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Rubber and plastics hoses and hose assemblies — Guide for use by purchasers, assemblers, installers and operating personnel

Tuyaux et flexibles en caoutchouc et en plastique — Guide technique à l'intention des acheteurs, des assembleurs, des installateurs et des utilisateurs

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 17784 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 1, *Hoses (rubber and plastics)* in collaboration with the Nederlands Normalisatie-instituut (NEN). Its aim is to promote operating security when using hoses. Technical safety, inspection, system design and fitting of hoses are considered. This may reduce or avoid the possibility of errors when working on or with hoses.

Introduction

Hoses are used in places where a rigid connection to one connecting point or between two points is impracticable or when a flexible connection is required for delivery purposes. Examples are suction and pressure hoses, loading and discharging hoses and connections between parts of moving and vibrating equipment. Hoses are used for carrying media which are generally under pressure in systems. Other applications include places where the frequent linking of one or both ends of a pipe may present problems. Users often ask hose suppliers' advice on potential uses of hoses for their applications. A hose supplier/manufacturer can give optimum advice only if he is fully informed of the specific operating circumstances. If insufficient information on envisaged use is obtained, incorrect advice may be given, so that a hose not suitable for the intended use is supplied and installed. Close consultation between user and hose manufacturer is therefore necessary. Thus, a major function of this Technical Report is to provide an information resource to assist in decision making.

The guidelines presented in this document are derived from the Nederlands Normalisatie-instituut (NEN) document SPE 5660 (Hoses and accessories, directives for the application), second edition 1999, and were prepared by a task group of ISO/TC 45/SC 1/WG 4. Metal hoses, included in SPE 5660, are excluded from this document because they fall outside the scope of ISO/TC 45/SC 1. Furthermore, the section in SPE 5660 concerning storage has been omitted as it is the subject of ISO 8331.

Rubber and plastics hoses and hose assemblies — Guide for use by purchasers, assemblers, installers and operating personnel

1 Scope

This Technical Report contains general information on rubber and plastic hoses with regard to both their properties and their practical application. This includes, amongst other things, the properties of materials used in hoses, the precautions to be taken when storing hoses and the care required when installing and fitting hoses and their couplings. Safety measures when testing hoses are also indicated. This Technical Report is intended for use by system designers, purchasers, assemblers, installers and operating personnel to improve the operating safety of hoses and hose assemblies.

NOTE Metal hoses are not included in this Technical Report. Attention is drawn to the following International Standards: ISO 8444, ISO 8445, ISO 8446, ISO 8447, ISO 8448, ISO 8449, ISO 8450, ISO 10807, ISO 10806 and ISO 10380.

This Technical Report cannot, in practice, cover all circumstances and therefore its content is largely based on examples. It is assumed that these examples will provide sufficient information to give guidelines for a range of practical circumstances.

2 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8330 apply.

3 General considerations for hoses

3.1 Choosing the type of hose

3.1.1 General

When choosing the type of hose the chief criteria are:

— the resistance of the lining and cover of the hose to the media to which the hose comes into contact (air, oil, water, steam and chemicals) and/or external influences (ozone, UV light and weathering);

— the maximum working pressure including any peak pressures;

— the minimum and maximum temperatures that may arise during operation;

— operational conditions i.e. static, dynamic, ship to shore, dragging on the ground;

— hazard category of the medium;

— required working life.

Most hose manufacturers include a “resistance list” with their hose documentation, indicating the media against which their hose material is resistant. It should be remembered that this list refers only to the materials used by the specific manufacturer, who will use their own composition of the product indicated by the collective name. Temperature-pressure diagrams are also available showing the admissible pressures in combination with certain temperatures. Although these tables are sometimes reasonably comprehensive, they are, nonetheless, not always adequate. Hoses should not be used at temperatures outside the range advised by the manufacturer.

The hose supplier should be notified of all requirements to which the hose needs to conform in order to make the right choice of materials. This includes all chemical, physical and mechanical. Hoses that are not purchased against a standard should only be used for media recommended by the manufacturer's list. The manufacturer's advice should be obtained if there is any doubt as to the suitability of a particular hose for a specific application.

3.1.2 Maximum working pressure, proof pressure[1] and minimum burst pressure

The hose manufacturer has information regarding maximum working pressure, test pressure and burst pressure for hoses (see also ISO 7751 regarding the ratio of working pressure to burst pressure). The user has information on the rated system pressure and the working pressure.

As a general rule, the hose working pressure will be selected so that it is greater than the rated pressure in the user's system.

NOTE Pressures are sometimes divided into three classes, such as “low pressure”, “medium pressure” and “high pressure”. However, hose manufacturers do not use these pressure categories and these terms should not be used, as the national or international standards will not refer to them.

