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Petroleum products — Lubricating grease — Determination of cone penetration

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FOREWORD

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Austria	Israel	Spain
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Petroleum products — Lubricating grease — Determination of cone penetration

0 INTRODUCTION

Two methods are presented in this International Standard for the determination of the consistency of lubricating greases by penetration of a standard cone. One method, entitled the "original method", is given in Part I. This method describes five procedures for measuring the consistency of lubricating greases by penetration up to 400 units of a standard cone. The other method, entitled the "alternative method", is given in Part II. This method describes five procedures for measuring the consistency of lubricating greases by penetration up to 475 units of a standard cone.

PART I : ORIGINAL METHOD

1 SCOPE AND FIELD OF APPLICATION

Part I of this International Standard describes five procedures for determining the consistency of lubricating greases by measurement of the penetration of a standard cone. These procedures cover the measurement of undisturbed, unworked, worked, prolonged worked, and block penetrations. Penetrations up to 400 units may be measured.

NOTES

1 An alternative method is provided in Part II with which penetrations over 400 units may be measured.

2 Undisturbed and unworked penetrations do not generally represent the consistency of greases in use as effectively as do worked penetrations. The latter are usually preferred for inspecting lubricating greases.

3 Penetration of block greases can be obtained on those products which are sufficiently hard to hold their shape. These greases generally have penetrations below 85 units.

2 DEFINITIONS

For the purpose of this International Standard, the following definitions apply :

2.1 penetration of lubricating grease : The depth, in tenths of a millimetre, that a standard cone penetrates the sample under prescribed conditions of mass, time, and temperature.

2.2 working : The subjection of a lubricating grease to the shearing action of a standard grease worker.

2.3 undisturbed penetration : The penetration at 25 °C (77 °F) of a sample of lubricating grease in its container as originally received with no disturbance.

NOTE — The penetration of soft greases is dependent upon the diameter of the container. Therefore, greases having undisturbed and unworked penetrations above 265 units should be tested in containers having the same diameter limitations as those of the grease worker cup. The results on greases having penetrations below 265 units are not significantly affected if the diameter of the container exceeds that of the grease worker cup.

2.4 unworked penetration : The penetration at 25 °C (77 °F) of a sample of lubricating grease which has received only minimum disturbance in transfer from the sample can to a grease worker cup or dimensionally equivalent container.

2.5 worked penetration : The penetration of a sample of lubricating grease after it has been brought to 25 °C (77 °F) and then subjected to 60 double strokes in a standard grease worker.

2.6 prolonged worked penetration : The penetration of a sample of lubricating grease after being worked more than 60 double strokes. The sample, initially at a temperature of 15 to 30 °C (59 to 86 °F), is subjected to a prescribed number of strokes in a standard grease worker, brought to 25 °C (77 °F) in 1.5 h, worked an additional 60 double strokes, and penetrated.

2.7 block penetration : The penetration at 25 °C (77 °F) of a sample of lubricating grease that is sufficiently hard to hold its shape.

3 PRINCIPLE

The penetration is determined at 25 °C (77 °F) by releasing the cone assembly from the penetrometer and allowing the cone to drop for 5 s.

Undisturbed penetrations are determined on the sample as received in its original container.

Unworked penetrations are determined on samples transferred with a minimum of disturbance to a container suitable for test purposes.

Worked penetrations are determined immediately after working the sample for 60 double strokes in a standard grease worker.

Prolonged worked penetrations are determined on samples worked more than 60 double strokes.

Block penetrations are determined on a freshly prepared face of a cube cut from a block of grease with a standard cutter.

4 APPARATUS

4.1 Penetrometer, similar to that shown in Figure 1, for measuring the penetration of the standard cone in the grease. The cone assembly or the table of the penetrometer shall be adjustable to enable accurate placement of the tip of the cone on the level surface of the grease while maintaining a "zero" reading on the indicator. The cone shall fall, when released, without appreciable friction for at least 40 mm. The tip of the cone shall not hit the bottom of the sample container. The instrument shall be provided with levelling screws and a spirit level to maintain the cone shaft in a vertical position.

