ORGANISATION INTERNATIONALE DE METROLOGIE LEGALE

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Commented [TM1]: Although the US proposed to possibly delete the word "pipe" from the title, the convener has decided to maintain it. The convener believes that "pipe" is still necessary because "prover" (by itself) could imply several other measuring instruments/standards in a broad range. There are different types of provers including standard tanks. The term "pipe" also includes a short straight cylinder used in flow measurements.

INTERNATIONAL

DOCUMENT

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~~5 June~~19 December
2019

Pipe provers for verification and calibration of ~~testing~~ measuring systems for liquids

Tubes étalons pour vérification et étalonnage~~l'essai~~ des ensembles de mesurage de liquides

ORGANISATION INTERNATIONALE
DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION
OF LEGAL METROLOGY

CONTENTS

FOREWORD

The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States.

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- International Recommendations (OIML R), which are model regulations that establish the metrological characteristics required of certain measuring instruments and which specify methods and equipment for checking their conformity. OIML Member States shall implement these Recommendations to the greatest possible extent;

- International Documents (OIML D), which are informative in nature and which are intended to harmonize and improve work in the field of legal metrology;

- International Guides (OIML G), which are also informative in nature and which are intended to give guidelines for the application of certain requirements to legal metrology; and

- International Basic Publications (OIML B), which define the operating rules of the various OIML structures and systems.

OIML Draft Recommendations, Documents and Guides are developed by Project Groups linked to Technical Committees or Subcommittees which comprise representatives from the Member States. Certain international and regional institutions also participate on a consultation basis. Cooperative agreements have been established between the OIML and certain institutions, such as ISO and the IEC, with the objective of avoiding contradictory requirements. Consequently, manufacturers and users of measuring instruments, test laboratories, etc. may simultaneously apply OIML publications and those of other institutions.

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This publication - reference OIML D yy, edition 20xx (E) - was developed by the OIML technical committee TC 8 on measurement of quantities of fluids. It was approved for final publication by the International Committee of Legal Metrology in 20xx and will be submitted to the International Conference of Legal Metrology in 20xx for formal sanction. It supersedes the OIML R 119 dated 1996.

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Introduction

A pipe prover is a measuring system that is used as a measurement standard for volume or for the flow~~-~~rate of liquid. These systems have ~~and it has~~ advantages over other conventional measurement methods for the ~~. For example, it enables a~~ precise volumetric measurement with the calibrated base volume, a semi-automatic measurement in a production/calibration line, and continuous measurement without interrupting the flow (for some types of the provers).

Due to such advantages, pipe provers are ~~this measuring system is~~ widely used as ~~a working~~ standards to calibrate/~~test/~~verify flow meters or as~~a~~ capacity measures for liquids, including water and oil. The users of these ~~the~~ instruments include: ~~a wide filed such as~~national/local metrology institutes, ~~in legal metrology, accredited~~ calibration laboratories, manufacturers of measuring instruments, water utilities,~~suppliers,~~ food industries, and oil/chemical industries. ~~Due to its structure, prover is normally used as a stationary working standard in a public/private testing laboratory or a factory.~~

Commented [TM2]: This sentence is not appropriate because some pipe provers are used on trucks.

This document is often used in conjunction with ~~closely related to~~other international recommendations and standard such as, OIML R 49 [1], OIML R 63 [4], OIML R 117-1/2/3 [5-7], ISO 91-1 [8], ISO 4267-2 [9], ISO 7278-1/2/3/4 [10-13] and ISO 8222 [14].

1 Scope

This International Document covers~~deals with pipe~~ provers, including piston provers, which are used as~~a working~~ standards to verify and/or calibrate measuring equipment/systems for volume or for the flow~~-~~rate of liquids. ~~(hereinafter called "measuring systems").~~These processes for verification/calibration are conducted in compliance with the ~~relevant~~ metrological requirements in the relevant OIML International Recommendations or other international standards. This International Document proposes model technical requirements for the design, installation, calibration, and use of provers ~~in designing, installing, calibrating and utilizing this measuring system for the users~~ in legal metrology and in industries involved in flow and volume measurements.

2 Terms and definitions

The general terms used in this Document are in accordance with the International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM:2012) [15], and the International Vocabulary of Terms in Legal Metrology (VIML:2013) [16]. Other terms specific to this Document are defined below.

2.1 Base volume

Constant reference volume that corresponds to the ~~a~~ displacement of a ~~single~~ full stroke of the displacer in the calibrated section.

Note: A base volume is usually equivalent to the volume of the calibrated section.

2.2 Calibrated section

A specified section in a prover ~~enclosed~~ defined with a pipe (or cylinder) and displacer(s) ~~which~~ that has a constant cross-sectional area.

Commented [TM3]: This wording was changed in accordance with a suggestion from the US. "Enclose" is normally used for a space surrounded by fixed walls or a container.

Note: The volume inside a calibrated section, which is precisely determined in advance, may be used to define the base volume of the pipe prover.

2.3 Detector

A ~~sensor~~ contact sensor or a non-contact (optical or mechanical) sensor that is used to detect the position of the displacer.

Commented [TM4]: The note was revised to provide additional information about two typical types of detectors. See also section 3.4.7.

Note: ~~The~~ A mechanical detector using a cantilever is often employed in certain pipe provers.~~A contact or contactless (optical or magnetic)~~ The lever is pushed by the displacer and actuates an electrical switch installed outside the pipe wall.~~in is used for a pipe prover, and~~ A linear encoder is used for a piston prover to transmit a pulse signal that is proportional to the displacement of the displacer.

2.4 Displacer

An object (usually a sphere or a piston) ~~delimiting the calibrated section which~~that travels along with the liquid flowing through the prover and is used to define the calibrated section.

3 Pipe provers covered by~~Pipe provers employed in~~ this document

3.1 General

A pipe prover is a pipe or cylinder whose volume is used to verify and/or calibrate~~, verify or prove a~~ flow measuring systems for liquids. A process of calibration is accomplished by a displacer (usually a sphere or piston) passing through the pipe~~a displacer (usually a sphere or piston) which~~ that actuates a pair of position detectors defining ~~delimiting~~ the calibrated section within a certain~~delay~~ time. The known volume of this section (base volume) is used as a standard to determine the instrumental error of the measuring system which is connected to the prover. The measured volume is corrected for the errors due to the differences in temperature and pressure of the liquid from the reference condition. The travel ~~travelling~~ time between the detectors is used to determine the~~a~~ flow~~-~~rate.

