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# **N-09 Global Positioning System (GPS) Receiver Equipment**

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Foreword:

This Guideline is a part of CCS Rules, which contains technical requirements, inspection and testing criteria related to classification and statutory survey of marine products.

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## **Global Positioning System (GPS) Receiver Equipment**

### **1 Application**

1.1 This guideline is applicable to the type approval and single piece/batch product inspection of shipborne global positioning system (GPS) receiver equipment.

1.2 This guideline is not applicable to the receiver equipment of shipborne satellite positioning systems other than GPS. This chapter is not applicable to equipment used on the ships of speed higher than 70 knots.

### **2 Basis for approval and inspection**

2.1 The Basis for approval and inspection is as follows:

2.1.1 Regulation 19, Chapter V of SOLAS (1974) and Amendments thereto;

2.1.2 Regulation 3, Chapter X of SOLAS (1974) and Amendments thereto;

2.1.3 Chapter 13 of 1994 HSC Code;

2.1.4 Chapter 13 of 2000 HSC Code;

2.1.5 IMO A.694(17) General Requirements for Ship-borne Radio Equipment Forming Part of the Global Maritime Distress and Safety System (GMDSS) and for Electronic Navigational Aids;

2.1.6 IMO MSC.112 (73) Adoption of the Revised Performance Standards for Ship-borne Global Positioning System (GPS) Receiver Equipment;

2.1.7 IMO MSC.191 (79) Performance Standards for the Presentation of Navigation-related Information on Ship-borne Navigational Displays;

2.1.8 IEC 61108-1(2003): Global Positioning System (GPS)-Receiver Equipment- Performance Standards, Methods of Testing and Required Test Results;

2.1.9 IEC 61162 series: Maritime navigation and radio communication equipment and systems, digital interface;

2.1.10 IEC 62288 (2008): Maritime Navigation and Radio Communication Equipment and Systems-Presentation of Navigation-related Information on Ship-borne Navigational Displays-General Requirements, Methods of Testing and Required Test Results;

2.1.11 IEC 60945(2002): Maritime Navigation and Radio Communication Equipment and Systems-General Requirements-Methods of Testing and Required Test Results;

2.1.12 GD01-2006 CCS Guidelines for Type Approval Test of Electric and Electronic Products

2.2 In the event of any change of the abovementioned conventions, codes, performance proposals and test standards, the latest valid revisions are to be used.

### **3 Terms and definitions**

The definitions and terms specified in the abovementioned documents are applicable for the purpose of the Guidelines. For convenience of preparation and use, the Guidelines have directly quoted or supplemented the following definitions.

3.1 GPS(Global Positioning System): global positioning system;

3.2 DGPS(Differential GPS): a technology to improve the positioning and timing accuracy of a GPS. Error correction values are generated from the GPS measurement errors obtained by a GPS reference receiver set on a known point, and these correction values are provided in real time or after the event to the differential GPS user equipment so that the user equipment will receive and use the correction values to improve the positioning accuracy.

3.3 C/A Code: a civil pseudo-random code used to modulate the carrier (1575.42MHz) signal of GPS satellite L1;

3.4 GPS Standard Positioning Service(SPS): public civil services provided by GPS C/A code;

3.5 Dilution of Precision (DOP): a factor describing the effect of the geometric position of the satellite to position error. GPS position error is a product of the distance measurement error and dilution of precision. Dilution of precision may, in different subjects concerned, be further defined as position dilution of precision (PDOP), horizontal dilution of precision (HDOP), time dilution of precision (TDOP), etc.

3.6 Acquisition: the processes of the user equipment to achieve code identification, code synchronization and carrier phase synchronization of the GPS satellite signals received.

3.7 Receiver autonomous integrity monitoring (RAIM): an algorithm used by a GPS receiver to autonomously monitor the integrity of the output position/time solution data. The algorithms are based on the consistency of redundant pseudo-range data sets. RAIM enable the GPS receiver to determine if any visible satellite fails and to exclude the failed satellite from the navigation solutions.

3.8 WGS-84 (world geodetic system 84):a geocentric reference system established by U.S Department of National Defense using 1980 geodetic reference system and BIH1984.0 system orientation on the basis of NSWC-9Z-2, a precise ephemeris system corresponding to WGS72.

