Guideline No.: N-11 (201712)

N-11

SHIPBORNE BEIDOU SATELLITE NAVIGATION SYSTEM (BDS) RECEIVER EQUIPMENT

Issued date: December 7, 2017

Foreword

CCS Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at http://www.ccs.org.cn. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn.

Historical version and release date: N-11(201712) December 7, 2017

Main change: New Release

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SHIPBORNE BEIDOU SATELLITE NAVIGATION SYSTEM (BDS) RECEIVER EQUIPMENT

1 Scope of Application

1.1 This Guideline is only applicable to type approval and Single-piece/batch testing for shipborne BDS receiver equipment.

1.2 This Guideline is not applicable to equipment used by ship at the speed higher than 70 knots.

2 Normative References

2.1.1 SOLAS (1974) and Article 19 in Chapter V of its amendment;

2.1.2 SOLAS (1974) and Article 3 in Chapter X of its amendment;

2.1.3 Chapter 13 of 2000 HSC Code;

2.1.4 IMO Resolution A.694(17): *General Requirements for Shipborne Radio Equipment Forming Part of the Global Maritime Distress and Safety System (GMDSS) and for Electronic Navigational Aids*;

2.1.5 IMO Resolution MSC.191(79): *Performance Standards for Presentation of Navigation-Related Information on Shipborne Navigational Displays*;

2.1.6 IMO Resolution A.1046(27): *Worldwide Radionavigation System*;

2.1.7 IMO Resolution A.915(22): *Revised Maritime Policy and Requirements for a Future GNSS*;

2.1.8 IMO Resolution MSC.379(93): *Performance Standards for Shipborne BeiDou Satellite Navigation System (BDS) Receiver Equipment;*

2.1.9 IEC 61162 (all parts): *Maritime Navigation and Radiocommunication Equipment and Systems – Digital Interfaces*;

2.1.10 IEC 62288 2014: *Maritime Navigation and Radiocommunication Equipment and Systems - Presentation of Navigation-related Information on Shipborne Navigational Displays - General Requirements, Methods of Testing and Required Test Results*;

2.1.11 IEC 60945:2002/COR1:2008: *Maritime Navigation and Radiocommunication Equipment and Systems - General Requirements - Methods of Testing and Required Test Results*;

2.1.12 *Technical Regulations for the Statutory Surveys of Sea-going Ships Engaged on Domestic Voyages* and Annex 5, Chapter 5 of Title 4 in its 2016 Amendments (hereinafter referred to as “the Regulations”);

2.1.13 GD22-2015 *CCS Guidelines for Type Approval Test of Electric and Electronic Products*.

2.2 The latest version of effective document shall be adopted in case of modifications on above-mentioned conventions, rules, performance recommendations and test standards.

3 Terms and Definitions

Terms and definitions specified in above-mentioned approval and survey basis apply to this Guideline. Considering convenience of compilation and application, the following definitions are directly referenced or complemented in this Guideline.

3.1 BDS: BeiDou Navigation Satellite System;

3.2 COG: Course over Ground;

3.3 SOG: Speed over Ground;

3.4 UTC: Universal Time Coordinated;

3.5 GNSS: Global Navigation Satellite System;

3.6 DBDS: Differential BeiDou Navigation Satellite System;

3.7 Dilution of Precision (DOP): factor indicating the contribution of the geometrical position of navigation satellite to errors. The error of satellite navigation system is the product of ranging error and dilution of precision. Based on different research objects, it can be further classified into Position Dilution of Precision (PDOP), Horizontal Dilution of Precision (HDOP), and Time Dilution of Precision (TDOP), etc.

3.8 Acquisition: the process that code recognition, code synchronization and carrier phase synchronization are completed for satellite signals received through user equipment.

3.9 Receiver Autonomous Integrity Monitoring (RAIM): the method that the pseudo-range measurement information from redundant satellites is used by the receiver to judge integrity of satellite system. It enables judging whether there are defective satellites or locating the specific defective satellite and excluding it from the navigation solution.

3.10 WGS-84 (World Geodetic System 84), the world geodetic system of 1984, is a geocentric reference system developed with the geodetic reference system of 1980 and the BIH1984.0 system, which is based on the precise ephemeris system NSWC-9Z-2 corresponding to WGS72 and is developed by the U.S. Department of Defense.

3.11 CGCS2000 (China Geodetic Coordinate System 2000): the system is the geocentric geodetic coordinate system incorporating the GPS continuously operating reference station of China, the space geodetic control network, the astronomical network and the space geodetic network through the combined adjustment mode. China Geodetic Coordinate System 2000 is based on the ITRF 97 reference frame and the reference frame epoch is 2000.0.

