INTERNATIONAL STANDARD

**ISO 13689**

First edition
2001-04-01

# Refrigerated light hydrocarbon fluids — Measurement of liquid levels in tanks containing liquefied gases — Microwave-type level gauge

*Hydrocarbures légers réfrigérés — Mesurage des niveaux de liquide dans les réservoirs contenant des gaz liquéfiés — Jauges de niveau à micro-ondes*

Reference number
ISO 13689:2001(E)

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# Foreword

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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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 13689 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 5, *Measurement of light hydrocarbon fluids*.

Annex A forms a normative part of this International Standard.

# Refrigerated light hydrocarbon fluids — Measurement of liquid levels in tanks containing liquefied gases — Microwave-type level gauge

## 1 Scope

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

## 2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

IEC 60079-10:1995, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas*.[1)]

## 3 Terms and definitions

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

**3.1**
**antenna**
generic term for equipment that radiates into, and receives from, the tank vapour space, electromagnetic energy in the microwave frequency band

**3.2**
**datum level**
reference level, equal to the zero level in the tank calibration table, from which liquid level $L$ is calculated

**3.3**
**dead zone**
zone above the minimum measurable ullage

**3.4**
**deflection plate**
metal plate set obliquely near the tank bottom to avoid influence of microwave reflection from the bottom or any obstacles

NOTE A deflection plate may also be used to reduce unwanted reflections from the tank structure or fittings

1) Reference for level gauges in shore tanks and ships' tanks.

**3.5**
**hazardous area**
space where gas or vapour may form a flammable mixture, as described in IEC 60079-10

NOTE This is similar to gas-dangerous space on board the ships as described in the IMO IGC Code (1993).

**3.6**
**upper reference point**
basic point for measurement of ullage, set on the level-gauge centre-line near the gauge flange

NOTE The height of the upper reference point is the distance between the datum level and the upper reference point ($H$ in Figure 1).

**3.7**
$L$
**liquid level**
distance between the liquid surface in a tank and the datum level

NOTE See Figure 1.

**3.8**
**microwave**
generic form for electromagnetic radiation, with wave length lying in the range 3 mm to 300 mm (equivalent to a frequency of 100 GHz to 1 GHz)

**3.9**
**microwave beam**
main directional beam formed by the electromagnetic signals radiated from the antenna into free space

**3.10**
**still pipe**
perforated metal pipe, extending throughout the height of the tank, used to reduce surface turbulence in the liquid that may cause fluctuations in the reflected signal

NOTE It may also be used to guide the microwave signal in difficult installation conditions

**3.11**
**ullage**
distance between the liquid surface in a tank and the upper reference point, measured along the vertical measurement axis

## 4 Function and construction of microwave-type level gauges

**4.1** A microwave-type level gauge functions by using electromagnetic radiation determining the distance from its antenna to the liquid surface.

The distance is then subtracted from the height of the upper reference point and the level of liquid in the tank thereby computed and transmitted electronically to a point outside the tank.

**4.2** A microwave-type level gauge consists of functional components comprising an antenna, microwave transceiver and other optional items.

Figures 1 and 2 show examples of arrangements.

**4.3** The materials and construction of a microwave-type level gauge shall be such that it can operate safely and effectively under applicable environmental conditions for which it is intended.

**4.4** A microwave-type level gauge shall be of gastight construction in order to prevent the escape of vapour from the tank.

**4.5** All microwave-type level gauges shall be manufactured and installed in accordance with appropriate National and International electrical safety codes and standards (IMO, IEC, ISO, etc.). All level gauges shall be certified for use in the hazardous-area classification appropriate to their installation.

NOTE The design and installation of the microwave-type level gauges may be subject to the approval of the national measurement organizations and classification societies, who may have issued a general type approval for the design of the microwave-type level gauge for the particular service for which it is to be employed. The type approval is normally issued after the microwave-type level gauge has been subject to a specific series of tests and is subject to the microwave-type level gauge being installed in an approved manner. Type-approval tests may include the following: visual inspection, resistance, vibration, performance, humidity, dry heat, inclination, electromagnetic compatibility, and fluctuation in power supplies.