One manufacturer may well refer to a hose with a working pressure of 10 bar[2] as a “medium-pressure” hose while a different manufacturer may still refer to a hose for a 200 bar pressure as a “low-pressure” hose.

The pressure-resisting strength of a hose is determined mainly by the reinforcement. The pressure-resisting strength of tubing (a hose without reinforcement) depends on its wall thickness and material of construction.

3.2 Electrical conductivity

3.2.1 General

Hoses are divided into three types with regard to electrical conductivity, namely electrically bonded, conductive and non-conductive (or discontinuous or insulating) hoses.

3.2.2 Design of electrically bonded hoses

Designs of electrically bonded hoses differ according to the type of hose. Electrically bonded rubber and plastic hoses contain conducting wires (see Figure 1). These wires are always applied spirally, either crosswise or in parallel during manufacture. The wires are connected to the metal couplings at the hose ends in such a way that an uninterrupted pathway with low electrical resistance is obtained throughout the assembled length when hose assemblies are coupled to each other. “Composite” or multilayer hoses (see 6.3) have no conducting wires but are equipped with two conducting metal helixes. In this case, the two helixes should be firmly connected to the hose coupling. Problems may arise in practice where one of the two ends of a coated internal helix is not connected through as a result of an assembly fault. The other wire will then still ensure a conductive connection so that the manufacturing error is not discovered when taking electrical measurements. The non-connected internal helix may cause sparking. Coated internal helixes should therefore be so designed that the electrical connection on both the internal and external helixes can be checked. This may be achieved, for example, by connecting the external helix to the coupling in such a way that it can be disconnected in order to check the electrical connection of the internal helix (to the coupling).

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1) This can also be the test pressure.

2) 1 bar = 0,1 MPa.

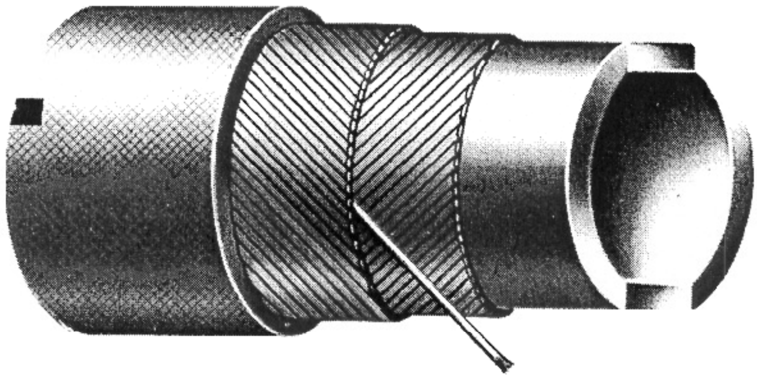

Figure 1 — Hose with metal conducting wires

3.2.3 Design of conductive hoses

The construction of conductive hoses differs entirely from the designs described in 3.2.2 through the absence of wire contacts with the couplings. The rubber composition contains a quantity of specially conductive carbon black such that the cover of the hose is conductive. The hose couplings discharge the static electricity through the connecting points of the installation in which the hose is fitted, or to earth. An anti-kinking spiral is often incorporated into the hose during manufacture but it is not electrically connected to the couplings. Hoses of this kind should be made with wire-free cuffs (see ISO 1823, ISO 2928, ISO 2929 and ISO 5772).

3.2.4 Design of non-conductive (or discontinuous or insulating) hoses

The materials used in the construction of a non-conductive hose should not be electrically conductive.

If metal materials are used within the construction, then these should not be connected to or come into contact with the coupling.

3.3 Static electricity

3.3.1 General

The generation of static charges can be avoided by a proper choice of operating circumstances:

- adjust liquid velocities (as low as possible);
- adjust air velocities (as low as possible);
- adjust dust loading ratio on pneumatic conveyance;
- earth all conductive parts;
- speed up removal of electrical charges, e.g. by increasing the conductivity of the material being transferred (e.g. by adding conductive additives).

NOTE 1 The removal of static electrical charge is also accelerated at high relative humidity, e.g. above 70 %.

NOTE 2 For information in connection with static electricity, see “Hazards of static electricity” (chapter 5 of document AI-25)[89] and, if applicable, Static Electricity Guidelines, latest Edition, 1980[90].

3.3.2 Earthing and through-connection

The purpose of earthing and through-connection is to reduce the mortality risk and the risk to equipment caused by:

— faults between live conductors and non-conductive metallic parts;

— atmospheric discharge;

— accumulation of static charges.

3.3.3 Hoses for loading and unloading units

Hoses used for loading and unloading road and rail tankers can be earthed by means of an external flexible copper cable of adequate cross-section. A spark-free make-or-break installation is desirable when linking up a flexible earth conductor.

Examples of materials which can be conveyed by conductive or semi-conductive hoses include the following:

— petroleum distillates;

— petroleum gases;

— water or aqueous chemicals if well mixed with an oil product of low conductivity, consisting of the latter sediments from the oil phase;

— solids (e.g. powders or granulates).

