Specification for

Lubricants for refrigerant compressors

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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/7, upon which the following bodies were represented:

Ball and Roller Bearing Manufacturers' Association
British Coal Corporation
British Fluid Power Association
British Gear Association
British Lubricants Federation Limited
British Railways Board
British Steel plc
Department of Transport
Electricity Industry in United Kingdom
Engineering Equipment and Materials Users' Association
Institute of Petroleum
London Regional Transport
Ministry of Defence

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

British Refrigeration Association
Institute of Refrigeration

This British Standard, having been prepared under the direction of the Petroleum Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 June 1992

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Contents

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Foreword

This British Standard has been prepared under the direction of the Petroleum Standards Policy Committee. It supersedes BS 2626:1975, which is withdrawn.

In preparing this revision the Committee noted the effect that the "Montreal Protocol on Substances that deplete the Ozone layer" will have on the development of refrigerants and suitable lubricants. The Committee was aware that the refrigerant used in the method for determination of material insoluble in Refrigerant 12 at – 40 °C has been shown to be among those compounds believed to have a significant depleting effect on the ozone layer. However, it was agreed to retain this refrigerant in the absence of a suitable equivalent substance that is not harmful in the same sense.

This British Standard defines lubricants suitable for use in systems containing commonly used refrigerants. No attempt has been made to recommend lubricants for specific applications as it is considered that this is the responsibility of the plant manufacturer or designer.

The lubrication of compressors in vapour compression refrigerating systems generally demands special or enhanced properties that are not normally possessed by, or necessary in, mineral oils used for the lubrication of other types of plant. This is because the lubricant may be transferred from the compressor to other parts of the refrigerating system where it will be exposed to extremes of temperature and may also come into contact with varying amounts of liquid or gaseous refrigerants.

These refrigerants may be fully miscible, partly miscible or practically immiscible with lubricants. The intimate contact of oil and refrigerant under varying conditions of pressure and temperature may determine the choice of lubricant and the test methods used to evaluate its performance.

For particular combinations of specific refrigerants and extreme temperatures, the use of special lubricants may be necessary and such lubricants are outside the scope of this standard.

CAUTION. In relation to potential health hazards and to precautions recommended for persons regularly in contact with mineral oils over long periods, attention is drawn to the following advisory notices:

MC (B4)	Skin cancer caused by pitch and tar
MC (B5)	Skin cancer caused by oil
MC (B6)	Save your skin. Occupational contact dermatitis
MC (B9)	Save your skin. Advice to employers
MC (B10)	Save your skin. Wear gloves

available from the Employment Medical Advisory Service (EMAS) of the Health and Safety Executive and from whom further advice may be obtained.

Attention is drawn to the Health and Safety at Work etc. Act 1974 and the need for ensuring that the methods specified in this British Standard are carried out with suitable precautions.

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The principal differences between BS 2626:1975 and this standard are as follows:

a) the extension of the scope from mineral oils without additives (type A lubricants) to cover, as type B lubricants, mineral oils containing additives, and lubricants wholly or partially containing synthetic lubricants;

b) the addition of viscosity grades VG 100, VG 150, VG 220, VG 320 and VG 460;

c) the reduction in acid number limit from 0.1 mg KOH per gram to 0.05 mg KOH per gram; and

d) the introduction of optional requirements concerning the integrity of containers based on the requirements of Defence Standard 91-60/1(OM-70).

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 14, 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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1 Scope

This British Standard specifies requirements for a range of 10 viscosity grades of two types of lubricants that are suitable for the lubrication of compressors for refrigerating systems operated with refrigerants as defined in BS 4434.

NOTE 1 This British Standard does not specify requirements for the compatibility or miscibility of lubricants with refrigerants. However, it is essential that care is taken in the selection of a lubricant/refrigerant combination.

NOTE 2 Appendix A gives explanatory notes on refrigerant compressor lubricants and is for information only.

NOTE 3 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Sampling

For the purposes of this British Standard all sampling shall be carried out in accordance with the relevant procedures and precautions described in BS 3195-1.

3 Composition

The lubricants shall be one of the following types:

a) *type A lubricants,* consisting of petroleum products free from additives;

b) *type B lubricants,* consisting of either petroleum products containing additives, or wholly or partially of synthetic lubricants which may contain additives.

NOTE Lubricants should not be mixed unless their compatibility has been established.

4 Appearance

On visual inspection the lubricants shall be clear and free from water, suspended matter, dirt and sediment.

5 Physical and chemical characteristics

When tested in accordance with the methods given in Table 1, the lubricants shall comply with the limiting requirements given in that table for the appropriate viscosity grade.

Table 1 — Physical and chemical requirements for refrigerant compressor lubricants

		Viscosity grade ISO VG										**Test method**
		15	**22**	**32**	**46**	**68**	**100**	**150**	**220**	**320**	**460**	
Kinematic viscosity at 40 °C, in cSt[a]	min.	13.5	19.8	28.8	41.4	61.2	90	135	198	288	414	BS 2000-71
	max.	16.5	24.2	35.2	50.6	74.8	110	165	242	352	506	
Pour point, in °C	max.	– 39	– 39	– 30	– 30	– 24	– 21	– 21	– 21	– 21	– 21	BS 2000-15
Flash point, by Pensky-Martens closed tester, in °C	min.	147	147	156	156	171	180	210	225	225	225	BS 2000-34
Total acid number, in mg KOH/g[bc]	max.	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	BS 2000-139
Free water content												
Type A		No audible crackle in two out of three tests										Appendix B
Type B, in mg/kg	max.	40	40	40	40	40	40	40	40	40	40	BS 6725
Content of material insoluble in Refrigerant 12 at – 40 °C, % (*m/m*)	max.	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	Appendix C
Copper corrosion classification (3 h at 100 °C)	max.	1	1	1	1	1	1	1	1	1	1	BS 2000-154

[a] $1\ \text{cSt} = 1\ \text{mm}^2/\text{s} = 1 \times 10^{-6}\ \text{m}^2/\text{s}$.

