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Petroleum and liquid petroleum products — Equipment for measurement of liquid levels in storage tanks — Manual methods

Pétrole et produits pétroliers liquides — Appareils de mesure du niveau des liquides dans les réservoirs — Méthodes manuelles

Reference number
ISO 4512:2000(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 4512 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 3, *Static petroleum measurement*.

Introduction

This International Standard describes the equipment required to measure the level of petroleum and petroleum products contained in a tank or container. Calculation of the quantity of petroleum and petroleum products contained in a tank or container also requires that the temperature of the liquid and its density are determined. The equipment required and the methods of determination of temperature and density are described in other International Standards to which reference should be made.

Petroleum and liquid petroleum products — Equipment for measurement of liquid levels in storage tanks — Manual methods

1 Scope

This International Standard specifies the requirements for the equipment required to measure manually the liquid level or the corresponding volume of petroleum and petroleum products stored in tanks and containers.

2 Normative references

The following normative documents contain 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 editions of the normative documents 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.

ISO 1998 (all parts), *Petroleum industry — Terminology.*

IEC 60079-11:1991, *Electrical apparatus for explosive gas atmospheres — Part 11: Intrinsic safety "i".*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 1998 and the following apply.

3.1
calibration table
tank table
tank capacity table
table showing the capacities of, or volumes in, a tank corresponding to various liquid levels measured from the specified dipping datum-plate and/or gauging reference point

3.2
dip
innage
depth of liquid in a tank above the dipping datum-plate

3.3
dip-rod
dip-stick
rigid length of wood or other material, graduated in units of volume or length, for measuring by dip the quantity of liquid in small tanks which have been calibrated in terms of dip

3.4
dip-tape
graduated steel tape used for measuring the level of oil or water in a tank, either directly by dipping or indirectly by ullaging

3.5
dip-weight
weight attached to a steel dipping-tape, of sufficient mass to keep the tape taut and of a shape to facilitate the penetration of any sludge that may be present on the datum-plate

3.6
dipping datum-point
point at the bottom of a tank which the dip-weight touches during dipping, and from which the measurements of the oil and water depths are taken

NOTE The dipping datum-point usually corresponds with the datum-plate but, when this is not so, the difference in level between the datum-plate and the datum-point should be allowed for in the calibration table.

3.7
free water
water, present in a tank, which is not in solution or suspension within the oil and which exists as a separate layer within the tank

3.8
gauge-hatch
opening at the top of a tank through which dipping, ullaging and/or sampling operations are carried out

NOTE When gauging operations are carried out under closed or restricted conditions (via a vapour lock valve), the term “gauging access point” may be used.

3.9
gauging
process of taking all the necessary measurements in a tank in order to determine the quantity of liquid which it contains

NOTE For the purposes of this International Standard, gauging refers to level measurements only.

3.10
gauging reference point
reference gauge point
upper datum
upper reference point
point clearly marked on the gauge-hatch, vapour lock valve or on a plate suitably located above or below the gauge-hatch, to indicate the position (and upper datum) from which the measurements of dip or ullage are made

3.11
identification marks
marks on a dip-tape that record the temperature and tension at which the tape was calibrated

NOTE Other marks may include the total length of the tape and/or its conformance with this International Standard.

3.12
master dip-tape
dip-tape and weight combination of known accuracy, which is calibrated by an accredited laboratory and is traceable to national standards of length

3.13
portable electronic gauging device
PEGD
portable instrument employing electronic or electrical sensor(s) for the measurement of liquid level, temperature and/or water interface

NOTE Other optional measurements such as density may also be provided.

3.14
pressure tank
storage tank designed to operate at pressures above atmospheric

NOTE For convenience, this type of tank is divided into two general classes:

— low-pressure tanks, used for volatile products which are liquid at ambient temperatures;

— high-pressure tanks, used for liquids which are normally in the vapour phase at ambient temperature and pressure.

3.15
ullage paste
product-finding paste
gasoline-finding paste
paste used to facilitate reading the liquid level on the scale of a dip-tape, dip-rod, ullage-rule or ullage-rod, when gauging products which do not give a clear cut on the gauging device

3.16
reference height
reference gauge height
height of the gauging reference point above the dipping datum-point

3.17
ullage
outage
working capacity of a tank not occupied by the liquid

3.18
ullage hatch
ullage port
ullage plug
manual gauge-hatch usually fitted with a heavy-duty cover

3.19
ullage-rod
ullage-stick
rigid length of wood or other material, usually graduated in units of volume, for measuring by ullage the quantity of liquid in small tanks which have been calibrated in terms of ullage

3.20
ullage-rule
graduated rule attached to a dip-tape to facilitate the measurement of ullage where it would not be practical to obtain a tape cut, for example when gauging viscous, waxy or heated oils

3.21
vapour lock valve
device fitted to the top of vapour-tight or pressure tanks to permit manual measurement and/or sampling operations to be carried out without loss of pressure

3.22
vapour-tight tank
tank intended primarily for the storage of volatile liquids, for example gasoline, and so constructed that it will withstand pressures slightly above atmospheric pressure

3.23
water bottom
water dip
depth of any free water at the bottom of a tank

3.24
water-finding paste
paste containing a chemical which changes colour on contact with water

NOTE The paste, when applied to a water-finding rule, indicates the level of any free water in a tank.

3.25
water-finding rule
graduated rule attached to a dipping tape which is used in conjunction with water-finding paste to measure the depth of any free water in a tank

4 General

4.1 If a certificate of calibration is required for any of the equipment, such as dip-tapes, dip-weights or ullage-rules, this shall be obtained from a competent authority and shall be traceable to national or international standards with a 95 % confidence limits uncertainty, which is within the maximum permissible error requirements specified in this International Standard (5.9).

4.2 Equipment which has been subjected to repair shall not be used for reference purposes, but may be used for other purposes if it has been verified by a competent authority and found to comply with the requirements of this International Standard.

5 Dip-tapes

5.1 General

5.1.1 Dip-tapes shall be used in conjunction with a standard dip-weight or ullage-rule or water-finding rule described in clauses 7, 8 and 9 (see Figure 1). They shall be wound onto a drum contained within a frame equipped with a handle (see Figure 2).

It is strongly recommended that dip-weights, ullage-rules and water-finding rules are detached from the dip-tape when either carried or stored to avoid constant flexing of the dip-tape at the point of attachment, leading to breakage of the dip-tape.

5.1.2 The dip-tape, hanging device (see 5.5) and dip-weight shall be so constructed that the zero of the system is at the lower face of the dip-weight, i.e. the dip-tape, hanging device and dip-weight form one continuous system. Graduations shall be continuous throughout the length of the tape.

NOTE In some countries, local metrological regulations may require that the graduations are also continuous throughout the tape/weight combination.

5.2 Construction

Dip-tapes shall be constructed from one continuous length of steel.

5.3 Material

The steel from which the tape is manufactured shall have the following specification (or shall be a steel of similar specification):

a) high carbon content (mass fraction of carbon of approximately 0,8 %);

b) tensile strength of between 1 600 N/mm^2 and 1 850 N/mm^2;

c) coefficient of linear expansion of $(11 \pm 1) \times 10^{-6}$ °C^{-1}.