Non-conductive hoses can be used when operating conditions are safe. Examples of these conditions are:

— the charge cannot accumulate (e.g. sufficiently high specific conductivity);

— there is no explosive gas mixture;

— no static charges can be generated (e.g. low flow velocities).

NOTE The following are regarded as safe product velocities in the oil industry:

a) 1 m/s generally during the start-up period and if no data are known regarding the product;

b) 7 m/s for potentially hazardous products in pipes without micro-filter/water separator or other obstructions, following the start-up period;

c) Unlimited, if safe conditions prevail and/or where a safe product is concerned.

3.3.4 Hoses between shore and ship

Landing platforms and tankers with loading and discharging facilities are naturally earthed by the water so that, from the static electricity aspect, there is bound to be a good through-connection between the metal parts and earth cables between shore and ship provide little additional protection against static. Furthermore, these electrically conductive connections can, if not properly linked up, prove dangerous, for example, as a result of cathodic protection installations which can cause relatively high electrical currents to flow between shore and ship. When uncoupling the connecting pipe and/or hose connections, sparking may occur at the very point where liquid spillages are most likely.

According to the IMO (International Maritime Organization) Regulations[91], the ship and shore installation should be electrically insulated from each other. Means that can be used for this purpose are:

a) an insulating flange in each hose system that may be used to make a connection with the vessel; or

b) a length of conductive hose in the connection between shore and ship.

The part of the loading hose located on the shore side of the insulating equipment should be electrically connected to the shore installation, while the hose on the ship's side should be electrically connected to the ship.

If insulating flanges are used, only one insulating flange may be present in each line or loading arm.

If hoses are used for interconnecting shore and ship's hoses, the connection should be of the correct length required to accommodate the maximum movement and should be electrically connected with the other lines of the pipe system concerned.

Hoses used for loading or discharging vessels should be so suspended that kinking is avoided. Hoses with large diameters, in particular, may not be suspended by cables. A “sling” is used for this purpose in which the hose is laid. A sling with a hose may be transported by a hoisting device. The “sling” should meet the safety requirements as laid down by the Shipping Inspectorate, amongst others. A so-called spreader bar may also be used for temporary transportation of hoses.

3.4 Hose internal diameter and couplings

Although there is a relation between the nominal hose internal diameter and the actual internal diameter, the connection between the internal diameter and the associated coupling is the most important in practice.

For hydraulic hoses, the last digit of the coupling number corresponds with the internal diameter of the hose. The SAE nominal hose dimensions are often included in the coupling coding as -4, -6, -8, etc. (see Table 1, column 6).

The attachment of hose to coupling can be:

- built-in;
- swaged;
- crimped;
- clamped;
- banded;
- wired-on.
- screw-on (re-usable)

NOTE See Clause 7 for end coupling connections.

Table 1 — List of internal hose diameters

Actual dimensions			Comparative indications		
Size in accordance with ISO 1307	Internal diameter		European	Britain/USA	USA (hydraulic) (dash size symbol)
		ISO 4397[a]			
mm	mm		mm	inches	1/16th inch
3	3,2	3,2	3 (3,2)	⅛	-2
4	4 ± 0,4	—	4 ± 0,4	—	—
5	4,8	5	5	3/16	-3
6,3	6,4	6,3	6	¼	-4
8	7,9	8	8	5/16	-5
10	9,5	10	10	⅜	-6
12,5	12,7	12,5	12 (13)	½	-8
16	15,9	16	16	⅝	-10
19/20	19,1	19/20	20	¾	-12
22	22,2	31,5	22	⅞	-14
25	25,4	25	25	1	-16
31,5	31,8	31,5	32	1 ¼	-20
38/40	38,1	38/40	40	1 ½	-24
50/51	50,8	50/51	50	2	-32
63	63,5	—	60	2 ½	-40
80/76	78,6/76,2	—	75	3	-48
—	88,9	—	90	3 ½	-56
100	101,6	—	100	4	-64
125	125 ± 1,6	—	—	5	—
160	150 ± 2	—	—	6	—
200	200 ± 2,5	—	—	8	—
250	250 ± 3	—	—	10	—
315	315 ± 3	—	—	12	—

NOTE Values obtained from SAE, DIN and ISO standards.

[a] ISO 4397:1993, *Fluid power systems and components — Connectors and associated components — Nominal outside diameters of tubes and nominal inside diameters of hoses.*

3.5 Pressures and safety factors

3.5.1 General

A hose can never function as a safety device for the system. When selecting a hose for a particular application, irrespective of the hose material, the maximum allowable pressure of the hose should therefore exceed the operating pressure of the system into which the hose is installed. This also applies to the assembled hose end connections. The user should always relate the maximum working pressures indicated in the manufacturer's documentation to the maximum allowable pressure of the desired end couplings and vice versa.