[b] The provisions of clause **8** do not apply as the limit is below the range provided for by the precision of the method.

[c] There are certain formulated lubricants blended with additives that have a total acid number up to 0.5 mg KOH/g which are commercially available. Information should be sought from the manufacturer regarding their use.

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6 Grade designation

6.1 General

Lubricants shall be categorized by type and viscosity grade number in accordance with clause **3** and **6.2**, respectively.

6.2 Viscosity grade designation

The lubricants shall be designated according to their particular viscosity in accordance with the classification given in BS 4231, i.e. a number corresponding to the midpoint of kinematic viscosity at 40 °C (e.g. VG 32).

7 Integrity of containers up to 5 l containing type A lubricant

If specified by the purchaser, a batch of filled containers of up to 5 l capacity shall be free from leakage and the ingress of water when tested in accordance with Appendix D.

8 Precision and interpretation of results

Most of the methods given in Table 1 contain a statement of precision, i.e. the repeatability and reproducibility to be expected from them, but in cases of dispute the procedure described in BS 4306, which uses precision data in the interpretation of the results, shall be used.

9 Packaging and marking

The lubricant shall be supplied either in bulk, or in clean, sound and dry containers. (See clause **7**.)

If the lubricant is supplied in containers, each container shall be legibly and durably marked with the following:

a) the number and year of this British Standard, i.e. BS 2626:1992[1)];

b) the type and viscosity grade designation, e.g. type A/VG 32;

c) the name or mark of the supplier or vendor and the batch or consignment number.

[1)] Marking BS 2626:1992 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

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Appendix A Explanatory notes on refrigerant compressor lubricants

A.1 General

These notes have been included to give some general background information for users of this standard. They are intended to indicate the relevance of the specific properties and are not definitions of the terms.

A.2 Viscosity

The viscosity ranges from BS 4231 quoted in this British Standard have been chosen to cover the normal requirements of refrigerant compressors. However, it should be remembered that as a result of the high mutual solubilities between lubricant and halocarbon refrigerants the lubricating fluid in a compressor can no longer be treated as a pure lubricant but rather as a lubricant/refrigerant solution that has properties which are markedly different from those of pure lubricant.

The amount of refrigerant that dissolves in a lubricant depends on the prevailing pressure and temperature. Therefore the composition of the lubricating fluid is different in different parts of the refrigeration system and varies as the operating parameters change.

Amongst other characteristics, it is found that the highest viscosity does not occur at the lowest temperature. As the lubricant temperature reduces and approaches the prevailing refrigerant saturation temperature, the quantity of dissolved refrigerant rapidly increases and the viscosity of the lubricating fluid tends towards the viscosity of pure refrigerant.

This and other properties of a lubricant/refrigerant solution are illustrated in Figure 1. It is typical of the pressure/temperature/viscosity charts that are usually obtainable from the lubricant suppliers, and which are different for each lubricant/refrigerant combination.

A.3 Pour point

The measurement of pour point, which is the lowest temperature at which a lubricant will flow under specified conditions, provides an indication of low-temperature properties. However, it may not accurately predict what will happen if a refrigerant is present in solution in the lubricant. Nevertheless, the pour point considered as an isolated property provides a good guide to the suitability of a lubricant for use in refrigerated applications.

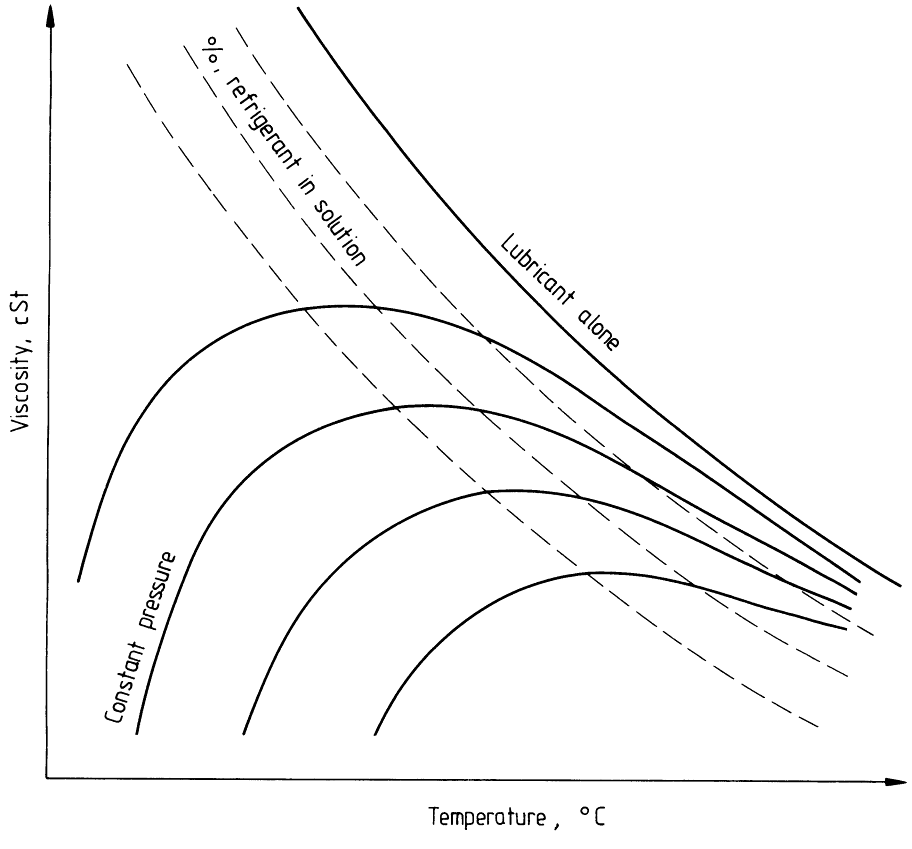

Figure 1 — Typical refrigerant/lubricant solubility/viscosity diagram

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A.4 Flash point

This test gives an indication of the flammability of the lubricant. It is the temperature at which sufficient lubricant has vaporized, when heated under controlled conditions, such that the vapours will ignite when an ignition source is present.

