receiver, can result in excessive missed messages and cause a loss of continuity of GBAS guidance. The interference is likely to be higher when the localizer is sited close to the runway threshold. 6.3, 6.3.1.2.8 specifies the conditions under which radiation by localizers not in operational use shall not be allowed. Additional information is contained in Attachment 6D, 7.2.3.3.

...

2.1.9.4 *Technical determination of critical and sensitive area dimensions.* Critical and sensitive areas are normally calculated in the planning stage, prior to ILS installation, using computer simulation. A similar process is used when there are changes to the installation or to the environment. When using computer simulations, it is necessary to allocate the protection of individual parts of the approach to either the critical or sensitive area. It is desirable to ensure that the combined critical and sensitive areas protect the entire approach. However, this may not be possible in all cases. Furthermore, if the logic described in 2.1.9.3 is used, this may lead to restrictively large critical areas. Some States have found that a reasonable compromise can be achieved using a different logic, whereby the critical area protects the segment from the edge of coverage down to 2 NM from the runway threshold, while the sensitive area protects the approach from 2 NM down to the runway. In this case, a sensitive area for Category I operations will exist and may require operational mitigation. [...]

2.1.9.9 *Typical examples of critical and sensitive areas.* Figures C-3 and C-4 (including associated Tables C-1, C-2-A and C-2-B)) show examples of critical and sensitive areas for the different categories of operations and for different classes of vehicle/aircraft heights and several localizer and glide path antenna types. [...]

Editorial Note.— Modify Note 2 of Table C-2B. Example of glide path critical and sensitive area dimensions for other orientation as follows:

Notes:

...

2. The ground vehicle category also applies to small aircraft. Simulations have approximated these aircraft or large ground vehicles using a rectangular box (4 m high x 12 m long x 3 m wide). Depending on local conditions, it may be possible to reduce especially Category I critical area dimensions such that taxiing or driving on the taxiway directly in front of the glide path antenna may be allowed.

...

2.4.8 To reduce multipath interference to Facility Performance Category III glide paths and to reduce siting requirements and sensitive areas at these sites, it is desirable that the signals forming the horizontal radiation pattern from the Facility Performance Category III — ILS glide path antenna system be reduced to as low a value as practicable outside the azimuth coverage limits specified in 6.3, 6.3.1.5.3. Another acceptable method is to rotate in azimuth the glide path antennas away from multipath sources thus reducing the amount of radiated signals at specific angles while still maintaining the azimuth coverage limits.

...

2.5 Diagrams

(Figures C-6 to C-12 illustrate certain of the Standards contained in 6.3)

Editorial Note.— Modify the last sentence of the caption of Figure C-6 as follows:

For Facility Performance Categories I and II ILS the ratio shall be greater than 0.903 and for Facility Performance Category III the ratio shall be greater than 0.951.

...

2.8.2.4 A design analysis can be used to calculate the level of integrity of the system in any one landing. [...]

...

M_2 = MTBF of the monitoring and associated control system

$\frac{1}{a_1}$ = ratio of the rate of failure in the transmitter resulting in the radiation of an erroneous signal to the rate of all transmitter failures

1 = ratio of the rate of failure in the
a_2 monitoring and associated control system resulting in inability to detect an erroneous signal to the rate of all monitoring and associated control system failures

2.8.3.1 A design analysis shall be used to predict the MTBF and continuity of service of the ILS equipment. Before assignment of a level of continuity of service and introduction into service, the mean time between outages (MTBO) of the Level 2, 3 or 4 ILS shall be confirmed by evaluation in an operational environment. [...]

...

2.8.3.3 *Additional detailed guidance.* Several States have published continuity of service policies and procedures. The following documents may be consulted for additional guidance and details:

...

b) *Instrument Landing System Continuity of Service Requirements and Procedures*, Order 6750.57A, United States Federal Aviation Administration.

...

2.14 ILS classification — supplementary ILS description method with objective to facilitate operational utilization

2.14.1 The classification system given below, in conjunction with the current facility performance categories, is intended to provide a more comprehensive method of describing an ILS.