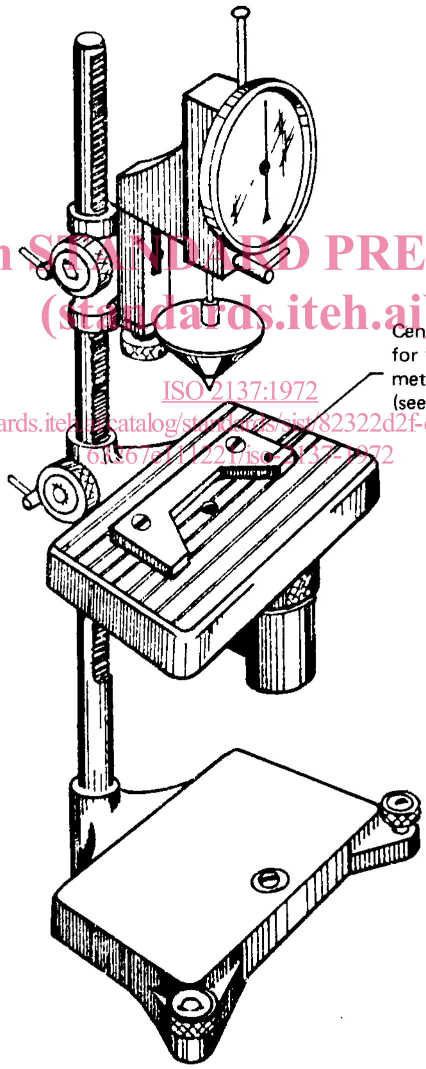


FIGURE 1 — **Penetrometer**

4.2 Cone, consisting of a conical body of brass or corrosion-resistant steel with a detachable, hardened steel tip. Dimensions and tolerances shall be as shown in Figure 2a). The total mass of the cone shall be 102.5 ± 0.05 g and that of its movable attachments shall be 47.5 ± 0.05 g. The attachments consist of a rigid shaft having a "step" at its upper end and a suitable means at its lower end for engaging the cone. The interior construction may be modified to achieve the specified mass, provided that the general contour and mass distribution are not altered. The outer surface shall be polished to a smooth finish.