A.5 Total acid number

The total acid number is important in two respects:

a) it is a control parameter for the quality of the lubricant;

b) lubricants containing more than the specified maximum acidity may adversely affect equipment in service.

A.6 Free water content

Water may be slightly soluble in lubricants. Lubricants normally supplied for refrigerating systems may contain up to about 40 mg/l of dissolved water, depending on the relative humidity of the atmosphere. Lubricants containing this amount of water are regularly used satisfactorily, but if a lower water content is for some reason necessary, the lubricant should be specially dehydrated immediately before use. For type A lubricants the crackle test described in Appendix B normally detects any significant quantity of free water present. For type B lubricants the free water content is determined in accordance with BS 6725.

A.7 Content of material insoluble in Refrigerant 12[2)]

Low temperatures may tend to cause the deposition of wax-like insoluble material from mixtures of refrigerants with mineral oils. The type, appearance and quantity of these insoluble materials are influenced, not only by the oil itself, but also by the amount and type of refrigerant and the temperature. These wax-like materials may interfere with the operation of the refrigerating system.

The best known methods used to assess the tendency of an oil to produce deposits in the presence of a refrigerant are the floc point test and the determination of the content of material insoluble in Refrigerant 12. The former defines qualitatively the maximum temperature at which wax-like insoluble material shows a tendency to separate from a specific mixture of oil and Refrigerant 12. The latter assesses quantitatively the amount of insoluble material precipitated in the presence of Refrigerant 12 at a particular temperature. Both methods are used in industry and both have drawbacks; neither appears to correlate very closely with practical performance. However, it is desirable to have a method of monitoring wax separation tendencies, and a method for determining the content of material insoluble in Refrigerant 12 has been retained in this standard (see Appendix C).

A.8 Miscibility of lubricants and refrigerants

Refrigerants are classified as completely miscible, partially miscible or immiscible according to their mutual solubility with the lubricant.

Completely miscible refrigerants and lubricants are mutually soluble in all proportions at any temperature and result in a single phase liquid. Typical refrigerants which are completely miscible with mineral oils are R 11, R 12 and R 500[2)].

Refrigerants which are usually classified as immiscible in type A lubricants are limited to ammonia and carbon dioxide. In fact a very small degree of mutual solubility exists but this can be ignored for most practical purposes.

The majority of refrigerants including R 22, R 502, R 114, R 13 and R 13B1 are classified as partially miscible with type A lubricants. This means that for any specific type A lubricant/refrigerant ratio there exists a temperature below which the mixture separates out into two phases. Such phase separation does not mean that the type A lubricant and the refrigerant are insoluble in each other. Each liquid phase is a solution. One is lubricant-rich and the other refrigerant-rich depending on the predominant component, but these two solutions are themselves immiscible.

The maximum temperature at which separation can occur regardless of the mixture ratio is referred to as the critical solution temperature.

The importance of this concept is largely in relation to the evaporator where the low temperatures can easily cause phase separation if unsuitable lubricants are specified. The possibility of phase separation also exists, but is far less likely, in the crankcase of heat pump compressors.

[2)] The designation of organic refrigerants is given in BS 4580.

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In the case of a flooded evaporator, if a lubricant-rich layer separates, it will float on top of the predominant refrigerant-rich remainder causing suppression of boiling and reduction of heat transfer rates. The return of this lubricant to the compressor is also problematical.

The partial miscibility characteristic is different for each and every lubricant combination. Attention is drawn to the fact that different synthetic lubricant formulations can exhibit widely varying critical solution temperature characteristics.

Combinations of some halocarbon refrigerants with non-hydrocarbon synthetic lubricants show mutual solubility at lower temperatures and separation into two phases at higher temperatures. In these cases, the critical solution temperature diagram is inverted and the minimum in the graph is the critical solution temperature.

Typically alkyl benzene based synthetics exhibit low critical solution temperatures, whereas synthetics based on polyalpha olefins tend to exhibit the opposite.

Figure 2 illustrates typical phase separation characteristics for R 22 with various types of lubricant and demonstrates the importance of obtaining specific data for the particular combination. Such data are usually obtainable from the lubricant, refrigerant or equipment suppliers and should be carefully studied during the refrigeration system design stage.

A.9 Lubricant compatibility

Additives included in the original lubricant, or added as a blend by the compressor manufacturer, are used to enhance the properties of the lubricant. In some cases the additives are essential to prevent failure of, and to give adequate life to, the compressor.

There is a variety of fluids available which can enhance some parameters but which may impair others.

As information on the influence of the additives used by the various lubricant producers or on the effects on the interactions of different synthetic fluids is generally not available, it is strongly recommended that type B lubricants should not be mixed.

A.10 Use of lubricants

Lubricants complying with this British Standard should be suitable for most vapour compression refrigerating systems. If any abnormal demands are being made on the lubricant due to design, operating conditions or choice of refrigerant, reference should be made to the appropriate supplier.

It is customary for refrigerating equipment manufacturers to conduct practical tests to evaluate all aspects of performance of lubricants in their equipment.

