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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3171 was drawn up by Technical Committee ISO/TC 28, *Petroleum products*, and circulated to the Member Bodies in May 1973.

It has been approved by the Member Bodies of the following countries :

Belgium	Israel	Spain
Bulgaria	Mexico	Sweden
Canada	Netherlands	Thailand
Czechoslovakia	New Zealand	Turkey
France	Norway	United Kingdom
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No Member Body expressed disapproval of the document.

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Petroleum products — Liquid hydrocarbons — Automatic pipeline sampling

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the procedures to be used for obtaining samples of all liquefied petroleum products and liquefied petroleum gases but excluding crude petroleum and liquefied natural gases being conveyed by pipeline.[1)]

Automatic sampling is the most accurate procedure for obtaining a representative sample from a pipeline in which a product is being in-line blended.

It is realized that in many countries some or all of the items covered by this International Standard are a subject of mandatory regulations imposed by the laws of those countries; such regulations must be rigorously observed. In cases of conflict between such mandatory regulations and this International Standard, the former shall prevail.

2 DEFINITIONS

2.1 automatic sampler : A device which, when correctly installed through a pipeline and when actuated by appropriate control equipment, enables a representative sample to be obtained of the fluid flowing in a pipeline.

NOTE — A suitable device may also be used for sampling in an open channel.

2.2 coalescer : A device installed in a sample line in order to bring together a discontinuous phase in droplet form, to facilitate its separation from the main sample stream.

2.3 externally-actuated sampler : A device which is operated by a power source other than the kinetic energy of the fluid being sampled, for example an electric or pneumatic motor.

2.4 fast sample loop : A secondary pipeline circuit designed for transferring product at high velocity. This enables a representative sample of product flowing through the main pipeline to be brought quickly to the sampling equipment which may be located some distance from the main pipeline.

2.5 flashing : The evaporation of low boiling point components from a sample, resulting from a sudden drop in pressure in a sampling system. The term "flashing" used in this sense should not be confused with a similar term used in the determination of flashpoint.

2.6 flow proportional sample : A sample taken from a pipeline, during the whole period of transfer of a batch, at a rate which is proportional to the rate of flow of the liquid through the pipeline at any instant.

2.7 heavy oils : A generic term used to describe light fuel oils, lubricating oils, electrical insulating oils, other special oils, and residual fuel oils.

2.8 inert gas : A gas (usually carbon dioxide or nitrogen) which does not react with the fluid being sampled.

2.9 isokinetic sample : A sample taken from a pipeline in which the linear velocity of the fluid through the opening of the sample probe is equal to the linear velocity in the pipeline and is in the same direction as the bulk of the fluid in the pipeline approaching the probe.

2.10 knock-out pot : A vessel in a sample line designed to remove entrapped liquids or solids by gravitational means.

2.11 liquefied hydrocarbon gases (LPG) : Liquefied gases including methane, ethane, propane, butane, ethylene, propylene, and butylene.

2.12 sample container : A receptacle used for storage and transport of a sample.

2.13 sample receiver : A receptacle to receive the samples, normally connected to a sampling draw off connection, or to a pipeline probe.

2.14 self-actuated sampler : A device which is operated by stream flow or stream pressure.

2.15 stream flow : The movement of the fluid being sampled through a pipeline or channel.

1) Automatic sampling methods for crude oil and LNG are under study by ISO/TC 28/SC 3.

2.16 stream pressure : The pressure exerted by the fluid being sampled.

2.17 time proportional sample : A sample composed of equal increments taken from a pipeline at regular intervals during the whole period of transfer of a batch through the pipeline.

2.18 turbulent flow : Fluid flow in which the particle motion at any point varies rapidly in magnitude and direction. Turbulent flow occurs in a pipeline when the Reynolds number (*Re*) is well above 2 000. The Reynolds number may be calculated from the formula :

$$Re = \frac{\rho D V}{\mu}$$

where

Re is the Reynolds number;

D is the pipeline diameter;

V is the linear velocity of the fluid;

ρ is the density of the fluid;

μ is the dynamic (absolute) viscosity of the fluid.