4 Drawings and Documents

4.1 General principle

4.1.1 The scope and detail level of drawings and technical documents submitted shall be adequate to check conformity of equipment with this Guideline and relevant standards and to carry out general inspection for mechanical and electrical design of products.

4.1.2 The documents submitted shall be identified in accordance with regulations of manufactory quality management system, and it shall be convenient for easy reference of technical requirements concerned.

4.2 The following drawings and documents shall be submitted to CCS for review:

4.2.1 Technical specifications (product specifications)

Product specifications shall clearly define the general performance and general design requirements of product, at least including the following items:

— Regulations on ambient conditions of product.

— Regulations on power supply conditions of product.

— Constituent parts of product, main purchased parts and sources.

— Detailed description for product function and performance index.

— Acceptance conditions of complete equipment.

4.2.2 Hardware and interfaces

At least, the following items shall be included:

— Detailed description of major hardware configurations of product.

— Necessary mechanical drawings (structure drawings and outline drawings), electric drawings (schematic diagram, wiring diagram and functional block diagram) and descriptive documents describing functions, mechanical properties and electrical properties of products and constituent parts.

— Detailed description of interfaces between major units, products and other equipment (or systems), including structural properties, electrical properties, data protocols, data formats or protocol switch and interface configuration.

— Schematic diagram or functional block diagram of power unit and product power supply layout.

－ System wiring diagram describing typical application status.

4.2.3 Software

At least, the following items shall be included:

－ Description of major software module and software version number.

－ Software maintenance and update description.

4.2.4 Product installation manual, operation manual and maintenance manual.

At least, the English versions shall be included. The Manuals shall include lists and related explanations of terms, abbreviations, symbols and icons displayed in system or equipment. The user interface and various functional menus shall be described in detail so that users and surveyors are familiar with the equipment and carry out related operations.

4.2.5 Type test outline and factory test outline

At least, descriptions of the following contents shall be included: sampling for type test, batch grouping of factory test, sampling principles, requirements of testing institutions and testing conditions, test items, test methods, test result analysis and its acceptance criteria.

4.2.6 Product identification and physical pictures; sample of product quality certificate.

4.2.7 Accepted ambient condition or performance test reports and authentication reports (if any) of product.

4.2.8 Product quality control documents of manufacturer (such as ISO9000)

4.2.9 Factory test specification

4.2.10 Other technical documents or quality control documents (if any) required to be submitted due to their necessity confirmed by CCS.

5 Technical Requirements of Design

5.1 Electrical safety, adaptability of power supply conditions, environment applicability and electromagnetic compatibility of equipment shall adapt to the usage environment of ship and meet test requirements of “indoor equipment” or “outdoor equipment” specified in IEC 60945.

5.2 Function and performance requirements

5.2.1 General requirements

(1) The equipment shall be capable of receiving and processing BDS positioning, velocity measurement and time signal, and fixing ionosphere delay with ionosphere model transmitted by satellite to the receiver equipment;

(2) The equipment shall provide location information with latitude and longitude expressed in degrees, minutes and 1/1000 minutes;

(3) The equipment shall provide the universal time coordinated (UTC) (NTSC) at that time;

(4) The equipment shall be configured with 2 output ports at least, to provide location, UTC, course over ground (COG), speed over ground (SOG) and alarm information to other equipment. Output of location information shall be based on WGS 84 datum and shall meet requirements of IEC 61162. Output of UTC, course over ground (COG), speed over ground (SOG) and alarm information shall be consistent with requirements in 5.2.1. (16) and 5.2.1. (18).

(5)The static positioning accuracy of antenna position shall be ensured within 25 m (95%) in the horizontal direction and 30 m (95%) in the vertical direction;

(6) During ship motion and general sea conditions, the dynamic position accuracy shall be equivalent to the static accuracy specified in 5.2.1. (5);

(7) The position information is expressed by longitude and latitude in degrees, minutes and 1/1000 minutes, and the position resolution shall be equal to or superior to 0.001 minutes;

(8) The equipment shall be capable of automatically selecting proper satellite signals, to acquire ship position, speed and time meeting requirements of accuracy and update rate;

(9) The equipment enables capturing input satellite signals with carrier level from -130 dBm to -120 dBm. The equipment shall continue to run under the normal state once satellite signals are captured and their carrier levels drops to -133 dBm.