3.2 Types of pipe provers

The following ~~types of devices~~are generally used as pipe provers. Other types of pipe provers can be used when ~~as far as~~ their metrological characteristics comply with the requirements of this Document.

3.2.1 Uni-directional type

A uni-directional prover uses a displacer that travels in one direction to actuate detectors in the calibrated section of the pipe (Figure 1). The measured volume corresponds to one passage of the displacer.

3.2.2 Bi-directional type

A bi-directional prover uses a displacer that travels in one direction and then in the opposite direction through the same calibrated section (Figures 2a and 2b). The measured volume corresponds to the sum of both passages of the displacer. One~~A~~ pair or two independent pairs of detectors are used to record the movement of the displacer.

3.2.3 Small volume type

A small volume type or compact prover uses a displacer which travels through a very short section of the pipe or cylinder (Figures 3a and 3b). The volume displaced in the calibrated section is usually much smaller than that of a conventional prover (such as in 3.2.1 and 3.2.2, above). For this reason, high-precision detectors and a method for pulse-interpolation are necessary to achieve good repeatability and high accuracy.

3.2.4 Full-stroke type

This type of pipe prover uses the standing start and stop method (Figure 4). Its base volume is the volume displaced by a single full stroke of the reversible displacer. The ~~F~~full-stroke type may be used mainly for the verification of LPG dispensers. ~~displacers.~~

3.3 Accuracy

The calibration of the~~a~~ base volume of a prover shall be carried out such that the expanded uncertainty of the calibration is~~be~~ significantly smaller than the acceptable criteria which is referred to as the maximum permissible error (MPE) in type ~~pattern~~ approval tests and verification tests. The treatment of the expanded uncertainty and the acceptance ~~acceptable~~ criteria should follow the requirements of OIML G 19 [17], ~~an~~ the applicable OIML Recommendation, and/or an international standard. The expanded uncertainty shall be determined using an appropriate coverage factor (k) which is usually equivalent to two (k=2).

3.4 Construction of pipe provers

3.4.1 General

Construction of pipe provers should meet the provisions of the ISO 4267-2 [9]. Typical layouts of pipe provers are shown in Figures 1 to 3b. Special care should be taken in the control system of a prover for the collection of necessary data. For the purposes ~~From the viewpoint~~of proper metrological control, some requirements are mentioned below.

3.4.2 Materials and fabrication

The materials of construction and the pressure rating of the prover should be compatible with the measuring systems to be verified/calibrated~~tested~~ and the fluids used. ~~for testing.~~ The prover should be adequately insulated for the required duty and operational~~ambient~~ conditions. If separation of ~~the~~prover components is necessary (such as for transportation), the proper reassembly of the components ~~individual parts~~shall be ensured ~~guaranteed either~~by an appropriate ~~and reproducible~~reconstruction and~~or~~ by a recalibration of the base volume. Internal coating of the prover ~~section~~ with the correct material should be used to reduce corrosion and wear.

3.4.3 Displacer

In general, provers use one or more spheres, or a piston as the~~a~~ displacer. Spheres should be ~~are~~made of a resilient material that is ~~which should be~~compatible with the fluids used~~test fluid~~, and they shall meet the specified ~~certain~~minimum and maximum sizes. Piston displacers shall be made of rigid material with resilient seals that are in contact with the pipe prover wall. The diameter of the sphere(s) shall be such that a seal is provided without excessive friction.

3.4.4 Valves

The valves used in a pipe-prover system shall not leak as their leakage would influence the measurement result.~~Necessary means~~ Means for checking possible leakage in the system shall be provided.

3.4.5 Temperature measuring devices

Temperature-measuring devices with an appropriate ~~suitable~~ range shall be installed at the inlet and outlet of the prover. These devices shall be immersed in the fluid to enable an accurate determination of the fluid temperature. The use of thermo-wells (tubular fittings used to protect the temperature sensors) is normally recommended. The accuracy and range of the devices should be such that the provisions of 3.3 and 5.3 are met.

3.4.6 Pressure measuring devices

Pressure-measuring devices with an appropriate ~~suitable~~ range shall be used ~~at appropriate locations~~ to properly measure pressure in the prover. The accuracy and range of the devices must be such that the provisions of 3.3 and 5.4 are met.

3.4.7 Detectors

~~Except for the full-stroke type of prover,~~ D~~d~~etection devices and switches for any given direction of the displacer shall respond to the displacer's position such that the prover meets the performance requirements specified in 3.3.

3.4.8 Vent valve and related piping

Vent valves shall be installed on the topmost part of the pipe to ensure that all the gas is vented from the dead spaces not swept by the displacer. This requirement ensures that the piping, the pipe prover and the meter being verified/calibrated remain ~~to be tested are~~ completely filled with~~the test~~ liquid. Provisions shall be made for the draining ~~disposal~~ of ~~the~~ liquids and for venting vapors ~~drained or vented~~from the prover. If the prover is intended to be calibrated using the water draw method or the master meter method, proper c~~C~~onnections shall be provided. ~~if necessary for the water draw method or the master meter method.~~

4 Calibration of pipe provers

4.1 General

The calibration methods summarized below are to be used as a guideline. ~~D~~A detailed description of these~~the~~ calibration methods is also given in the ISO 7278-2 [11]. National regulations should ~~may~~ specify that pipe provers are to~~shall~~ be calibrated when they are installed, ~~for testing other measuring systems for liquids,~~and that they shall ~~may~~be re-calibrated periodically at an interval fixed by these regulations. Pipe provers shall also be re-calibrated when they ~~may~~ have been repaired or modified~~mechanically~~ (e.g. change of detectors, recoating, dismantling, and/or re-installation).

4.2 Reference conditions

The base volume of a pipe prover shall be determined on the basis of the reference conditions specified in national/regional regulations.

4.3 Methods for calibrating pipe provers

There are three methods for calibrating a pipe prover: the water draw method, the master meter method, and the dimensional method.

4.3.1 Water draw method

Commented [TM5]: This clause was revised in order to explain the practical calibration procedure more accurately.

The calibration of a pipe prover by the water draw method requires standard capacity measures (volumetric method) or a weighing instrument with a tank (gravimetric method) to determine~~, against which~~ the base volume of the prover. ~~may be determined.~~ To allow a continuous and uniform flowrate to be produced, the base volume of the prover may be transferred ~~run~~into a holding tank using~~typical~~ arrangements such as those shown in Figures 5 and 6. This volume is then measured either gravimetrically ~~subsequently by weighing~~ or volumetrically by transferring the liquid into ~~the~~ standard capacity measures. The prover shall be thoroughly flushed and cleaned before calibration.