Consistent units must be used.

The minimum linear flow to produce turbulent flow can be calculated by putting $Re = 2\,000$ and rearranging the formula as :

$$V = \frac{2\,000\,\mu}{\rho D}$$

2.19 ullage : The space in a sample receiver or container left unfilled to allow for thermal expansion of the fluid.

3 PRINCIPLE

3.1 In order to determine accurately, in pipeline movements, the volume at standard temperature and the mass of bulk quantities of petroleum products, the change of volume with temperature and the mass per unit volume of the materials must be known. These characteristics can only be conveniently ascertained from a determination of the density of samples taken from a pipeline; the sampling procedures given have been drawn up so that the volume/mass properties of the samples will be, as nearly as possible, the same as those of the bulk quantities.

NOTE – A knowledge of the mean temperature of the material being sampled is required, and this may be determined by the procedures laid down in ISO 4268, *Petroleum products – Temperature measuring methods excluding averaging thermometers.* [1)]

3.2 In order that samples obtained by the use of automatic sampling equipment shall be truly representative of the bulk flowing through the pipeline it is important that the basic principles of design given in this International Standard shall be met by the selected apparatus and that it shall be correctly installed and operated. In addition, because an otherwise representative sample can be rendered completely valueless by subsequent carelessness in handling during any transfer operation which may be necessary or during transfer to the laboratory or test centre, it is essential to ensure that all personnel carrying out sampling shall have the necessary experience and skill and shall at all times pay scrupulous attention to detail. Particular care is required in the transfer of BS and W samples.

4 PRECAUTIONS

4.1 General precautions

4.1.1 Whatever apparatus is used for taking samples, the following general precautions shall always be observed where applicable. In addition there are special precautions which shall be observed in sampling for certain tests; these are noted in the relevant method of test.

4.1.2 When automatic sampling apparatus is used to take samples from flowing streams in pipelines it is, of course, not possible to take duplicate samples later should it be found that the original sample or samples are suspect. Accordingly, all apparatus and equipment shall be inspected before sampling commences, and it cannot be over-emphasized that the most careful work in the laboratory or in quantity measurement may be rendered useless if care is not taken in the subsequent handling of the samples upon which such work is based.

4.1.3 A sample shall not include material other than that to be sampled and the process of sampling shall not cause any change in the sample, for example by evaporation of volatile constituents or by oxidation.

4.1.4 The sampling apparatus shall be adequately maintained and sampling connections shall be kept scrupulously clean.

4.1.5 Sample receivers or containers shall be dry and free from any contaminating substance.

4.1.6 During sampling operations the material being sampled shall be protected from the effects of atmospheric conditions and the sample containers or sample receivers shall be closed immediately after the sample has been taken.

1) In preparation.

4.1.7 The operator engaged in connecting or disconnecting sample receivers or containers or in transferring samples to another container, shall ensure that contamination of the sample by material present on hands or gloves does not occur. Plastics gloves resistant to the material being handled shall be used in preference to those made of absorbent material.

4.1.8 The automatic sampling apparatus, its connecting lines, sample discharge lines, and whenever possible the sample receiver or container, shall be thoroughly flushed through before sampling commences. After flushing, the sample container shall be drained before being used to contain the actual sample.

4.1.9 Samples of materials which may be affected by light or heat shall be stored in a cool, dark place and sample containers holding volatile materials shall be stored upside down to prevent possible loss of low boiling point components. Periodic examination shall be made for leakage.

4.1.10 A faulty sample (i.e. a sample which does not adequately represent the material being sampled) is frequently due either to failure to comply with 4.1.3 to 4.1.9 or to faulty labelling. The provision of clean sample containers is greatly simplified if containers are reserved and kept separate for different classes of products, while the possibility of errors in labelling may be largely eliminated if each sample container is marked before the next sample is taken.

If the Reid vapour pressure of the material being sampled is expected to be greater than 1,8 bar, a container of suitable construction for the highest expected pressure shall be used. A suitable container is the liquid chamber with two openings described in ISO 3007, *Petroleum products — Determination of vapour pressure — Reid method*, and shown in figure 1.