Maximum working, proof and minimum burst pressures are normally indicated in the manufacturer's documentation concerned, leaving end connections out of consideration. For example, for a hose with a maximum working pressure, as quoted by the manufacturer, of 40 bar at −10 °C to +38 °C and assembled with couplings rated for a lower pressure, the maximum working pressure of the assembly will be reduced.

The assembly should be tested to the required pressures.

3.5.2 Types of pressure

3.5.2.1 Constant pressure

Constant pressure is when the pressure no longer varies once the hose has been pressurized. It only needs to be checked as to whether the hose is suitable for the operating circumstances.

3.5.2.2 Fluctuating pressure

Fluctuating pressure varies between a minimum and a maximum with a certain regularity. If the variations do not occur rapidly, it is sufficient to check that the hose is suitable for maximum operating conditions.

3.5.2.3 Pulsating pressure

Pulsating pressure or “cyclic pressure” varies continuously at fixed intervals e.g. with plunger pumps. With each pulse, the material stress is raised, so that material fatigue may occur more rapidly. In order to ensure a viable working life, where pulsating pressures are involved a burst pressure/working pressure ratio of at least 4:1 (see ISO 7751) is normal.

3.5.2.4 Intermittent pressures

Peak pressures arising at irregular intervals may be caused e.g. by fast-closing sealing elements (quick shut-off valves). If a slow-operating pressure gauge is used, it might not indicate the peak pressure so that it is possible hose damage and leakage to occur within a short period.

If peak pressures are anticipated, they may be measured with the aid of an oscilloscope. In order to achieve a reasonable working life for the hoses, a burst pressure/working pressure ratio of 5:1 should be adopted.

NOTE It is recommended that, where pulsating or intermittent pressures arise, this is discussed with the manufacturer or supplier.

3.6 Installation and handling of hoses

3.6.1 General

Reference is made, throughout this report, to the minimum bending radius of hoses. This also means that a different bending radius applies to each type of hose. Standards for hoses normally include requirements for minimum bend radius. A 50 mm hose reinforced with a spiral has a smaller minimum bending radius than a hose with 50 mm bore without spiral. A corrugated hose has a smaller minimum bending radius than a “smooth” hose whether or not it is fitted with a spiral. See Figures 2 and 3.

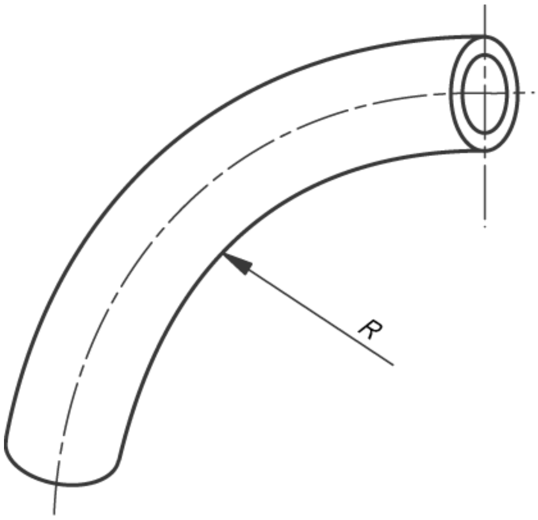

Figure 2 — Bending radius

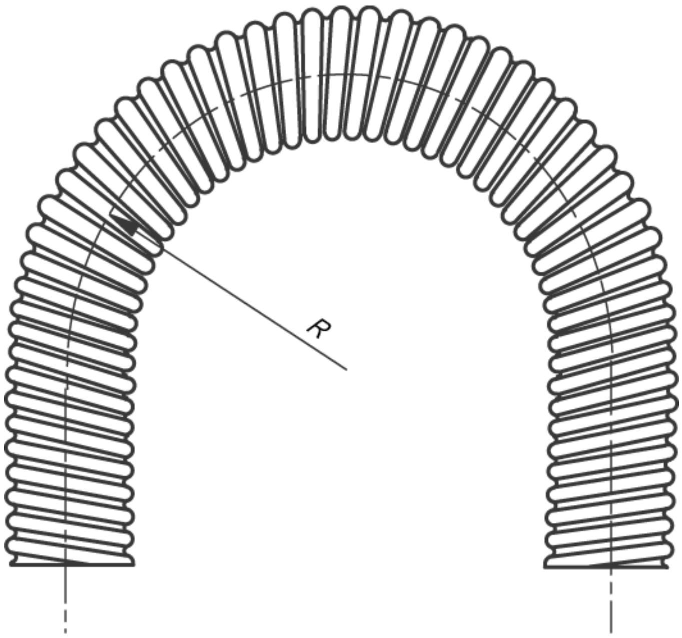

Figure 3 — Bending radius of corrugated hose with spiral

A hose should be installed with caution. The correct and incorrect installation of hoses is indicated in Figures 4 to 18. A hose should be of the right length and no tension should be exerted on the connecting points. If hoses are incorrectly installed, the bending stress adjacent to the fixed connections will be excessive.