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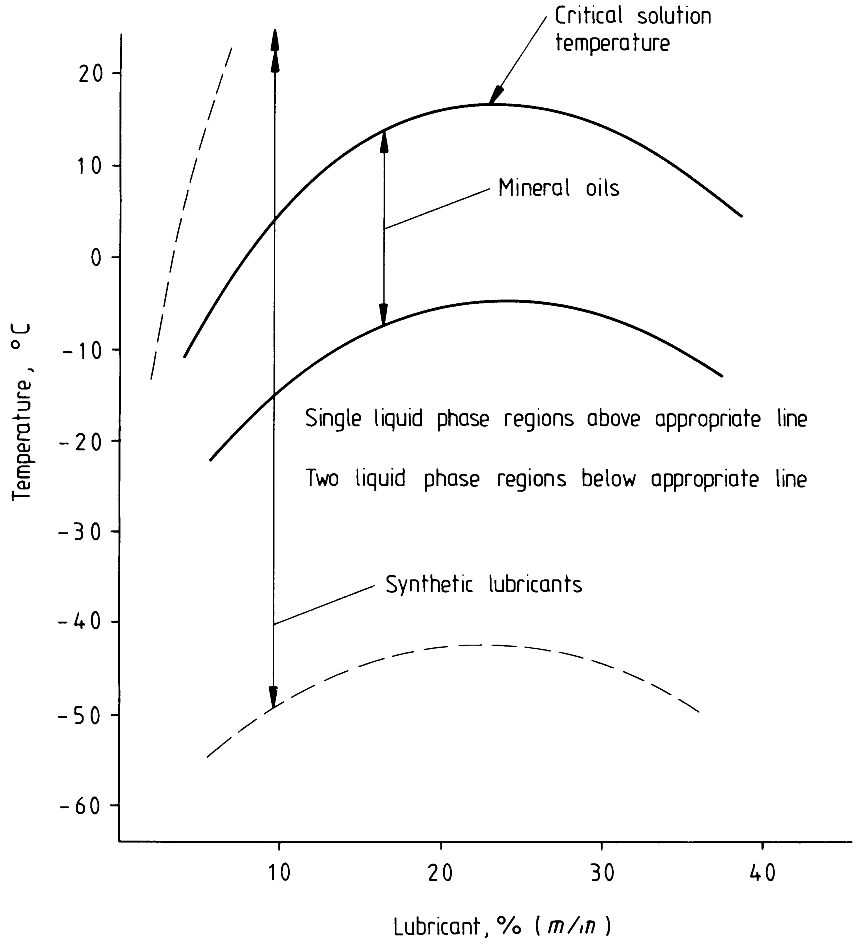

Figure 2 — R 22/lubricant phase separation characteristics illustrating typical variation in type A and type B lubricants

Appendix B Method for detection of free water in type A lubricants (the crackle test)

B.1 Principle

Test portions of a type A lubricant are rapidly heated to boiling. If crackling is heard it indicates the presence of free water.

NOTE This test is not applicable to type B lubricants.

B.2 Apparatus

B.2.1 *Test tubes,* 125 mm long by 12.5 mm in diameter.

B.3 Procedure

B.3.1 Fill approximately one-quarter of the clean dry test tube (**B.2.1**) with a test portion of the type A lubricant under test, taking care that the lubricant is not in an aerated condition.

Heat the tube and contents rapidly in a silent flame until the lubricant commences to boil. Record any crackling heard during the boiling process.

B.3.2 Repeat **B.3.1** on two further test portions of the oil under test.

B.3.3 Report the number of tests in which crackling was recorded.

B.4 Test report

The test report shall include at least the following:

a) the number and date of this British Standard, i.e. BS 2626:1992;

b) the title of this method;

c) the result, i.e. the number of tests in which crackling was reported;

d) any special conditions relating to the test, or departures from the test method;

e) the name of the testing laboratory;

f) the date on which the test was carried out;

g) an identification of the batch or consignment tested.

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Appendix C Method for determination of content of material insoluble in Refrigerant 12 at – 40 °C

C.1 Principle

A 10 % (*m*/*m*) solution of the lubricant in Refrigerant 12 is prepared in a glass test cylinder under pressure generated by the refrigerant. The solution is allowed to attain ambient temperature before being cooled to – 40 °C, at which temperature any separated wax is filtered off and dissolved in warm chloroform. The chloroform is removed by evaporation and the residue weighed.

NOTE The test cylinder simulates the hot side of a refrigerant compressor, prior to cooling and subsequent wax precipitation. By employing a glass test cylinder the method allows visual confirmation of the complete and intimate mixing of the refrigerant and lubricant. In addition, the precipitation of wax in such a cylinder enables wax particles to be seen during the precipitation process and during their subsequent removal to a filter crucible. By dispensing the refrigerant from a suitable aerosol container, the handling problems normally associated with refrigerant are considerably simplified.

C.2 Reagents

C.2.1 *Carbon dioxide,* solid, crushed.

C.2.2 *Chloroform,* analytical reagent grade.

C.2.3 *Cleaning solution,* chromic acid or a suitable detergent (see the note to **C.4.4**).

C.2.4 *Cooling solvent.*

NOTE Acetone, ethanol, industrial methylated spirits[3], propan-1-ol and petroleum naphtha have been found to be suitable.