4.3.2 Master-meter method

Commented [TM6]: This clause was revised in order to explain the practical calibration procedure more accurately. "Master meter method" intends to calibrate a pipe prover using a master meter as an intermediate standard. A reference standard at a higher level is used to calibrate the master meter.

Firstly, ~~In this method, the reading of~~ a master meter for flowrate is calibrated ~~compared with the values of volume obtained~~ by ~~a master prover~~ another reference standard of flow or volume~~and by a pipe prover being calibrated, respectively~~. Secondly, a pipe prover under calibration is calibrated using the master meter. ~~If necessary, a proving tank may be replaced with the master prover.~~ Where, the master meter functions merely as an intermediate link between the ~~two provers~~reference standard and the prover under calibration. Therefore, it is necessary to assure before and after the calibration that the performance of the master meter is stable ~~stabilized~~ by using the reference standard~~master prover as a reference~~. Another calibrated master prover may be used for the reference standard. A typical arrangement of the master-meter method is shown in Figure 7. This method is not applicable, however, to a full-stroke type of pipe prover with a small volume.

4.3.3 Dimensional method

This method is based on precise dimensional measurements of the calibrated section of the pipe prover. The measurements are typically conducted by ~~through~~evaluating effective and averaged values for the inner length and the inner diameter of the calibrated section of the cylinder.~~which is in a cylindrical shape.~~ This method is particularly effective to reduce measurement uncertainty for ~~pipe prover or a~~ piston provers and other ~~using a~~straight~~-~~tube provers.

5 General requirements for the calibration and verification ~~testing~~ of measuring systems using a pipe prover

5.1 Test liquids

Commented [TM7]: Although the US suggested to delete "test" from "test liquids", the convener has decided to maintain it. It is believed that this will be more helpful for the user of this document to envision what liquids are meant.

A measuring system shall be tested using one of the liquids marked on the data plate (or instruction manual) of the measuring system, or with a liquid whose flow characteristics are within the ranges of those of the marked liquids. All appropriate safety and environmental measures concerning the~~Any regulations concerning the security of~~ handling of the liquids~~the measuring system~~ shall be observed.

5.2 Base volume of the pipe prover

It shall ~~should~~be ensured that the base volume of the pipe prover is ~~shall be~~ matched to the resolution of the measuring system and is~~shall be~~ adequate to meet the requirements of 3.3. If ~~Where~~the measuring system is equipped with a pulse generator which does not generate enough pulses for the base volume, a pulse-interpolation method may be used in compliance with ISO 7278-3 [12].

5.3 Temperature measurement

Appropriate temperature-measuring devices shall be used~~In order~~ to ensure proper ~~determine the necessary~~temperature correction of~~s for~~ the ~~test~~liquid volume.~~, the measuring system and the pipe prover being used, appropriate temperature measuring devices shall be used~~ These devices shall be mounted in~~at~~ suitable locations ~~places~~on the prover and the measuring system. ~~and the testing equipment.~~It is recommended to use the temperature-measuring devices with an expanded uncertainty of 0.2 °C or less. ~~For increased accuracy, accurate measurement of large volumes of petroleum products, it may be necessary to measure the temperature with a smaller expanded uncertainty of 0.05 °C or less to better take into account of the thermal expansions of the liquidproduct and the measuring system.~~ Calibration certificates shall be provided for t~~T~~emperature measuring devices.~~ should be provided with the calibration certificates~~.

Commented [TM8]: The US suggested possibly returning this section to the original R 119's description in this sentence of temperature-measurement device with the term "accuracy". The convener has, however, decided to maintain this expression. The expression using uncertainty is already common in the NMIs. A measurement uncertainty is easily estimated from the value of accuracy assuming a rectangular distribution of errors.

Commented [TM9]: The convener has decided to delete this sentence. A smaller value of uncertainty may be specified by each country.

5.4 Pressure measurement

Appropriate pressure-measuring devices shall be used to ensure proper pressure correction of the liquid volume.~~When a correction for the pressure of the liquid and/or prover is required, a p~~ Pressure gauges shall be mounted in a ~~at a~~ suitable location on the prover and ~~place~~ on the measuring system ~~or on the testing equipment~~ in order to measure the pressure of the liquid with a necessary accuracy. Normally, pressure gauges with an expanded uncertainty of 0.05 MPa (0.5 bar) or less are ~~is~~ suitable. ~~For increased accuracy, accurate measurement of large volumes of petroleum products, it may be necessary to measure the pressure with a smaller expanded uncertainty of 0.025 MPa or less to take into account of the compressibility of the liquid product and the measuring system.~~ Calibration certificates shall be provided for pressure-measuring devices. ~~Pressure gauges should be provided with the calibration certificates.~~

Commented [TM10]: Same comment with above (5.3).

Commented [TM11]: Same comment with above (5.3).

5.5 Inspection of electronic devices

The electronic devices including detectors, pulse generator and pulse counter shall be inspected to ensure proper operation.~~confirm that they function correctly.~~

5.6 Preliminary runs

A sufficient number of preliminary runs shall be carried out before the actual verification/calibration runs ~~test run~~ in order to ensure complete elimination of any ~~eliminate the~~ gases which may be contained in the prover and associated piping~~test equipment including the pipe prover,~~ and to ensure ~~make sure~~ that the liquid temperature is stable and uniform. The measuring system shall be checked to ensure that leaks do not exist. ~~tested for leakage before the test.~~

5.7 Test flowrates

The total number and the range of flowrates applied for verification/calibration ~~testing~~ are specified in the applicable OIML Recommendation(s) for ~~applied to~~ the measuring system.~~ under legal control.~~

Commented [TM12]: Although the US suggested the possible deletion of the word "test" from "test flowrates", the convener has decided to maintain it. It is believed that this will be more helpful for the users of this document to envision what flowrates are meant.

5.8 Number of test runs

The number of ~~test~~ runs to be carried out at a particular flowrate is specified in the applicable OIML Recommendation(s) for ~~applicable applied to~~ the measuring system. In general, the number of runs is more than two in order to ensure~~evaluate~~ the good repeatability of the measuring system~~adequately~~ as well as to verify whether each ~~test~~ result meets the maximum permissible error (MPE).