For gauging certain petrochemical products, alternative material such as stainless steel may be specified. In this case, a length-correction table according to temperature may be required.

Dimension in millimetres

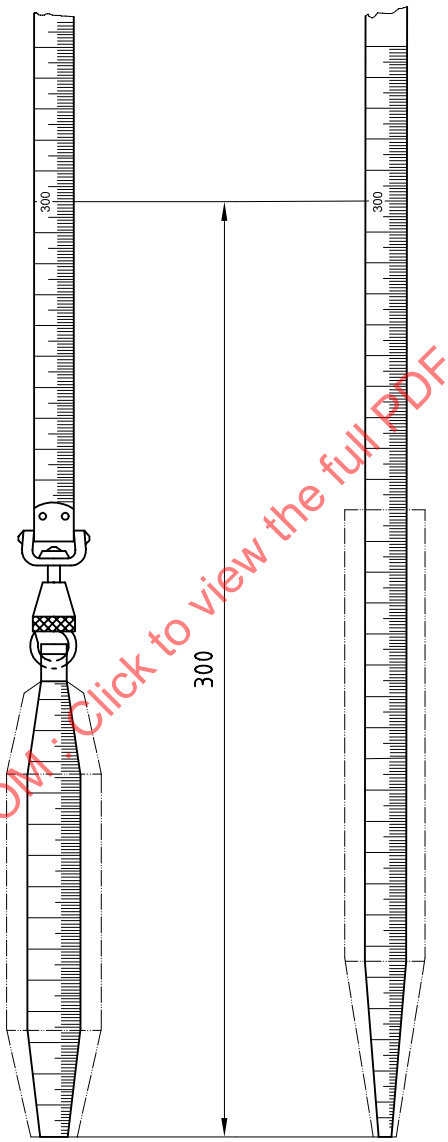
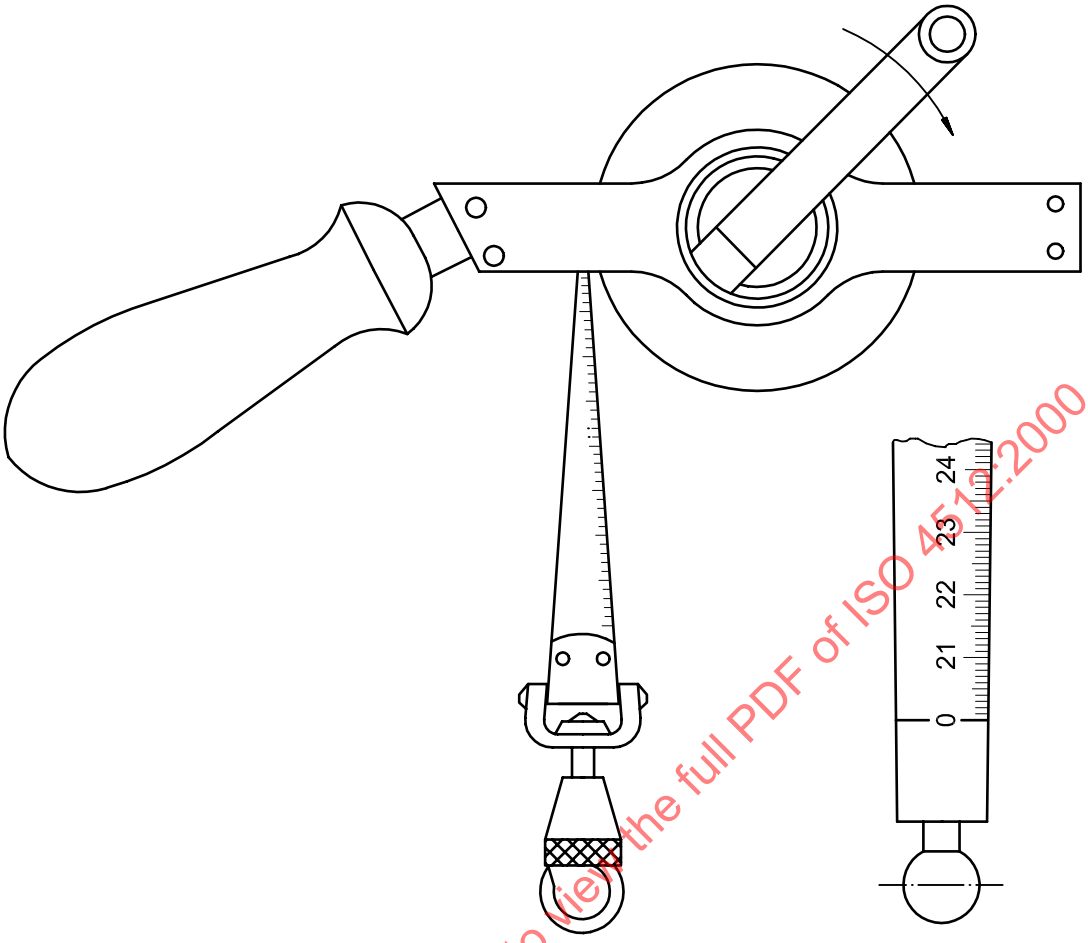


Figure 1 — Examples of dip-tapes with different dip-weights



NOTE This figure is an example, other types of winding frames are acceptable.

Figure 2 — Typical winding-frame

5.4 Coating

Dip-tapes shall be supplied coated with a suitable anticorrosion material for protection in storage. Such coatings shall not electrically insulate the dip-tape.

5.5 Attachment

A hanging device such as a rotule or swivel hook shall be permanently secured (e.g. rivetted) to the leading end of the tape for the attachment of a dip-weight, ullage-rule or water-finding rule. The hanging device shall have a means of preventing the accidental detachment of the dip-weight, ullage-rule or water-finding rule.

5.6 Dimensions

The dimensions of the dip-tape shall be:

— width, (13 ± 0,5) mm;

— thickness (before etching), (0,25 ± 0,05) mm.

Recommended lengths for dip-tapes are 5 m, 10 m, 15 m, 20 m, 25 m, 30 m, 40 m and 50 m.

5.7 Graduation

5.7.1 Dip-tapes shall be graduated on one face only.

5.7.2 Dip-tapes shall be graduated in metres, centimetres and millimetres throughout their nominal lengths. The graduation marks shall relate to specified reference conditions of temperature and tension, where the tension is equal to that which the tape will experience due to the mass of the dip-weight when the tape/weight combination is suspended vertically in air (± 10 %).

5.7.3 The graduation marks shall be of uniform width of not more than 0,5 mm, and shall be normal to the edge of the tape.

5.7.4 The graduation marks shall be permanent and indelibly marked. The process of marking the graduations shall not electrically insulate the dip-tape.

The markings may be relief etched, engraved or marked by any other permanent and indelible means which is resistant to solvents.

5.7.5 The scale marks shall be of uniform width and shall be normal to the edge of the dip-tape. The length of the scale marks shall be related to the corresponding unit of measurement. The scale marks shall be such that they form a distinct and clear scale, and that their thickness does not cause any inaccuracy of measurement.