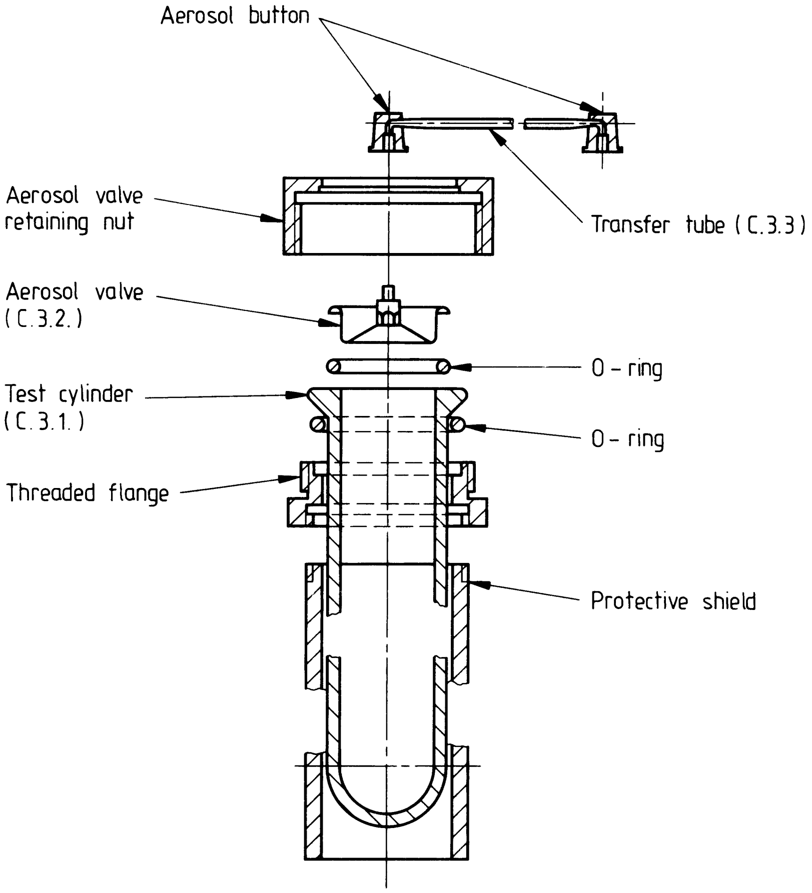

Figure 3 — Example of test cylinder with aerosol valve and transfer tube

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[3] The use of industrial methylated spirits is governed by the Methylated Spirits Regulations 1987 (SI 1987 No.2009). It is not permissible to use duty-free ethanol received under the provisions of the Alcoholic Liquor Duties Act 1979, Section 10, for purposes for which industrial methylated spirit is an acceptable alternative to ethanol.

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C.2.5 *Refrigerant 12,* contained either in a suitable aluminium one-piece or aluminium/tin plate container which has been filled according to current safe practice, or in some other type of suitable container provided suitable transfer equipment is available.

C.3 Apparatus

C.3.1 *Glass test cylinder,* of 100 ml nominal capacity, pressure tested to 1.4 MPa, with screw attachments by which an aerosol valve may be fitted (see Figure 3). The cylinder shall be fitted with a protective shield of polymethyl methacrylate or similar material.

C.3.2 *Aerosol valve.*

C.3.3 *Polyethylene transfer tube,* fitted with two aerosol buttons to fit the aerosol valve (**C.3.2**) (see Figure 3).

C.3.4 *Polyethylene delivery tube,* 25 cm in length and fitted with one aerosol button to fit the aerosol valve (**C.3.2**).

C.3.5 *Sintered glass crucibles,* 33 mm in diameter by 35 mm deep, of approximately 30 ml capacity, porosity grade designation P16 complying with BS 1752.

C.3.6 *Measuring cylinders,* of 100 ml capacity and made of borosilicate glass complying with BS 604.

C.3.7 *Filtration apparatus,* as shown in Figure 4 and including a Gooch crucible adapter and collar.

C.3.8 *Cooling baths,* of convenient size and shape to hold the containers (**C.3.1** and **C.3.6**) immersed in the cooling solvent, which is cooled by the addition of crushed solid carbon dioxide.

NOTE The baths used in the filtration apparatus (**C.3.7**) may be suitable.

C.3.9 *Thermometer,* with a range to include – 40 °C and graduated in 1.0 °C divisions.

NOTE Thermometers to IP2C are suitable. The essential requirements of IP2C thermometers are given in BS 2000-0:Addendum 1.

C.3.10 *Beakers,* of 100 ml capacity, or suitable flat dishes of equivalent capacity.

C.3.11 *Desiccator.*

C.3.12 *Balance,* capable of weighing to the nearest 0.2 mg.

C.3.13 *Safety screen,* made of laminated safety glass or similar material.

CAUTION. Gloves and eyeshields should be worn during the period of transfer of Refrigerant 12 from the aerosol container to the test cylinder and while the test cylinder is under pressure. The test cylinder should at all times be placed behind a protective screen.

C.4 Procedure

C.4.1 *General*

Carry out duplicate determinations in accordance with **C.4.2** to **C.4.4**.

C.4.2 *Precipitation of wax*

Weigh by difference, to the nearest 0.2 mg, 5 ± 0.2 g of the lubricant into a clean and dry test cylinder. Determine the combined mass of the test cylinder, lubricant, aerosol valve, screw attachments and protective screen, to the nearest 0.5 g. Purge air from the test cylinder by injecting Refrigerant 12 liquid into the open cylinder.

NOTE 1 It is essential that the air be thoroughly purged from the cylinder. Failure to do so is likely to result in increased pressure inside the cylinder and the danger of an explosion is considerably increased. Purging is best achieved by using the delivery or transfer tube to inject the liquid to a position half-way down the cylinder wall. Quickly assemble the valve head onto the cylinder to form a gas-tight seal. Normal hand tightness should be sufficient.

Connect the transfer tube to the test cylinder and an aerosol can containing Refrigerant 12 and simultaneously depress both buttons to allow Refrigerant 12 to flow into the test cylinder. Continue the addition of Refrigerant 12 until the combined mass noted above has increased by 45 ± 0.5 g.

NOTE 2 Transfer will be assisted by swirling the contents of the test cylinder to mix the refrigerant and lubricant; alternatively the test cylinder may be cooled to slightly below the temperature of the Refrigerant 12 container in order to create a pressure differential.

Check the valve assembly for leaks (escaping gas is easily heard) and allow 10 min to elapse so that the test cylinder and its contents reach ambient temperature (25 °C maximum). During this time swirl the lubricant/refrigerant mixture occasionally in order thoroughly to disperse the lubricant in the Refrigerant 12 to form a homogeneous phase. Remove the protective shield from the test cylinder assembly and place the cylinder in a cooling bath at ambient temperature. Over a period of approximately 10 min, cool the bath and test cylinder to – 40 ± 1 °C by adding solid crushed carbon dioxide, and maintain the bath at this temperature. Do not cool below – 41 °C.