5.9 Calculation of errors

The errors of the measuring system may be calculated either from the meter factor determined according to Clause 7 of ISO 4267-2 [9], or using directly the following equations in which the second order terms are neglected.

$$E = E'' + E_\alpha + E_\beta + E_\gamma + E_\delta \qquad (1)$$

$$E'' = [(V_{lm} - V_B) / V_B] \times 100 \qquad (2)$$

$$E_\alpha = \alpha \times (t_{lp} - t_{lm}) \times 100 \qquad (3)$$

$$E_\beta = \beta \times (t_s - t_{lp}) \times 100 \qquad (4)$$

$$E_\gamma = \gamma \times (p_{lm} - p_{lp}) \times 100 \qquad (5)$$

$$E_\delta = -\delta \times p_{lp} \times 100 \qquad (6)$$

where

E is the instrumental error of the measuring system, in %
E'' is the uncorrected error, in %
E_α is the temperature correction for the test liquid, in %
E_β is the temperature correction for the pipe prover, in %
E_γ is the pressure correction for the test liquid, in %
E_δ is the pressure correction for the pipe prover, in %
V_{lm} is the volume indicated by the meter, in L
V_B is the base volume of the pipe prover, in L
t_{lp} is the liquid temperature in the pipe prover, in °C
t_{lm} is the liquid temperature in the meter, in °C
t_s is the reference temperature of the pipe prover, in °C
p_{lp} is the gauge pressure of the liquid in the pipe prover, in kPa
p_{lm} is the gauge pressure of the liquid in the meter, in kPa
α is the cubic expansion coefficient of the test liquid due to temperature, in °C^{-1}
β is the cubic expansion coefficient of the pipe prover due to temperature, in °C^{-1}
γ is the compression coefficient of the test liquid, in kPa^{-1}
δ is the pressure expansion coefficient of pipe prover, in kPa^{-1}

Notes: The four coefficients may be determined as shown below.

α: Refer to OIML R 63 or ISO 91-1[8] for petroleum products; refer to ISO 8222 for water
β: 33×10^{-6} °C^{-1} for mild steel, 51×10^{-6} °C^{-1} for stainless steel
γ: Refer to the coefficient C_{pl} (5.4) of ISO 4267-2
δ: Refer to the coefficient C_{ps} (5.3) of ISO 4267-2

To obtain more precise result, the following equations can be used without neglecting the second order terms.

$$E = \left(\frac{V_{lm}}{V_B} \cdot \frac{[1-\alpha(t_{lm}-t_{lp})][1+\gamma(p_{lm}-p_{lp})]}{[1+\beta(t_{lp}-t_s)](1+\delta_{lp})} - 1 \right) \times 100$$

Commented [TM13]: The convener has decided to add this form as an exact expression.

~~6 Test procedures for the verification of measuring systems~~

~~6.1 General~~

~~Clauses 6.2, 6.3 and 6.4 describe examples of typical verification procedures using a pipe prover for the following measuring systems:~~

~~Clause 6.2: a measuring system for liquid fuel on road tanker and a measuring system on pipe line~~
~~Clause 6.3: a measuring system for LPG under pressure~~
~~Clause 6.4: a measuring system for LPG dispenser~~

~~It is should be noted that there are exist many other acceptable test methods which are may be described in multiple OIML Recommendations and or in ISO Standards. The E examples below are provided merely given to illustrate a few typical applications. All verification procedures should Any test method should, however, comply with the provisions metrological specifications of this Document. , in order to ensure the integrity of testing.~~

~~6.2 Test procedure for measuring systems for liquid fuel~~

~~Two Ttypical installations in which a pipe prover and a measuring system for liquid fuel are connected are shown in Figures 8 and 9. , depending on the applications of the measuring systems. The basic test procedure for these systems is as follows:~~

~~(1) Carry out a sufficient number of preliminary runs.~~
~~(2) Locate the displacer at the starting position, reset the pulse counter and interval timer.~~
~~(3) Start the displacer in movement. Ensure that Check whether both the pulse counter and the interval timer start when the start detector is activated.~~
~~(4) While counting pulses, the pulse is counted, read and record the temperature and pressure of the pipe prover and the measuring system.~~
~~(5) Check that both the pulse counter and the interval timer stop when the end detector is activated.~~
~~(6) Read and record the indicated results of the pulse counter and the interval timer.~~

~~6.3 Test procedure for measuring system for LPG under pressure~~

~~A typical installation in which a measuring system for LPG under pressure is tested using a pipe prover is shown in Figures 10, and 11. It should be ensured that the LPG remains in liquid phase inside the pipe prover by means of an appropriate device, if necessary. The basic test procedure shall be the same as those described in Clause 6.2.~~

~~6.4 Test procedure for LPG dispensers~~

~~T A typical installation in which a full-stroke type of pipe prover is used for verifying anthe measuring systems for LPG dispenser is shown in Figure 11. The basic test procedure is as follows:~~

~~(1) Locate the pipe prover horizontally, and close to the dispenser (to and make the pipework as short as possible).~~
~~(2) Connect the outlet nozzle of the dispenser to the inlet of the pipe prover.~~

Commented [TM14]: The convener has decided to transfer this chapter to an informative annex. Such a procedure should be mentioned in the applicable OIML Recommendation. There is no need for duplicating all procedures in this Document.

~~(3) Position the flow diverter valve to initiate cause circulation of flow. Purge gas adequately and conduct preliminary runs. Check that no air bubbles are present by means of athe sight glass.~~

~~(4) Locate the displacer at the starting position and reset the indication of the dispenser.~~

~~(5) Start the displacer movement.~~

~~(6) Read and record the temperature, pressure, and flowrate of the liquid during flow.~~

~~(7) Read and record the volume displayed total count on the dispenser when the displacer reaches the end point of its stroke.~~

~~7~~6 Bibliography

[1] OIML R 49-1: 2013 “Water meters for cold potable water and hot water, Part 1: Metrological and technical requirements”

[2] OIML R 49-2: 2013 “Water meters for cold potable water and hot water, Part 2: Test methods”

[3] OIML R 49-3: 2013 “Water meters for cold potable water and hot water, Part 3: Test report format”

[4] OIML R 63: 1994 “Petroleum measurement tables”

[5] OIML R 117-1: 20~~07~~19 “Dynamic measuring systems for liquids other than water, Part 1: Metrological and technical requirements”

[6] OIML R 117-2: 20194 “Dynamic measuring systems for liquids other than water, Part 2: Metrological controls and performance tests”

[7] OIML R 117-3: 20194 “Dynamic measuring systems for liquids other than water, Part 3: Test report format”

[8] ISO International Standard 91: First edition 2017: Petroleum and related products - Temperature and pressure volume correction factors (petroleum measurement tables) and standard reference conditions, International Organization for Standardization

