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Refrigerated light hydrocarbon fluids — Measurement of temperature in tanks containing liquefied gases — Resistance thermometers and thermocouples

Hydrocarbures liquides légers réfrigérés — Mesurage de température dans les réservoirs contenant le gaz liquéfié — Thermomètres à résistance et thermocouples

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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 8310 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Sub-Committee SC 5, *Measurement of light hydrocarbon fluids*.

Annexes A and B of this International Standard are for information only.

Refrigerated light hydrocarbon fluids — Measurement of temperature in tanks containing liquefied gases — Resistance thermometers and thermocouples

1 Scope

This International Standard specifies the essential requirements and verification procedures for resistance-thermometer sensors, thermocouples and associated equipment to be used for ship and shore tanks containing refrigerated hydrocarbon fluids.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IPTS-68, *The International Practical Temperature Scale — 1968.*

IEC 79-0:1983, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements.*

IEC 79-1:1971, *Electrical apparatus for explosive gas atmospheres — Part 1: Construction and test of flameproof enclosures of electrical apparatus.*

IEC 79-1A:1975, *Electrical apparatus for explosive gas atmospheres — First supplement: Appendix D: Method of test for ascertainment of maximum experimental safe gap.*

IEC 79-2:1983, *Electrical apparatus for explosive gas atmospheres — Part 2: Electrical apparatus — type of protection "p".*

IEC 79-3:1972, *Electrical apparatus for explosive gas atmospheres — Part 3: Spark test apparatus for intrinsically-safe circuits.*

IEC 79-4:1975, *Electrical apparatus for explosive gas atmospheres — Part 4: Method of test for ignition temperature.*

IEC 79-4A:1970, *Electrical apparatus for explosive gas atmospheres — First supplement.*

IEC 79-5:1967, *Electrical apparatus for explosive gas atmospheres — Part 5: Sand-filled apparatus.*

IEC 79-6:1968, *Electrical apparatus for explosive gas atmospheres — Part 6: Oil-immersed apparatus.*

IEC 79-7:1969, *Electrical apparatus for explosive gas atmospheres — Part 7: Construction and test of electrical apparatus, type of protection "e".*

IEC 79-10:1986, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas.*

IEC 79-11:1984, *Electrical apparatus for explosive gas atmospheres — Part 11: Construction and test of intrinsically-safe and associated apparatus.*

IEC 79-12:1978, *Electrical apparatus for explosive gas atmospheres — Part 12: Classification of mixtures of gases or vapours with air according to their maximum experimental safe gaps and minimum igniting currents.*

IEC 92-504:1974, *Electrical installations in ships — Part 504: Special features — Control and instrumentation.*

IEC 533:1977, *Electromagnetic compatibility of electrical and electronic installations in ships.*

IEC 584-1:1977, *Thermocouples — Part 1: Reference tables.*

IEC 584-2:1982, *Thermocouples — Part 2: Tolerances.*

IEC 654-1:1979, *Operating conditions for industrial-process measurement and control equipment — Part 1: Temperature, humidity and barometric pressure.*

IEC 654-2:1979, *Operating conditions for industrial-process measurement and control equipment — Part 2: Power.*

IEC 751:1983, *Industrial platinum resistance thermometer sensors.*

The International Code for the construction and equipment of ships carrying liquefied gases in bulk (IGC Code), 1983, published by IMO.

3 Definitions

3.1 temperature-measurement system: A system consisting of a temperature detector, a receiving instrument which processes the signal and gives a temperature display, and cables linking the detector to the receiving instrument.

3.2 gas-dangerous space: A space where gas or vapour may form flammable mixtures when mixed with air. This is equivalent to the "hazardous area" as provided by IEC 79-10 for shore tanks, and to the "gas-dangerous space or zone" as provided by IMO resolution A.328(IX), 1.4.16 (see IGC Code), for ships' tanks.

3.3 maximum permissible error: The extreme value of the error permitted, by specification, in a system.