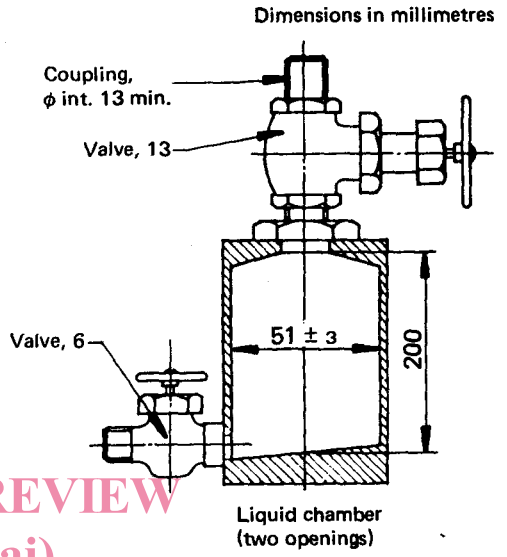


FIGURE 1 — **Sample container with two openings**

4.2 Safety precautions

4.2.1 The safety precautions given below apply in all cases and constitute good practice, but the list is not necessarily comprehensive. It is recommended that the list should be read in conjunction with the appropriate national safety regulations or any recognized code in the petroleum industry. The precautions given below shall be taken whenever they do not conflict with local or other regulations which must, in any case, always be followed.

a) All regulations covering entry into hazardous areas shall be rigorously observed.

b) Plant and equipment shall be adequately maintained, and shall be regularly inspected by a competent person.

c) Sampling equipment and sample containers shall be properly designed for the pressures to which they will be subjected in use. They shall be pressure tested to at least 1,5 times the maximum operating pressure before being taken into use and thereafter at regular intervals dictated by the nature of the apparatus and the pressure range involved. All such equipment shall be clearly marked with the date of the last testing and the maximum permissible working pressure.

4.2.2 Glass sample containers used for sampling materials with a Reid vapour pressure between 1,0 and 1,8 bar shall be protected with a metal case until the sample is discarded.

4.2.3 Unless the sample receiver or container is designed to be used without ullage, it shall not be completely filled with liquid but sufficient ullage shall always be left to allow for expansion. For some applications it may be necessary to fill completely a sample receiver or container with liquid; in such cases the receiver or container :

a) shall be fitted with a relief valve to avoid over-pressurizing under ALL subsequent handling conditions;

b) shall be constructed and certified to withstand the maximum hydrostatic pressure that can possibly be encountered during subsequent handling.

4.2.4 Care shall be taken to avoid breathing petroleum vapours during sampling operations.

4.2.5 Protective gloves of hydrocarbon-insoluble material shall be worn when sampling. Eye shields or face shields shall be worn where there is a danger of splashing.

4.2.6 All metal sampling containers used in flammable atmospheres should be made of non-ferrous metal, unless otherwise specified.

4.2.7 All electrical components used in connexion with automatic sampling apparatus situated in a classified area, shall be appropriate to the classification of the area and shall conform to the appropriate national safety regulations or any recognized code in the petroleum industry.

4.3 Special safety precautions

The following special precautions shall be observed, in addition, when dealing with particular equipment or products :

4.3.1 *Leaded fuels*

The appropriate regulations regarding the handling of leaded fuels shall be meticulously observed.

4.3.2 *Liquefied hydrocarbon gases*

a) Liquefied hydrocarbon gases can cause serious cold burns. Care shall be taken, therefore, to prevent the liquid product from coming into contact with the skin.

b) Discharge of liquefied hydrocarbon gases can give rise to static electricity and it is essential to connect bombs to a satisfactory electrical earth or ground before discharging.

c) The safety precautions mentioned in 5.3.3.4 shall also be rigorously observed.

5 APPARATUS

5.1 Automatic samplers

5.1.1 Automatic samplers shall be designed to procure representative samples of fluid products from pipelines either on shore or on board ship, or from open channels either on a continuous basis or on an intermittent basis.

