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Testing method of ocean pressure measuring instrument

海洋压力测量仪器检测方法

(English Translation)

(Draft fot Approval)

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Contents

Foreword

SAC/TC 283 is in charge of this English translation. In case of any doubt about the contents of the English translation, the Chinese original shall be considered authoritative.

This document is drafted in accordance with the rules given in GB/T 1.1-2009.

This document was proposed by the National Center of Ocean Standards and Metrology, China.

This document was prepared by the National Technical Committee on Oceans of the Standardization Administration of China (SAC/TC 283).

Testing method of ocean pressure measuring instrument

1 Scope

This document specifies the technical requirements, test items, test equipment and test methods of ocean pressure measuring instrument (hereinafter referred to as “pressure measuring instrument”).

This document is applicable to the first test, the subsequent test and the commission test of pressure measuring instrument.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the *edition cited applies*. For undated reference, the latest edition of the referenced document (including any amendments) applies.

JJF 1008 Pressure Metrological Terms and Their Definitions

HY/T 008 Oceanographic instrument terminology

3 Terms and definitions

For the purposes of this document, the terms and definitions given in HY/T 008 and JJF 1008, and the following apply.

3.1

ocean pressure measuring instrument

an instrument used for automatic field measurement of seawater pressure in the ocean, mainly used for measuring water depth, waves, tides, tsunamis, including the real-time type and the self-contained type

4 Technical requirements

4.1 Appearance and power-on inspection

Requirements of appearance and power-on inspection for the pressure measuring instrument are as follows:

a) The surface paint layer and cladding layer of the pressure measuring instrument shall be uniform in color and smooth, and without wear, corrosion and obvious cracks.

b) The pressure measuring instrument shall have the following identifications: Name and model, manufacturer’s name, serial No. and measurement range of instrument.

c) The pressure measuring instrument shall be assembled securely and be fully airtight. The pressure sensor shall be in good shape without damage and without any appearance of damage affecting the test of normal performance, and shall work normally after being powered on.

d) The accessories of the pressure measuring instrument, CDs and technical documents shall be complete.

4.2 Metrological performance

The metrological performances of the pressure measuring instrument shall comply with the requirements in Table 1.

Table 1 Metrological performances of the pressure measuring instrument

Metrological Performance	Accuracy Class		
	Class 1 MPa	Class 2 MPa	Class 3 MPa
Indication error	± 0.05% FS	± 0.1% FS	± 0.5% FS
Repeatability	≤ 0.016% FS	≤ 0.03% FS	≤ 0.16% FS
Stability	0.1% FS	0.5% FS	3% FS

5 Test items

The test items of the pressure measuring instrument include:

a) Appearance and power-on inspection.

b) The metrological performance test items of the pressure measuring instrument include:

1) Pressure indication errors.

2) Pressure measurement repeatability.

3) Pressure measurement stability.

6 Test equipment

The test equipment requirements of the pressure measuring instrument include:

a) The standard devices for testing may be an optional piston gauge or a digital pressure gauge; the measurement range of the standard selected shall be larger than or equal to that of the pressure measuring instrument; absolute values of the maximum permissible error of the standard pressure instrument shall not be larger than one-third of the pressure measuring instrument.

b) Barometer: The measurement range shall be not less than 600 hPa~1,100 hPa, and the maximum permissible error shall not be larger than ±0.3 hPa.

7 Test environment conditions

The requirements for environment conditions during the pressure measuring instrument test are as follows:

a) Ambient temperature: (20 ± 1) ° C.

b) Relative humidity: Not more than 80%.

c) Supply voltage: AC (220 ± 22) V.

d) There shall be no strong mechanical vibration or electromagnetic interference nearby.

8 Test methods

8.1 Appearance and power-on inspection

Visual inspection, tactile examination and power-on inspection shall be used to inspect the

appearance of the pressure measuring instrument.

8.2 Metrological performance test

8.2.1 Pressure indication errors test

8.2.1.1 Uniformly set pressure test points within the pressure range of the pressure measuring instrument with at least 7 pressure test points in the single sequence. The pressure test shall follow the sequence of boosting first and then depressurizing.

8.2.1.2 Place the pressure measuring instrument on the workbench and adjust its lifting platform to keep the pressure sensor position of the pressure measuring instrument consistent with the reference position of the standard pressure instrument. Connect the standard pressure instrument and the pressure measuring instrument. At least 10 groups of data shall be recorded when pressure measuring instrument being stable at each pressure test point. The average value shall be calculated as the pressure indication value of such test points. If a piston gauge is used, the standard pressure value should be calculated and corrected with reference to Annex A.