2.14.2 The ILS localizer classification is defined by using three characters as follows:

a) I, II or III: this character indicates conformance to Facility Performance Category in 6.3, 6.3.1.3.
b) A, B, C, T, D or E: this character defines the ILS points to which the localizer structure conforms to the course structure given at 6.3, 6.3.1.3.4.2, except the letter T, which designates the runway threshold. The points are defined in 6.3, 6.3.1.1.

c) 1, 2, 3 or 4: this number indicates the level of integrity and continuity of service of the localizer as defined in 6.3, 6.3.1.3.12 and summarized in Table C-4.

2.14.3 The ILS glide path classification is defined by using three characters as follows:

a) I, II or III: this character indicates conformance to Facility Performance Category in 6.3, 6.3.1.3 and 6.3.1.5.

b) A, B, C or T: this character defines the ILS points to which the glide path structure conforms to the path structure given at 6.3, 6.3.1.5.4.2, except the letter T, which designates the runway threshold. The points are defined in 6.3, 6.3.1.1.

c) 1, 2, 3 or 4: this number indicates the level of integrity and continuity of service of the glide path as defined in 6.3, 6.3.1.5.8 and summarized in Table C-4.

2.14.4 *Examples*

2.14.4.1 As an example, a Facility Performance Category II — localizer which meets the localizer course structure criteria appropriate to a Facility Performance Category III — localizer down to ILS point "D" and conforms to the integrity and continuity of service objectives of Level 3 would be described as class II/D/3.

2.14.4.2 As an example, a Facility Performance Category I — glide path which meets the glide path structure criteria appropriate to a Facility Performance Category III — glide path down to ILS point "T" and conforms to the integrity and continuity of service objectives of Level 3 would be described as class I/T/3.

2.14.5 ILS classes are appropriate only to the ground ILS element. Consideration of operational categories must also include additional factors such as operator capability, critical and sensitive area protection, procedural criteria and ancillary aids, such as transmissometers and lights.

. . .

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

. . .

3.1.2 Two types of approach and landing operations with vertical guidance (APV), APV-I and APV-II, use vertical guidance relative to a glide path, but the facility or navigation system may not satisfy all of the requirements associated with precision approach. These operations combine the lateral performance equal to that of a Facility Performance Category I localizer with different levels of vertical guidance. [...]

. . .

3.3.6 Alert limits for typical operations are provided in Note 2 to Table 3.7.2.4-1. A range of vertical alert limits (VAL) from 10 m (33 ft) to 35 m (115 ft) is specified for Category I precision approach operations, reflecting potential differences in system design that may affect the operation. The derivation of the range values is explained in 3.3.7 and 3.3.8. When using a VAL greater than 10 m (33 ft), a system-specific analysis must determine which value in the 10 m (33 ft) to 35 m (115 ft) range is appropriate to ensure suitable guidance quality. The analysis must take into account the system monitor design and other factors relevant to system implementation (i.e. additional mechanisms which prevent exposure to significant vertical biases). In the case of SBAS, this analysis is normally done by the augmentation system service provider, supported by the system designer and accepted by the appropriate safety oversight authority. Additionally, regardless of the VAL used, local implementation- and procedure-specific safety cases are normally conducted separately from the system-specific safety case. These are conducted by the local air navigation service provider, taking into account information provided by the augmentation system service provider (see 3.3.9 and 3.3.10).

3.3.7 The range of values for VAL reflects the different characteristics of GNSS integrity monitoring as compared to ILS integrity monitoring. In ILS, monitor thresholds for key signal parameters are standardized, and the monitors themselves have very low measurement uncertainty on the parameter that is being monitored. With differential GNSS, some system monitors have comparably large measurement noise uncertainty whose impact must be considered on the intended operation. In all cases, the effect of the alert limit is to restrict the satellite-user geometry to one where the monitor performance (typically in the pseudo-range domain) is acceptable when translated into the position domain. The smallest (most stringent) precision approach vertical alert limit (VAL) value (10 m (33 ft)) was derived based on the monitor performance of ILS as it could affect the glide slope at a nominal decision altitude of 60 m (200 ft) above the runway threshold, without taking into account the specific characteristics of GNSS integrity monitoring which could potentially enable the use of a less stringent VAL. By applying the 10 m (33 ft) VAL, the GNSS error, under faulted conditions, can be directly compared to an ILS error under faulted conditions, such that the GNSS errors are less than or equal to the ILS errors. For those faulted conditions with comparably large measurement uncertainty in GNSS, this results in monitor thresholds which are more stringent than ILS. When using a 10 m (33 ft) VAL no further analysis of navigation system error distribution is required.