5.1.2 Automatic samplers shall consist of :

a) a device for extracting the sample;

b) a receiver for containing the sample, or alternatively, means for transferring the sample to an analyzer or similar continuous testing apparatus;

c) means for controlling the rate of sampling;

d) means for flushing the equipment.

5.1.3 Automatic samplers can be sub-divided into the following categories according to their method of operation :

a) self-actuated

- by stream flow;
- by stream pressure.

b) externally actuated

- pneumatic;
- electric;
- hydraulic;
- mechanical.

NOTE – All electrical installations shall comply with appropriate safety requirements (see 4.2.7).

5.1.4 Depending on the type of operation, automatic samplers may be either time or flow proportional.

For steady flow rates, i.e. if variations in flow are less than 10 % of the mean flow, time proportional sampling is satisfactory. Otherwise a flow proportional sampling device is preferable.

Automatic samplers shall be provided with a means for adjusting the sampling rate.

5.1.5 The following information is required when selecting equipment for any particular service :

a) Type and size sample, whether sampling is to be intermittent or continuous, and the purpose for which the sample is required.

b) Size of pipeline from which sample is to be taken.

c) Rate of flow of liquid to be sampled.

NOTE – Special attention is drawn to 5.1.4.

d) Minimum and maximum as well as normal operating pressure and temperature in the system.

e) Physical properties of the liquids to be sampled.

f) Any corrosive effects of the liquids.

g) Whether there is need for adjustment of sampling rate.

h) Services available on site.

j) The schedule of routine maintenance required.

k) Whether it is possible or required to withdraw the probe for pipeline cleaning or other purposes.

5.1.6 For most applications samplers constructed of stainless steel with flexible parts of polytetrafluoroethylene (PTFE) are satisfactory although samplers may be constructed using combinations of other suitable materials.

5.2 Sample receivers and containers – General

5.2.1 Sample receivers and containers shall be constructed of materials resistant to solvent action or chemical attack by the product being sampled (see 5.1.6).

5.2.2 Sample receivers and containers shall be constructed to withstand the maximum pressure and temperature encountered in use.

5.2.3 Sample receivers and containers shall be so constructed as to avoid contamination of the sample by extraneous foreign matter.

5.2.4 The sample line from the automatic sampler shall be so designed as to eliminate water and sediment traps.

5.2.5 Sample receivers shall be constructed to allow for a minimum of 5 % ullage under all conditions of operation.

5.2.6 Corks shall not be used to close sample containers for volatile liquids.

5.3 Sample receivers and containers for liquefied hydrocarbon gases from pressurized lines

5.3.1 Sample receivers and containers shall be so constructed that no loss of vapour or liquid can take place.

5.3.2 There are two methods for handling samples for laboratory testing after they have been collected in the sample receiver :

— Method 1 : The sample is transferred from the receiver into a suitable high pressure bomb for transporting to the laboratory (see 3.2).

— Method 2 : The filled sample receiver is taken from the automatic sampling equipment for transporting to the laboratory and is replaced by an empty receiver.

NOTE — Method 2 is preferred as it involves less handling of the sample.

5.3.3 *Sample receiver and containers for method 1*

It is recommended that the volume in the sample receiver should be 2,5 times greater than the volume required in the sample bomb to allow for purging of the bomb with the product.

5.3.3.1 The sample receiver shall be suitably constructed for effecting the transfer of the sample to the bomb. Provision shall be made for mixing the sample in the receiver so that it is homogeneous before transfer to the bomb.

5.3.3.2 The high pressure bomb shall be constructed of a suitable grade of stainless steel with two steel needle valves, for example 6 mm. In the absence of any local code requiring other test conditions, the bomb shall be tested to 1,5 times the working pressure (see 5.3.3.4). If the maximum working pressure is doubtful or indeterminate, due to uncertainty as to the product properties or environmental conditions then due allowance must be made in the design, to give an adequate margin of safety to allow for these uncertainties. (See CAUTION). Stainless steel is recommended because it is less subject to attack by sulphur compounds which may be present in the sample. For sampling LPG, one valve should preferably be fitted with an ullage tube, marked with the appropriate percentage ullage setting.