3.9 Coordinated universal time (UTC): time scale which forms the basis of a coordinated radio dissemination of standard frequencies and time signals; UTC is established by the International Bureau of Weights and Measures (BIPM) and the International Earth Rotation Service (IERS).

## **4 Drawings and documentation to be submitted**

### 4.1 General

4.1.1 The scope and extent of the plans and technical data submitted are to be such that the compliance of the equipment with this Guidelines and relevant standards can be verified and the mechanical and electrical designs of the product can be generally reviewed.

4.1.2 The documents submitted are to be identified in accordance with the manufacturer's quality management system and to facilitate the review of relevant technical requirements.

4.2 The following drawings and documentation are to be submitted to CCS for review::

#### 4.2.1 Product technical description (product specifications)

Product specifications are to expressly specify the overall performance and design requirements, including the following information at least:

- Rules and standards applicable to the product;
- Specification of environmental conditions the product works in;
- Specification of power supply conditions the product works in
- Components of the product (all the components required to perform its expected function)
- Detailed description of the product's functions and performance specification .

#### 4.2.2 Hardware and interface

Include at least,

- Detailed description of the hardware configuration ;
- Mechanical drawings (assembly and/or outline ), electrical diagrams ( theory, wiring and function block ) and illustrative documents describing the functions, mechanical and electrical properties of the product and its components;
- Detailed description of the interface between main components of the product and the interface between the product and other equipment (or systems), including the mechanical and electrical properties, data protocol, data format or protocol conversion, interface configuration, etc.;
- Power unit diagram or block diagram, power supply arrangement ;

- wiring diagrams showing typical application of the system.

#### 4.2.3 Software

Included at least,

- Description of the main software modules and software version;
- Instructions for software maintenance and update.

#### 4.2.4 Installation manual, operation manual and maintenance manual

Manual of English versions are to be provided. The manuals include a list and explanations of terms, abbreviations, symbols and icons displayed on the equipment. There are detailed descriptions of MMI and/or function menus to help the users and inspection personnel to get familiar with the equipment and to perform relevant operations.

#### 4.2.5 Type test procedure (program) and routine test procedure (program)

The test procedures include at least,

Description of the test specimens and explanation of the selected test sample(s), arrangement of the routine test (include the sample principle), requirements of testing laboratory and the test conditions, test items, test methods and the acceptance criteria.

#### 4.2.6 Description of product marking; photos of the product; sample of product quality certificate;

#### 4.2.7 Environmental and Performance type test reports (if any);

#### 4.2.8 The documentation concerning the quality management system (e.g. ISO9000);

#### 4.2.9 Specifications for the routine test or the final-product inspection and/or testing;

#### 4.2.10 Other technical documents or quality control documents (if any) deemed necessary by CCS.

### **5 Design requirements**

5.1 The equipment are to be suitable for shipborne use in electrical safety, power supply condition environmental condition and electromagnetic compatibility. The equipment are to comply with the test requirements for “protected equipment” or “exposed equipment” (equipment installed outdoors) specified in IEC60945.

#### 5.2 Function and performance requirements

5.2.1 The GPS receiver equipment shall operate on the L1 signal and C/A code. The GPS receiver equipment is to be capable of receiving and processing the Standard Positioning Service (SPS) and provide the longitude, latitude and positioning time (UTC) in WGS—84 coordinate system with a data accuracy of degree, grade and milligrade. The equipment is to have the function of converting the position data based on WGS—84 coordinate system into the position data of other coordinate systems compatible with the sea chart being used. When this function is used, the display is to be available to indicate the ongoing coordinate conversion and the coordinate system on which the displayed position data is based. The minimum position resolution, i.e. longitude and latitude, is to be 0.001 min;

5.2.2 The equipment should be provided with at least one output from which position information can be supplied to other equipment. The output of position information based upon WGS-84 should be in accordance with international standards IEC61162. The equipment should generate and output to the digital interface conforming to the IEC61162 series the course over the ground (COG), speed over the ground (SOG) and universal time co-ordinated (UTC). Such outputs should have a validity mark aligned with that on the position output. The accuracy requirement for COG and SOG should not be inferior to the relevant Performance Standards for Heading and SDME.