(10) The equipment shall be able to run under normal interference conditions meeting requirements of Resolution A.694(17);

(11) Position, speed and time meeting accuracy requirements shall be acquired within 12 min if no effective satellite almanac data (cold starting) is provided;

(12) Position, speed and time meeting accuracy requirements shall be acquired within 1 min if effective satellite almanac data (warm starting) is provided;

(13) Position, speed and time meeting accuracy requirements shall be acquired within 1 min if duration of service interruption is no more than 60 s;

(14) For common ship, at least one new position result shall be generated per second and outputted to the display and digital interface; for high-speed ship, at least two new position results shall be generated per second and outputted to the display and digital interface;

(15) COG, SOG and UTC outputs shall be provided, and validity signs shall be consistent with signs of position output. Accuracy requirements of COG and SOG shall not be inferior to related performance standards of heading, speed and distance measuring equipment (SDME), and the accuracy requirements shall be met under various possible dynamic conditions;

(16) At least, a contact that can be closed under normal conditions shall be configured, indicating failure of BDS receiver equipment;

(17) The bidirectional communication interface shall be configured, to transmit alarm signals to the external system and to confirm acoustic alarm signals from BDS receiver equipment with the bidirectional communication interface of external system; the interface shall meet requirements of IEC 61162;

(18) The facility, enabling processing differential BDS (DBDS) data inputted into the receiver equipment in compliance with ITU-R standards and RTCM standards and indicating the DBDS signal received and judging whether it is being used for ship positioning, shall be configured. If the BDS receiver equipment is set with the differential receiver, the standard performance (subject to regulations of 5.2.1. (5) and 5.2.1. (6)) of static and dynamic accuracy shall be 10 m (95%) of confidence.

5.2.2 Integrity inspection, failure warning and status display

(1) The BDS receiver equipment shall indicate the conformity of BDS performance with requirements of regulations on common navigation in oceans, coastal waters, approach channels, restricted waters and inland waterway channels specified n Annex 2 of Resolution A.1046(27) or Resolution A.915(22) and any subsequent amendments.

(2) BDS receiver equipment shall at least have the following functions:

① The equipment shall send out a warning within 5 s after losing position or if it fails to compute the new location according to information from the BDS space segment after 1 s (for conventional ship) or 0.5 s (for high-speed ship). Under the condition, the equipment shall output the last known location and the last effective positioning time before returning to normal operation, and its status display shall be clear without any fuzziness.

② The receiver automatic integrity monitoring (RAIM) is used, ensuring complete performance related to relevant operations;

③ The self-testing function is configured;

5.2.3 It is required to ensure that no permanent damage will occur in case of unexpected short circuit or grounding of antenna or its input or output wires or continuous 5-min input or output in BDS receiver equipment.

5.2.4 Equipment output

Output requirements of BDS receiver equipment shall comply with requirements of Articles 5.2.1. (4), 5.2.1. (16) and 5.2.1. (17).

(1) PNT (positioning, navigation and timing) report statements shall meet requirements of IEC 61162 standards and the following statements shall be used:

DTM – Datum reference

GBS – GNSS satellite fault detection

GFA – GNSS Fix Accuracy and integrity

GNS – GNSS fix data

RMC – Recommended minimum specific GNSS data

ZDA – Time and date

If the WGS-84 coordinate is not adopted in the statements, the DTM statements shall be used and its conformity with IEC 61162 shall be ensured.

(2) Alarm report statements shall meet requirements of IEC 61162 standards and the following statements shall be used:

ALR – Set Alarm State

ACK – Acknowledge Alarm

In addition, the following statements can be also used for integration with other navigational aids and navigation equipment.

GRS – GNSS range residuals

GSA – GNSS DOP and active satellites

GST – GNSS pseudorange error statistics

GSV – GNSS satellites in view

Note: GBS, GRS, GSA, GST and GSV statements shall support external integrity inspection and shall be synchronized with GNSS fix data concerned.

6 Raw Material and Parts

Materials and components are to comply with relevant requirements of CCS Rules.**7 Type Approval and Unit/ Batch Test**

7.1 Principle

Shipborne BeiDou Satellite Navigation System (BDS) Receiver Equipment is subject to the type approval of CCS. The issuance, retention, revision, renewal and withdrawal of the type approval certificates shall be in accordance with Chapter 3, Volume 1 of the Rules for Classification of Sea-going Steel Ships.

7.2 Selection of typical samples and test planning

Model and specification of test sample shall be technically representative and cover scopes of products applied and submitted for type approval. Test samples shall be randomly selected by CCS surveyor in the product manufactory.

7.3 Test agencies

The type approval tests shall be carried out by an authorized impartial testing agency approved by CCS and certified by international/national laboratories. If the manufacturer is provided with the required testing conditions, some test items, except for the Beidou performance test, may be carried out at the premise of the manufacturer upon the review and approval of the surveyors of CCS and under their supervision on the site.

During determination of test agencies, test conditions specified in laws and regulations concerned shall be fully considered and written documents shall be submitted to CCS surveyor for approval.

7.4 Type approval test items and requirements

The type approval test items are as shown in the tables below.