Figure 4 shows an incorrect installation and how a hose kinks adjacent to the couplings. The hose then has a very short working life. The installed hose shown in Figure 5 will last much longer.

It should be remembered that the weakest point of a hose is generally immediately adjacent to the couplings. The length of hose required for installation can be calculated by adding 6 to 10 times the internal diameter to the length of the arc of the bend (see Figure 5).

INCORRECT

Figure 4

CORRECT

Figure 5

Hoses should not be installed as illustrated in Figures 6, 7 and 8. The working life will be shortened even further if the hoses are fitted at points where vibration is heavy. The correct fitting is shown in Figure 9. When both connecting points are provided with an elbow, the hose will last much longer.

INCORRECT

Figure 6

INCORRECT

Figure 7

INCORRECT

Figure 8

CORRECT

Figure 9

Incorrect installation may cause compression of the longitudinal axis. This fault may arise both during installation, as in Figure 10, and during movement, as indicated in Figure 11.

INCORRECT

Figure 10

INCORRECT

Figure 11

Torsional movements lead to rapid fracture in hoses and are generally caused by incorrect installation, see Figure 12. It should be ensured that the hose centrelines run in parallel as in Figure 13, where the directions of movement lie within the same plane.

INCORRECT

Figure 12

CORRECT

Figure 13

Rotation, especially with threaded couplings, may produce torsion. The hose should therefore be held with a second spanner. Torsion can be avoided as indicated in Figure 14.

CORRECT

Figure 14

Incorrect installation is shown in Figures 15 and 16.

INCORRECT

Figure 15

INCORRECT

Figure 16

Deformation and torsion of the hose will be avoided if a support is provided as in Figure 17 or 18.

CORRECT

Figure 17

CORRECT

Figure 18

A shaped support can be used to prevent sagging (Figure 16), as shown in Figure 17 or 18. If the support is provided with a balance weight, the hose will also retain a good bending radius without the hose connections being overloaded (Figure 18).

It is not always easy, in a pipe system, to install two “permanent” flanges in such a way that the bolt holes line up precisely. To avoid twisting hoses with flange end connections, hoses should be fitted with one “swivel” (pivoting) flange. Hoses with diameters exceeding 50 mm may have a coloured stripe over their entire length. This is called a “longitudinal” stripe. The stripe will show if a hose is twisted during installation. The hose should then be “disconnected” and refitted. A hose may sometimes have to be used in situations where it is exposed to horizontal and vertical movement simultaneously during use. The torsion then arising in the hose may be fatal to it. The correct installation is a so-called “dog-leg”, where two hoses are mounted with a 90° metal elbow between them (see Figure 19).

Figure 19 — "Dog-leg" installation

In principle, the hose in one leg absorbs the expansion of the other leg and vice versa. The hoses can also relieve each other, so that partial movements which are not lying in the same plane are still absorbed.

No hoses can be exposed to bending without restriction. They cannot absorb axial forces and may not be twisted. Sharp bends should be avoided. With frequent bending occurring in a regular cycle, the minimum bending radius as quoted by the manufacturer should be strictly adhered to, special attention being paid to the increasing of the minimum bending radius with high operating temperatures and pressures.

During installation, pipelines connected to hoses should be adequately supported so that their weight is never taken up by the hoses, as this may cause the reinforcing braiding to "distort" so that it no longer supports the inner hose wall beneath the reinforcement against the internal pressure.

3.6.2 Contact with media

Hoses should not normally come into contact internally or externally with media such as oil, solvents, corrosive substances, etc. unless the hose has been specially designed for this purpose. In the event of doubt, the manufacturer should be consulted.

3.6.3 End connections

End connections, unless fitted by the manufacturer during production, should be of a design (including the incorporated couplings) approved by the manufacturer.

WARNING — Failure to follow the manufacturer's instructions regarding care, maintenance and storage (see 4.5 and 5.5) of hoses may result in their not functioning in the right way and causing bodily injury and/or damage to property.

3.7 Inspection and testing

3.7.1 General

The condition of hoses in critical applications should be regularly tested. The more critical the application, the more frequently they should be tested. Reference may be made to the manufacturer for this purpose. There is a large number of standards describing hose test methods. They should be used where possible. See the Bibliography.

Various bodies and firms prescribe periodic inspection for certain hoses, which should then be tested for the recommended pressure in each case dependent on type, application and frequency of use.

3.7.2 Visual inspection

Hoses and connections should be visually inspected for damage, blisters and non-bonded sections of the cover of the hose. Rubber hoses should be inspected for soft areas and for any debonding of the reinforcement.