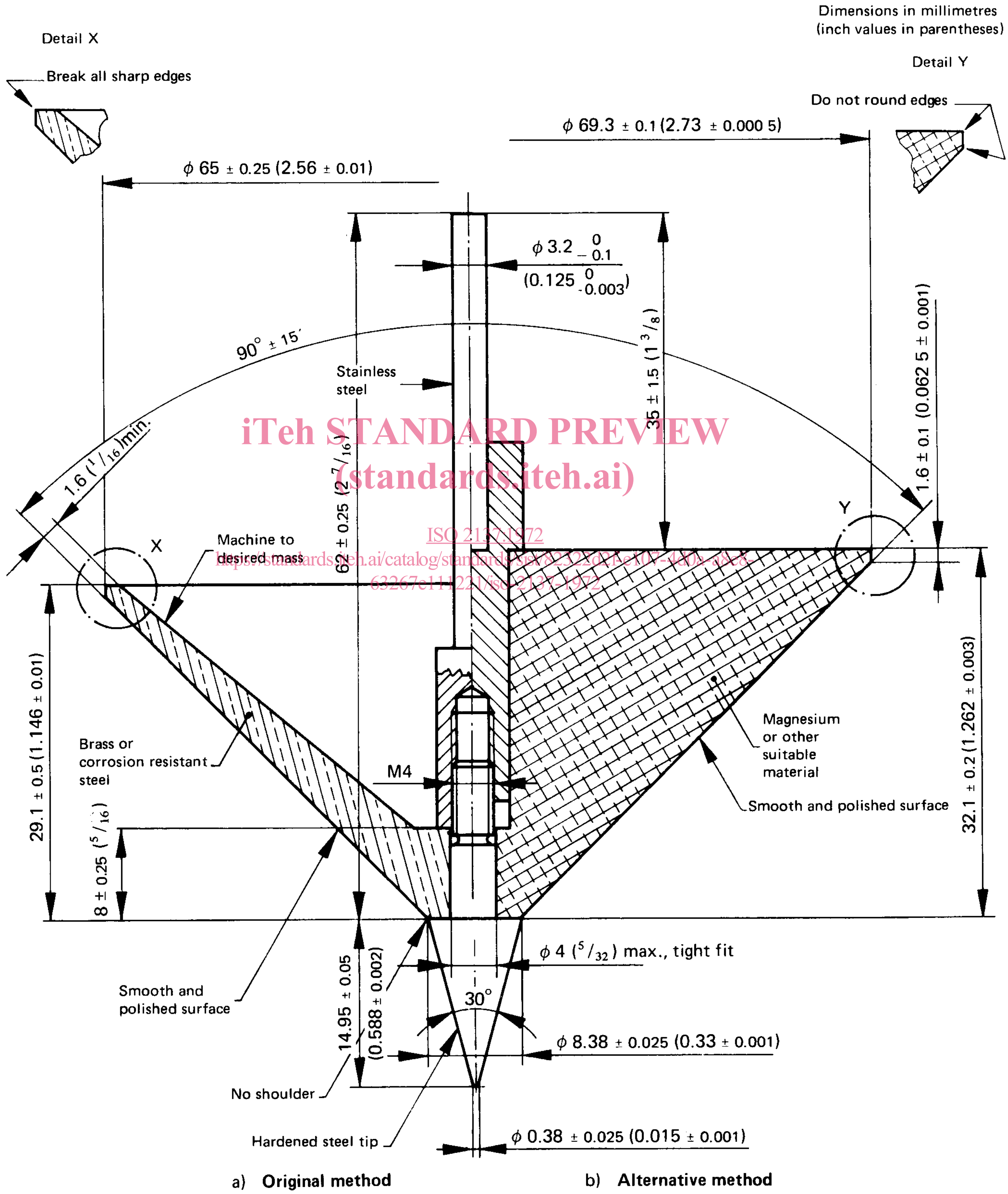