5.7.6 The scale marks shall be clearly figured as shown in Table 1.

Table 1 — Figuring of dip-tapes

Intermediate graduations		Major graduations	
Figured at each centimetre	Larger figures at each decimetre	Larger figures at each metre or figured by etching into a raised bright tablet	Figuring repeated in smaller figures at each decimetre after the first metre

5.8 Zero datum

The zero datum of the combined dip-tape and dip-weight shall be at the bottom face of the dip-weight.

5.9 Accuracy (maximum permissible error, m.p.e.)

The maximum permissible error (m.p.e.) for any distance from the zero datum of the dip-weight up to the 30 m graduation mark shall not exceed ± 1,5 mm for a new dip-tape/weight combination at its specified reference temperature and tension when compared against a reference measurement instrument. The m.p.e. for a dip-tape/weight combination that has been in service shall not exceed ± 2,0 mm in 30 m (see Table 2).

In some countries, local metrological regulations may require that the m.p.e. should be more stringent in certain circumstances. This will typically occur at short distances when the metrological m.p.e. is permitted to vary with the length that is measured.

If the nominal length of the dip-tape/weight combination exceeds 30 m, an additional tolerance of 50 % of the m.p.e. for the first 30 m shall be permitted for each additional 30 m of tape length (see Table 2).

The certified traceable 95 % confidence limits uncertainty of the reference measurement instrument(s) used to verify the m.p.e. of dip-tape/weight combinations shall not exceed ± 0,5 mm for any distance between 0 m and 30 m.

The calibration accuracy of each working dip-tape/weight combination should be verified before first use and thereafter at regular intervals (e.g. every 6 months). Typically this verification should comprise two elements, as follows.

a) Firstly, the distance of the zero datum of the dip-weight from a convenient graduation on the dip-tape (e.g. the 300 mm graduation) should be verified using a travelling vernier microscope or similar reference measurement device (with a 95 % confidence limits uncertainty of measurement not exceeding ± 0,20 mm at any point up to 500 mm) when the tape/weight combination is suspended vertically in air.

b) Secondly, the distance from the chosen tape graduation mark to a series of other graduation marks at approximately 5 m intervals should be verified by direct comparison with a reference master dip-tape or other reference device (with a 95 % confidence limits uncertainty of measurement not exceeding ± 0,25 mm at any point up to 30 m) when the tape is suspended vertically under the tension due to the dip-weight or alternatively is supported horizontally at its reference tension and temperature.

EXAMPLE In a typical verification procedure, the combined 95 % confidence limits uncertainty of the two reference measurement instruments used is estimated by a root sum squared calculation as $\pm\sqrt{[0{,}20^2 + 0{,}25^2]} = \pm\ 0{,}32$ mm, which is within the maximum (± 0,5 mm) specified above.

A reference tension of 10 N or 15 N is recommended for traditional dip-tape/weight combinations as this represents a close approximation to the tension that a standard 30 m dip-tape would experience when suspended vertically in air with a standard 0,7 kg dip-weight attached. Length corrections may be required when tapes which are manufactured or calibrated at other reference tensions are subjected to a different tension when in use.

Table 2 — Maximum permissible errors for dip-tape and weight combinations

Tape/weight length m	m.p.e. for new tape/weight combination mm	m.p.e. for a used tape/weight combination mm
0,000 to 30,000	± 1,5	± 2,0
30,001 to 60,000	± 2,25	± 3,0
60,001 to 90,000	± 3,0	± 4,0

5.10 Marking

Each dip-tape shall be marked on its leading end with the following:

a) the number of this International Standard, i.e. ISO 4512;

b) the manufacturer's name or trade mark;

c) the standard conditions of calibration:

   1) the temperature, normally 20 °C,

   2) the tension applied at the time of calibration (normally 10 N or 15 N);

d) any necessary official marking of conformity.

6 Winding frames

6.1 The capacity of the winding frame shall be sufficient to hold the entire length of the dip-tape without a strain on either the dip-tape or winding frame.

6.2 The winding frame shall be constructed of some suitable spark-resistant material (e.g. brass).

NOTE A sprung steel rubbing strip may be provided on the inner face of the frame to prevent mechanical damage to the frame by the action of the tape when being wound in or out of the frame.

6.3 The length of dip-tape for which the frame is designed shall be clearly marked upon it.

6.4 The winding drum shall be not less than 28 mm in diameter and shall be provided with a winding handle which carries a freely rotating knob.

6.5 The winding drum shall be provided with a suitable pin or peg to which the loop, on the inner end of the tape or tape leader if provided, shall be fastened.

NOTE The winding handle may be constructed so that is folds flat on the frame when not in use.

6.6 The tape shall be wound so that it will pass freely through the gap between the winding drum and handle (see Figure 2), with the graduation markings visible on the wound tape.

If the design of the winding frame incorporates spacing rods or cylinders at the opposite end from the handle, the tape should not pass between the rods or cylinders as this can result in the tape being bent sharply and damaged.

6.7 Provision shall be made for the tape and winding frame to be electrically earthed when in use.

7 Dip-weights

7.1 General

The dip-weights shall be designed for use in conjunction with the dip-tapes specified in clause 5.

7.2 Material

Dip-weights shall be made of some suitable spark-resistant material of suitable density (e.g. brass).

7.3 Construction

7.3.1 Dip-weights shall be of cylindrical shape tapered at the lower end. The base shall be flat with a surface normal to the major axis (see Figure 3).

NOTE The tapered cylindrical shape provides the necessary sensitivity in dipping and penetrates sludge more easily than a completely cylindrical pattern.

A sharp, pointed lower tip is not recommended because it is susceptible to mechanical damage which will affect the accuracy of measurement. It may also wear rapidly in use.

7.3.2 The top of the dip-weight shall be designed to allow a secure fixing to the dip-tape. This fixing shall not impair the accuracy of the complete tape and weight assembly.

