

Liquid hydrocarbons — Dynamic measurement — Proving systems for volumetric meters —

Part 2: Pipe provers

The European Standard EN ISO 7278-2:1995 has the status of a British Standard

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Petroleum Standards Policy Committee (PTC/-) to Technical Committee PTC/12, upon which the following bodies were represented:

- Department of Energy (Gas and Oil Measurement Branch)
- Department of Trade and Industry (National Engineering Laboratory)
- Department of Transport (Marine Directorate)
- General Council of British Shipping
- Institute of Petroleum
- Royal Institution of Naval Architects
- Salvage Association

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- GAMBICA (BEAMA Ltd.)
- Institute of Measurement and Control
- United Kingdom Offshore Operators' Association

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National foreword

This Part of BS EN ISO 7278 has been prepared by Technical Committee PTI/12 (formerly PTC/12) and is the English language version of EN ISO 7278-2:1996 *Liquid hydrocarbons — Dynamic measurement — Proving systems for volumetric meters — Part 2: Pipe provers* published by the European Committee for Standardization (CEN). It is identical with ISO 7278-2:1988 published by the International Organization for Standardization (ISO).

Cross-references

International Standard	Corresponding British Standard
ISO 91-1:1982	BS 6441:1983 <i>Schedule for petroleum measurement tables</i> (Identical)
ISO 2715:1981	BS 6619 <i>Methods for volumetric measurement of liquid hydrocarbons</i> Part 2:1984 <i>Turbine meter-systems</i> (Identical)
ISO 4267-2:1988	BS 7286 <i>Method for calculation of petroleum and liquid petroleum products</i> Part 2:1990 <i>Dynamic measurement</i> (Identical)
ISO 7278-3:1986	BS 6866 <i>Proving systems for meters used in dynamic measurement of liquid hydrocarbons</i> Part 3:1987 <i>Methods for pulse interpolation</i> (Identical)
ISO 8222:1987	BS 6922:1988 <i>Specification for temperature corrections for use in the calibration of reference measuring systems for petroleum measurement</i> (Identical)

ISO 5024:1976 is related to BS 5579:1978 “*Specification for standard reference conditions for measurement of petroleum liquids and gases*”; the standard reference conditions referred to in 1.3 are identical to those given in BS 5579.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN ISO title page, pages 2 to 22, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Proving systems for volumetric meters —
Part 2: Pipe provers

(ISO 7278-2:1988)

Hydrocarbures liquides — Mesurage
dynamique — Systèmes d'étalonnage des
compteurs volumétriques — Partie 2: Tubes
étalons
(ISO 7278-2:1988)

Flüssige Kohlenwasserstoffe — Dynamische
Messung — Prüfsysteme für volumetrische
Meßgeräte — Teil 2: Rohrprüfer
(ISO 7278-2:1988)

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Foreword

The text of the International Standard from ISO/TC 28, Petroleum products and lubricants, of the International Organization for Standardization (ISO) has been taken over as a European Standard by the Technical Committee CEN/TC 19, Petroleum products, lubricants and related products'.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 1996, and conflicting national standards shall be withdrawn at the latest by April 1996.

According to CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

0 Introduction

Pipe provers are used as volume standards for the calibration of liquid meters. The purpose of this part of ISO 7278 is to outline the essential elements of a pipe prover, to provide specifications for its performance, and to give guidance on its design, installation and calibration. Pipe provers discussed in this part of ISO 7278 are of the running-start/running-stop type, in which flow is uninterrupted during proving, thus permitting the meter to be proved under its normal operating conditions. This type of prover includes a calibrated section of pipe in which a displacer travels, actuating detection devices which produce electrical signals as the displacer passes each end of the calibrated portion. The displacer finally stops at the end of the run as it enters a region where the flow bypasses it.

Both stationary and mobile provers may be constructed on this principle. The calibrated section of the prover may be straight or folded (U-shaped), and the design may be such that the displacer moves around a closed loop in only one direction (unidirectional) or, alternatively, in both directions (bidirectional).

ISO 7278 consists of the following parts, under the general title *Liquid hydrocarbons — Dynamic measurement — Proving systems for volumetric meters*:

- Part 1: General principles;
- Part 2: Pipe provers;
- Part 3: Pulse interpolation techniques.