After 15 min withdraw the test cylinder from the bath, depress the aerosol valve in order to break the vacuum and remove the valve assembly from the test cylinder. Lightly cover the cylinder with the aerosol valve in order to prevent ingress of water vapour and replace it in the cooling bath at – 40 ± 1 °C for a further 15 min. Ensure that the lubricant/refrigerant mixture is not unduly agitated during this period, in order to allow flocculation of the wax to take place.

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C.4.3 *Filtration*

Collect two 100 ml portions of Refrigerant 12 liquid and store at – 40 °C.

NOTE 1 Liquid refrigerant is best collected by cooling each 100 ml measuring cylinder to – 40 °C and injecting the refrigerant liquid at the bottom, using the delivery tube.

When the Refrigerant 12 has cooled to – 40 °C inspect the liquid for any coloration or the presence of solid material and reject it if either is present.

Assemble the filtration apparatus as shown in Figure 3 so that the surface of the cooled solvent is approximately 1 cm below the upper rim of the crucible. Apply only sufficient vacuum to seat the crucible in the collar and thereby prevent ingress of coolant into the filter lines. Do not allow the absolute pressure in the system to fall below 800 kPa.

Pre-cool the filter and filter lines by flushing with 20 ml of cooled Refrigerant 12, and immediately commence filtration of the wax/lubricant/refrigerant mixture. Do not allow the wax precipitate to become dry. Thoroughly rinse the test cylinder with four 20 ml washings of Refrigerant 12 at – 40 °C, adding the washings to the mixture being filtered in the crucible. Agitate each addition to the cylinder in order to ensure the removal of any wax particles retained on the walls. Filter to dryness and release the vacuum.

Wash the precipitate with five 20 ml portions of Refrigerant 12 at – 40 °C, allowing each 20 ml to remain in the crucible for 2 min in order to allow any lubricant present to become dissolved in the Refrigerant 12 before applying vacuum to filter dry. After the five washings have been completed, remove the crucible from the Gooch assembly and allow it to reach room temperature. After the crucible has reached room temperature remove any condensed water from the exterior of the crucible with a paper tissue and inspect the crucible visually for evidence of free lubricant.

NOTE 2 Further washings may be necessary but traces of lubricant may, with care, be removed with paper tissue.

Carry out a blank determination by filtering 200 ml of cooled Refrigerant 12 through a clean sintered glass crucible.

C.4.4 *Removal of wax from filter*

Clean two of the beakers thoroughly and, after rinsing thoroughly with water, immerse them in detergent cleaning solution or chromic acid.

NOTE If a detergent is used, the conditions for its use need to be established. The criterion for satisfactory cleaning is to match that obtained with chromic acid cleaning solution on used sample containers; use fresh chromic acid, soak the containers for 6 h, rinse with distilled water and dry. For this comparison, visual appearance and loss of mass on heating the glassware under test conditions may be used.

Remove the beakers from the cleaning solution by means of stainless steel forceps and handle only with forceps thereafter. Wash the beakers thoroughly, first with tap water then with distilled water, and dry in an oven at 105 °C for at least 1 h. Cool the beakers for at least 2 h in a desiccator.

Weigh the sample beaker to the nearest 0.2 mg against the tare beaker, or if a single pan balance is used weigh both beakers; then into the sample beaker wash the wax from the crucible, using three 15 ml portions of the chloroform at 50 °C to 55 °C. Similarly wash through the blank crucible into the tare beaker with 45 ml of the chloroform. Evaporate the solvent from both beakers on a water bath, then wipe the outside of the beakers with paper tissue and dry for at least 1 h at 105 °C. Cool them for 2 h in a desiccator. At the end of the cooling period weigh the sample beaker against the tare beaker and calculate the content of material insoluble in Refrigerant 12 as described in **C.5**.

C.5 Calculation

If a double pan balance is used calculate the content of material insoluble in Refrigerant 12, X [in % (m/m)], using the following equation:

$$X = \frac{m_3 - m_2}{m_1} \times 100$$

where

m_1 is the mass of lubricant taken for the test (in g);

m_2 is the initial mass of the sample beaker (in g);

m_3 is the mass of the sample beaker plus the material insoluble in Refrigerant 12 (in g).

If a single pan balance is used calculate the content of material insoluble in Refrigerant 12, X [in % (m/m)], using the following equation:

$$X = \frac{(m_4 - m_2 + m_3 - m_5)}{m_1} \times 100$$

where

m_1 is the mass of lubricant taken for the test (in g);

m_2 is the initial mass of the sample beaker (in g);

m_3 is the initial mass of the tare beaker (in g);

m_4 is the mass of the sample beaker plus the material insoluble in Refrigerant 12 (in g);

m_5 is the final mass of the tare beaker (in g).

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Report the test result as the mean of the two determinations of the content of material insoluble in Refrigerant 12 to the nearest 0.01 % (*m*/*m*).

C.6 Precision

The precision of the method, as obtained by statistical examination of interlaboratory test results, is as follows.

a) *Repeatability.* The difference between successive test results[4], obtained by the same operator with the same apparatus under constant operating conditions on identical test material, would, in the long run, in the normal and correct operation of the test method, exceed 0.05 % (*m*/*m*) only in one in 20 cases.

b) *Reproducibility.* The difference between two independent test results, obtained by different operators working in different laboratories on identical test material, would, in the long run, in the normal and correct operation of the test method, exceed 0.10 % (*m*/*m*) only in one in 20 cases.