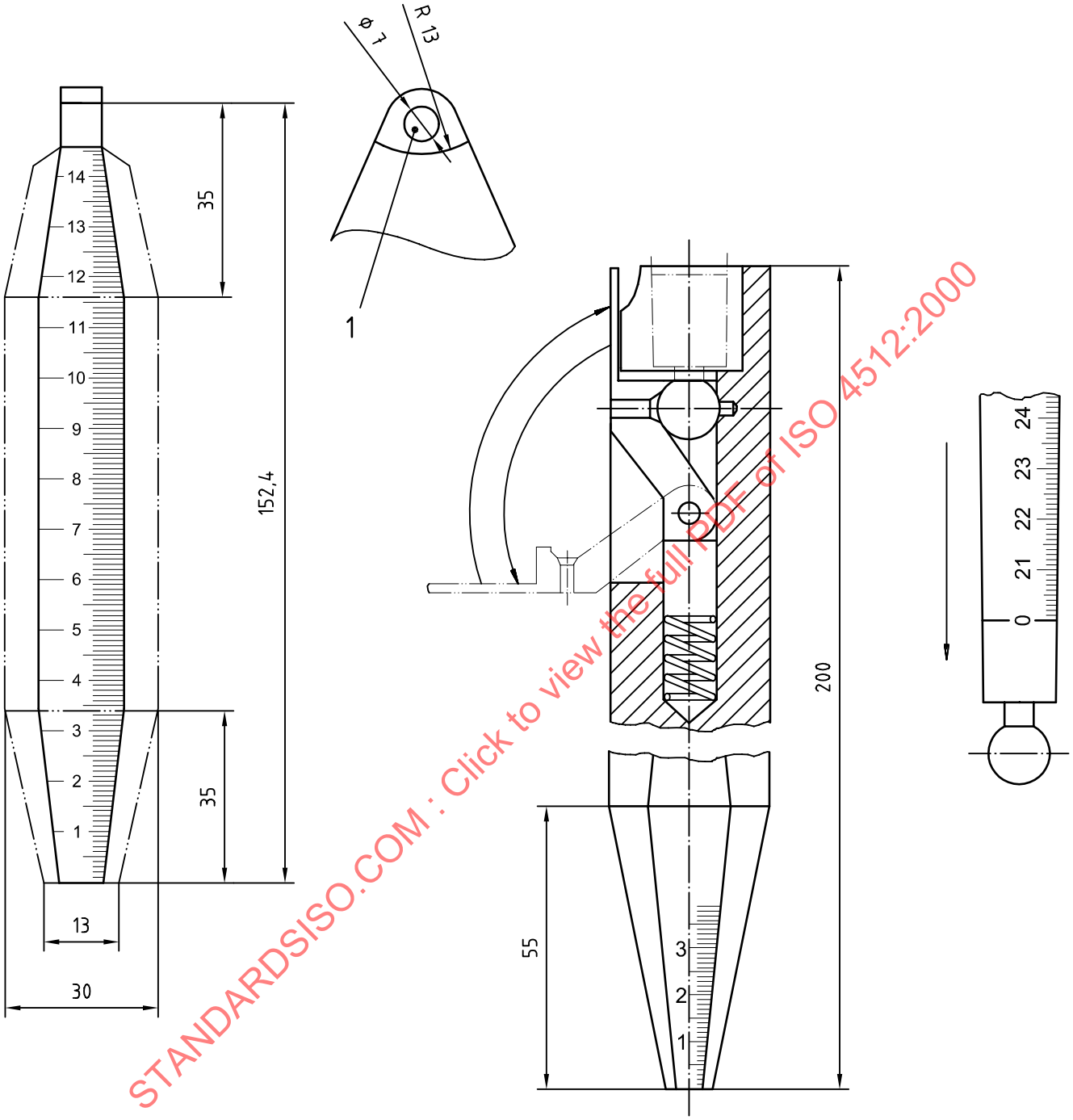
7.3.3 A flat face not less than 10 mm wide shall be provided to take an engraved scale continuing the scale of the dip-tape.

7.4 Mass

The mass of dip-weights shall be at least 0,6 kg in order to keep the tape repeatably taut when in use.

When gauging tanks which may contain a bottom layer of separated sediment, it may be desirable to use a heavier dip-weight (e.g. 1,5 kg) in order for it to more easily penetrate the sediment. However, the dip-tape calibration accuracy (5.9) assumes that the tape is calibrated with a normal 0,7 kg dip-weight. Thus a small length correction may be required to compensate for the increased tension that the tape will experience if a heavier dip-weight is used.

Dimensions in millimetres



Key

1 Hole in dip-weight for swivel hook

Figure 3 — Typical dip-weights

7.5 Accuracy of graduation

Dip-weights shall be graduated throughout their length.

The maximum permissible error for any distance from the zero datum to any other point on the graduated scale shall not exceed 0,5 mm. If the accuracy of the scale graduations is required to be certified, the scale shall be calibrated using a travelling vernier microscope or similar reference measurement device with a 95 % confidence limits uncertainty of measurement which does not exceed ± 0,20 mm at any point from zero to 500 mm.

7.6 Zero marking

The bottom face of the weight shall act as the zero datum for graduation of both dip-tape and dip-weight.

7.7 Scale marks

7.7.1 Scale marks shall be engraved and shall be not more than 0,50 mm wide.

7.7.2 The scale marks shall be normal to the major axis of the weight and shall be a projection of the corresponding distances on the axis of the weight.

7.7.3 Scale marks shall be normal to the edge of the face and shall extend across the face to correspond with the marking on the dip-tape.

7.8 Marking

Each weight shall bear the following markings:

a) the number of this International Standard, i.e. ISO 4512;

b) any necessary official marking of conformity.

8 Ullage-rules

8.1 General

8.1.1 Ullage-rules shall be designed for use in conjunction with the dip-tapes described in clause 5.

8.1.2 Ullage-rules may be graduated on more than one face, but the graduations shall be at the same level in relation to the zero datum of the rule.

NOTE It is normal practice to graduate one face only.

8.1.3 The graduations on an ullage-rule which are engraved below the zero mark are supplementary to those on the dip-tape (see Figure 4).

8.1.4 Combined ullage-rules and water-finding rules (see clause 9) shall not be permitted because their zero datum points are different.