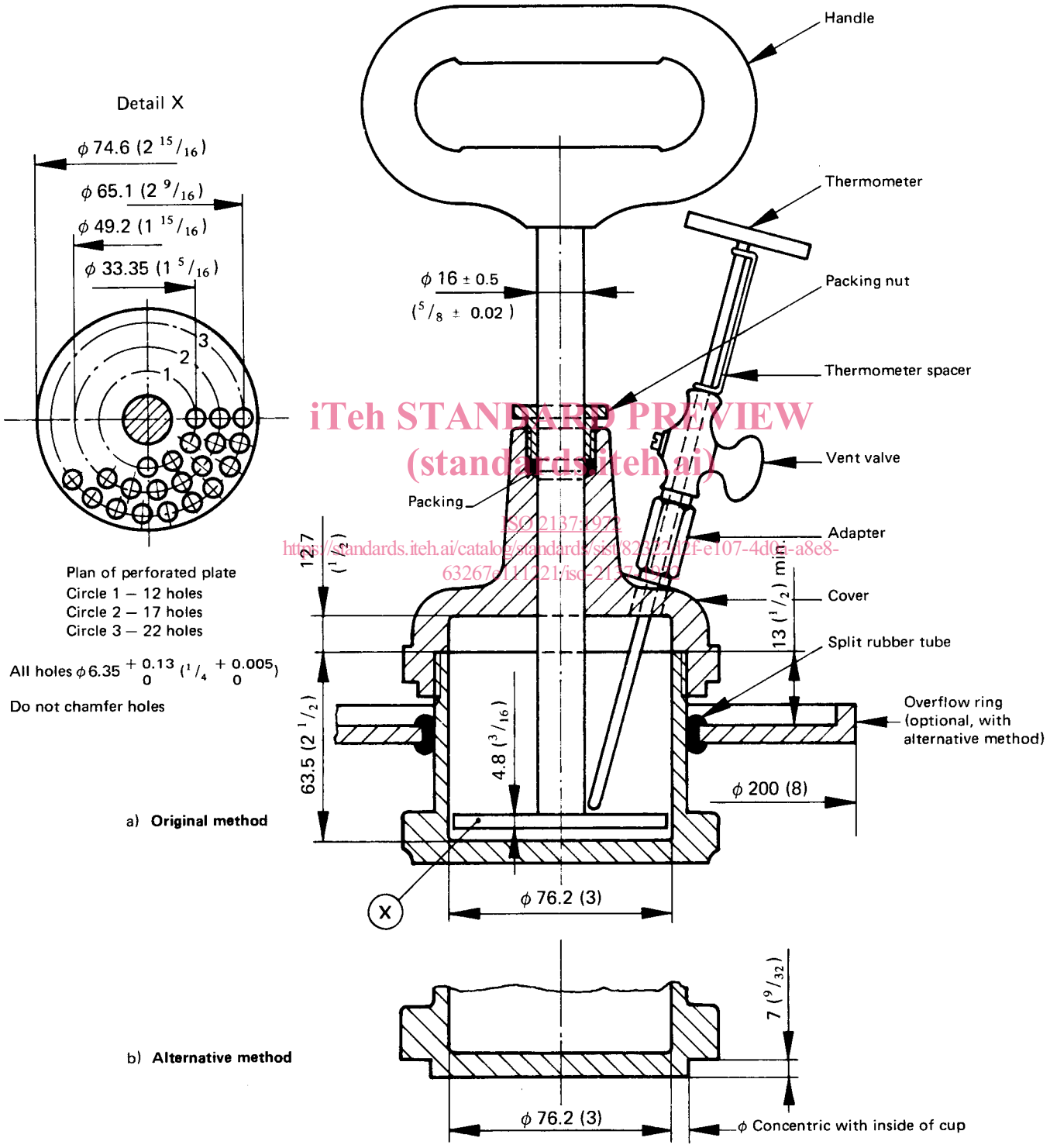