[9] ISO 4267-2: 1988 “Petroleum and liquid petroleum products - Calculation of oil quantities Part 2: Dynamic measurement”

[10] ISO 7278-1: 1987 “Liquid hydrocarbons - Dynamic measurement - Proving systems for volumetric meters - Part 1: General principles”

[11] ISO 7278-2: 1988 “Liquid hydrocarbons - Dynamic measurement - Proving systems for volumetric meters - Part 2: Pipe provers”

[12] ISO 7278-3: 1998 “Liquid hydrocarbons - Dynamic measurement - Proving systems for volumetric meters - Part 3: Pulse interpolation techniques”

[13] ISO 7278-4: 1999 “Liquid hydrocarbons - Dynamic measurement - Proving systems for volumetric meters – Part 4: Guide for operators of pipe provers”

[14] ISO 8222: 2002 “Petroleum measurement systems - Calibration - Temperature corrections for use when calibrating volumetric proving tanks”

[15] JCGM 200:2012 "International Vocabulary of Metrology - Basic and General Concepts and Associated Terms (VIM 3rd edition)"

[16] OIML V 1: 2013 "International vocabulary of terms in legal metrology (VIML)"

[17] OIML G 19: 2017 "The role of measurement uncertainty in conformity assessment decisions in legal metrology"

Commented [TM15]: Version of R 117 was updated following the resolution of 54th CIML in Bratislava.

Annex A (informative): Example of Test procedures for the verification of measuring systems

This annex describes examples of typical verification procedures using pipe provers. It should be noted that there are many other applicable test methods described in OIML Recommendations and ISO Standards. All verification procedures should comply with the provisions of this Document.

A.1. Test procedure for measuring systems for liquid fuel

Two typical installations in which a pipe prover and a measuring system for liquid fuel are connected are shown in Figures 8 and 9. The basic test procedure for these systems is as follows:

(1) Carry out a sufficient number of preliminary runs.
(2) Locate the displacer at the starting position, reset the pulse counter and interval timer.
(3) Start the displacer in movement. Ensure that both the pulse counter and the interval timer start when the start detector is activated.
(4) While counting pulses, read and record the temperature and pressure of the pipe prover and the measuring system.
(5) Check that both the pulse counter and the interval timer stop when the end detector is activated.
(6) Read and record the indicated results of the pulse counter and the interval timer.

A.2. Test procedure for measuring systems for LPG under pressure

A typical installation in which a measuring system for LPG under pressure is tested using a pipe prover is shown in Figure 10. It should be ensured that the LPG remains in liquid phase inside the pipe prover by means of an appropriate device, if necessary. The basic test procedure shall be the same as those described in Clause A.1.

A.3. Test procedure for LPG dispensers

A typical installation in which a full-stroke type of pipe prover is used for verifying an LPG dispenser is shown in Figure 11. The basic test procedure is as follows:

(1) Locate the pipe prover horizontally, and close to the dispenser (to make the pipework as short as possible).
(2) Connect the outlet nozzle of the dispenser to the inlet of the pipe prover.
(3) Position the flow diverter valve to initiate circulation of flow. Purge gas adequately and conduct preliminary runs. Check that no air bubbles are present by means of a sight glass.
(4) Locate the displacer at the starting position and reset the indication of the dispenser.
(5) Start the displacer movement.
(6) Read and record the temperature, pressure, and flowrate of the liquid during flow.
(7) Read and record the volume displayed on the dispenser when the displacer reaches the end point of its stroke.

Commented [TM16]: The contents of Annex A are nearly identical to the contents of the "old" Chapter 6 in the 1CD.

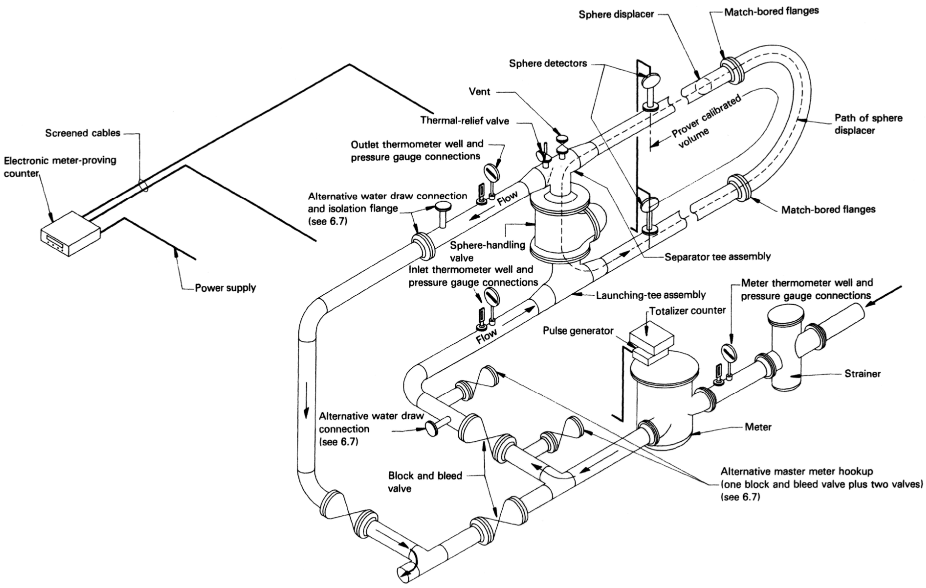

Figure 1 Typical uni-directional pipe prover
(Extracted from ISO 7278-2*)

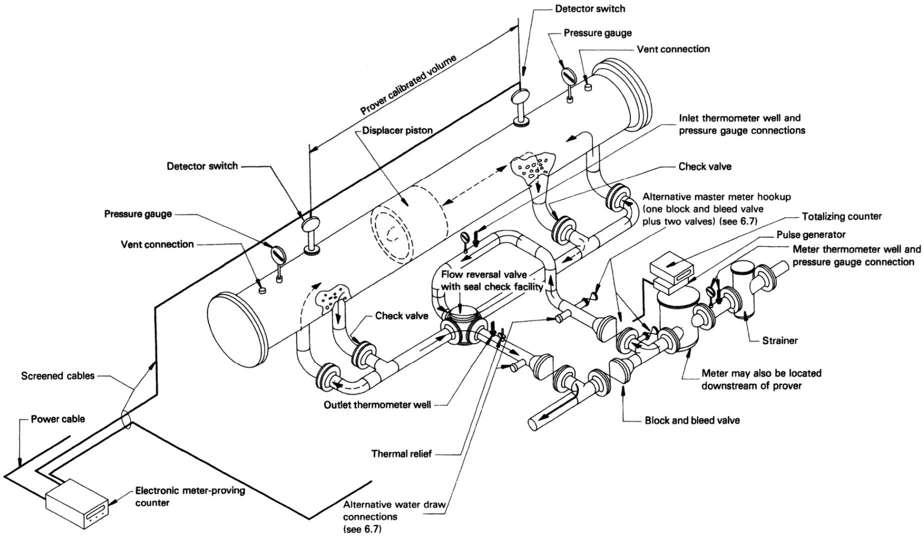

Figure 2a Typical bi-directional straight-type piston pipe prover
(Extracted from ISO 7278-2*)