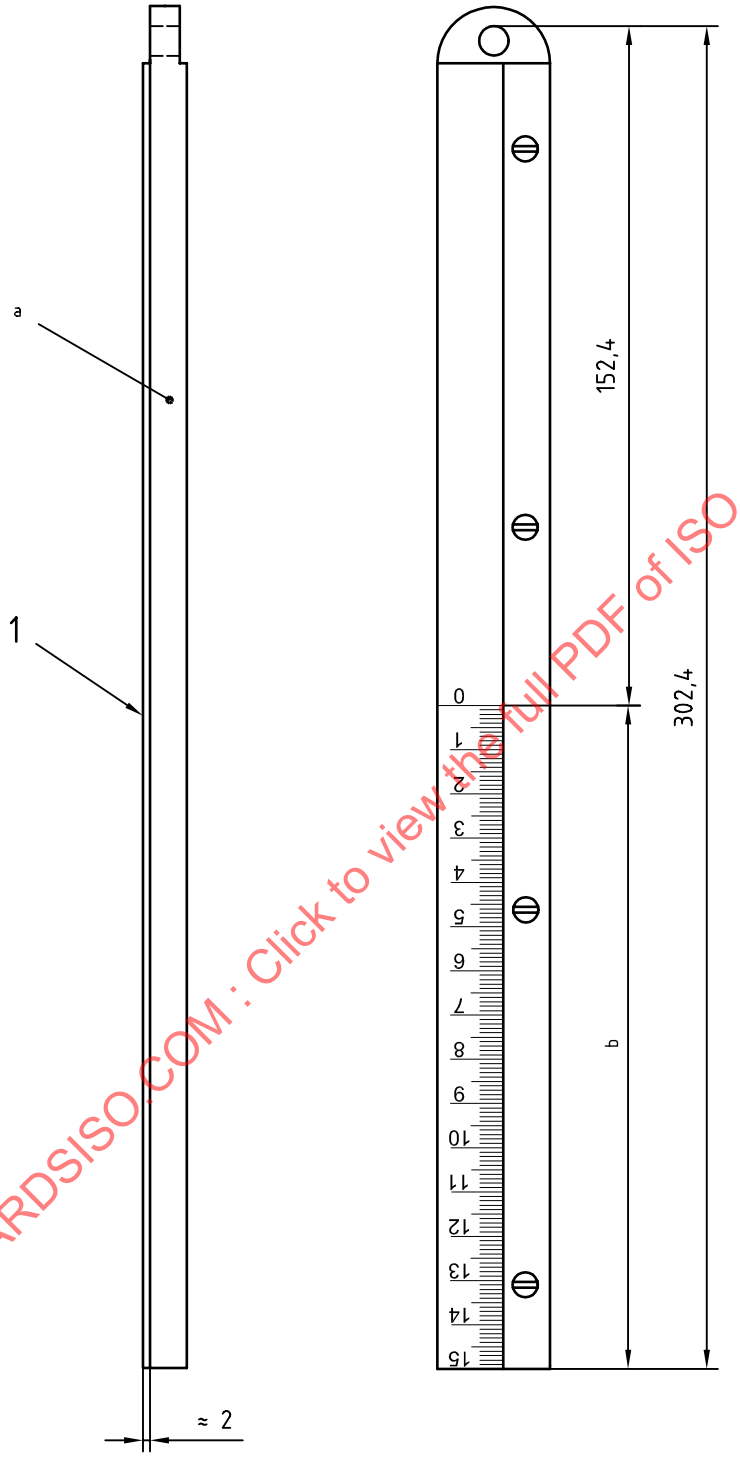
8.2 Material

Ullage-rules shall be made from a suitable spark-resistant material (e.g. brass).

8.3 Construction

8.3.1 Ullage-rules shall be manufactured from a bar having flat faces, upon which the scale is engraved, and all edges cut square and smooth.

Dimensions in millimetres



Key

1 Ebonite inset

a "ULLAGE RULE" etched on reverse side.

b Graduations in centimetres and millimetres.

Figure 4 — Example of an ullage-rule

8.3.2 The top of the ullage-rule shall be designed to allow a secure fixing to the tape. The fixing shall not impair the accuracy of the complete tape and ullage-rule assembly.

8.4 Mass

The mass of the ullage-rule shall be at least 0,6 kg in order to keep the tape repeatably taut when in use.

8.5 Accuracy of graduation

Ullage-rules shall be graduated in centimetres and millimetres from the zero mark, aproximately at the middle of the rule to the bottom face of the rule.

The maximum permissible error for any distance from the zero datum to any other point on the graduated scale shall not exceed 0,5 mm. Where the accuracy of the scale graduations is required to be certified, the scale shall be calibrated using a travelling vernier microscope or similar reference measurement device with a 95 % confidence limits uncertainty of measurement which does not exceed ± 0,20 mm at any point from zero to 500 mm.

8.6 Zero mark

The zero datum of the combined dip-tape and ullage-rule shall be at the zero mark engraved on the ullage-rule (see Figure 4).

8.7 Scale marks

8.7.1 According to the design of the ullage-rule, graduation shall be made in accordance with either 5.7 or 7.7.

8.7.2 Scale marks shall be engraved, and shall not be more than 0,50 mm wide.

8.7.3 The scale marks shall be normal to the edges of the faces of the ullage-rule.

8.8 Figuring

Each major graduation mark shall be figured downwards from zero.

8.9 Marking

Each ullage-rule shall bear the following marking:

a) the number of this International Standard, i.e. ISO 4512;

b) any necessary official marking of conformity.

9 Water-finding rules

9.1 General

9.1.1 Water-finding rules shall be designed to be used with the type of dip-tape described in clause 5.

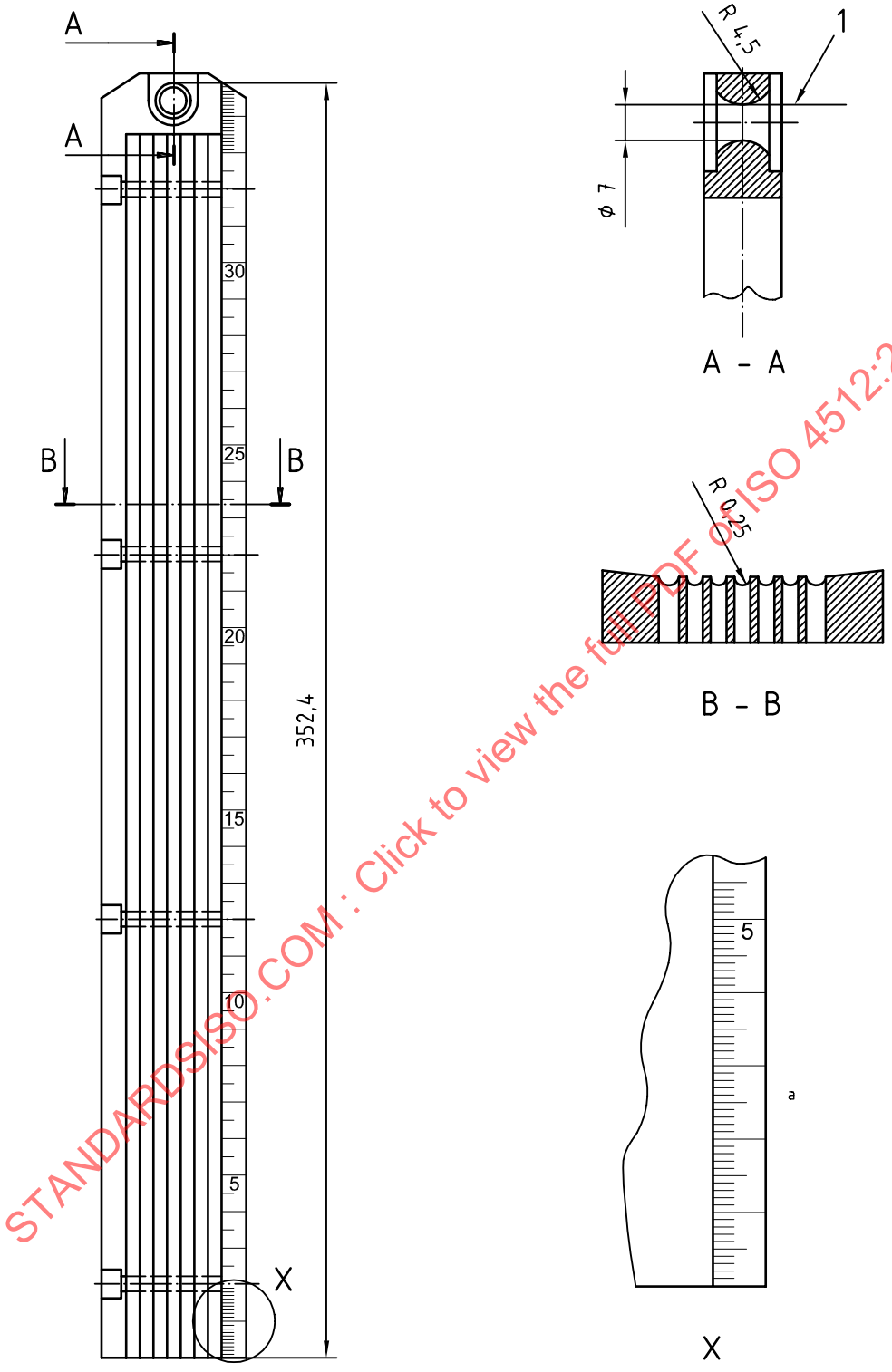
9.1.2 Water-finding rules may be graduated on more than one face, but the graduations shall be at the same level in relation to the zero datum of the rule.