Figure 2 illustrates suitable designs. Preferably a bomb with a built-in ullage chamber, as shown in figure 2c) should be used.

CAUTION — It is essential before sampling propane/propylene mixtures, that the marking on the bomb shall be examined to ensure that it has been tested to a suitable pressure in relation to the product to be sampled (see 5.3.3.4).

5.3.3.3 The metal connecting tubing and the associated fitted unions shall together be of sufficient strength to withstand the operating pressure of the system.

5.3.3.4 SAFETY PRECAUTIONS. Sample bombs shall be tested at regular intervals to detect weaknesses that might lead to sudden failure. This testing must comply with any regulations in force at the time and place of use applicable to pressurized containers used for the transport of LPG. If no such regulations exist, testing of the sample bombs, which must include cleaning, inspection of valves and hydrostatic pressure test, shall be done at least every 5 years. A more frequent inspection of valves is recommended. Each bomb shall be marked with the date of last pressure test, maximum working pressure, and tare weight. The marking shall be etched on to the bomb, or stamped on a metal plate tack-welded to the bomb.

5.3.4 *Sample receiver for method 2*

A suitable receiver for removal and transport to the laboratory is shown in figure 3. The receiver shall be constructed of a suitable grade of stainless steel and shall be tested to 1,5 times the maximum working pressure to which it may be subjected (see 4.2.1c)), it shall be fitted with unions to permit its easy removal from the sampler.

5.4 Sample receivers and containers for LPG pumped under refrigerated conditions

5.4.1 For sampling LPG being pumped under refrigerated conditions, suitable facilities shall be provided for cooling sample receivers and containers.

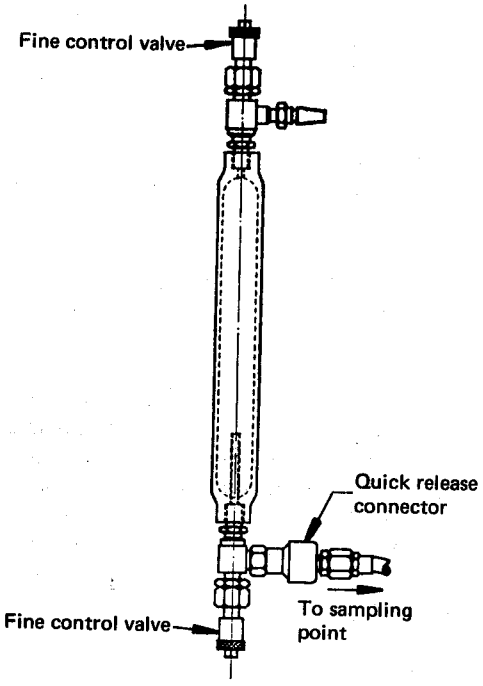
5.4.2 Special consideration shall be given to the choice of the material of construction, which shall be suitable for the temperature range involved.

CAUTION — Protective gloves shall be worn when handling liquids under refrigerated conditions.

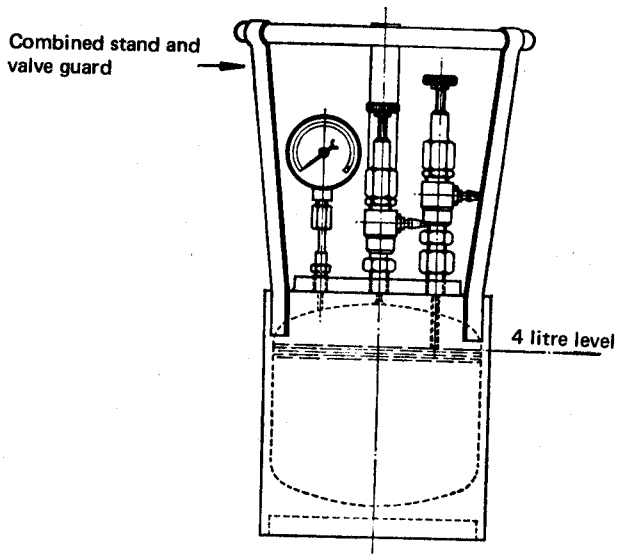
5.5 Sample receivers and containers for light distillates and gasolines