Ambient Condition Test Items Specified in IEC 60945 Table 7.4(1)

S/N	Test items	Test methods	Remarks
1.	Man-machine engineering and HMI inspection	IEC 60945, 6.1	Together with performance test
2.	Hardware	IEC 60945, 6.2	Together with performance test
3.	Software	IEC 60945, 6.3	Together with performance test
4.	Connection between units	IEC 60945, 6.4	Together with performance test
5.	Extreme power supply change test	IEC 60945, 7.1	Normal test temperature
6.	Excessive power supply conditions	IEC 60945, 7.2	
7.	Dry heat, including extreme power supply conditions	IEC 60945, 8.2 & 7.1	
8.	Moist heat	IEC 60945, 8.3	
9.	Low temperature, including extreme power supply conditions	IEC 60945, 8.4 & 7.1	

Continued Table 7.4(1)

10.	Vibration test	IEC 60945, 8.7	
11.	Rain and water pouring test for antenna part	IEC 60945, 8.8	
12.	Salt mist test	IEC 60945, 8.12	
13.	Conducted emission test	IEC 60945, 9.2	
14.	Test for radiated emission from enclosure port	IEC 60945, 9.3	
15.	Immunity to conducted disturbance inducted by radio frequency field	IEC 60945, 10.3	
16.	Radiated immunity of radio-frequency electromagnetic field	IEC 60945, 10.4	
17.	Electric fast transient immunity	IEC 60945, 10.5	
18.	Surge immunity	IEC 60945, 10.6	
19.	Immunity to short term change in power supply	IEC 60945, 10.7	
20.	Immunity to power failure	IEC 60945, 10.8	
21.	Electrostatic discharge immunity	IEC 60945, 10.9	
22.	Noise and acoustic signal	IEC 60945, 11.1	
23.	Safe distance of magnetic compass	IEC 60945, 11.2	
24.	Insulation of dangerous voltage	IEC 60945, 12.1	Enclosure IP of equipment installed in cabin shall be IP 20 at least
25.	Emission of visual display unit (VDU)	IEC 60945, 12.3	Unnecessary for liquid crystal display
26.	Withstand voltage test	Article 2.14 of GD22-2015	Complete equipment test (only applicable to power supply unit higher than 50 V)
27.	Measurement of insulation resistance	Article 2.3 of GD22-2015(for all components)	
Performance check / test items in combination with ambient condition test shall following steps below: • Start the equipment from its initial state (cold start); • Check the receiver acquisition time; • Check and verify the normal signal tracking, continuous output of valid fix results and normal navigation of the receiver.			

Equipment Function and Performance Test Items Table 7.4 (2)

S/N	**Test items**	**Test methods**	**Remarks**
1.	Function test	Referring to Article 5.2 of this Guideline	Functions of complete equipment
2.	General requirements	Article 5.6.2, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	Document review
3.	Equipment output	Article 5.6.3, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	Specific inspection and test items shall be determined in accordance with IEC 61162 standard collections defining interfaces.
4.	Accuracy	Article 5.6.4, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	Take test conditions, required reference point and swing table for antenna into account
5.	Acquisition	Article 5.6.5, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	—
6.	Connection between antenna and input/output	Article 5.6.6, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	—
7.	Antenna installation	Article 5.6.7, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	Document review
8.	Sensitivity and dynamic range	Article 5.6.8, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	Special anechoic chamber and signal simulator are required
9.	Disturbance through specific interference signal	Article 5.6.9, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	Signal simulator and S-band radar are required

Continued Table 7.4(2)

10.	Location update	Article 5.6.10, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	
11.	Differential BDS input	Article 5.6.11, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	Document review
12.	Failure alarm and status indication	Article 5.6.12, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	
13.	COG and SOG output	Article 5.6.13, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	
14.	UTC output	Article 5.6.13, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	—
15.	Typical interference condition	Article 5.6.14, Attachment 2, Annex 5, Chapter 5, Title 4 of Regulations	Special anechoic chamber and signal simulator are required
16.	Display of navigation-related information	Articles 4 and 7 of IEC 62288-2014	Completing tests specified in Article 4 in combination with performance test is recommended.

7.5 Single-piece/batch testing

Before the delivery from the factory, the single-piece/batch testing shall be performed and the certificates of marine products shall be issued.

After the type approval, the manufacturer shall, according to the quality control documents submitted for approval, control the production and testing processes of the products, perform the specified delivery test on every marine product and issue the delivery test reports. The surveyors of CCS shall, on the basis of the review of delivery test reports, sample for testing at the rate of 5%, but no less than two sets

The single-piece/batch testing shall at least include the following items:

— Review for main element (part) data;

— Confirmation of software version;

— Appearance inspection;

— Functional confirmation test: display function, failure alarm, status indication and acquisition test;

— Performance test: positioning accuracy

If the surveyors deem necessary, the test items and sample quantity shall be added.