NOTE It is normal practice to graduate one face only.

9.1.3 Water-finding rules shall be graduated from the bottom of the rule.

NOTE The graduations are not necessarily directly related to the graduations of the dip-tape to which they are attached in use because a water-finding rule will normally be longer than a standard dip-weight (see Figure 5).

Dimensions in millimetres



Key

1 Reference plane

a Graduations in millimetres and centimetres as shown.

Figure 5 — Example of water-finding rule

9.1.4 Combined water-finding rules and ullage-rules shall not be permitted because their zero datum points are different.

9.1.5 Water-finding rules are designed for use with water-finding paste.

NOTE Information on interface detection by means of water-finding paste is given in ISO 4511.

9.2 Material

The outer framework and conducting spacer parts shall be made of some suitable spark-resistant material (e.g. brass). The non-conducting spacer parts shall be made from transparent plastic which is resistant to the materials to which it is expected to be exposed.

9.3 Construction

9.3.1 The alternating transparent plastic spacers shall be sized so as not to present a potential electrostatic hazard, while still permitting the reaction of the water-finding paste to be observed through the rule.

The surface area of any one non-conducting plastic spacer shall be less than $2{,}8 \times 10^{-3}$ m^2.

9.3.2 The top of the water-finding rule shall be designed to allow a secure fixing to the tape. The fixing shall not impair the accuracy of the measurements made with the water-finding rule.

9.4 Accuracy of graduation

Water-finding rules shall be graduated in centimetres and millimetres throughout their working length (typically 350 mm).

The maximum permissible error for any distance from the zero datum to any other point on the graduated scale shall not exceed 0,5 mm. Where the accuracy of the scale graduations is required to be certified, the scale shall be calibrated using a travelling vernier microscope or similar reference measurement device with a 95 % confidence limits uncertainty of measurement which does not exceed ± 0,20 mm at any point from zero to 500 mm.

9.5 Scale marks

9.5.1 According to the design of the water-finding rule, graduation shall be in accordance with either 5.7 or 7.7.

9.5.2 Scale marks shall be engraved, and shall not be more than 0,50 mm wide.

9.5.3 The scale marks shall be normal to the edges of the face of the rule.

9.6 Marking

Each water-finding rule shall bear the following markings:

a) the number of this International Standard, i.e. ISO 4512;

b) any necessary official marking of conformity.

10 Interface-detecting pastes

10.1 General

The level of oil products and the level of any oil/water interface may be detected by indicating pastes which change colour on contact with either light volatile petroleum products or water, respectively.

10.2 Ullage pastes

10.2.1 Ullage pastes, when smeared thinly on either dip-tapes, dip-weights or ullage-rules, may be used in the measurement of the level of volatile petroleum products, which may not give a clear, unambiguous level measurement (cut) (e.g. motor spirit/gasoline, naphtha) on a clean dip-tape, dip-weight or ullage-rule.

10.2.2 Ullage pastes shall indicate the level by a clear and unambiguous colour change.

10.2.3 Ullage pastes shall not exhibit any tendency for the indicated level to creep upwards, i.e. indicate a higher level than the true level and thus a smaller ullage.

The use of grease or chalk instead of a properly formulated ullage paste shall not be permitted for measurements requiring the highest accuracy. Levels measured by either grease or chalk may indicate readings several millimetres higher than the true level.

10.3 Water-finding pastes

10.3.1 Water-finding pastes, when smeared thinly on either dip-weights or water-finding rules, may be used in the measurement of the depth of free water below a quantity of petroleum product, stored in tanks or containers.

10.3.2 Water-finding pastes shall indicate the level by a clear and unambiguous colour change.

10.3.3 Water-finding pastes shall not exhibit any tendency for the indicated level to creep upwards, i.e. indicate a higher level than the true level.

11 Portable electronic gauging devices (PEGDs)

11.1 General

11.1.1 Portable electronic gauging devices are often multi-functional in that they may measure other parameters such as the level of any oil/water interface, temperature, and/or density, etc., in addition to measuring ullage. The method for their use for level measurement is described in ISO 4511, while the method for temperature measurement is described in ISO 4268.

11.1.2 Portable electronic gauging devices may be designed for either open, restricted or closed gauging applications. Closed and restricted gauging operations will generally require the portable electronic gauging device to be used in conjunction with a compatible vapour lock valve (see clause 12).

11.2 Safety

The electronic systems in the instrument shall be operated by low power dry cells. They shall be intrinsically safe and all indicating systems shall be housed in intrinsically safe containment systems. Each system shall comply with the requirements of IEC 60079-11.

11.3 Measuring tape construction, graduation and marking

The main measuring tape shall comply with the specification for dip-tapes given in 5.2, 5.3 and 5.6. The graduation of the tape shall comply with the specification detailed in 5.7, except that the reference tension for the tape shall be equal to that tension which the tape will experience due to the mass of the PEGD sensor probe/housing when the PEGD tape is suspended vertically in air (± 10 %).

11.4 Sensor probe/housing

The sensor housing shall be constructed from a spark resistant material. The mass of the sensor probe shall be sufficient to keep the tape repeatably straight and taut when in use.

NOTE If the portable electronic gauging device tape is provided with a plastic coating (which may also protect additional signal cables along the edges of the tape), the mass of the sensor probe may need to be substantially more than that of a conventional dip-weight in order to ensure that the tape is repeatably taut when in use.

11.5 Zero datum

The zero datum of a level measuring PEGD shall be the reaction point at which the PEGD sensor detects an oil surface when operating in the ullage mode.

Because the electronic sensor(s) usually need to be protected from mechanical damage, the zero datum of the tape/probe combination is generally not the bottom surface of the PEGD probe. Thus the zero datum will not be directly verifiable without vertical suspension into a liquid surface. In these circumstances, the zero datum shall be at a fixed distance (specified by the manufacturer) from the bottom face of the PEGD probe.

If the PEGD can be used to measure the reference height of a tank, then it will be necessary to add this manufacturer-specified distance (the zero datum offset distance) to the observed tape reading to calculate the actual reference height value.

11.6 Accuracy of measurement

The maximum permissible error (m.p.e.) for measurements made with PEGDs shall not exceed the m.p.e. specification limits for traditional dip-tape/weight combinations as detailed in 5.9, except that an additional tolerance of ± 0,5 mm shall be permitted for hysteresis of the PEGD sensor reaction point.

NOTE 1 This additional tolerance should not be interpreted to imply that PEGD measurements are any less accurate than those made with a traditional dip-tape and weight. Some hysteresis is inevitable, and the hysteresis tolerance is equivalent to part of the measurement repeatability tolerance for the traditional measurement procedures defined in ISO 4511.