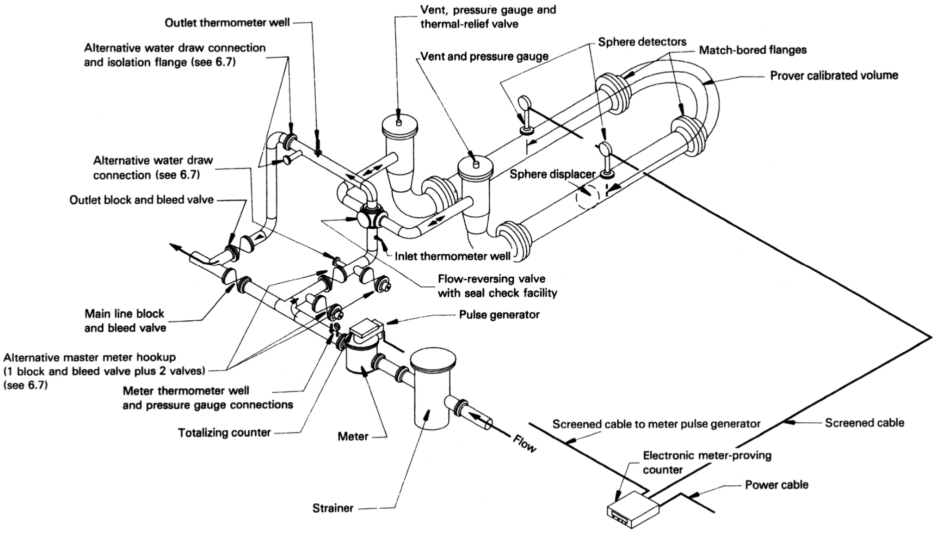

Figure 2b Typical bi-directional U-type pipe prover
(Extracted from ISO 7278-2*)

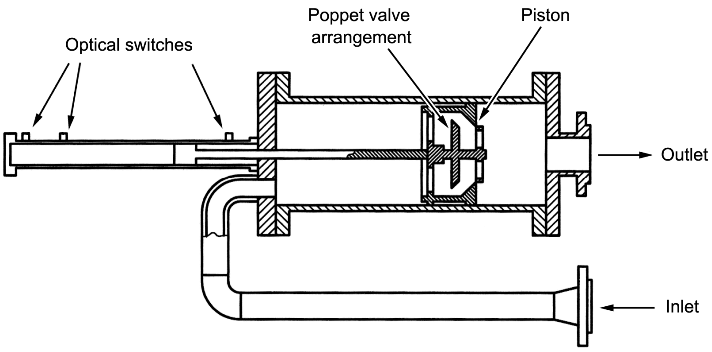

Figure 3a Typical small volume pipe prover with internal valve
(Extracted from ISO 7278-4*)

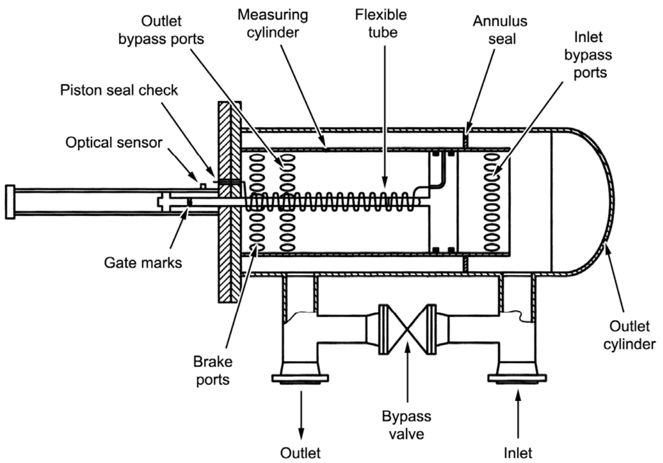

Figure 3b Typical small volume pipe prover with external valve
(Extracted from ISO 7278-4*)

(*) Figures 1 to 3b are extracted from ISO 7278-2:1988 and ISO 7278-4:1999, reproduced with the authorization of the International Organization for Standardization (ISO) which holds the copyright.

Commented [TM17]: Figures 1 to 3b are almost identical with those in the present R 119.

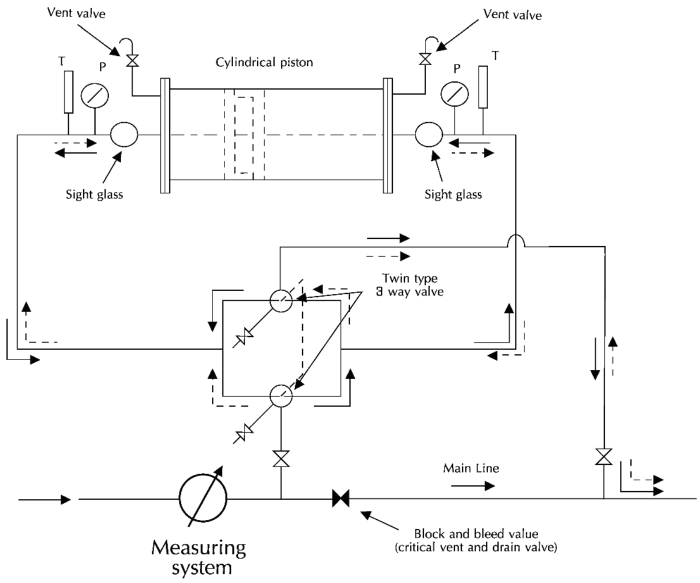

Figure 4 Typical full-stroke type pipe prover

Commented [TM18]: This figure corresponds to Figure 4 of the present R 119 with the following change. 'Measuring system' was indicated clearly.