FIGURE 2 — **Penetrometer cone**

4.3 Grease worker, conforming to the dimensions shown in Figure 3a), but the dimensions not shown may be altered and other methods of fastening the lid and securing the worker may be used. The grease worker may be constructed for either manual or mechanical operation. The design shall be such that a rate of 60 ± 10 strokes per minute, with a minimum length of 67 mm (2 5/8 in), can be maintained. A suitable temperature indicator, standardized at 25 °C (77 °F), shall be provided for insertion through the vent valve.

Dimensions in millimetres
(inch values in parentheses)



Tolerance on dimensions except where otherwise stated : ± 0.25 mm (0.01 in)

FIGURE 3 — **Grease worker**

4.4 Grease cutter, having a sharp, rigidly mounted, bevelled blade, essentially as shown in Figure 4. It is necessary that the blade be straight and sharpened as shown.

Dimensions in millimetres
(inch values in parentheses)

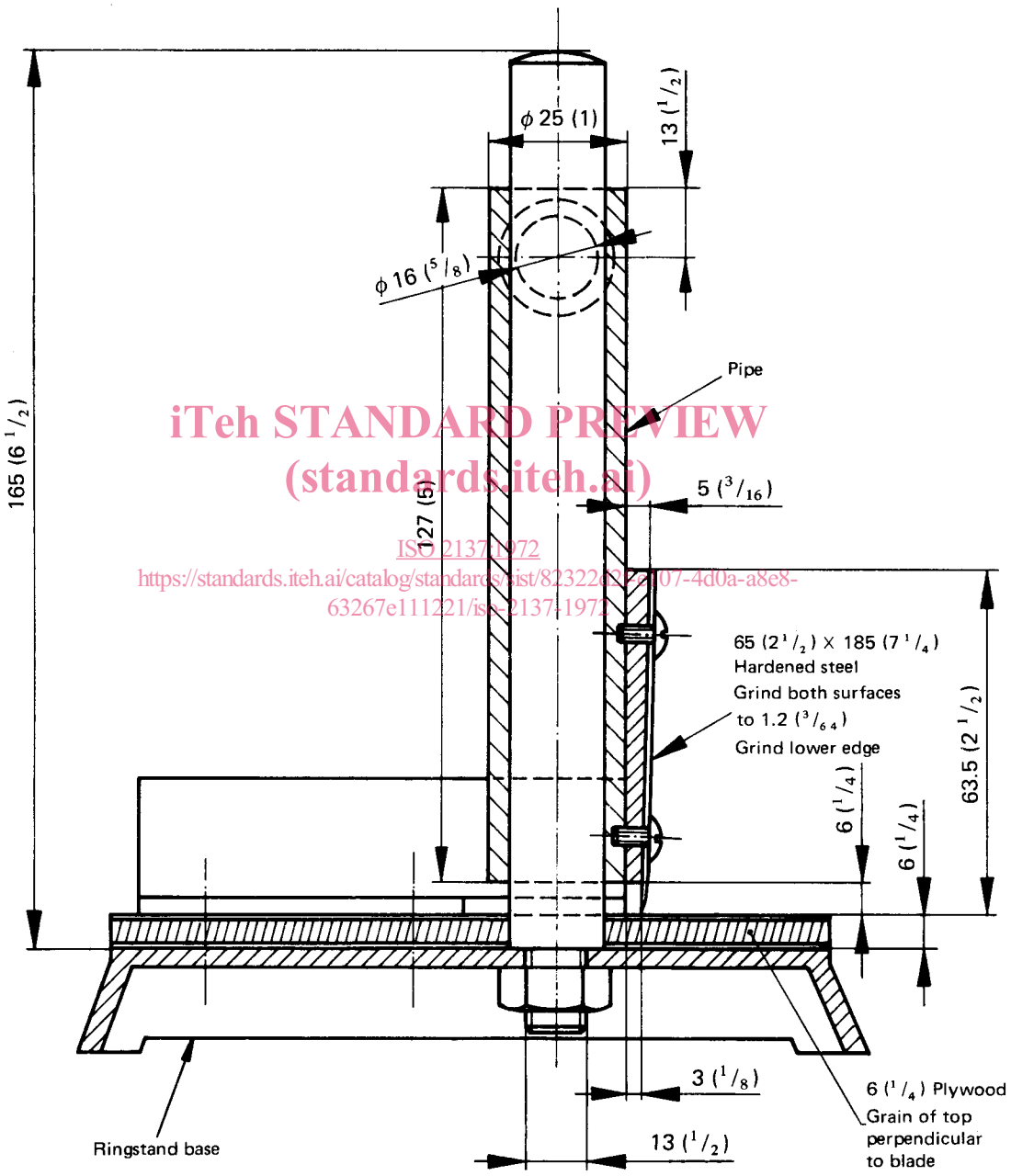


FIGURE 4 — **Grease cutter**

4.5 Water bath capable of being controlled at 25 ± 0.5 °C (77 ± 1 °F) and designed to bring the assembled grease worker to the test temperature conveniently. If the bath is also to be used for samples for undisturbed and unworked penetrations, a means shall be provided for protecting the grease surface from water. A cover shall also be provided to maintain the air temperature above the sample at 25 °C (77 °F).

An air bath, maintained at 25 ± 0.5 °C (77 ± 1 °F), is required for determining block penetration; a tightly sealed container placed in the water bath will suffice.

NOTE – A constant temperature test room or an air bath may be used instead of the water bath.

4.6 Spatula, corrosion-resistant, square-ended, having a stiff blade 32 mm (1.25 in) wide and at least 150 mm (6 in) long.

