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Refrigerated light hydrocarbon fluids — Measurement of liquid levels in tanks containing liquefied gases — Electrical capacitance gauges

Hydrocarbures légers réfrigérés — Mesurage du niveau de liquide dans les réservoirs contenant des gaz liquéfiés — Jauges à effet capacitif

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Contents

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Annexes

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 8309 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 liquid levels in tanks containing liquefied gases — Electrical capacitance gauges

1 Scope

This International Standard specifies the essential requirements and verification procedures for capacitance-type liquid level gauges to be used for ship and shore tanks containing refrigerated light 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.

IMO (International Maritime Organization) Resolution A.328(IX), *Code for the construction and equipment of ships carrying liquefied gases in bulk.*[1]

IEC 79-0:1983, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements.*[2]

IEC 79-1:1971, *Electrical apparatus for explosive gas atmospheres — Part 1: Construction and test of flameproof enclosures of electrical apparatus.*[2]

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

IEC 79-3:1972, *Electrical apparatus for explosive gas atmospheres — Part 3: Spark test apparatus for intrinsically-safe circuits.*[2]

IEC 79-4:1975, *Electrical apparatus for explosive gas atmospheres — Part 4: Method of test for ignition temperature.*[2]

IEC 79-5:1967, *Electrical apparatus for explosive gas atmospheres — Part 5: Sand-filled apparatus.*[2]

IEC 79-6:1968, *Electrical apparatus for explosive gas atmospheres — Part 6: Oil-immersed apparatus.*[2]

IEC 79-7:1969, *Electrical apparatus for explosive gas atmospheres — Part 7: Construction and test of electrical apparatus, type of protection "e".*[2]

IEC 79-10:1986, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas.*[2]

IEC 79-11:1984, *Electrical apparatus for explosive gas atmospheres — Part 11: Construction and test of intrinsically-safe and associated apparatus.*[2]

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.*[2]

1) Reference for level gauges in ship's tanks.

2) Reference for level gauges in shore tanks.

IEC 92-504:1974, *Electrical installations in ships — Part 504: Special features — Control and instrumentation.*[1)]

IEC 533:1977, *Electromagnetic compatibility of electrical and electronic installations in ships.*[1)]

IEC 654-1:1979, *Operating conditions for industrial-process measurement and control equipment — Part 1: Temperature, humidity and barometric pressure.*[2)]

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

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 accuracy test: A test for determining the extent of errors.

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" described in IEC 79-10 for shore tanks, and to the "gas-dangerous space or zone" described in IMO Resolution A.328(IX) for ship's tanks.

3.3 gauge reference point: A point fixed as a reference for measuring the liquid level.

3.4 intrinsically safe construction: A construction which is proved by testing in accordance with IEC 79-11 to be incapable of producing an incendiary spark in normal or fault condition in the gases or vapours for which it is certified.

3.5 liquid level: The distance between the surface of the liquid in a tank and the gauge reference point, measured along the centreline of the level gauge.

3.6 offset constant: The height of the lower end of the main sensor from the tank bottom after installation in the tank.

3.7 maximum permissible error: The extreme value of the error permitted by specification as a system.

3.8 Sensors

3.8.1 main sensor: That part of the level gauge that responds to changes in liquid level.

3.8.2 reference sensor: That part of the level gauge that measures the dielectric constant of the liquid.

3.9 standard scale: A measure used for testing the accuracy of the level gauge.

4 Gauge design

A capacitance-type liquid level gauge is composed of the components as shown in figure 1.

The materials and the construction of a liquid level gauge shall be such that the gauge will withstand, without damage, exposure to the environmental conditions specified in tables 1 and 2.

4.1 Sensors

The sensors shall consist of a main sensor and a reference sensor.

4.1.1 Main sensor

The main sensor, consisting of two electrodes formed by dual coaxial tubes or similar structures, measures the liquid level through differences in the electrostatic capacity of the sensor due to the changing liquid level. The main sensor shall be constructed taking into consideration the following requirements:

a) In order to obtain the measurement accuracy required for each measurement range, the electrodes shall be divided into sections of appropriate length to provide the accuracy specified in clause 6.

b) The non-sensing parts, at the joints of the divided electrodes, shall be made as small as possible to reduce interruptions in the continuous measurement.

c) To maintain linearity of all the electrodes, dual coaxial-type tubular electrodes, for example, shall be manufactured with sufficient control of the dimensional variation of the inner and outer diameters of the tubes. The tubes shall be assembled tightly to prevent shifting of the coaxial positioning thereof, but the use of supports between the electrodes shall be restricted as far as possible.

d) Provision shall be made for free circulation of the liquid between the outside and inside of the electrodes so that the composition of the liquid inside the electrodes is identical to that on the outside. Provision of flow holes at regular intervals is recommended.