## 5 Performance

**5.1** Indication: minimum range display resolution shall not be greater than 1 mm.

**5.2** Maximum permissible error: $\pm$ (3,3 + 0,08$D$) mm where $D$ is the distance, in metres, from the upper reference point to the liquid surface.

**5.3** If the level gauge fails to meet the performance requirements of this clause, the cause shall be investigated. If the level gauge needs to be adjusted or components replaced, with the tank in service, it should be reverified in accordance with clause 8.

## 6 Installation

The microwave-type level gauge shall be installed in accordance with the manufacturer's instructions.

## 7 Initial verification of accuracy

After installation, accuracy of the level gauge shall be verified by means of an appropriate proven method under atmospheric temperature and pressure in the tank. The error shall not exceed that defined in 5.2.

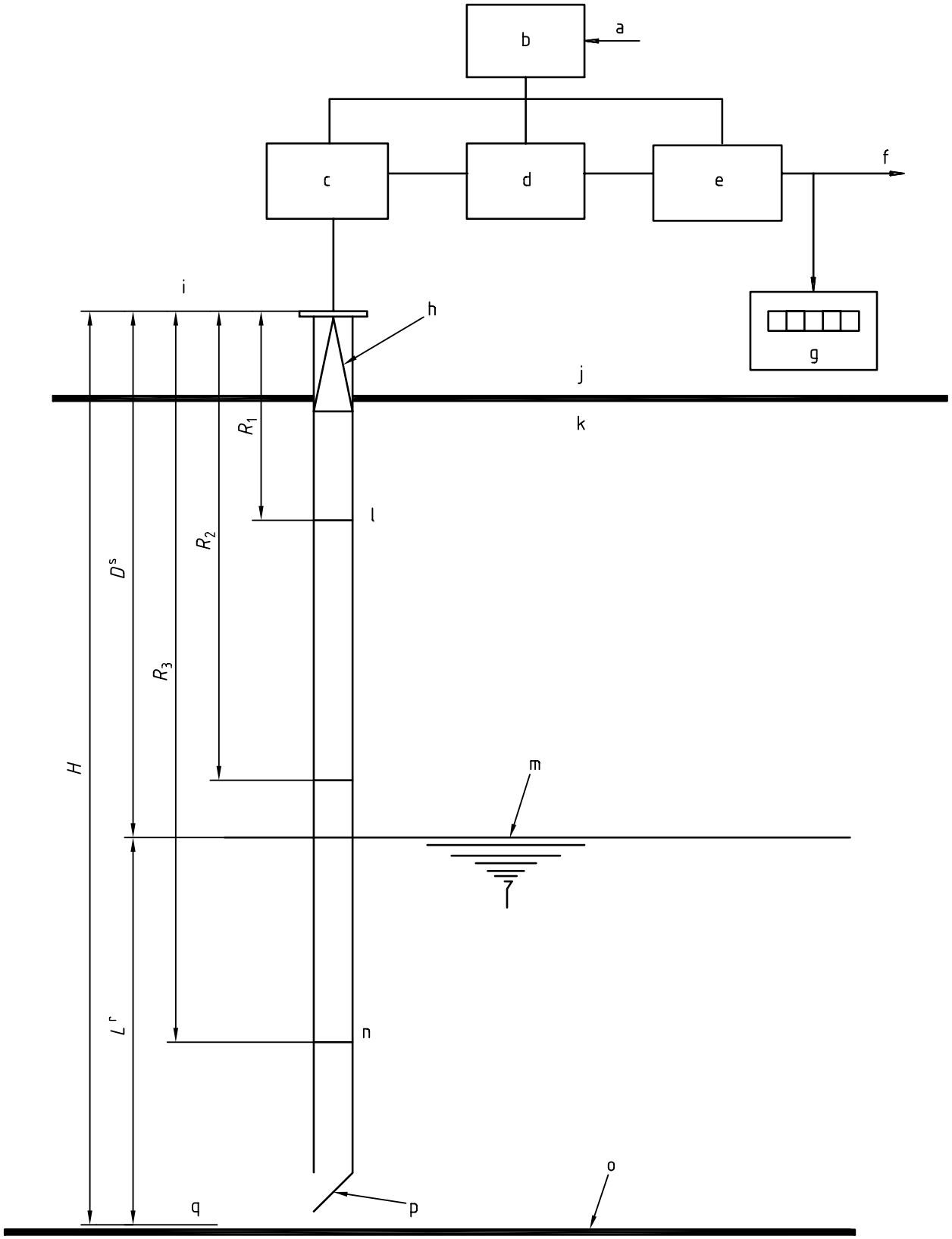
After a tank is opened up for survey, the accuracy of the gauge should be rechecked using this method.