5.2.3 The GPS receiver equipment should:

have static accuracy such that the position of the antenna is determined to within 13 m (95%) with horizontal dilution of precision (HDOP)  $\leq 4$  (or PDOP  $\leq 6$ ); have dynamic accuracy such that the position of the ship is determined to within 13 m (95%) with HDOP  $\leq 4$  (or PDOP  $\leq 6$ ) under the conditions of sea states and ship's motion likely to be experienced in ships.

5.2.4 The GPS receiver is to be capable of:

- acquiring satellite signals with input signals having carrier levels in the range of  $-130$  dBm to  $-120$  dBm. Once the satellite signals have been acquired the equipment shall continue to operate satisfactorily with satellite signals having carrier levels down to  $-133$  dBm.
- acquiring position to the required accuracy, within 30 min, when there is no valid almanac data.
- acquiring position to the required accuracy, within 5 min, when there is valid almanac data.
- re-acquiring position to the required accuracy, within 5 min, when the GPS signals are interrupted for a period of at least 24 h, but there is no loss of power.
- re-acquiring position to the required accuracy, within 2 min, when subjected to a power interruption of 60s.

5.2.5 The GPS receiver equipment is to be capable of selecting automatically the appropriate satellite transmitted signals for determination of the ship's position with the required accuracy and update rate.

The GPS receiver equipment is to generate and output to a display and digital interface a new

position solution at least once every 1 s( For craft meeting the HSC code, a new position solution at least every 0,5 s ) ..

5.2.6 The GPS receiver equipment is to have the facilities to process differential GPS (DGPS) data fed to it in accordance with the standards of Recommendation ITU-R M.823 and an appropriate RTCM standard. When a GPS receiver is equipped with a differential receiver, performance standards for static and dynamic accuracies are to be 10 m (95 %).

5.2.7 The equipment is to be capable of operating satisfactorily under typical interference conditions.

5.2.8 Precautions are to 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 GPS receiver equipment inputs or outputs for a duration of 5 min.

#### 5.2.9 Fault alarm and condition indication

The equipment is to provide an indication if the position calculated is likely to be outside of the requirements of these performance standards;

The GPS receiver equipment is to provide as a minimum:

- an indication within 5 s if either:

1) the specified HDOP has been exceeded; or

2) a new position has not been calculated for more than 1 s( For craft meeting the HSC Code, 0,5 s ).

Under such conditions the last known position and the time of the last valid fix, with explicit indication of this state, so that no ambiguity can exist, are to be output until normal operation is resumed;

- a warning of loss of position; and

- differential GPS status indication of:

1) the receipt of DGPS signals; and

2) whether DGPS corrections are being applied to the indicated ship's position;

- DGPS integrity status and alarm; and

- DGPS text message display.

5.2.10 When the equipment displays the information specified in 8.5.2(2), i.e. the ship's position, UTC, SOG and COG, the applicable requirements of Part 4 and Part 7 of IEC62288 are to be complied with.

## 6 Type approval and unit/batch inspection

### 6.1 General provisions

Global positioning system (GPS) receiver equipment is subject to type approval by CCS. The issue and validity of the type approval certificate are to be in accordance with relevant requirements of Chapter 3, PART 1 of CCS Rules for Classification of Sea-going Steel Ships.

### 6.2 Selection of typical test samples and test arrangement

The specimens for testing are to have typical specification and cover the scope of approval applied. Test specimens are to be sampled by CCS surveyor at the premise of the manufacturer.

### 6.3 Testing agency

The type test is to be carried out at a Nationally or Internationally Accredited Laboratory, which has been accepted by CCS. CCS surveyor may agree the manufacturer with relevant test facilities to conduct some function test under the supervision of CCS surveyor.

When determining the testing agency, due consideration is to be given to the test conditions/facilities specified in IEC 61108-1 and written documents are to be submitted to CCS surveyor for approval.

### 6.4 Type approval test items and requirements

Type approval test items are listed in table 6.5(1) and table 6.5(2).

### 6.5 Unit/batch inspection

Before delivery, unit / batch inspection and issuance of products certificate is required for this product.

After type approval, the quality control in manufacture and inspection are to be in compliance with the documented procedures submitted during type approval. For each equipment, routine test is to be carried out and test reports are to be prepared. On the basis of review of these test reports, the unit/batch inspection will be conducted in accordance with the approved product inspection plan.

The unit/batch inspection includes the following inspection items, at least:

- Review of technical files of main components (parts) and confirmation of software version
- Visual inspection and confirmation of software version
- Insulation resistance measurement
- Dielectric strength test

—Function verification test

Where deemed necessary by the surveyor, the test items and sampling amount may be increased.