The certified traceable 95 % confidence limits uncertainty of the reference measurement instrument(s) used to verify the m.p.e. of a PEGD shall not exceed ± 0,5 mm for any distance between 0 m and 30 m.

The calibration accuracy of each PEGD should be verified before first use and thereafter at regular intervals (e.g. every 6 months).

NOTE 2 Typically this verification comprises the following steps.

a) Firstly, the distance of the zero datum (sensor oil reaction point) from a convenient graduation on the PEGD tape (e.g. the 300 mm graduation) should be verified using a travelling vernier microscope or similar reference measurement device (with a 95 % confidence limits uncertainty of measurement not exceeding ± 0,20 mm at any point up to 500 mm) when the PEGD sensor probe is suspended vertically into a light hydrocarbon liquid surface (e.g. kerosine). Where it is also required to verify the PEGD sensor's water reaction point, the procedure may be repeated with the sensor probe suspended vertically into a water surface.

b) Secondly, the distance from the chosen tape graduation mark to a series of other graduation marks at approximately 5 m intervals should be verified by direct comparison with a reference master dip-tape or other reference device (with a 95 % confidence limits uncertainty of measurement not exceeding ± 0,25 mm at any point up to 30 m) when the tape is supported horizontally at its reference tension and temperature. Alternatively, the PEGD tape may be suspended vertically so that the tension it experiences is that due to the mass of the tape and probe when suspended in air.

If the bottom surface of the PEGD sensor probe can be used as a datum to determine tank reference heights, the distance from the sensor bottom to the chosen tape graduation mark should be verified directly by using a travelling vernier microscope or similar reference measurement device (with a 95 % confidence limits uncertainty of measurement not exceeding ± 0,20 mm at any point up to 500 mm) with the PEGD tape and sensor probe suspended vertically in air.

11.7 PEGD reading index

PEGDs which are designed for use via a vapour lock valve shall be provided with a reading index mark to read the PEGD tape against.

The width of the reading index mark shall not exceed the maximum width of a tape graduation mark as specified in 5.7.3 (i.e. 0,5 mm).

The offset distance of the centre of the reading index mark from the point of the PEGD which corresponds to the gauging reference point (or datum surface of the vapour lock valve) shall be pre-set and shall be specified by the manufacturer. The m.p.e. for the reading index offset distance shall be ± 0,2 mm.

11.8 Electrical continuity

Electrical continuity shall be provided between sensor probe/housing and winding frame. An earthing point shall be provided on the frame to enable earthing of the frame to the container when measuring.

11.9 Marking

The body of the winding frame of each PEGD shall be marked with the following:

a) the number of this International Standard, i.e. ISO 4512;

b) a unique serial number.

In addition, the PEGD graduated tape shall be marked with the following:

a) the standard conditions of calibration:

   1) the calibration temperature, and

   2) the tension applied at the time of calibration;

b) any necessary official marking of conformity.

12 Vapour-lock valve

Vapour-lock valves shall be designed to enable gauging or sampling of vapour-tight tanks to be carried out with the tank under pressure and with minimum loss of vapour. The vapour-lock valve shall be suitable for use at the specified tank operating pressures (with an appropriate safety margin).

A typical vapour-lock valve is illustrated in Figure 6. It consists essentially of a flanged or threaded stand pipe with a vapour-tight ball-valve in the lower portion and a quick connecting or threaded cap at the top. The diameter of the ball-valve shall be large enough to allow the gauging device(s) to pass through it.

The blanking cap is removed to enable the installation of a portable electronic gauging device (PEGD) with a mating connector fitting. Alternatively, an adaptor may be fitted to enable the use of other gauging equipment via the vapour lock valve.

When a vapour-lock valve is used to provide access for a portable electronic gauging device, means should be provided to prevent the closure of the valve until the PEGD tape and sensor have been completely withdrawn.

Sealing materials and gaskets which form part of a vapour lock valve shall be fully resistant to petroleum products in the liquid and vapour phases. Earth continuity shall be maintained between the tank shell and the gauging tape installed via the vapour lock valve.

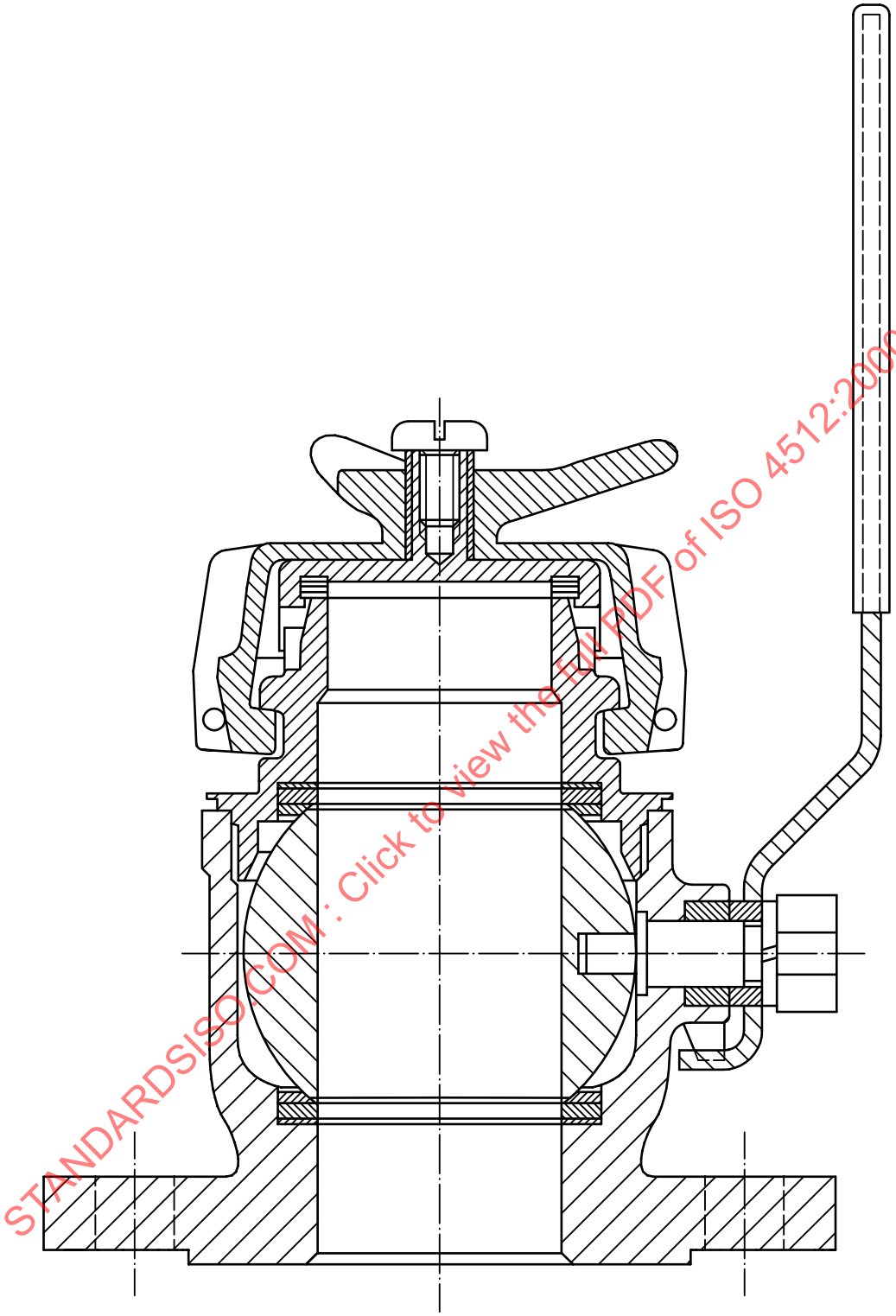


Figure 6 — Example of a typical vapour-lock valve

13 Dip-rods (or sticks) and ullage-rods (or sticks)

13.1 General

Dip-rods or ullage-rods may be used to replace a dip-tape and dip-weight for gauging a small tank such as a road or rail vehicle tank or a horizontal cylindrical tank of small diameter. The length should not be greater than 5 m because of difficulty in use, particularly in high winds.