C.7 Test report

The test report shall include at least the following:

a) the number and date of this British Standard, i.e. BS 2626:1992;

b) the title of this method;

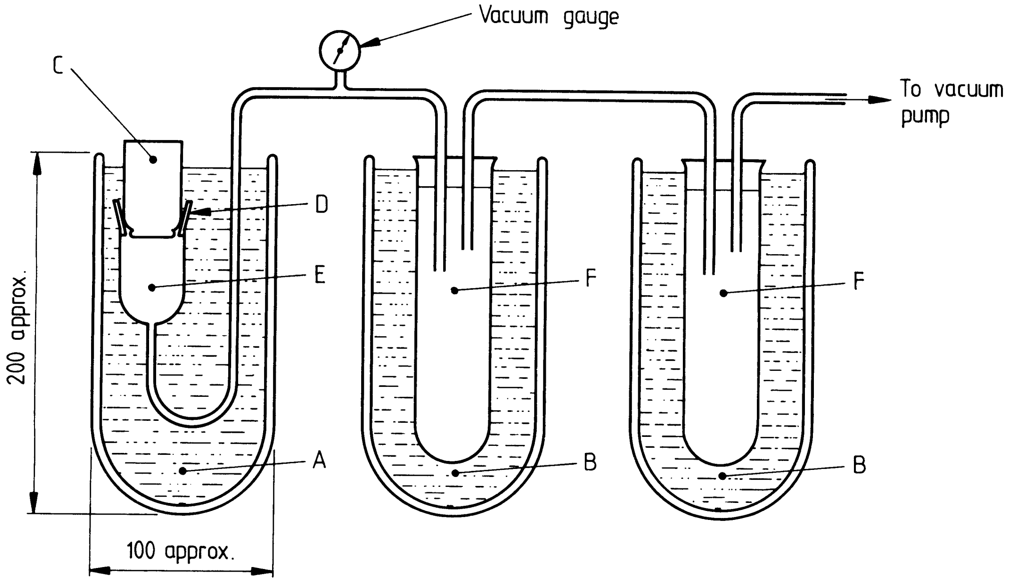
c) the result;

d) any special conditions relating to the test, or departures from the test method;

e) the name of the testing laboratory;

f) the date on which the test was carried out;

g) an identification of the batch tested.



Key

A	Dewar vessel containing cooling solvent controlled at − 40 ± 1 °C;
B	Dewar vessel containing cooling solvent at temperature approximately − 50 °C;
C	Sintered glass crucible (**C.3.5**);
D	Rubber adapter;
E	Gooch crucible adapter;
F	Trap for filtrate, of approximately 200 ml capacity.

Dimensions are in millimetres.

Figure 4 — Filtration apparatus

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[4] Such test results are the means of pairs of determinations; the repeatability for single determinations is 0.07 % (*m*/*m*).

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Appendix D Method for determination of the integrity of containers filled with type A lubricant up to and including 5 l capacity

D.1 Principle

A number of containers selected at random from a production batch are immersed in water at 50 °C. The containers are monitored to observe signs of leakage during the immersion period. On obtaining a satisfactory result to this immersion test, the containers are cooled under water to 20 ± 5 °C. Five containers (more if necessary) are selected from the immersed containers and their contents are tested for contamination by free water, by the crackle test in Appendix B. The batch is accepted if, after following the test procedure, the contents of each of the five containers finally tested are all shown to be free from water by the crackle test result.

NOTE 1 The procedure is illustrated schematically in Figure 5.

NOTE 2 This test is not applicable to type B lubricants.

D.2 Apparatus

D.2.1 *Water bath,* controlled at 50 ± 5 °C and of size sufficient to accommodate the total number of containers making up the sample, totally immersed in water.

D.3 Sampling

The minimum number of containers to be drawn at random from a batch shall be 10, where a batch is the total number of containers filled in one continuous operation or from one blend of lubricant, whichever is the smaller. If the total number in the batch exceeds 1 000, the number of containers to be drawn shall be the cube root, or the next highest integer, of the total number in the batch.

Example

Total number of batch	1 560
Cube root	11.3
Number of containers required	12

D.4 Conditioning

The containers (see **D.3**) drawn from the batch shall be allowed to stand for not less than 2 h at 20 ± 5 °C.

D.5 Procedure

D.5.1 *Immersion test*

D.5.1.1 Totally immerse the conditioned containers (see **D.4**), with their closures uppermost, in the water bath for 2 h. Observe and record the emission of any air bubbles and/or lubricant seepage from the containers.

D.5.1.2 If no air bubbles or lubricant seepage are observed, continue the test at **D.5.2.1**.

D.5.1.3 If air bubbles and/or lubricant seepage are observed from more than one container, discontinue testing (see **D.6**).

D.5.1.4 If air bubbles and/or lubricant seepage are observed from only one container, repeat **D.3**, **D.4** and **D.5.1.1**.

D.5.1.5 If no air bubbles or lubricant seepage is observed from the second set of containers, continue the test at **D.5.2.1**. If more than one container emits air bubbles and/or seeps lubricant, discontinue testing (see **D.6**).

D.5.1.6 If only one container emits air bubbles and/or seeps lubricant when the procedure given in **D.3**, **D.4** and **D.5.1.1** is repeated, repeat the procedure given in **D.3**, **D.4** and **D.5.1.1** a third time, but draw two sets of sample containers. If any of the two sets of containers emits air and/or seeps lubricant, discontinue testing (see **D.6**), otherwise continue the test at **D.5.2.1**.

D.5.2 *Crackle test*

D.5.2.1 Transfer the set or sets of containers from which no air bubbles or oil seepage is observed (see **D.5.1.2** and **D.5.1.5**) from the water bath and immediately fully immerse them in water at 20 ± 5 °C for 12 h.

D.5.2.2 Remove five of the containers and dry them thoroughly.

Carry out the test procedure in accordance with **B.3** on samples of the contents of each of the five containers. Record the results.

D.5.2.3 If the contents of all the containers are deemed not to contain water, i.e. there is no audible crackling on two of the three test portions (see Table 1), testing is complete.