3.3.8 The largest precision approach VAL value (35 m (115 ft)) was derived to ensure obstacle clearance equivalent to ILS for those error conditions which can be modelled as a bias during the final approach, taking into account that the aircraft decision altitude is independently derived from barometric pressure. An assessment has been conducted of the worst-case effect of a latent bias error equal to the alert limit of 35 m (115 ft), concluding that adequate obstacle clearance protection is provided on the approach and missed approach (considering the decision altitude would be reached early or late, using an independent barometric altimeter). It is important to recognize that this assessment only addressed obstacle clearance and is limited to those error conditions which can be modelled as bias errors. Analysis has shown 35 m (115 ft) bias high and low conditions can be tolerated up to the approach speed category (Categories A through D) glide path angle limits in the *Procedures for Air Navigation Services — Aircraft Operations* PANS-OPS, Doc 8168) without impinging on the ILS obstacle clearance surfaces during the instrument segment of the approach. However, it is important to note that GNSS systems using a VAL greater than 10 m (33 ft) will not produce sustained bias errors of such magnitude. Instead, the increased VAL is used in conjunction with additional system monitors to produce guidance quality equivalent to or better than ILS. When using a VAL greater than 10 m (33 ft), additional characterization of navigation system error distribution is required to ensure that position errors, in both the instrument and visual segments of the approach, are sufficiently small to ensure obstacle clearance and acceptable touchdown performance.

3.3.9 When conducting the system-specific safety assessment to support the use of a VAL greater than 10 m (33 ft), the factors discussed below shall be considered.

3.3.9.1 When a visual contact with approach/runway lighting or marking is established and the pilot takes a decision to land, the instrument phase ends and the flight continues with a visual reference. In the presence of a vertical navigation system error (VNSE), pilots may not be able to recognize a navigation error during the transition from the instrument to the visual segment. As a consequence of the VNSE, the decision altitude may be reached either above or below the nominal flight path, such that there might be a necessity to manually align the aircraft with reference to visual cues in order to cross the runway threshold at a height suitable for landing. Such actions, in a very late phase of flight, could lead to a destabilization of the approach or a go-around from inside the visual segment. Although possible consequences of the exposure to a VNSE depend on various contributors, such as flight technical error (FTE), aircraft velocity, wind speed, glide path angle, visibility, runway lighting and human performance, the magnitude of the VNSE is the most relevant factor for assessing the safety of the navigation system.

3.3.9.2 The following values of the VNSE shall be considered in the design of the augmentation system:

a) VNSE of 4 m (13 ft) or less. This is considered as an equivalent to ILS Category I with acceptable touchdown performance and a standard number of missed approaches due to visibility conditions.

b) VNSE higher than 4 m (13 ft) but not higher than 10 m (33 ft). Either a safe landing with an acceptable touchdown performance or a go-around can be expected.

c) VNSE higher than 10 m (33 ft) but not higher than 15 m (50 ft). The touchdown performance may be affected and flight crew workload may be increased.

d) VNSE higher than 15 m (50 ft). The safety margin would be significantly reduced under some operational configurations.

3.3.9.3 In considering the values above, one acceptable means to manage the risks in the visual segment is for the system to comply with the following criteria:

a) the fault-free accuracy is equivalent to ILS at ILS point B. This includes system 95 per cent VNSE than 4 m (13 ft), and a fault-free system VNSE exceeding 10 m (33 ft) with a probability less than 10^{-7} per approach for each location where the operation is to be approved. This assessment is performed over all environmental and operational conditions under which the service is declared available;

b) under system failure conditions, the system design is such that the probability of an error greater than 15m (50 ft) is lower than 10^{-5}, so that the likelihood of occurrence is remote. The fault conditions to be taken into account are those affecting either the core constellations or the GNSS augmentation under consideration. This probability is to be understood as the combination of the occurrence probability of a given failure with the probability of detection for applicable monitor(s). Typically, the probability of a single fault is large enough that a monitor is required to satisfy this condition.

3.3.9.4 In case these criteria are applied, the service provider could declare the Category I service area considering where Category I integrity is available, for a given VAL in the 10 m (33 ft) to 35 m (115 ft) range, in accordance with the system analysis showing where the additional conditions a) and b) described above are met.

Note.— Further guidance on the technical interpretation of these requirements is given in the GNSS Manual (Doc 9849, SBAS Operations, 4.3.3.3).

