RESOLUTION MSC.233(82)
(adopted on 5 December 2006)
ADOPTION OF THE PERFORMANCE STANDARDS FOR SHIPBORNE
GALILEO RECEIVER EQUIPMENT

ANNEX 25

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THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING ALSO resolution A.886(21), by which the Assembly resolved that the function of adopting performance standards and technical specifications, as well as amendments thereto shall be performed by the Maritime Safety Committee and/or the Marine Environment Protection Committee, as appropriate, on behalf of the Organization,

RECALLING FURTHER that, in accordance with resolution A.815(19) by which the Assembly adopted the IMO policy for the recognition and acceptance of suitable radionavigation systems intended for international use to provide ships with navigational position-fixing throughout their voyages, the GALILEO satellite system may be recognized as a possible component of the world-wide radionavigation system,

NOTING that shipborne receiving equipment for the world-wide radionavigation system should be designed to satisfy the detailed requirements of the particular system concerned,

RECOGNIZING the need to develop performance standards for shipborne GALILEO receiver equipment in order to ensure the operational reliability of such equipment and taking into account the technological progress and experience gained,

HAVING CONSIDERED the recommendation made by the Sub-Committee on Safety of Navigation, at its fifty-second session,

1. ADOPTS the Performance standards for Shipborne GALILEO receiver equipment, set out in the Annex to the present resolution;

2. RECOMMENDS Governments ensure that GALILEO receiver equipment installed on or after 1 January 2009 conform to performance standards not inferior to those specified in the Annex to the present resolution.

ANNEX

PERFORMANCE STANDARDS FOR SHIPBORNE GALILEO RECEIVER EQUIPMENT

1 INTRODUCTION

1.1 Galileo is the European satellite navigation system. Galileo is designed as a wholly civil system, operated under public control. Galileo comprises 30 medium earth orbit (MEO) satellites in 3 circular orbits. Each orbit has an inclination of 56° and contains 9 operational satellites plus one operational spare. This geometry ensures that a minimum of 6 satellites are in view to users world-wide with a position dilution of precision (PDOP) ≤ 3.5.

1.2 Galileo transmits 10 navigation signals and 1 search and rescue (SAR) signal. The SAR signal is broadcast in one of the frequency bands reserved for the emergency services (1544-1545 MHz) whereas the 10 navigation signals are provided in the radio-navigation satellite service (RNSS) allocated bands:

- 4 signals occupy the frequency range 1164-1215 MHz (E5a-E5b).
- 3 signals occupy the frequency range 1260-1300 MHz (E6).
- 3 signals occupy the frequency range 1559-1591 MHz (E2, L1, E1).

Each frequency carries two signals; the first is a tracking signal – the so-called pilot signal – that contains no data but increases the tracking robustness at the receiver whereas the other carries a navigation data message.

Galileo provides two different services of use for the maritime community.

1.3 The Galileo Open Service provides positioning, navigation and timing services, free of direct user charges. The Open Service can be used on one (L1), two (L1 and E5a or L1 and E5b) or three (L1, E5a and E5b) frequencies.

1.4 The Galileo Safety of Life Service can be used on one (L1 **or** E5b) or two (L1 and E5b) frequencies[1]. Each of the L1 and E5b frequencies carries a navigation data message that includes integrity information. The E5a frequency does not include integrity data.

1.5 Galileo receiver equipment intended for navigation purposes on ships of speeds not exceeding 70 knots, in addition to the general requirements specified in resolution A.694(17)[2], should comply with the following minimum performance requirements.

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[1] The integrity parameters broadcast by the Galileo Safety of Life service will be unencrypted and therefore fully accessible. Service Guarantees and Authentication services can be made available, at a charge, through contractual means if desired.

[2] Refer to publication IEC 60945.

1.6 These standards cover the basic requirements of position fixing, determination of course over ground (COG), speed over ground (SOG) and timing, either for navigation purposes or as input to other functions. The standards do not cover the other computational facilities which may be in the equipment nor cover the requirements for any other systems that may take input from the Galileo receiver.

2 GALILEO RECEIVER EQUIPMENT

2.1 The words "*Galileo receiver equipment*" as used in these performance standards include all the components and units necessary for the system properly to perform its intended functions. The Galileo receiver equipment should include the following minimum facilities:

.1 antenna capable of receiving Galileo signals;
.2 Galileo receiver and processor;
.3 means of accessing the computed latitude/longitude position;
.4 data control and interface; and
.5 position display and, if required, other forms of output.

Note: If Galileo forms part of an approved Integrated Navigation System, requirements of 2.1.3, 2.1.4, 2.1.5 may be provided within the INS.

2.2 The antenna design should be suitable for fitting at a position on the ship which ensures a clear view of the satellite constellation, taking into consideration any obstructions that might exist on the ship.

3 PERFORMANCE STANDARDS FOR GALILEO RECEIVER EQUIPMENT

The Galileo receiver equipment should:

.1 be capable of receiving and processing the Galileo positioning and velocity, and timing signals on:

i) for a single frequency receiver, the L1 frequency alone. The receiver should use the ionospheric model broadcast to the receiver by the constellation to generate ionospheric corrections;

ii) for a dual frequency receiver, **either** the L1 and E5b frequencies **or** the L1 and E5a frequencies. The receiver should use dual frequency processing to generate ionospheric corrections;

.2 provide position information in latitude and longitude in degrees, minutes and thousandths of minutes[3];

[3] Galileo uses Galileo Terrestrial Frame System (GTRF) datum which is a realization of the International Terrestrial Frame Reference (ITRF) system and differs from WGS 84 by less than 5 cm worldwide.