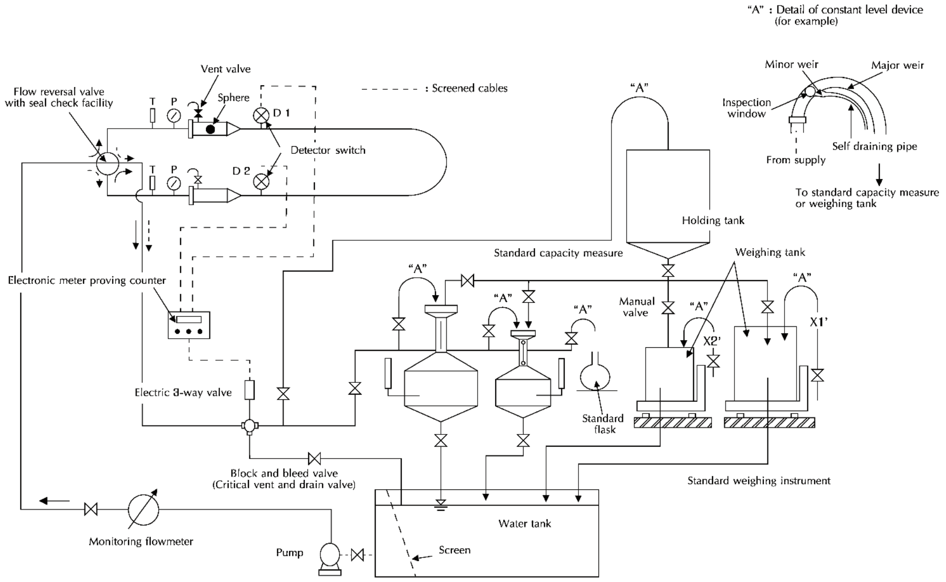

Figure 5 Calibration of pipe prover (water draw method)

Commented [TM19]: This figure corresponds to Figure 5 of the present R 119 with the following changes. A vertical pipe in the holding tank was deleted. Piping around two standard tanks and a flask was modified. The level device was redrawn for better understanding.

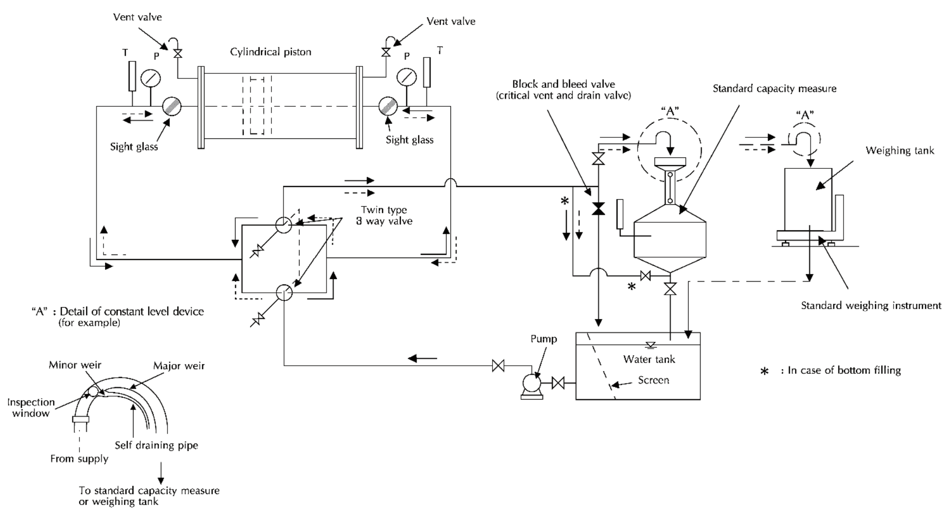

Figure 6 Calibration of full-stroke type pipe prover (water draw method)

Commented [TM20]: This is identical to Figure 6 of the present R 119.

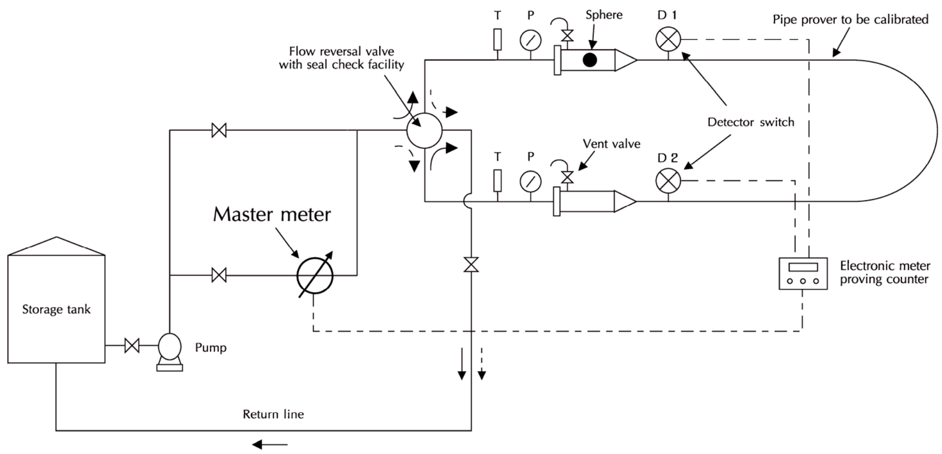

Figure 7 Calibration of a pipe prover (master meter method)

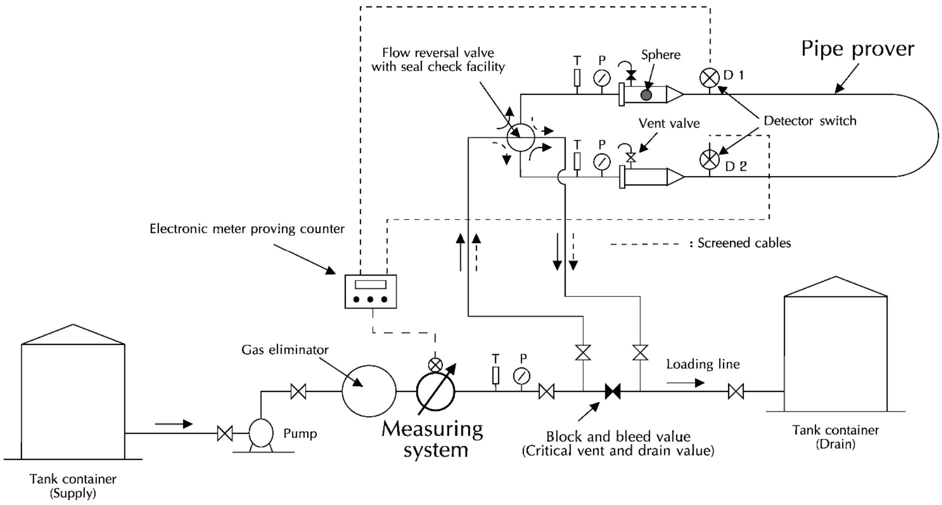

Figure 8 Verification of measuring systems for tank containers connected with pipelines

Commented [TM21]: This figure corresponds to Figure 7 of the present R 119 with the following changes. One of the two provers in the original figure was deleted because a master meter is not used with two provers at the same time.