3.3.10 For GBAS, a technical provision has been made to broadcast the alert limit to aircraft. For SBAS, technical provisions have been made to specify the alert limit through an updatable database (see Attachment 6C).

...

6.2.2 Satellite-based augmentation services are provided by the Wide Area Augmentation System (WAAS) (North America), the European Geostationary Navigation Overlay Service (EGNOS) (Europe and Africa), the Michibiki Satellite-based Augmentation Service (MSAS) (Japan) and the GPS-aided Geo-augmented Navigation (GAGAN) (India). The System of Differential Correction and Monitoring (SDCM) (Russia), the BeiDou SBAS (BDSBAS) (China), the Korea Augmentation Satellite System (KASS) (Republic of Korea), the SBAS for Africa and Indian Ocean (A-SBAS) (ASECNA) and the Southern Positioning Augmentation Network (SPAN) (Australia and New Zealand) are also under development to provide these services.

...

7. GROUND-BASED AUGMENTATION SYSTEM (GBAS) AND GROUND-BASED REGIONAL AUGMENTATION SYSTEM (GRAS)

7.2 RF characteristics

...

7.2.1.4.2 The geographic separation for co-channel, co-slot GBAS VDB assignments is obtained by determining the distance at which the transmission loss equals 145 dB for receiver altitude of 3 000 m (10 000 ft) above that of the GBAS VDB transmitter antenna. This distance is 318 km (172 NM) using the free-space attenuation approximation and assuming a negligible transmitter antenna height. The minimum required geographical separation can then be determined by adding this distance to the nominal distance between the edge of the service volume and the VDB transmitter antenna. For example, using a service volume extending to 43 km (23 NM) from the VDB transmitter antenna. ~~This~~ results in a co-channel, co-slot reuse distance of 361 km (195 NM).

7.2.1.5 *Guidelines on GBAS/GBAS geographical separation criteria.* Using the methodology described above, typical geographic separation criteria can be defined for GBAS to GBAS and GBAS to VOR. The resulting GBAS/GBAS minimum required geographical separation criteria are summarized in Table D-4.

Note.— Geographical separation criteria between the VDB transmitters antennas providing the GBAS positioning service are under development. A conservative value corresponding to the *radio horizon may be used as an interim value for separation between co-frequency, adjacent time slot transmitters to ensure time slots do not overlap.*

7.2.3.2 *Same-airport compatibility.* To analyse the constraints for the deployment of a GBAS ground station at the same airport as ILS, it is necessary to consider ILS and VDB compatibility in detail taking into account information such as the actual desired service field strength and actual undesired service transmit antenna radiation patterns. For GBAS equipment with transmitter power such that the maximum field strength of 0.879 volts per metre (–27 dBW/m^2) for the horizontally polarized signal component is not exceeded in the ILS coverage volume, the 16th channel (and beyond) will be below –100.5 dBm in a 25 kHz bandwidth at a distance of 80 m from the VDB transmitter antenna, including allowance for a +5 dB increase due to constructive multipath. This –100.5 dBm in a 25 kHz bandwidth translates to a signal-to-noise ratio of 21.5 dB (above the assumed minimum signal-to-noise ratio of 20 dB) for a –79 dBm localizer signal which corresponds to an ILS localizer field strength of 90 microvolts per metre (–107 dBW/m^2).

. . .

7.2.3.3 At those locations where an ILS facility and a GBAS facility serve opposite approach directions to the same runway, there is a possibility of interference to the GBAS VDB signals in the region where the aircraft overflies the localizer. The interference can result in exceedance of the message failure rate requirement (Appendix 6B, 3.6.8.2.2.3) and cause a loss of continuity of GBAS guidance. The condition of unacceptable interference is when the ILS localizer signal does not support compliance with the requirements in Appendix 6B, 3.6.8.2.2.5 and 3.6.8.2.2.6, defining the desired to undesired signal ratios and the maximum adjacent channel power tolerable by the GBAS VDB receiver. The interference is likely to be higher when the localizer is sited close to the runway threshold. 6.3, 6.3.1.2.8 specifies the conditions under which radiation by localizers not in operational use shall not be allowed. Compliance with 6.3.1.2.8 will ensure there is no interference by the ILS localizer to GBAS during low visibility operations that require GAST D. Generally, this shall not be an issue for GAST C operations due to the 3.5 seconds window allowed to receive three Type 1 messages, when the aircraft overflies the localizer. However, there may be conditions during GAST C operations where the VDB signal power does not support the D/U, or the maximum ILS localizer power is incompatible with recovery from short-term excess undesired signal power (Appendix 6B, 3.6.8.2.2.6.5), and that would require the localizer to be turned off.