They shall conform to the specification detailed in 13.2 to 13.7. Typical examples are shown in Figures 7 and 8.

13.2 Material

Brass, wood, carbon-impregnated glass-reinforced plastic (GRP) or other safety-approved materials are recommended for the manufacture of dip-rods and ullage-rods. If wood is used, it shall be straight-grained maple, or similar wood, free from warping or twisting, dyed with aniline-black and rubbed down to a smooth polish.

Parts subject to wear may be protected, but the protection should not form an insulated conductor. Any non-metallic material used should be of a kind that does not accumulate static charge.

If plastics are used, they shall be dissipative, having a surface resistance < 10^9 Ω when measured at 25 °C and 50 % relative humidity, and a leakage resistance < 10^{11} Ω.

For safety reasons, magnesium or aluminium alloys should not be used in the construction of dip-rods and ullage-rods.

13.3 Construction and dimensions

13.3.1 General

Dip and ullage-rods made of materials other than wood should preferably be constructed from profiled section bar such as a T- or U-shaped extrusions, having a face width of approximately 20 mm and a thickness of web and face of not less than 3 mm.

NOTE This form of construction combines lightness and consequent ease of handling with adequate rigidity. Other sections with a flat face of not less than 16 mm width and such other dimensions as will produce sufficient rigidity may be used.

13.3.2 Dip-rods

Dip-rods shall be of sufficient length to reach the dip point at the bottom of the tank and, in this position, shall have not less than 150 mm of the overall length extending above the edge of the tank gauge hatch to allow for a suitable operating grip or handle.

13.3.3 Ullage-rods

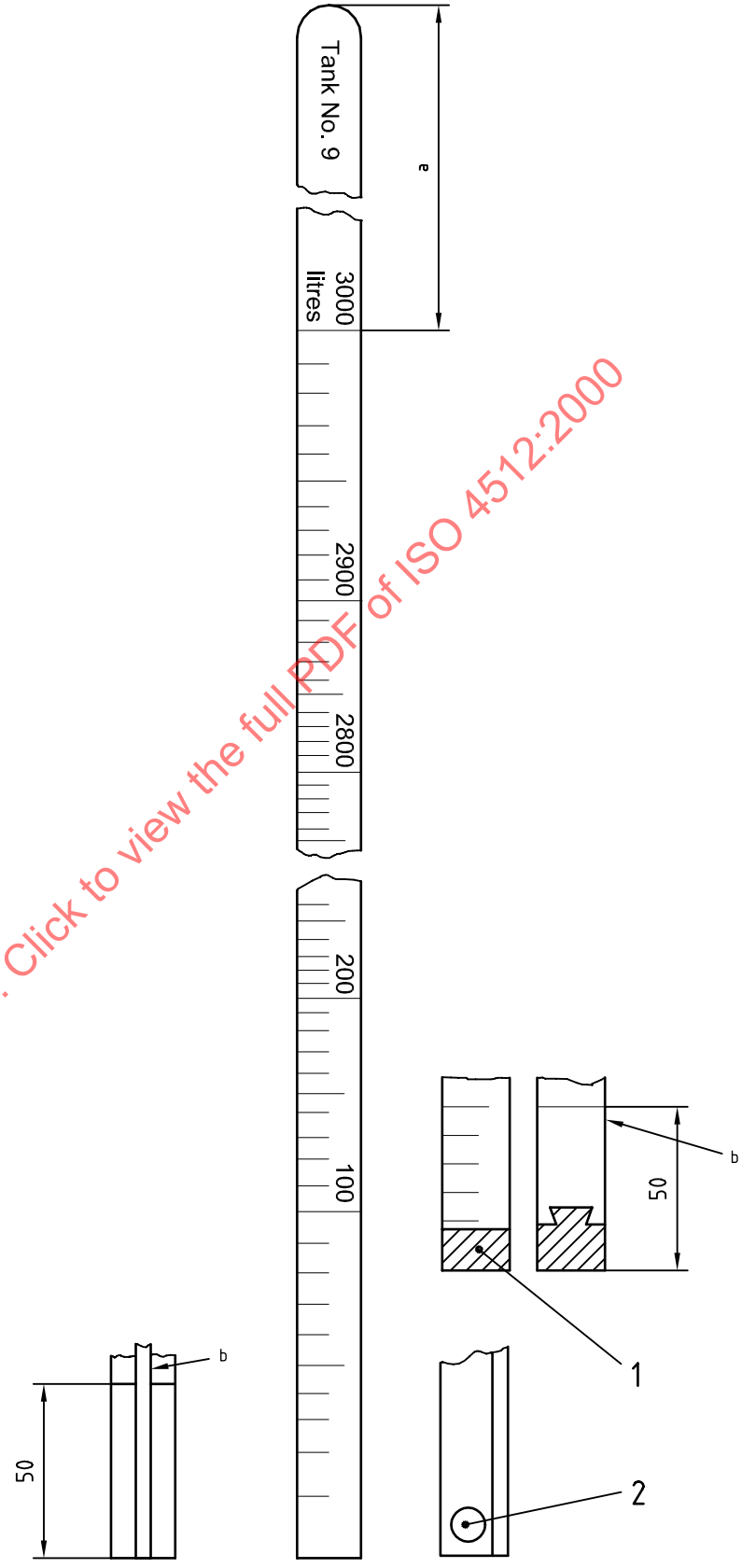
Ullage-rods shall be of suitable length to cover the normal operating range of levels for the tank to be gauged. They shall be provided with a cross piece of sufficient length to rest on the gauging reference points or on the rim of the ullage hatch and rigidly fastened at right angles to the major axis of the rod. The underside of the cross piece, if made of wood, shall be protected against wear by a metal strip.

NOTE Rods may also be provided with a handle above the cross piece.

13.4 Graduation

13.4.1 Units

The scales of rods graduated in length units shall be graduated in metres, centimetres and millimetres. Scales of rods graduated in units of volume shall be graduated in multiples of 1 litre.



Key

1 Teflon anti-wear tip

2 Lead plug for verification of authority stamp

a Length to suit tank safety ullage + height of dip-hatch + handle.

b "Datum" engraved on reverse of rod.

Figure 7 — Typical volumetric dip-rod