D.5.2.4 If the contents of one container are deemed to contain water, i.e. crackling is heard on two or more of the three test portions, remove a further five containers from the water bath at 20 °C ± 5 °C and repeat **D.5.2.2**.

D.5.2.5 If the contents of more than one container are deemed to contain water, discontinue testing (see **D.6.4**).

D.6 Interpretation of results

D.6.1 If the contents of none of the containers were deemed to contain water, the integrity of the containers shall be deemed to be satisfactory.

D.6.2 If the contents of not more than one of the containers were deemed to contain water, but when the test was repeated on a further five containers the contents of none of a further five containers were deemed to contain water, the integrity of the containers shall be deemed to be satisfactory.

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D.6.3 If testing is discontinued because of the observation of air bubbles and/or lubricant seepage during the immersion test, the integrity of the containers shall be deemed to be unsatisfactory.

D.6.4 If the contents of more than one of the containers were deemed to contain water, the integrity of the containers shall be deemed to be unsatisfactory.

D.6.5 If the contents of not more than one of the containers were deemed to contain water, but when the test was repeated on a further five containers the contents of one or more of the containers were deemed to contain water, the integrity of the containers shall be deemed to be unsatisfactory.

D.7 Test report

The test report shall include at least the following:

a) the number and date of this British Standard, i.e. BS 2626:1992;

b) the title of this method;

c) the result, i.e. whether the integrity was deemed to be or deemed not to be satisfactory;

d) any special conditions relating to the test, or departures from the test method;

e) the name of the testing laboratory;

f) the date on which the test was carried out;

g) an identification of the batch tested.

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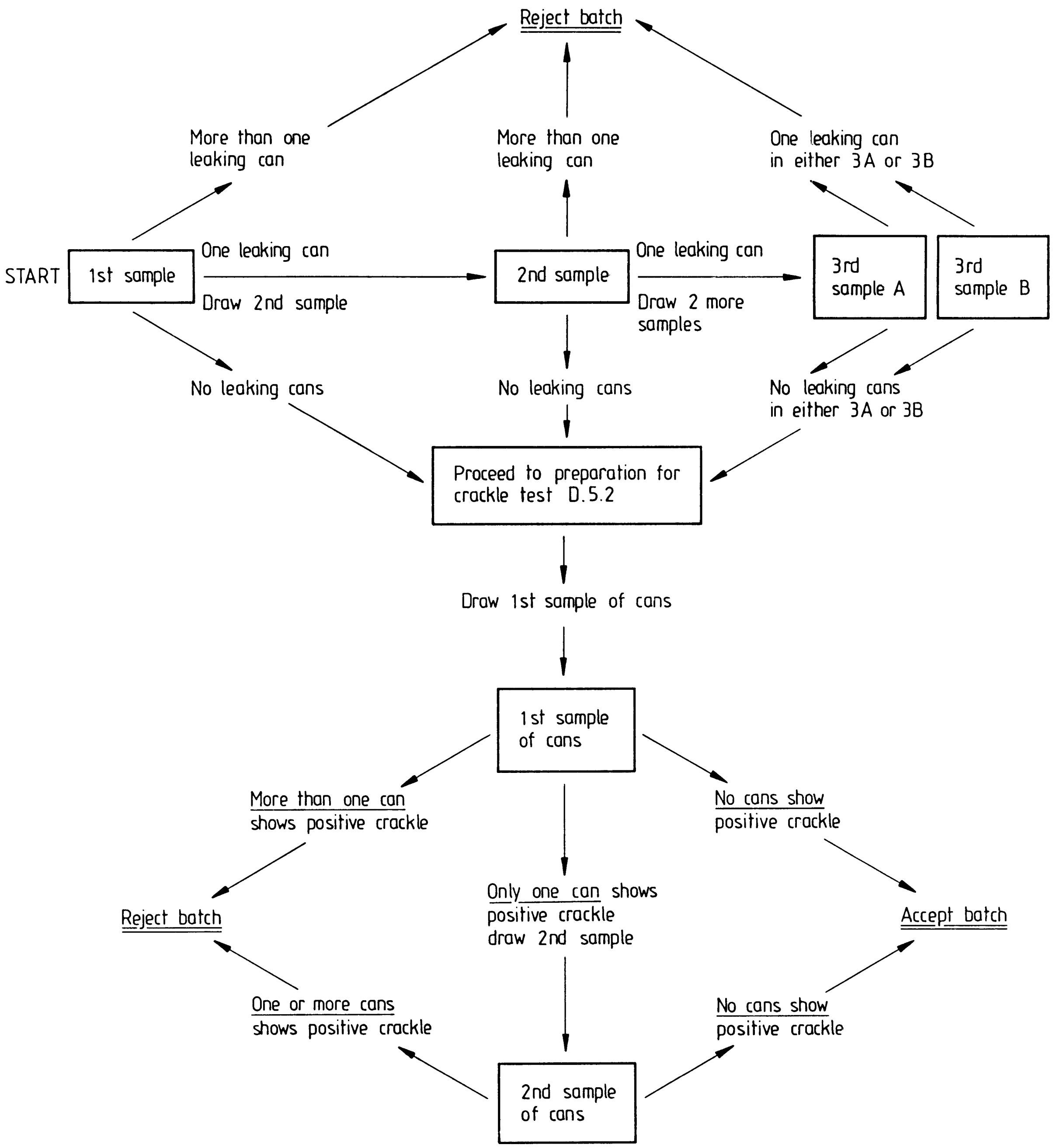

Figure 5 — Schematic illustration of the procedure for determination of integrity of filled containers

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Defence Standard 91-60/1(OM-70), 2nd July 1982, Lubricating oil, refrigerant compressor: uninhibited[5)][6)].

[5)] Referred to in the foreword only.

[6)] Available from Ministry of Defence, Directorate of Standardization, Kentigern House, 65 Brown Street, Glasgow G2 8EX.

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