8.2.1.3 Calculate the absolute pressure indication error according to Formula (1):

$$\Delta p_i = \overline{p_i} - p_{is} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (1)$$

where:

Δp_i -- Pressure indication error of the pressure measuring instrument on the i^{th} pressure test point, MPa;

$\overline{p_i}$ -- Pressure indication of the pressure measuring instrument on the i^{th} pressure test point , MPa;

p_{is} -- Standard pressure value on the i^{th} pressure test point, MPa.

8.2.2 Pressure measurement repeatability test

Repeat 10 measurements at the test point with maximum pressure. Record the data when they are stable, and calculate as Formula (2) to obtain the measurement repeatability:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(p_i - \overline{p})^2}{n-1}} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (2)$$

where:

σ -- Pressure repeatability of the pressure measuring instrument, MPa;

p_i -- The i^{th} pressure indication of the pressure measuring instrument on the maximum pressure test point, MPa;

$\overline{p}$ -- Arithmetic mean value of the pressure indication of the pressure measuring instrument on the maximum pressure test point, MPa;

n - Number of measurements times repeated, n=10.

8.2.3 Pressure measurement stability test

Regard the absolute value of the difference between the indication errors of pressure test points and those of corresponding test points in the test certificate from the previous year as the

stability value of such test points in two consecutive years, and calculate as per Formula (3):

$$D_i = |\Delta p_i - \Delta p_{bi}| \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (3)$$

where:

D_i-- Stability of the pressure measuring instrument on the i^{th} pressure test point, MPa;

Δp_i -- Pressure indication error of the pressure measuring instrument on the i^{th} pressure test point in the present year, MPa;

Δp_{bi} -- Pressure indication error of the pressure measuring instrument on the i^{th} pressure test point in previous year, MPa.

Take the maximum absolute value as the measurement stability test result of the pressure measuring instrument.

9 Test report

9.1 The test report shall report test results accurately, clearly, and objectively, and shall include:

a) The title: "Test Report".

b) Name and address of inspection organization.

c) Certificate number of the test report appearing on each page, which identifies that this page is part of the test report; and mark that indicates the end of the test report.

d) Name and address of clients.

e) Name, model/specification, serial number and manufacturer of the instrument inspected.

f) Technical document on which the report is based.

g) Name, signature or equivalent identification of approver of the test report.

h) Description of the state of the instrument inspected.

i) Name, model/specification, technical index, certificate number, validity period, etc., of the standard instrument tested.

j) Test date, location and environmental conditions.

k) Test results.

l) Signature of tester and verifier.

9.2 For the format of the test record table, see Annex B.

9.3 For the inside page format of the test report, see Annex C.

Annex A
(Informative)
Pressure Calculation Formula of the Piston Gauge

A.1 Pressure calculation formula of the piston pressure gauge:

$$P = \frac{m \times (1 - \rho_a/\rho_m) \times g}{A[1 + \alpha(t\text{-}20)] \times (1 + \lambda \times P_0)} \quad \text{(A.1)}$$

where:

P -- Pressure generated by the piston pressure gauge, in pascal, Pa;

m -- Weight mass added on the piston, in kilogram (kg);

ρ_a -- Air density, in kilograms per cubic meter (kg/m^3);

ρ_m -- Material density of the weight, piston and fastenings, in kg/m^3;

g -- Gravitational acceleration in meters per square second (m/s^2);

A -- Area of the piston in square meters (m^2);

t -- Piston temperature in degrees Celsius, ℃;

P_0 -- Nominal pressure in MPa;

α -- Thermal expansion coefficient of the piston system, related to the piston material, in per degree centigrade, ($℃^{-1}$); and

λ -- Deformation coefficient of the piston system, related to elasticity modulus of piston and piston barrel E and E_1, Poisson's ratios of piston and piston barrel μ and μ_1, outside radius of piston barrel R_1 and inside radius of piston barrel R_2, per MPa^{-1}.

$$\lambda = \frac{1}{2E} \times (3\mu - 1 + \frac{E_1}{E} \times \frac{R_1^2 + R_2^2}{R_1^2 - R_2^2} + \mu_1) \quad \text{(A.2)}$$

When the piston and piston barrel use the same material, Formula A.2 may be combined in Formula A.3 to:

$$\lambda = \frac{1}{E} \times (2\mu + \frac{R_2^2}{R_1^2 - R_2^2}) \quad \text{(A.3)}$$

A.2 Air density is calculated in Formula A.4:

$$\rho_a = \frac{3.4848(p\text{-}0.0037960U \times e_s)}{273.15 + t} \quad \text{(A.4)}$$

where:

ρ_a -- Air density in kg/m^3;

p -- Atmospheric pressure in kilopascals (kPa);

U -- Relative humidity, percentage (%);

t -- Ambient temperature in ℃;

e_s -- Saturated vapor pressure kPa, calculated as per Formula A.5:

$$e_s = 1.7256 \times 10^8 exp[-5315.66/(t + 273.15)] \quad \text{(A.5)}$$

where:

t —— Ambient temperature in degrees Celsius, ° C.