4 Types of temperature detector

Temperature detectors shall be either platinum resistance-thermometer sensors (IEC 751 recommends 100 Ω except for high-temperature use) or copper/constantan thermocouples (type T) (see IEC 584-1 and IEC 584-2). The materials of the temperature detectors and the leads connecting the detectors to the receiving instruments shall have properties which change only minimally with time.

Resistance-thermometer sensors shall be either three- or four-wire types.

5 Errors in the temperature-measurement system

5.1 Temperature detector

5.1.1 Class A resistance-thermometer sensors used for measurement of the temperature of the liquid phase (see table 1) shall have an error not greater than

a) ± 0,15 °C for LNG

or

b) ± 0,3 °C for LPG and other cryogenic fluids.

NOTE 1 These different error limits have been specified owing to the difference in the coefficients of expansion of LNG and LPG.

5.1.2 Class A resistance-thermometer sensors used for measurement of the temperature of the vapour phase shall have an error not greater than ± 0,3 °C.

5.1.3 The measurement current in the resistance thermometer sensors shall be of such a value that the electrical power dissipated in the thermometer does not cause the temperature to rise by more than one-fifth (IEC 751) of the maximum permissible error specified in 5.1.1 and 5.1.2.

5.1.4 Class A thermocouples used for measurement of the temperature of the vapour phase shall have a maximum permissible error equal to or less than ± 0,5 °C or 1 % whichever is the greater, in the measurement range (− 200 °C to 0 °C).

5.1.5 The error due to the compensating cable connected to class A thermocouples shall be not greater than ± 0,5 °C when the temperature of the connecting terminals lies between − 25 °C and 100 °C (IEC 584-1 and IEC 584-2).

5.2 Overall error

5.2.1 The overall temperature-measurement error, including error in the temperature measurement system elements, shall be not greater than the value given in table 1 for the appropriate application.

Table 1 — Overall error

	Use	LNG	LPG and others
Class A	Liquid phase	± 0,3 °C	± 1 °C
	Vapour phase	± 2 °C	± 2 °C
Class B	Liquid phase	± 2 °C	± 2 °C
	Vapour phase	± 2 °C	± 2 °C

NOTES

2 Class A: for applications requiring high accuracy.

3 Class B: for applications not requiring high accuracy.

Class A accuracy is preferable for determining the quantity in commercial transactions.

4 The individual error is specified depending on the difference of the coefficients of expansion between LNG and LPG and others.

5.2.2 The overall error shall be taken as the square root of the sum of the squares of the maximum instrument errors given by the tests specified in clause 9.

6 Requirements on receiving instruments

6.1 Receiving instruments shall be installed in a location free from temperature variations of a magnitude likely to cause measurement errors outside the limits specified in 5.2.1.

6.2 A receiving instrument shall have a high-impedance receiving circuit so as to minimize the error.

7 Insulation resistance

7.1 Temperature detectors shall have an insulation resistance of not less than 10 MΩ, when tested by the method specified in 7.2.

7.2 The insulation resistance shall be tested by applying a voltage of 500 V d.c. between each terminal and the sheath or the protecting tube while keeping the temperature of the sensor portion of the detector at ambient, near 100 °C and near − 196 °C.

8 Environmental conditions and permissible power-supply fluctuations

The environmental conditions of the various parts of the resistance thermometers or thermocouples shall be as shown in tables 2 and 3. Fluctuations of power supply shall not exceed the values shown in table 4.

NOTE 5 These limits are imposed to prevent damage to the system, not to maintain its accuracy.

Table 2 — Environmental conditions for the various parts of resistance thermometers and thermocouples (for shore tanks)

	Inside the tank	Outside the tank	
		Exposed area	Other areas
Temperature	LNG: − 165 °C to + 55 °C LPG: − 50 °C to + 55 °C	− 25 °C to + 70 °C (Quoted from IEC 654-1)	0 °C to 55 °C (Quoted from IEC 654-1)
Relative humidity	5 % to 100 % at 0 °C to 40 °C (Quoted from IEC 654-1) 5 % to 70 % above 40 °C		

NOTES

1 In the case of liquids other than liquefied natural gas or liquefied petroleum gas, the lower temperature limit inside the tank may be specified on the basis of the boiling points of the liquids.