The weakest part of a rubber hose assembly is usually the section located at a distance of approximately three times the hose diameter from the inboard end of the hose connection. Blisters or disbonded cover may be cause for a pressure test to be carried out, or the hose should be replaced. Couplings should be examined for movement, demonstrated by out-of-line assembly and/or by torn or exposed areas where movement has occurred. Any evidence of movement of the coupling is a reason for renewing the hose or reassembling the coupling and re-testing the hose and coupling assembly, where this is permissible.

Small cracks and folds and cloth marking in the cover of the hose that do not penetrate the cover entirely need not result in replacement.

NOTE The pricking of hoses, e.g. for steam and gas hoses, by the manufacturer is a useful practice. A uniformly pricked hose should not be regarded with suspicion for that reason. The depth of the pricking should not be more than the thickness of the cover and subcover.

3.7.3 Periodical testing

Hoses should be periodically tested under pressure in accordance with ISO 1402 at a pressure corresponding to the product standard or ISO 7751. The pressure test should be carried out with water. Hoses should be tested in a straight position. The following should be noted in particular.

a) High-pressure air or other compressed gases should not be used as the testing medium because of the risk of explosion if the hose is not resistant to the pressure test. Air tests under water may be carried out if acceptable precautions are taken; these tests are usually carried out with low-pressure air to test for leaks at the hose-coupling connection or porosity throughout the hose walls.

b) The hose should be ventilated through an outlet valve during filling with the testing medium.

c) Steps should be taken to restrict whiplash of the hose in the event of fracturing, but in such a way that radial expansion and the elongation of the hose under pressure are not restricted.

d) The free end of the hose should be so secured that a loose coupling cannot blow off freely; this can be done e.g. by a cable connecting the two couplings (with sufficient slack to allow free expansion of the assembly under test pressure).

e) The personnel carrying out the test should never stand in front of or behind the ends of a hose being tested.

f) During testing, the hose should be uncoiled to its full length in a dry, clean area without looping or kinking. The cover and, if possible, the lining should be inspected for blistering, serious damage or cracks; end connections should also be inspected.

3.7.4 Pressure testing

Following visual inspection, hoses that meet the requirements should be connected to a pressure pump, with clamps, bolts and nuts being tightened before the pressure test is carried out in accordance with ISO 1402.

A quick-acting valve should be fitted to the end of the hose. Make sure that all connections are tight and fill the hose with water with the valve open and the end lifted in order to expel the air from the hose.

Close the quick-acting valve when all the air has been expelled. Using the pressure pump, increase pressure in the hose to that stated in ISO 7751. Examine the hose for leakage, especially at the connections. Look out for any blistering or swollen parts. Any hose that displays swellings, leakage or tearing should be rejected. The affected parts may be cut out. The remaining hose length can then again be fitted with couplings and pressure-tested. If there is no further leakage, it may be assumed that the hose and connections are reliable and can be used under normal operating conditions.

NOTE It is essential that the precautions mentioned in 3.7.3 are observed when a pressure test is carried out.

3.7.5 Vacuum testing

Suction hoses may be tested under vacuum if applicable. A vacuum test, with both ends of the hose blanked off with PMMA (“Perspex”) sheet discs (of sufficient thickness) should also be carried out on suction and discharge hoses to check the integrity of lining-to-reinforcement bond.

3.7.6 Electrical continuity

If electrical continuity is required, this should be tested after the pressure test is completed. The hose should be tested on a non-conductive support, making use of a suitable resistance meter to determine the resistance between the couplings (see ISO 8031).

3.7.7 Repairs

Repairs, if allowed, should be carried out in consultation with the supplier after which the hose should be re-inspected and pressure tested.

3.7.8 Rejection

A hose should be rejected if there is any doubt regarding its operational safety due to:

a) kinking and serious damage to the lining and/or cover wall of the hose, cracks or damaged internal reinforcement, damage to the textile or wire inlays, or shifting of the latter;

b) wear, tear or corrosion of the outer armouring or metal braiding;

c) swelling or loosening of rubber and reinforcement;

d) corrosion or damage to hose connections;

e) faulty fastening of connections, causing leaks that cannot be fixed;

f) leakage through the hose material;

g) unacceptable deviations from the specified electrical resistance in case of electrically conductive, or semi-conductive hoses.

Rejected hoses should be destroyed after removal of any couplings or flanges. Couplings that are still found to be serviceable after a hose has been rejected may be reused in consultation with the hose supplier.

3.7.9 Records

Records should be kept for hoses that are intensively used and/or for critical media. These records should include an inspection card on which all data for the hose should appear, such as hose identification number, manufacturer, hose type, standard, date of receipt and commissioning, order number and inspection date. The length, diameter and hose end connections may also be entered on the card. The inspection card should be such that all inspection findings can be listed on it. The inspection card number or code should be indicated on the hose.