Commented [TM22]: This figure is a combination of Figures 9, 10 and 11 of the present R 119 with the following changes. Various measuring systems in the three original figures, which were connected to supply or drain liquid, were summarized into the two tank containers for supply and drain. Measuring system' was indicated clearly.

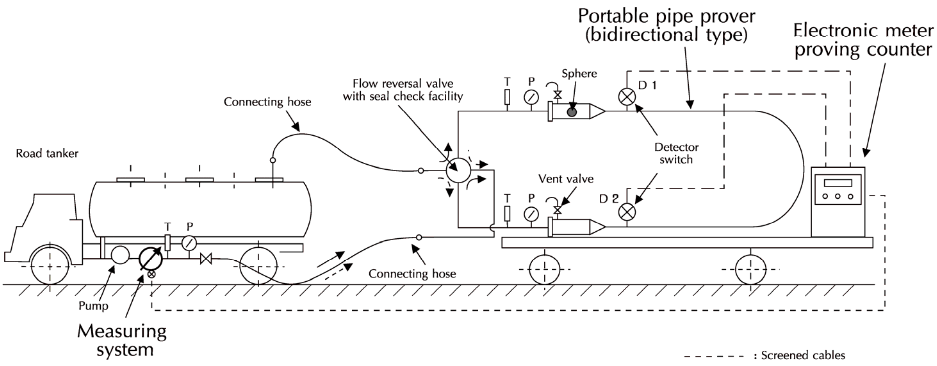

Figure 9 Verification of measuring systems on road tankers

Commented [TM23]: This figure corresponds to Figure 8 of the present R 119 with the following change. Measuring system' was indicated clearly.

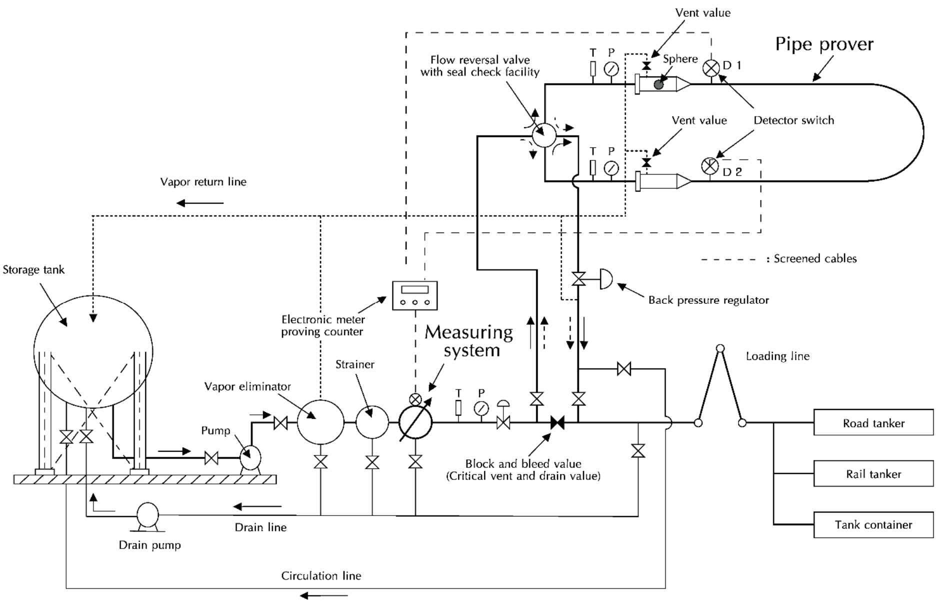

Figure 10 Verification of measuring systems for LPG under pressure

Commented [TM24]: This figure corresponds to Figures 12 of the present R 119 with the following changes. Measuring system' was indicated clearly. Piping around the back-pressure gauge was modified.

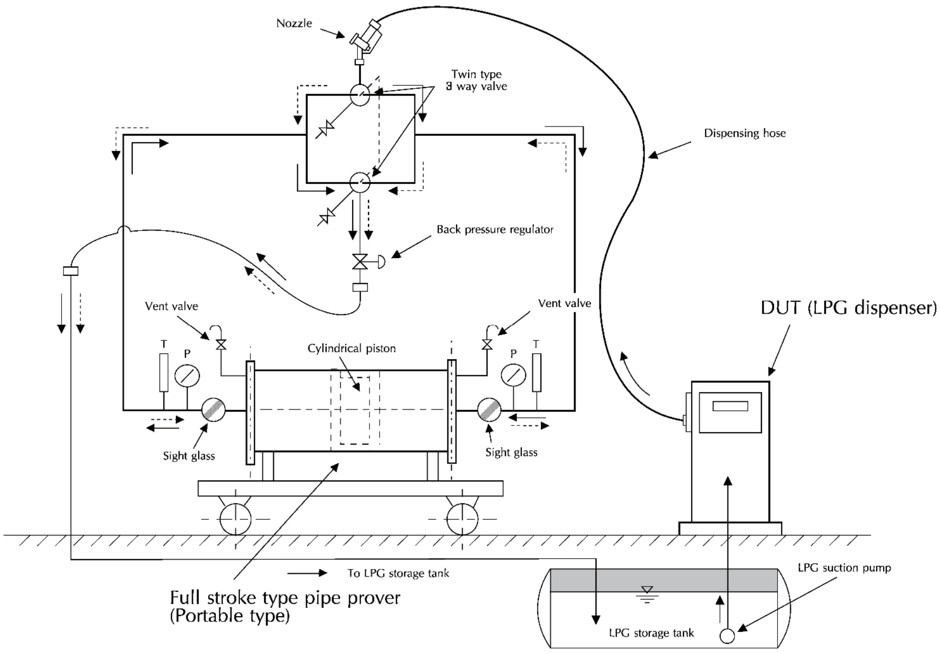

Figure 11 Verification of LPG dispensers

Commented [TM25]: This figure corresponds to Figure 13 of the present R 119. Figure 14 in R 119 with an application to fuel dispensers was removed as it is not used frequently.