4.7 Timer, registering to 0.1 s.

5 PROCEDURE FOR UNDISTURBED PENETRATION

5.1 Sample

The sample shall remain in its original container. The surface of the grease must be essentially even and level with the top of the container (see Note to 2.3 and the Note to this clause). When mutually agreed upon by the interested parties, the diameter of the container can be larger than that of the worker cup and the grease surface can be below the top of the container.

NOTE – The undisturbed penetration of a grease usually varies with the age of the sample. For reference purposes, a mutually agreeable period of storage shall be established.

5.2 Preparing sample for measurement

Bring the temperature of the sample to 25 ± 0.5 °C (77 ± 1 °F) by placing it, immersed within 25 mm (1 in) of the rim, in the covered water bath for 1 h (see Note to 4.5). Take care that water is not allowed in contact with the surface of the grease. After 1 h, remove the container from the bath and wipe off the water (see Notes 1 and 2).

NOTES

1 If the initial sample temperature differs from 25 °C (77 °F) by more than about 8 °C (15 °F), or if an alternative method of adjusting the sample to 25 °C (77 °F) is used, allow sufficient additional time to ensure that the sample is at 25 ± 0.5 °C (77 ± 1 °F) before proceeding. Also, if the sample is larger than 0.5 kg (1 lb), allow sufficient additional time to ensure that the sample is at 25 ± 0.5 °C (77 ± 1 °F). Testing may proceed if the sample is at a uniform temperature of 25 ± 0.5 °C (77 ± 1 °F).

2 When mutually agreed upon by the interested parties, the surface of the grease may be levelled before testing by removing the top portion of the sample with a suitable scraper, to a depth of about 3 mm (1/8 in) below the lowest depression. Care shall be taken to minimize disturbance of the underlying grease.

5.3 Cleaning cone and shaft

Clean the penetrometer cone carefully before each test. Bending of the cone shaft can be avoided by holding it securely in its raised position while cleaning. Do not permit grease or oil on the penetrometer shaft, as they can cause drag on the shaft assembly. Do not rotate the cone, as this may cause wear on the release mechanism.

5.4 Penetration measurement

Place the container on the penetrometer table, making certain that is cannot topple. Set the mechanism to hold the cone in the "zero" position, and adjust the apparatus carefully so that the tip of the cone just touches the surface of the test sample at the point specified in 5.4.1 or 5.4.2. (Watching the shadow of the cone tip is an aid to accurate setting.) Release the cone shaft rapidly, and allow it to drop for 5.0 ± 0.1 s. The release mechanism shall not drag on the shaft. Gently depress the indicator shaft until it is stopped by the cone shaft and read the penetration from the indicator scale.

5.4.1 If the sample has a penetration over 200 units, centre the cone carefully in the container; this sample can then be used for only one test.

5.4.2 If the sample has a penetration of 200 units or less, perform three tests in a single container, spacing the penetrations on three radii 120° apart, and midway between the centre and the side of the container, so that the cone will neither strike the side of the container nor impinge on the disturbed area made in a previous test.

5.5 Expression of results

Make a total of three tests on the sample (either in three containers – see 5.4.1 – or in one container – see 5.4.2) and report the average value, to the nearest unit (0.1 mm) as the **undisturbed penetration** of the sample and make reference to this International Standard, indicating Part I or Part II, as applicable.

6 PROCEDURE FOR UNWORKED PENETRATION

6.1 Sample

Take sufficient sample (at least 0.5 kg (1 lb)) to overfill the cup of the standard grease worker (4.3). If the penetration is above 200, at least three times the amount needed to fill the cup will be required.

6.2 Preparing sample for measurement

Place the empty assembled grease worker, or metal container of equal inside dimensions, and an appropriate amount of the sample in a metal container in the water bath (4.5) maintained at 25 °C (77 °F) (see Note to 4.5 and Note 1 to 5.2) for sufficient time to bring the temperature of the sample to 25 ± 0.5 °C (77 ± 1 °F). Transfer from the container a portion of the sample, preferably in one lump, to overfill the cup of the grease worker or metal container of equal inside dimensions (see Note to 2.3). Make this transfer in such a manner that the grease will be worked as little as possible. Jar the container to drive out trapped air and pack the grease with the spatula (4.6), with as little manipulation as possible to obtain a cupful without air pockets. Scrape off the excess grease extending above the rim by moving the blade of the spatula, held inclined toward the direction of motion at an angle of 45°, across the rim of the cup. Do not perform any further levelling or smoothing of the surface throughout the determination of unworked penetration, and carry out the measurement immediately.