Annex A forms an integral part of this part of ISO 7278. Annex B is for information only.

1 Scope and field of application

1.1 This part of ISO 7278 provides guidance for the design, installation and calibration of pipe provers. Calculation techniques for use when calibrating and operating provers are detailed in ISO 4267-2.

1.2 Most of the material in this part of ISO 7278 is general in that it applies to pipe provers for use with different liquids and types of meters and for proving them in different services. This part of ISO 7278 does not apply to the newer “small volume” or “compact” provers.

1.3 The standard reference conditions for petroleum measurement are a temperature of 15 °C and a pressure of 101 325 Pa as specified in ISO 5024.

NOTE In some countries other reference temperatures are used, e.g. 20 °C and 60 °F.

2 References

- ISO 2715, *Liquid hydrocarbons — Volumetric measurement by turbine meter systems*.
 ISO 4267-2, *Petroleum and liquid petroleum products — Calculation of oil quantities — Part 2: Dynamic measurement*¹⁾.
 ISO 5024, *Petroleum liquids and gases — Measurement — Standard reference conditions*.
 ISO 7278-3, *Liquid hydrocarbons — Dynamic measurement — Proving systems for volumetric meters — Part 3: Pulse interpolation techniques*.
 ISO 8222, *Petroleum measurement systems — Calibration — Temperature corrections for use with volumetric reference measuring systems*.

3 Definitions

For the purposes of this part of ISO 7278, the following definitions apply:

3.1

base volume

the volume of a prover calibrated section, i.e. the length between the detectors, at specified reference conditions of temperature and pressure

3.2

K-factor

the ratio of the number of electrical pulses emitted by a meter during a proving run to the volume of liquid passed through the meter

3.3

meter factor

the ratio of the actual volume of a liquid passed through a meter to the volume indicated by the meter

3.4

prover calibration

the procedure for determining the base volume of a prover

3.5

proving; proof

the determination of the meter factor or *K*-factor

3.6

range

the difference between the highest and the lowest values within a batch of results

¹⁾ At present at the stage of draft.

4 Description of systems

4.1 General

4.1.1 There are several types of pipe prover, all of which are relatively simple and commercially available. All types operate on a common principle, namely the precisely measured displacement of a volume of liquid in a calibrated section of pipe between two signalling detectors, by means of a displacer (a slightly oversized sphere or piston) being driven along the pipe by the liquid stream being metered. While the displacer is travelling between the two detectors, the output of the meter is recorded automatically. Pipe provers may be operated automatically or manually.

4.1.2 A meter being proved on a continuous-flow basis shall, at the time of proof, be connected to a counter which can be started or stopped instantly by the signalling detectors. The counter is usually of the electronic-pulse-counting type. The counter is started and stopped by the displacing device actuating the detector at each extremity of the calibrated section.

4.1.3 There are two main types of pipe prover: unidirectional and bidirectional. The unidirectional prover allows the displacer to travel in only one direction through the proving section, and has a transfer arrangement for returning the displacer to its starting position. The bidirectional type allows the displacer to move first in one direction, then in the other. It therefore incorporates a means of reversing the flow through the pipe prover. (See Figure 1, Figure 2 and Figure 3.)

4.1.4 Both unidirectional and bidirectional provers shall be constructed so that the full flow through the meter being proved passes through the prover.

4.2 Unidirectional provers

4.2.1 Unidirectional provers may be subdivided into two categories depending on the manner in which the displacer is handled, namely the manual-return in-line type sometimes referred to as a “measured distance” type, and the automatic-return or circulating type, often called the “endless loop” type.

a) The manual-return unidirectional prover is an elementary form of in-line prover which uses a section of pipeline as the prover section. The entire metered stream may flow continuously through the prover even when the prover is not being used for proving. Detectors are placed at selected points which define the calibrated volume of the prover section. A displacer launching device is upstream of the prover section, and receiving facilities are installed at some point downstream of the prover section. Usually, conventional launching and receiving scraper traps are used for this purpose. To make a proving run, a displacer (a sphere or specially designed piston) is launched, allowed to traverse the calibrated section, received downstream and then manually transported back to the launching site.

