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Marine Industry Standard of the People's Republic of China

Method for testing ocean pressure measuring instruments

海洋压力测量仪器检测方法

(English Translation)

Table of contents

Foreword

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

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

This standard was placed under centralized management by the National Technical Committee on Oceans of the Standardization Administration of China (SAC/TC283).

The drafting units of this standard were the National Center of Ocean Standards and Metrology, the National Institute of Metrology and the National Ocean Technology Center.

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Method for testing ocean pressure measuring instruments

1 Scope

This standard specifies the technical requirements, test items, test equipment and test methods of ocean pressure measuring instruments (hereinafter referred to as "pressure measuring instruments").

This standard is applicable to the first test, the subsequent test and the commission test of pressure measuring instruments.

2 Terms and Definitions

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

2.1 Ocean pressure measuring instrument

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

3 Technical Requirements

3.1 Appearance and power-on check

The appearance and power-on check requirements of the pressure measuring instrument are:

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, shall be free of any appearance of damage affecting the test of normal performance, and shall work normally after being powered on.

d) All accessories, software and documents shall be complete.

3.2 Metrological performance

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

Table 1 Pressure Indication Error Indicators

Metrological Performance	Accuracy Class		
	Class 1	Class 2	Class 3
Indication error (MPa)	± 0.05% F.S.	± 0.1% F.S.	± 0.5% F.S.
Repeatability (MPa)	≤ 0.016% F.S.	≤ 0.03% F.S.	≤ 0.16% F.S.
Stability (MPa)	0.1% F.S.	0.5% F.S.	3% F.S.

4 Test Items

4.1 Appearance and power-on check;

4.2 Metrological performance test

The metrological performance test items of the pressure measuring instrument are:

a) Pressure indication errors.

b) Pressure measurement repeatability.

c) Pressure measurement stability.

5 Test Equipment

The test equipment requirements of the pressure measuring instrument are:

a) The standard devices for testing may be an optional piston gauge or a pressure controller; 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—1,100 hPa, and the maximum permissible error shall not be larger than ±0.3 hPa.

6 Test Environmental Conditions

The test environmental conditions of the pressure measuring instrument are:

a) Ambient temperature: (20 ± 1) °C.

b) Relative humidity: Not more than 80%.

c) Voltage supply: AC (220 ± 22) V.

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

7 Test Methods

7.1 Appearance and power-on check

The appearance and power-on check of the pressure measuring instrument that is carried out by visual and manual inspection or by other methods shall comply with the requirements in 3.1.

7.2 Metrological performance test

7.2.1 Pressure indication errors test

7.2.1.1 There shall be at least 7 pressure test points, equally selected within the range of the pressure measuring instrument. Start from zero pressure, go up to the maximum sensor pressure, and come back down to zero pressure. The pressure test shall follow the sequence (1) boosting and (2) depressurization.

7.2.1.2 Place the pressure measuring instrument on the workbench and adjust the 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. Record at least 10 pressure measuring instrument data at each pressure test point when the data are stable, and take the mean value as the pressure indication of the pressure measuring instrument. If using the piston gauge, calculate and correct the standard pressure value with reference to Annex A.

7.2.1.3 Calculate the absolute pressure indication error as per Formula (1):

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

where:

Δp_i —— Pressure indication error of the pressure measuring instrument on the ith pressure test point, in megapascals (Mpa);

$\overline{p_i}$ —— Pressure indication of the pressure measuring instrument on the ith pressure test point in MPa; and

p_{is} —— Standard pressure value on the ith pressure test point in MPa.

7.2.2 Pressure measurement repeatability test

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

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

where:

σ —— Pressure repeatability of the pressure measuring instrument in MPa;

p_i —— The ith pressure indication of the pressure measuring instrument on the maximum pressure test point in MPa;

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

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

7.2.3 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):

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

where:

D_i -- Stability of the pressure measuring instrument on the ith pressure test point in Mpa;

Δp_i -- Pressure indication error of the pressure measuring instrument on the ith pressure test point in the present year in Mpa; and

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

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

8 Test Report

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

a) Title: Test Report.

b) Name and address of testing organization, and place where test carried out.

c) Unique identifier of test report and identifier on every page, to identify every page as part of the test report; and clear identification indicating the end of the test report.

d) Name and address of customers.

e) Name, model/specification, factory number and manufacturer of the instrument tested.

f) Technical documentation on which the report is based.

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

h) Signature of tester and verifier.

i) Description and state of the instrument to be tested.

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

k) Test date and time, location and environmental conditions.

l) Test results.

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

8.3 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:

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

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, °C;

P_0 —— Nominal pressure in MPa;

α —— Thermal expansion coefficient of the piston system, related to the piston material, in per degree centigrade, °C^{-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}.

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

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

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

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

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

where:

ρ_a —— Air density in kg/m^3;

p —— Atmospheric pressure in kilopascals (kPa);

U —— Relative humidity, percentage (%);

t —— Ambient temperature in °C;

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

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

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

Product name		Serial No.	
Model		Sensor No.	
Range		Uncertainty or accuracy class or maximum permissible error	
Test basis			
Test item			
No.		Test item	Test result

Main measuring instrument and equipment used for test				
Name	Measurement range	Uncertainty or accuracy class or maximum permissible error	Certificate No.	Valid until

Test time, place and environmental conditions					
Date:			Location:		
Temperature:		Relative humidity:		Air pressure:	

Test result					
Boosting calibration			Depressurization calibration		
Standard pressure value (MPa)	Instrument pressure indication (MPa)	Indication error (MPa)	Standard pressure value (MPa)	Instrument pressure indication (MPa)	Indication error (MPa)

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

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

Tested by: Verified by:

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