7.2.4 *Compatibility with VHF communications.* For GBAS VDB assignments above 116.400 MHz, it is necessary to consider VHF communications and GBAS VDB compatibility. Considerations for assignment of these VDB channels include the frequency separation between the VHF communication and the VDB, the distance separation between the transmitter's antennas and coverage areas, the field strengths, the polarization of the VDB signal, and the VDB and VHF communication receiver sensitivity. Both aircraft and ground VHF communication equipment are to be considered. For GBAS/E equipment with a transmitter maximum power of up to 150 W (100 W for horizontal component and 50 W for vertical component), the 64th channel (and beyond) will be below –112 dBm in a 25 kHz bandwidth at a distance of 80 m from the VDB transmitter antenna including an allowance of +5 dB increase due to constructive multipath. For GBAS/H equipment with a transmitter maximum power of 100 W, the 32nd channel (and beyond) will be below –112 dBm in a 25 kHz bandwidth at a distance of 80 m from the VDB transmitter antenna including an allowance of +5 dB increase due to constructive multipath, and a 10 dB polarization isolation. It must be noted that due to differences in the GBAS VDB and VDL transmitter masks, separate analysis must be performed to ensure VDL does not interfere with the GBAS VDB.

. . .

7.3.2.3 Simplified analysis method.

In order to apply this method, it is assumed the following:

o VDB transmitters antennas are installed above a planar ground with line-of-sight to runways in the desired GBAS service volume as mentioned in 7.12.3.

. . .

To estimate the power *PhdBm* (in dBm) at a height *h* (in metres) from the power *Ph0dBm* at a height h0 (in metres), one can use the following expression:

$$P_{h\,dBm} = P_{h_0\,dBm} + 20\log\left(\sin\left(\frac{2\pi h h_a}{\lambda d}\right)\right) - 20\log\left(\sin\left(\frac{2\pi h_0 h_a}{\lambda d}\right)\right)$$

Where

- *d* is the horizontal distance to the transmitter antenna in metres
- *ha* is the height of the transmitter antenna phase centre in metres
- $\lambda = c / f$ is the wavelength in metres
- *f* is the frequency in Hertz
- c is the speed of light

. . .

The applicability of the above-mentioned formula at different heights above the runway surface may vary with the distance between the VDB transmitter antenna and the intended path on the runway surface, and the VDB transmitter antenna height. Some siting constraints may be needed to verify the minimum signal strength is met in the service volume above the runway surface.

. . .

7.12.3 *Locating the VDB transmitter antenna.* The VDB transmitter antenna must be located to comply with the minimum and maximum field strength requirements within the service volume(s) as defined in 6.3, 6.3.7.3.5.4.4. Compliance with the minimum field strength for approach services can generally be met if the VDB transmitter antenna is located so that an unobstructed line-of-sight exists from the antenna to any point within the service volume for each supported FAS. Consideration shall also be given to ensuring the minimum VDB transmitter antenna-to-aircraft antenna separation so that the maximum field strength is not exceeded. [...]

7.12.3.1 In order to ensure that the maximum field strength requirements defined in 6.3, 6.3.7.3.5.4.4 are not violated, VDB transmitters antennas shall not be located any closer than 80 m to where aircraft are approved to operate based on published procedures using GBAS or ILS guidance information. This applies to aircraft on final approach, departure, and on runways. The 80-metre separation applies to the slant range distance between VDB transmitter antennas and the aircraft antenna position. [...]

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xxx

— End of Amendment —

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 following completion of its publication in a newspaper of general circulation or the Official Gazette and a copy filed with the U.P. Law Center - Office of the National Administrative Register. The amendment shall be incorporated to Philippine CAR-ANS in the next regular Amendment Cycle.

So Ordered. Signed this 14 day of JAN 2021, at the Civil Aviation Authority of the Philippines, MIA Road, Pasay City, Metro Manila, 1301.

CAPTAIN JIM C. SYDIONGCO
Director General