**Environmental Conditions Test and Inspection Items Specified by IEC60945 Table 6.5(1)**

No	Test item	Test method	Remark
1.	Ergonomic and HMI inspection	IEC 60945, 6.1	May be carried out in conjunction with performance test.
2.	Hardware	IEC 60945, 6.2	May be carried out in conjunction with performance test.
3.	Software	IEC 60945, 6.3	May be carried out in conjunction with performance test.
4.	Inter-unit connection	IEC 60945, 6.3	May be carried out in conjunction with performance test.
5.	Extreme power fluctuation test	IEC 60945, 7.1	Normal test temperature
6.	Excessive conditions	IEC 60945, 7.2	
7.	Dry heat, including extreme power supply conditions	IEC 60945, 8.2 & 7.1	Performance check is to be carried out.
8.	Damp heat	IEC 60945, 8.3	
9.	Low temperature, including extreme power supply conditions	IEC 60945, 8.4 & 7.1	Performance check is to be carried out.

**Continued Table 6.5(1)**

10.	Vibration test	IEC 60945, 8.7	
11.	Salt mist test	IEC 60945, 8.12	May be waived if the manufacturer has provided documents.

12.	Conducted emission testing	IEC 60945, 9.2	
13.	Radiated emission testing	IEC 60945, 9.3	
14.	Immunity to conducted radiated radio-frequency disturbance	IEC 60945, 10.3	
15.	Immunity to radiated radio-frequency disturbance	IEC 60945, 10.4	
16.	Immunity to fast transient/bursts	IEC 60945, 10.5	
17.	Surge immunity	IEC 60945, 10.6	
18.	Immunity to short-term power fluctuation	IEC 60945, 10.7	
19.	Immunity to power failure	IEC 60945, 10.8	
20.	Immunity to electrostatic discharge	IEC 60945, 10.9	
21.	Sound noise requirements and alarm signals	IEC 60945, 11.1	
22.	Compass safe distance	IEC 60945, 11.2	
23.	Prevention of accidental contact with dangerous voltage	IEC 60945, 12.1	The degree of protection provided by enclosure is to be at least IP20.
24.	Visual display unit emission test	IEC 60945, 12.3	
<p>The performance check items to be carried out in conjunction with environmental conditions test include starting, acquisition and tracing tests. See 5.8 of IEC 61108-1:2003.</p>			

**Equipment Performance Test and Inspection Items**

**Table 6.5(2)**

No	Test item	Test method	Remark
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1.	Inspection of ship's position output	5.6.2 of IEC 61108-1:2003	Document review
2.	Test of interface to other equipment and output test	5.6.3 of IEC 61108-1:2003	Specific inspection and test items are to be determined in accordance with the applicable standard for interface- IEC61162 standard.
3.	Accuracy test	5.6.4 of IEC 61108-1:2003	Attention to be paid to the test conditions.
4.	Acquisition test	5.6.5 of IEC 61108-1:2003	—
5.	Protection	5.6.6 of IEC 61108-1:2003	—
6.	Antenna design	5.6.7 of IEC 61108-1:2003	Document review
7.	Sensitivity and dynamic range	5.6.8 of IEC 61108-1:2003	A signal simulator is required.
8.	Test of the effect of specific interfering signal	5.6.9 of IEC 61108-1:2003	A signal simulator is required.
9.	Position update	5.6.10 of IEC 61108-1:2003	Attention to be paid to the test conditions.
10.	DGPS input	5.6.11 of IEC 61108-1:2003	Document review
11.	Fault alarm and condition indication	5.6.12 of IEC 61108-1:2003	A signal simulator is required.
12.	COG and SOG accuracy	5.6.13 of IEC 61108-1:2003	Attention to be paid to the test conditions.

Continued Table 6.5(2)

13.	UTC output	5.6.14 of IEC 61108-1:2003	—
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14.	Performance test under typical reference conditions	5.7 of IEC 61108-1:2003	A signal simulator is required.
15.	Display of navigational information	4 and 7 of IEC62288:2008	The test specified in item 4 may be carried out in conjunction with performance test.
16.	Voltage withstanding test	2.14 of GD01-2006	—
17.	Insulation resistance measurement	2.3 of GD01-2006	—