## 8 Subsequent periodical verification of accuracy

A means of verification shall be provided, whereby the level-gauge accuracy can be checked at high and low tank levels, with the tank in service.

The high-level verification point shall be capable of being used when the tank is fully loaded. The error shall not exceed that described in 5.2.

This procedure should be used following maintenance on the level gauge or as required by the sale and purchase agreement.

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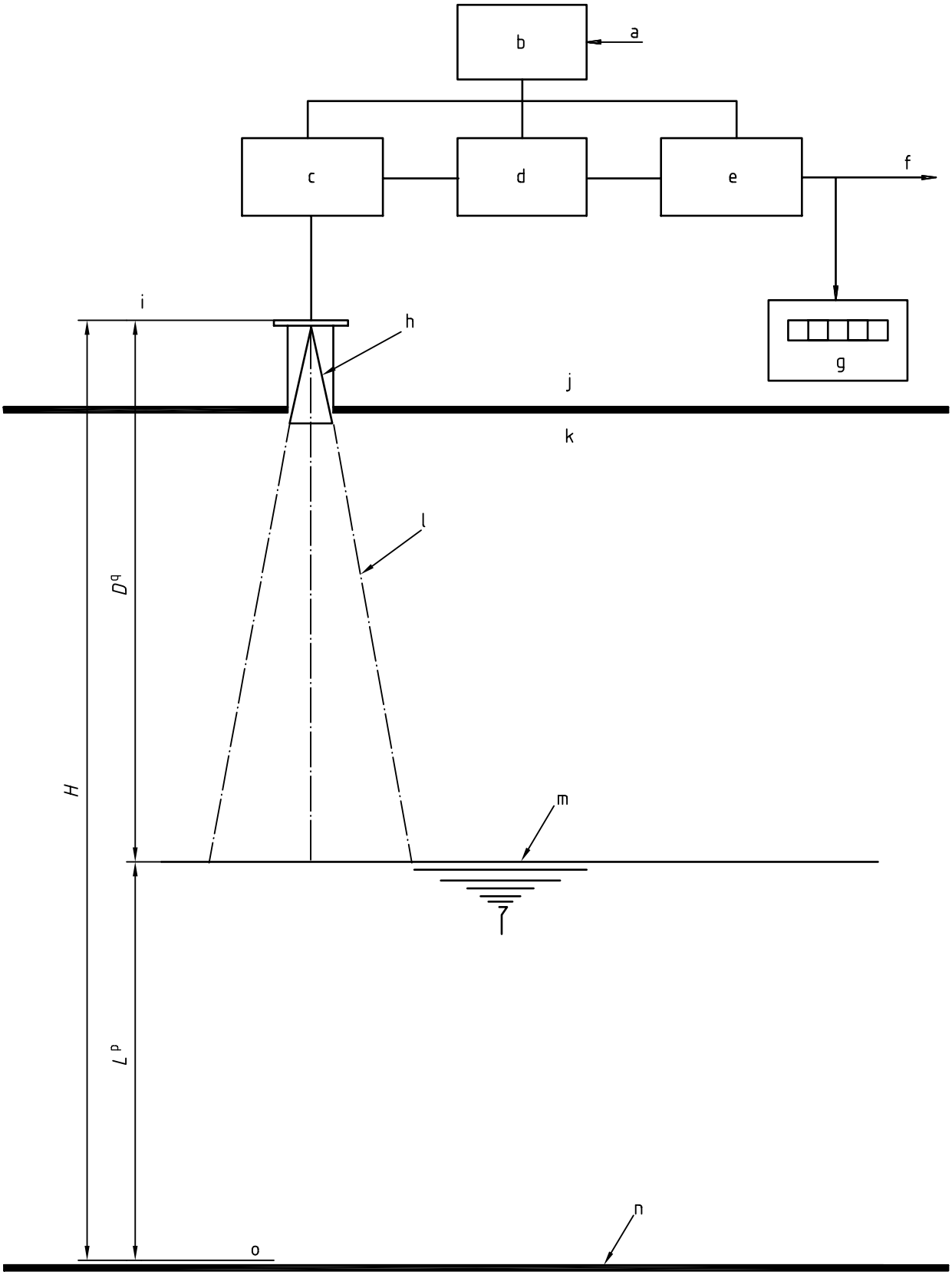
|---|---|---|---|---|---|---|---|
| a | Power source | f | Level signal output | k | Inside tank | p | Deflection plate |
| b | Power supply unit | g | Display | l | Verification level | q | Datum level |
| c | Transceiver unit | h | Antenna | m | Liquid surface | r | Liquid level |
| d | Computer unit | i | Upper reference point | n | Verification level | s | Ullage |
| e | Data transmitter unit | j | Outside tank | o | Tank bottom | | |