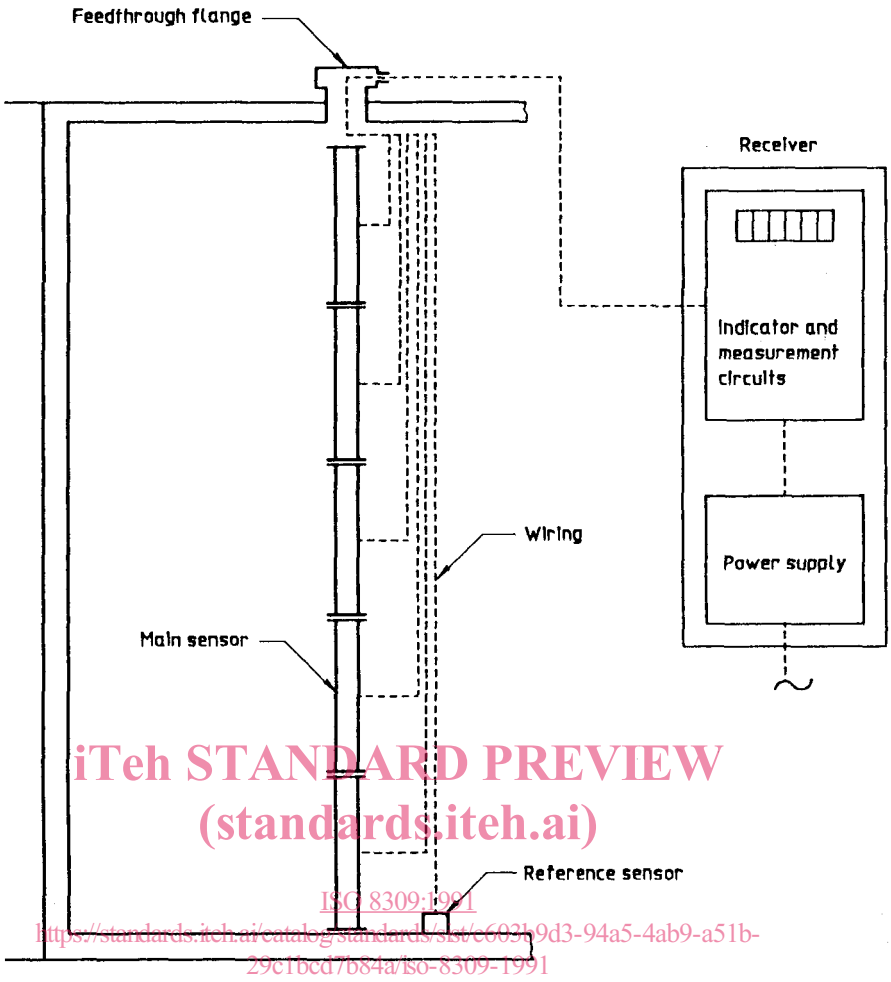

Figure 1 — Example of capacitance-type level gauge

Table 1 — Environmental conditions for the various parts of capacitance-type level gauges (for shore tanks)

	Inside tank	Out of tank	
		Exposed area	Other areas
Temperature	LNG: − 165 °C to + 55 °C LPG: − 50 °C to + 55 °C	− 25 °C to + 70 °C*	0 °C to 55 °C*
Relative humidity	5 % to 100 % at 0 °C to 40 °C* 5 % to 70 % above 40 °C		

* Quoted from IEC 654-1.

NOTES

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

2 Every part of the equipment installed inside the tank shall possess sufficient strength to withstand static pressure and wave motion or other action of the liquid.