6.3 Penetration measurement

Determine the penetration of the sample, as described in 5.3, 5.4 and 5.5, and report the average value, to the nearest unit (0.1 mm), as the **unworked penetration** of the sample and make reference to this International Standard, indicating Part I or Part II, as applicable.

7 PROCEDURE FOR WORKED PENETRATION

7.1 Sample

Take sufficient sample (at least 0.5 kg (1 lb)) to overfill the cup of the standard grease worker (4.3).

7.2 Working

Transfer sufficient of the sample to the cup of the clean grease worker to overfill it (mounded up about 13 mm (0.5 in) at the centre), avoiding the inclusion of air by packing with the spatula. Jar the cup from time to time as it is being packed to remove any trapped air. Assemble the grease worker and, with the vent valve open, depress the plunger to the bottom. Insert a thermometer through the vent valve so that its tip is in the centre of the grease. Place the assembled grease worker in the water bath maintained at 25 °C (77 °F) (see Note to 4.5, Note 1 to 5.2, and the Note to this clause) until the temperature of the grease worker and contents is 25 ± 0.5 °C (77 ± 1 °F) as indicated by the thermometer. Then remove the grease worker from the bath and wipe off the water adhering to its surfaces. Remove the thermometer and close the vent cock. Subject the grease to 60 full (67 to 71.5 mm) (2 5/8 to 2 13/16 in) double strokes of the plunger, completed in about 1 min, and return the plunger to its top position. Open the vent valve, remove the top and plunger, and return to the cup as much of the grease clinging to the plunger as may readily be removed. As the worked penetration of a lubricating grease may change significantly on standing, proceed in accordance with 7.3, 7.4 and 7.5 without delay.

NOTE – If it is desired to immerse the portion of the grease worker above its closure, take care that the lid is watertight in order to prevent the entrance of water to the grease worker.

7.3 Preparing sample for measurement

Prepare the worked sample in the cup for testing so that a uniform and reproducible structure of grease will be obtained. As this part of the procedure is the most difficult to reproduce, the following steps must be followed in detail :

Jar the cup sharply on the bench or floor to fill the holes left by the plunger (see Note 1, below).

Scoop out with the spatula a generous portion of the grease and return it, inverted, to the cup so that portions of the grease from the bottom will be brought to the surface, and the irregular portions previously at the surface will be buried in the cup. If the surface still presents an irregular appearance, repeat the operation as required.

Do not mix the grease any more than necessary and under no circumstances mix the grease by stirring it in the cup. Alternatively, jar the cup and pack the grease down in the cup with the spatula to remove any air pockets (see Note 1 below).

Scrape off the excess grease extending above the rim of the cup by moving the blade of the spatula, held inclined toward the direction of motion at an angle of 45°, across the rim of the cup, retaining the portion removed (see Note 2 below).

NOTES

1 The jarring should be as vigorous as is required to remove the entrapped air without splashing the sample from the cup. In performing these operations, a minimum of manipulation shall be used, as continued agitation of the grease may have the effect of increasing the working beyond the specified 60 strokes.

2 Particularly when testing soft greases, retain the grease removed when scraping the cup to provide a full cup for subsequent tests. Keep the outside of the rim of the cup clean so that the grease forced by the penetrometer cone to overflow the cup may be returned to the cup prior to turning the sample for the next test.

7.4 Penetration measurement

Determine the penetration of the sample as described in 5.3 and 5.4.

7.5 Expression of results

Make a total of three tests in succession on the same sample, returning to the cup the portion previously removed with the spatula. Repeat the operations described