**Figure 1 — Example of installation with a still pipe including optional devices**




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| a | Power source | f | Level signal output | k | Inside tank | p | Liquid level |
| b | Power supply unit | g | Display | l | Microwave beam | q | Ullage |
| c | Transceiver unit | h | Antenna | m | Liquid surface | | |
| d | Computer unit | i | Upper reference point | n | Verification level | | |
| e | Data transmitter unit | j | Outside tank | o | Datum level | | |

**Figure 2 — Example of installation without a still pipe including optional devices**

# Annex A
(normative)

# Instructions on installation

**A.1** The antenna shall be installed in a position such that the upper dead zone does not interfere with the accurate measurement of the liquid level when the tank is at full capacity.

**A.2** The still pipe shall be a metal tube with a smooth, uniform bore. Its wall should be perforated at intervals by holes or slits in order to allow the inner and outer liquid level to equalize. Targets may be provided in the still pipe at the known distance from the upper reference point to enable verification to take place.

**A.3** The still pipe may be dispensed with where there is no turbulence of the liquid surface exposed to the microwave beam and the transmission and reception of microwave signals is not subject to interference from equipment inside the tank, such as pipe work.

An example is shown in Figure 2.

**A.4** A deflection plate, or a device with a similar function, e.g. an attenuator, may be set directly underneath the antenna so that the signal reflected at the bottom of the tank is deflected in such a way that it does not interfere with the signal reflected from the liquid surface. The deflection plate, or a device with a similar function, may be omitted where the signal reflected from the tank bottom causes no interference with the reflection from the liquid surface. Some signal-processing techniques can also be used to eliminate fixed echoes without any reflector.

# Bibliography

[1] IEC 60079-0:1998, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements*.[2) 3)]

[2] IEC 60079-1:1990, *Electrical apparatus for explosive gas atmospheres — Part 1: Construction and verification test of flameproof enclosures of electrical apparatus*.[2)]

[3] IEC 60092-502:1999, *Electrical installations in ships — Part 502: Tankers — Special features*.

[4] IEC 60092-504:1994, *Electrical installations in ships — Part 504: Special features — Control and instrumentation.*[3)]

[5] IEC 60654-1:1993, *Industrial-process measurement and control equipment — Operating conditions — Part 1: Climatic conditions.*

[6] IEC 60654-2:1979, *Operating conditions for industrial-process measurement and control equipment — Part 2: Power*.[2)]

[7] IMO (International Maritime Organization) — *International code for the construction and equipment of ships carrying liquefied gases in bulk: IGC Code 1993*.[3)]

2) Reference for level gauges in shore tanks.

3) Reference for level gauges in ships' tanks.

**ICS 75.180.30**

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