3.8 Certificates

3.8.1 New hoses

The supplier/manufacturer should provide a certificate for new hoses that are to be used for critical or hazardous media. The certificate should at least state the following:

- manufacturer;
- order number (dated);
- make and type of hose as well as the specification and hose serial numbers (optional) covered by the certificate;
- test pressure;
- any standard according to which the hose has been tested, e.g. national, European or industry standards;
- test date;
- any required electrical resistance of rubber and composite hoses.

3.8.2 Re-inspected and repaired hoses

Hoses that are re-inspected and/or repaired by the supplier/manufacturer should be accompanied by a test certificate on redelivery with the test results for the hose concerned. If a hose has to conform to certain electrical conductivity or resistance requirements, the certificate should indicate the value measured.

4 Rubber hoses

4.1 Material

4.1.1 General

Natural or synthetic rubber is homogenized with a number of chemicals mixed in a certain ratio by mixing and milling equipment, by means of which non-vulcanized rubber compounds are obtained. Apart from the rubber raw material itself, the added chemicals determine the properties subsequently obtained by the finished product.

4.1.2 Types of rubber

Although natural rubber is still widely used, synthetic rubber is occupying an ever-greater position. Especially after World War II, use of this type of rubber became very popular. Synthetic rubber is more suited for certain purposes than natural rubber. Its resistance to oil, petrol and other hydrocarbons, in particular, means it is ever-more widely used in the chemical and petro-chemical industries. The main types of rubber are shown in Table 2 together with their characteristic properties (see also ISO/TR 7620).

Table 2 — Types and properties of rubber

Type of rubber	Symbol	Temp. range °C	Generally resistant to:	Generally not resistant to:	Special properties
Natural rubber Isoprene rubber	NR IR	−50 to +70 −50 to +70	Most non-aggressive chemicals, organic acids, alcohols, aldehydes, ketones	Ozone, strong acids, fats, oils and most hydrocarbons	High resilience and mechanical strength
Styrene butadiene rubber	SBR	−40 to +80	As for NR/IR	As for NR/IR	High mechanical strength
Butyl rubber	IIR	−40 to +130	Resistant to animal and vegetable fats and oils, alcohols and ketones, strong and oxidizing chemicals	Mineral oils, solvents, aromatic hydrocarbons	Gas tightness
Ethylene propylene rubber	EP(D)M	−50 to +130	Even more highly resistant to ozone than IIR & ER, otherwise as for IIR.	As for IIR	Low water absorption
Nitrile rubber	NBR	−25 to +110	Many hydrocarbons, fats, oils, hydraulic liquids	Ozone, chlorinated and nitrohydrocarbons, ketones, esters and aldehydes	High oil resistance
Chloroprene rubber	CR	−25 to +100	Effectively resistant to ozone, oils and fats, various solvents	Highly oxidizing acids, esters, ketones, chlorinated aromatic and nitrohydrocarbons	Flame-retardant
Chlorinated and sulfonated polythene	CSM	−25 to +130	As for CR	As for CR	Flame-retardant
Polyether urethane rubber Polyester urethane rubber	EU AU	−20 to +80	Effectively resistant to ozone, hydrocarbons, fats and oils	Concentrated acids, ketones and esters, chlorinated and nitro-hydrocarbons	Hard-wearing
Silicone rubber	MQ	−70 to +200	Effectively resistant to ozone and oxidants	Concentrated acids, many oils and solvents	Wide temperature range
Fluoro rubber	FMK	−25 to +200	Effectively resistant to all aliphatic, aromatic and chlorinated hydrocarbons	Ketones, simple esters and compounds containing a nitro group	Resistance to aromatics
NOTE The properties are determined not only by the sub-type of the rubber concerned but largely by the composition of the compounds.					

4.1.3 Rubber compounds

A rubber compound may comprise the following:

— rubber: natural or synthetic rubber;

— sulfur: to achieve vulcanization;

— accelerators: for speeding up vulcanization;

— activators: to activate the effect of the accelerators;

— fillers: with or without reinforcing properties;

— softeners: to make the rubber more flexible;

- anti-oxidants: to prevent ageing of the rubber through oxygen;
- colorants: to give the product a particular colour.

4.1.4 Processing of rubber compounds

The homogenized rubber compound (see 4.1.3) consisting of a pliable mass is worked up into the desired article in the rubber factory. Working up may differ according to the method of manufacture. The product is vulcanized after moulding.

In vulcanization, which generally takes place at temperatures between 135 °C and 160 °C, a chemical reaction occurs whereby the rubber mixture changes from a pliable mass into a permanently shaped elastic material.