2 Any part of the equipment installed inside the tank shall possess sufficient strength and be secured to withstand the static pressure and wave motion or other action of the liquids.

Table 3 — Environmental conditions for the various parts of resistance thermometers and thermocouples (for ships' tanks)

	Inside the tank	Outside the tank	
		Exposed area	other areas
Temperature	LNG: − 165 °C to + 80 °C LPG: − 50 °C to + 80 °C	− 25 °C to + 70 °C (Quoted from IEC 92-504)	0 °C to 55 °C
Vibration	Equipment shall have no natural frequencies within the range 0 Hz to 80 Hz (Quoted from IEC 92-504) Amplitude: ± 1,0 mm within the range 2,0 Hz to 13,2 Hz Acceleration: 0,7 G within the range 13,2 Hz to 80 Hz Maximum acceleration: 0,7 G		
Relative humidity	0 % to 100 % at 0 °C to 40 °C (Quoted from IEC 92-504) 0 % to 70 % above 40 °C		
Inclination	Inclination angle (in all directions): 22,5° (Quoted from IEC 92-504) Roll (10 s period): 22,5°		
Pitch	Acceleration: + 1,0 G, in vertical direction (Quoted from IEC 92-504)		
Electromagnetic compatibility	To IEC 533		

NOTES

1 All values in the above table indicate operating conditions.

2 Wiring to the sensors and inside the tank shall possess ample strength and be secured to withstand wave motion or other action of the liquid contained in the tank.

3 All equipment installed on the weather deck of a ship shall have adequate protection against exposure to or immersion in sea water.

4 For liquids other than liquefied natural gas or liquefied petroleum gas, a lower temperature limit inside the tank may be specified on the basis of the boiling points of the liquids.

Table 4 — Fluctuations in the power supply

Power source	Variant	Variation		
		Permanent	Transient	
		Variant value, %	Variant value, %	Recovery time, s
Alternating current	Voltage frequency	± 10 [1)] ± 5	± 20 [1)] ± 10	3 [1)] 3
Battery	Voltage	+ 30 [1)] − 25	—	—

NOTE — When the equipment is not connected to the battery during charging or when voltage-stabilizing equipment is used, the value of the voltage variation of a battery may be reduced to ± 20 %.

1) Quoted from IEC 654-2 and IEC 92-504.

9 Verification procedures

9.1 Verification prior to installation

The following tests shall be performed.

9.1.1 Temperature detectors

The accuracy of the temperature detectors shall be checked by a fixed-point method or by calibration against standard thermometers.

It is recommended that the fixed-point temperature device, the constant-temperature device, the standard thermometers and the method used to determine the errors in the temperature detectors be as given in annexes A and B.

9.1.2 Receiving instruments

Errors in the receiving instruments shall be determined as follows:

a) Feed a standard value to the input terminals. This value may be a resistance or an electromotive force, depending whether a resistance thermometer or a thermocouple is to be calibrated.

b) Read the indicated value.

c) Compare the indicated value with the standard value fed to the input terminals.

9.2 Verification after installation

After the temperature detector is completely installed, the following tests shall be performed:

9.2.1 Check all wire, cable connections and hook-ups and all other installation-related devices to ensure they are in accordance with the manufacturer's recommendations.

9.2.2 Check the insulation resistance value of the sensor and the cables connected to the temperature detector and compare with the original readings taken as specified in clause 7.

9.3 Verification during service life

It is advisable that the following test be performed as regularly as possible.

9.3.1 When the tank is opened and can be entered, check that the installation of the temperature detectors, their connecting cables and the associated connections are in accordance with this International Standard and the manufacturer's recommendations.

9.3.2 If two or more temperature detectors are installed in one tank, use the small differences in temperature in the liquid phase to monitor that the devices are operating correctly.

9.3.3 The receiving instruments shall then be tested again as specified in 9.1.2.

10 Instrumentation requirements for gas-dangerous spaces

The temperature-measurement system shall be in accordance with the relevant national or international standards, such as IEC 79-0 to 79-12, IEC 92-504 and IMO resolution A.328, 10.2 (see IGC Code).