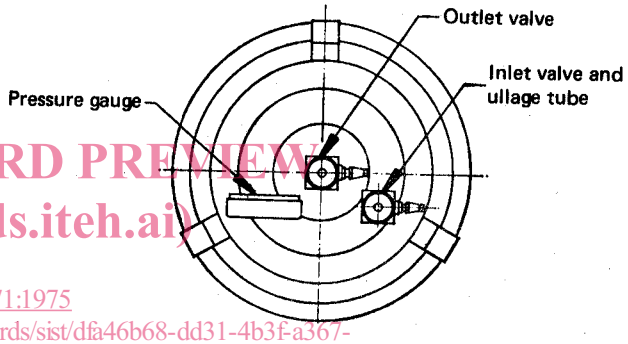
5.5.1 *Sample receivers*

Sample receivers shall be made of metal and shall be capable of being vented to atmosphere through a pressure control valve with an appropriate setting to minimize the loss of low boiling point components. Provision shall be made to enable the receiver to be kept cool when necessary (see 6.6.1).

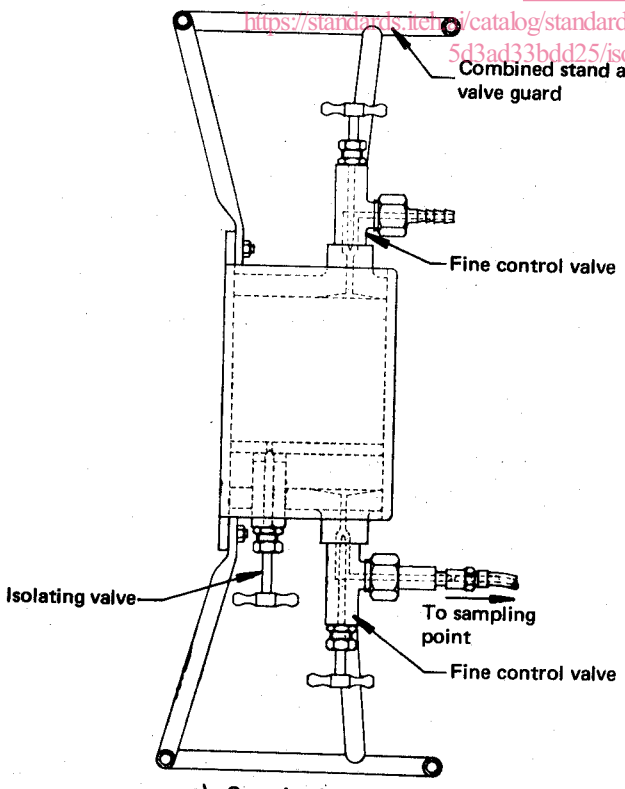


a) With optional ullage tube





b) Capacity 4 litres



c) Capacity 1 litre, with ullage chamber

FIGURE 2 — **Examples of sampling bombs**

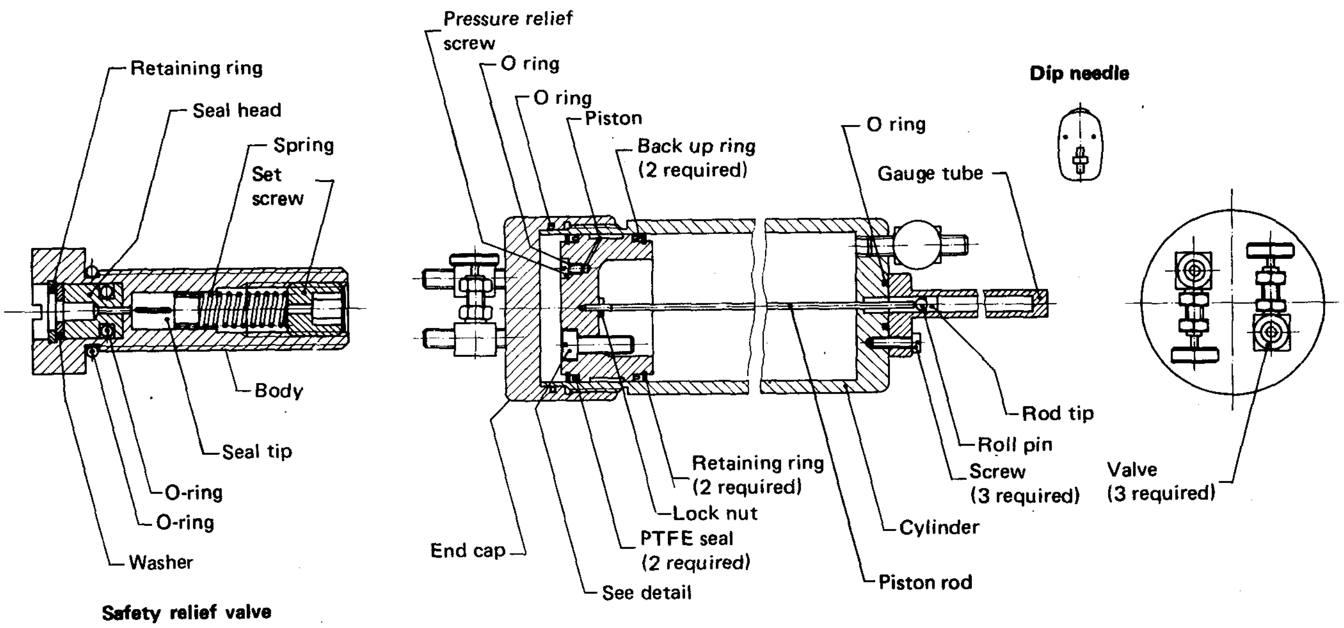


FIGURE 3 — **Example of pressure equalized sample receiver**

5.5.2 *Sample containers*

Metal or plastics screw-type closures with suitable oil-resistant inserts are preferred for all sample containers. If corks are used they must be of good quality. Corks shall not be used with volatile liquids.

If the Reid vapour pressure is known to exceed 1,8 bar or it is considered likely that it may be in excess of 1,8 bar, a container similar to the vapour pressure gasoline chamber with two openings shall be used (figure 1). For a complete specification see ISO 3007, *Petroleum products — Determination of vapour pressure — Reid method.*

5.6 Sample receivers for medium and heavy distillates

5.6.1 Sample receivers shall be manufactured in a suitable material and shall be capable of being vented to atmosphere through a pressure control valve with an appropriate setting.

5.6.2 When necessary, for example if used for easily oxidizable products, the construction shall permit blanketing of the contents of the receiver with an inert gas.