Table 2 — Environmental conditions for the various parts of capacitance-type level gauges (for ship's tanks)

	Inside tank	Out of tank	
		Exposed area	Other areas
Temperature	LNG: −165 °C to +80 °C LPG: −50 °C to +80 °C	−25 °C to +70 °C*	0 °C to 55 °C
Vibration	No natural frequencies of equipment within 0 Hz to 80 Hz* Amplitude: ±1,0 mm within 2,0 Hz to 13,2 Hz Acceleration: 0,7 G within 13,2 Hz to 80 Hz Maximum acceleration: 0,7 G		—
Relative humidity	0 % to 100 % at 0 °C to 40 °C* 0 % to 70 % above 40 °C		
Inclination	Inclination angle (in all directions): 22,5°* Roll angle (10 s period): 22,5°		
Pitching	Acceleration: +1,0 G in vertical direction*		
Electromagnetic compatibility	To IEC 533		

* Quoted from IEC 92-504.

NOTES

1 All values in the above table indicate conditions when in operation.

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

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

4 In the case of liquids other than liquefied natural gas or liquefied petroleum gas, lower temperature limits inside the tank may be specified on the basis of the boiling point of the liquid.

4.1.2 Reference sensor

The reference sensor shall always be immersed in the liquid in order to sense changes in dielectric constant. It is used to provide a means by which the main sensor is compensated for changes in dielectric constant of the liquid. A reference sensor is necessary wherever highly accurate measurement is required. The reference sensor may be either a dedicated piece of equipment or a section of the main sensor that is fully immersed in liquid.

A sensor that is used exclusively as a reference and set directly on the bottom of a tank shall be constructed in such a way so as not to accumulate foreign substances and also so that cleaning and maintenance are as simple as possible.

4.2 Receiver

The receiver shall be composed of the following units:

a) a power supply unit for generating power to drive the sensors;

b) a measurement unit for impedance transformation, and amplification and conversion of the signals from the sensors;

c) a control unit for switching, calculation and logic operations, controlling all functions of the equipment;

d) an indicator unit.

The receiver indicates the measurement results and shall satisfy the following conditions:

1) the functions of the controller unit shall be easily validated;

2) the design shall be such that numerical values, like the zero points of the sensors, etc., which are of importance for the measurements, shall be unaffected by power failures, vibrations, etc., and easy to validate for each measurement.

4.3 Wiring

The wiring passing through a feedthrough flange on the tank to connect the sensors with the receiver shall satisfy the following conditions:

a) the wiring shall not be affected by electrical interference;

b) the wiring inside the tank shall be able to withstand cryogenic temperatures and also any shocks caused by vibration or by flowing liquid;

c) the feedthrough flange on the tank shall be of hermetic construction, securely sealing off the inside of the tank from the outside.

5 Environmental conditions and allowable power supply fluctuations

Environmental conditions for the various parts of capacitance-type level gauges shall be as shown in table 1 for shore tanks and in table 2 for ship's tanks. Fluctuations in the power supply shall not exceed the values shown in table 3. Note that these limits are imposed to prevent damage to the system, not to maintain the accuracy thereof.

6 Performance

6.1 Combined error of main sensor and receiver

The combined error of main sensor and receiver (as defined in 8.2.3) shall not exceed the following limits:

a) Class A: 5 mm

b) Class B: as required

6.2 Maximum permissible error

The maximum permissible errors (as defined in 3.7) of the level gauge as a system shall not exceed the following limits:

a) Class A: $7{,}5 + 0{,}05L$ mm

where L is the liquid level in metres.

b) Class B: as required

6.3 Level indication

The indication of the liquid level shall be on an instrument with a resolution of:

a) 1 mm for class A

b) as required for class B

6.4 Class of gauge

The class of gauge (class A or class B) shall be selected according to the application.

7 Installation

7.1 Main sensor

7.1.1 In principle, the main sensor shall be fixed at its lowest point to the tank bottom directly or with a fitting attached thereto. The position of the lowest point of the sensor shall not be significantly altered by variations in temperature.

7.1.2 The main sensor shall be installed along a supporting column having sufficient strength, and shall be secured to it at regular intervals. The sensor structure shall be flexible, allowing vertical movement along the supporting column for thermal expansion and contraction.

7.1.3 The main sensor shall be installed in a vertical direction from the tank bottom.

Table 3 — Fluctuations in the power supplies

Power source	Variant item	Variation		
		Permanent	Transient	
		Variant value %	Variant value %	Recovery time s
Alternating current	Voltage frequency	± 10* ± 5	± 20* ± 10	3* 3
Battery	Voltage	+ 30* − 25		—

* Quoted from IEC 654-2 and IEC 92-504.

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