.3 provide time referenced to universal time coordinated UTC (BIPM)*;

.4 be provided with at least two outputs from which position information, UTC, course over ground (COG), speed over ground (SOG) and alarms can be supplied to other equipment. The output of position information should be based on the WGS84 datum and should be in accordance with international standards[4]. The output of UTC, course over ground (COG), speed over ground (SOG) and alarms should be consistent with the requirements of 3.16 and 3.18;

.5 have static accuracy such that the position of the antenna is determined to within:

i) 15 m horizontal (95%) and 35 m vertical (95%) for single frequency operations on the L1 frequency;

ii) 10 m horizontal (95%) and 10 m vertical (95%) for dual frequency operations on L1 and E5a or L1 and E5b frequencies[5];

.6 have dynamic accuracy equivalent to the static accuracy specified in **.5** above under the sea states and motion experienced in ships[6];

.7 have position resolution equal or better than 0.001 minutes of latitude and longitude;

.8 have timing accuracy such that time is determined within 50ns of UTC;

.9 be capable of selecting automatically the appropriate satellite-transmitted signals to determine the ship's position and velocity, and time with the required accuracy and update rate;

.10 be capable of acquiring satellite signals with input signals having carrier levels in the range of –128dBm to –118dBm. Once the satellite signals have been acquired, the equipment should continue to operate satisfactorily with satellite signals having carrier levels down to –131dBm;

.11 be capable of operating satisfactorily under normal interference conditions consistent with the requirements of resolution A.694(17);

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* Bureau International des poids et measures.

4 Publication IEC 61162.

5 The minimum accuracy requirements specified for dual frequency processing are based on the performance requirements established by the Organization in resolution A.915(22) and resolution A.953(23) for navigation in harbour entrances, harbour approaches and coastal waters.
The Galileo satellite navigation system will be able to provide better accuracy (4 m horizontal 95% and 8 m vertical 95%).

6 Refer to resolution A.694(17), publications IEC 6721-3-6 and IEC 60945.

.12 be capable of acquiring position, velocity and time to the required accuracy within 5 min when there is no valid almanac data (cold start);

.13 be capable of acquiring position, velocity and time to the required accuracy within 1 min when there is valid almanac data (warm start);

.14 be capable of re-acquiring position, velocity and time to the required accuracy within 1 minute when there has been a service interruption of 60 s or less;

.15 generate and output to a display and digital interface[7] a new position solution at least once every 1 s for conventional craft and at least once every 0.5 s for high-speed craft;

.16 provide the COG, SOG and UTC outputs, with a validity mark aligned with that on the position output. The accuracy requirements for COG and SOG should not be inferior to the relevant performance standards for heading[8] and speed and distance measuring equipment (SDME)[9] and the accuracy should be obtained under the various dynamic conditions that could be experienced onboard ships;

.17 provide at least one normally closed contact, which should indicate failure of the Galileo receiver equipment;

.18 have a bidirectional interface to facilitate communication so that alarms can be transferred to external systems and so that audible alarms from the Galileo receiver can be acknowledged from external systems; the interface should comply with the relevant international standards;[10] and

.19 have the facilities to process differential Galileo (dGalileo) data fed to it in accordance with the standards of ITU-R[11] and the appropriate RTCM[12] standard and provide indication of the reception of dGalileo signals and whether they are being applied to the ship's position.

4 INTEGRITY CHECKING, FAILURE WARNINGS AND STATUS INDICATIONS

4.1 The Galileo receiver equipment should also indicate whether the performance of Galileo is outside the bounds of requirements for general navigation in the ocean, coastal, port approach and restricted waters, and inland waterway phases of the voyage as specified in either resolution A.953(23) or Appendix 2 to resolution A.915(22) and any subsequent amendments as appropriate. The Galileo receiver equipment should as a minimum:

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7 Conforming to the IEC 61162 series.
8 Resolution A.424 (XI) for conventional craft and resolution A.821(19) for high-speed craft.
9 Resolution A.824(19).
10 Publication IEC 61162.
11 ITU-R Recommendation M.823.
12 RTCM 10402 or 10403.

.1 provide a warning within 5 s of loss of position or if a new position based on the information provided by the Galileo constellation has not been calculated for more than 1 s for conventional craft and 0.5 s for high-speed craft. Under such conditions the last known position and the time of last valid fix, with the explicit indication of the state so that no ambiguity can exist, should be output until normal operation is resumed;

.2 use receiver autonomous integrity monitoring (RAIM) to provide integrity performance appropriate to the operation being undertaken;

.3 provide a self-test function.

4.2 For receivers having the capability to process the Galileo Safety of Life Service, integrity monitoring and alerting algorithms should be based on a suitable combination of the Galileo integrity message and receiver autonomous integrity monitoring (RAIM). The receiver should provide an alarm within 10 s Time to Alarm (TTA) of the start of an event if an alert limit of 25 m Horizontal Alert Limit (HAL) is exceeded for a period of at least 3 s. The probability of detection of the event should be better that 99.999% over a 3-h period (integrity risk <= 10^{-5}/3 h).

5 PROTECTION

Precautions should be taken to ensure that no permanent damage can result from an accidental short circuit or grounding of the antenna or any of its input or output connections or any of the Galileo receiver equipment inputs or outputs for a duration of 5 min or less.

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