Annex B
(Informative)
Format of Test Record Tables

The test record table of pressure indication errors, the test record table of pressure repeatability and the test record table of pressure stability are given in Tables B.1–B.3, respectively.

Table B.1 Test Record Table of Pressure Indication Errors

<table>
<tr><td>Product name</td><td colspan="2"></td><td>Serial No.</td><td colspan="2"></td></tr>
<tr><td>Model</td><td colspan="2"></td><td>Sensor No.</td><td colspan="2"></td></tr>
<tr><td>Range</td><td colspan="2"></td><td>Uncertainty or accuracy class or maximum permissible error</td><td colspan="2"></td></tr>
<tr><td>Test basis</td><td colspan="5"></td></tr>
<tr><td colspan="6">Test item</td></tr>
<tr><td colspan="2">No.</td><td colspan="2">Test item</td><td colspan="2">Test result</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="6">Main measuring instrument and equipment used for test</td></tr>
<tr><td>Name</td><td>Measurement range</td><td>Uncertainty or accuracy class or maximum permissible error</td><td>Certificate No.</td><td colspan="2">Valid until</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="6">Test time, place and environmental conditions</td></tr>
<tr><td colspan="3">Date:</td><td colspan="3">Location:</td></tr>
<tr><td colspan="2">Temperature:</td><td colspan="2">Relative humidity:</td><td colspan="2">Air pressure:</td></tr>
<tr><td colspan="6">Test result</td></tr>
<tr><td colspan="3">Boosting calibration</td><td colspan="3">Depressurization calibration</td></tr>
<tr><td>Standard pressure value MPa</td><td>Instrument pressure indication MPa</td><td>Indication error MPa</td><td>Standard pressure value MPa</td><td>Instrument pressure indication MPa</td><td>Indication error MPa</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</table>

Table B.2 Test Record Table of Pressure Repeatability

Test result			
No.	Instrument pressure indication MPa	Indication mean MPa	Measurement repeatability MPa
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Tested by: Verified by:

Table B.3 Test Record Table of Pressure Stability

Test result							
Boosting process				Depressurization process			
Standard pressure value MPa	Indication error in this year MPa	Indication error in previous year MPa	Stability MPa	Standard pressure value MPa	Indication error in this year MPa	Indication error in previous year MPa	Stability MPa

Tested by: Verified by:

Annex C
(Informative)
Inside Page Format of Test Report

The inside page format of test report is given in Table C.1.

Table C.1 Inside Page Format of Test Report

<table>
<tr><td colspan="6">Basic information on the instrument to be tested</td></tr>
<tr><td colspan="2">Receiving date</td><td colspan="4"></td></tr>
<tr><td colspan="2">Description</td><td colspan="4"></td></tr>
<tr><td colspan="6">Summary of test results</td></tr>
<tr><td>No.</td><td colspan="2">Test item</td><td colspan="2">Subclause No./method standard No.</td><td>Test result</td></tr>
<tr><td>1</td><td colspan="2">Indication error</td><td colspan="2"></td><td></td></tr>
<tr><td>2</td><td colspan="2">Measurement repeatability</td><td colspan="2"></td><td></td></tr>
<tr><td>3</td><td colspan="2">Measurement stability</td><td colspan="2"></td><td></td></tr>
<tr><td colspan="6">Test basis:</td></tr>
<tr><td colspan="6">Metrological performance test</td></tr>
<tr><td colspan="6">Main measuring instruments and equipment used for test</td></tr>
<tr><td>Name</td><td>Model/specification</td><td>Uncertainty or accuracy class or maximum permissible error</td><td colspan="2">Certificate No.</td><td>Valid until</td></tr>
<tr><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td colspan="6">Test time, location and environmental conditions</td></tr>
<tr><td colspan="3">Time:</td><td colspan="3">Location:</td></tr>
<tr><td colspan="6">Temperature: Relative humidity: Air pressure:</td></tr>
<tr><td colspan="6">Test result</td></tr>
<tr><td colspan="6">Sensor No.:</td></tr>
<tr><td colspan="3">Boosting calibration</td><td colspan="3">Depressurization calibration</td></tr>
<tr><td>Standard pressure value MPa</td><td>Instrument pressure indication MPa</td><td>Indication error MPa</td><td>Standard pressure value MPa</td><td>Instrument pressure indication MPa</td><td>Indication error MPa</td></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Measurement repeatability:</td><td colspan="3">Measurement stability:</td></tr>
</table>

Tested by: Verified by:

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