5.7 Sample receivers for heavy oils

5.7.1 Sample receivers shall be manufactured in a suitable material and shall be capable of being vented to atmosphere through a pressure control valve with an appropriate setting.

5.7.2 Sample receivers and connections shall where necessary be thermally insulated and/or heat traced to prevent solidification of the sample.

5.7.3 Where necessary, for example if used for easily oxidizable products, the construction shall permit blanketing of the contents of the receiver with an inert gas.

5.8 Sample receiver for bitumen

5.8.1 Sample receivers shall be manufactured in a suitable material and shall be capable of being vented to atmosphere.

5.8.2 For molten bitumen grades, sample receivers and connections shall have provision for heat tracing.

5.8.3 For bitumen emulsions, thermal insulation of the sample receiver may be necessary to prevent the sample freezing.

5.8.4 Where necessary, for example if used for easily oxidizable products, the construction shall permit blanketing of the contents of the receiver with an inert gas.

5.8.5 Sample receivers for volatile grades of cutback bitumen shall be capable of being vented to atmosphere through a pressure control valve with an appropriate setting to minimize the loss of low boiling point components.

5.9 Sample containers

5.9.1 Except where otherwise specified, sample containers shall conform to the following specifications :

5.9.2 *Type of containers*

The container shall be made of glass, metal, or plastics as appropriate and shall have a suitable cap, stopper or lid.