b) The automatic-return unidirectional (endless loop) prover has evolved from the prover described in 4.2.1 a) and is shown in Figure 1. In this endless loop, the piping is arranged so that the downstream end of the looped section crosses over and above the upstream end of the loop. The interchange is the means whereby the displacer is transferred from the downstream end to the upstream end of the loop without removing it from the prover. The displacer detectors are located at a suitable distance from the interchange inside the looped portion. Such endless prover loops may be manually operated or they may be automated so that the entire sequence for proving a meter can be actuated by a single action. The metered stream may be permitted to run through the prover when the prover is not being used for proving, and the prover need not be isolated from the carrier line unless desired. This permits the movement of several different types of liquid in succession through the prover, and affords a self-flushing action which minimizes intermixing between them, as well as providing temperature stabilization.

4.2.2 A meter proof run in a unidirectional prover consists of a single one-way run, therefore the base volume of a unidirectional prover is the volume of liquid, corrected to standard temperature and pressure conditions, displaced between the detectors during a single trip of the displacer.

4.3 Bidirectional provers

The bidirectional prover has a length of pipe in which the displacer travels back and forth, actuating a detector at each end of the calibrated section and stopping at the end of each run when it enters a region where the flow can bypass it or when the action of a valve diverts the flow. Suitable supplementary pipework and a reversing valve, or valve assembly, either manually or automatically operated, make possible the reversal of the flow through the prover. The main body of the prover is often a straight piece of pipe (see Figure 2), but it may be contoured or folded (see Figure 3) so as to fit in a limited space or to make it more readily mobile. Normally, a sphere is used as the displacer in the folded or contoured type and a piston is used in the straight-pipe type. A meter proof run usually consists of a "round trip" of the displacer, and the displaced volume in this type of prover is expressed as the sum of the displaced volumes in two consecutive one-way trips in opposite directions.

5 Essential performance requirements

The design of a pipe prover shall ensure that the following performance requirements are met.

5.1 Short-term repeatability

When a unidirectional prover is calibrated using the master meter method, the results of five successive calibration runs shall lie within a range of 0,02 %. When a bidirectional prover is calibrated with a master meter, the results of five successive runs each comprising a round trip of the displacer, shall be within a range of 0,02 %.

The short-term calibration repeatability when using the volumetric or gravimetric water draw methods shall be such that the results of three successive calibration runs are within a range of 0,02 %.

When a prover is used to prove a high-performance flow meter such as one suitable for custody transfer or fiscal measurement, the results of five successive provings shall lie within a range of 0,05 %.

5.2 Valve seating

The sphere interchange in a unidirectional prover or the flow reversing valve or valves in a bidirectional prover shall be fully seated and sealed (so that the displacer is travelling at full velocity) before the displacer meets the first detector. These and any other valves whose leakage can affect the accuracy of proving shall be provided with some means of demonstrating that they are sealed during the proving run.

5.3 Freedom from shock

When the prover is operating at its maximum design flow rate, the displacer shall come to rest safely and without shock at the end of its travel.

5.4 Freedom from cavitation

When the prover is operating at its maximum design flow rate and with the liquids for which it was designed, there shall be no risk of cavitation in the prover, valves or elsewhere, over the specified pressure and temperature range.

6 Equipment

6.1 Materials and fabrication

6.1.1 The materials selected for a prover shall conform with the applicable codes specifying the pressure rating and the area where the prover is to be used. Pipes, pipe fittings and bends shall be selected for internal roundness and smoothness.

6.1.2 In the fabrication of provers, care shall be exercised to ensure proper alignment and concentricity of pipe joints. All welds within the path of the displacer shall be ground internally, and the design shall provide for this requirement. All welding shall be in accordance with applicable codes.

6.1.3 Internal coating of the prover section with a material which will provide a hard, smooth, long-lasting finish will reduce corrosion and wear and will prolong the life of the displacer and prover. Experience has shown that internal coatings are particularly useful when the prover is used with liquids having poor lubricating properties, such as gasoline or LPG.

6.2 Temperature stabilization

Temperature stabilization of the proving system is normally accomplished by the continuous circulation of liquid through the prover section, with or without insulation. When large portions of the prover are buried and the liquids are at or near ground temperature, additional insulation is usually not required. When provers are installed above ground, the application of thermal insulation will contribute to better temperature stabilization. Where a high temperature gradient can appear along the prover pipe, as with heated products, thermal insulation is recommended.