4.2 Properties

Hoses made of rubber have to meet a number of requirements. One of these requirements, for example, is the hardness of the rubber from which the lining of hoses is made. The hardness is often determined by a hardness meter with a scale gradation of 1 to 100. The hardness is normally expressed in IRHD (International Rubber Hardness Degrees).

See 3.1 for other required properties.

4.3 Construction

4.3.1 General

A rubber hose consists in principle of a lining around which a reinforcement (single or multi-layered) and a cover is applied. These parts are described in 4.3.2 to 4.3.7.

4.3.2 Lining

The lining is used to carry media through the hose. The lining protects subsequently located parts of the inner hose against damage by the medium passing through. Linings are made of a number of types of rubber (see Table 2). The composition of the lining depends on the application. In some cases, a particular application requires a lining built up of various materials in order to achieve a combination of different properties.

4.3.3 Lining manufacture

For manufacturing linings, rubbers are mixed in order to achieve the desired composition and properties. The rubber lining may be either extruded, spirally applied or formed by a so-called “build up method”. In this case, sheets or strips of rubber are wrapped very uniformly round a mandrel. The mandrel has an external diameter equal to the desired internal diameter for the hose.

4.3.4 Reinforcing layers

A certain pressure will normally be necessary if a medium is to be carried through a hose. A direct consequence of this is that the hose needs to be reinforced.

The various pressures determine the type of reinforcement. For low-pressure applications, the reinforcement may consist of cotton or synthetic textile yarns applied round the lining.

In some cases, metal wire or a combination of textile yarns with metal wire is used.

Within a particular pressure range, the choice of reinforcement and the method of applying the reinforcing layers round the lining depend on flexibility, dimensions and price.

For low-pressure applications, hoses sometimes require only a textile layer or outer cover, while for high-pressure applications six to eight layers of steel wire may be necessary, e.g. for 800 bar and above.

The following terms are used in practice when applying reinforcing layers around a lining:

— knitted (fabric);

— spiral wound (metal or textile wire);

— braided (metal or textile wire);

— wrapped (textile or wire cord).

The type and number of reinforcing layers determine the flexibility of the hose.

Depending on the application, hoses may be reinforced with several layers with a steel spiral added (see Figure 20). This serves as additional reinforcement for the hose for vacuum applications or to obtain a smaller bending radius without kinking.

The spiral is generally vulcanized in. There are four ways of doing this:

— entirely embedded or “covered” spiral;

— semi-embedded or “semi-covered” spiral;

— unbonded internal spiral;

— unbonded external spiral.

Most frequently used is the hose with an embedded spiral.

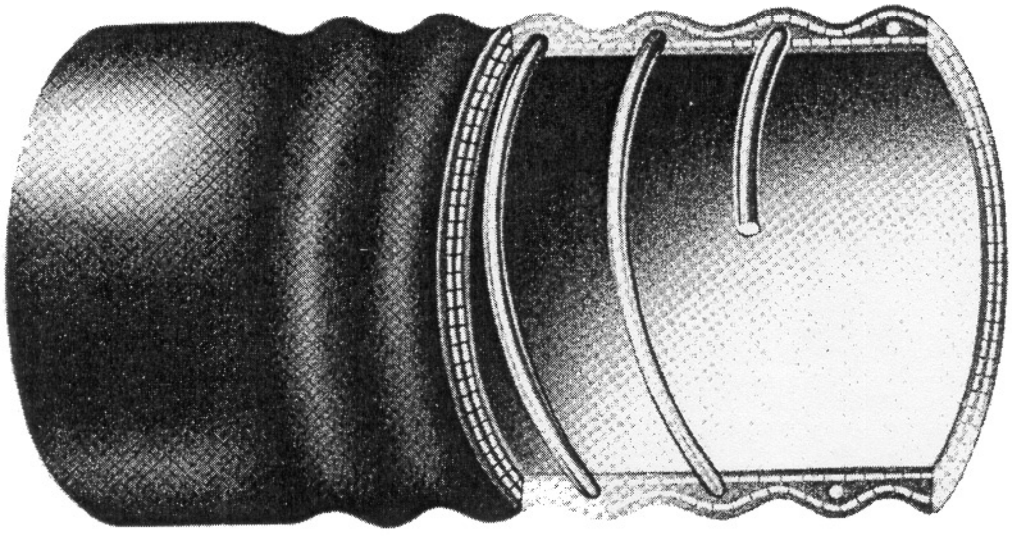

Figure 20 — Wrapped, with embedded spiral and corrugated cover

4.3.5 Cover

The outer surface or “cover” protects the reinforcement against damage and all detrimental influences from external sources.

With most applications, the cover may directly affect the hose's working life.

4.3.6 Types of cover

4.3.6.1 General

Six types of cover may be found in practice:

— smooth rubber cover;

— fluted or ribbed cover (longitudinal);

— cover with cloth imprint;

— rubber-impregnated textile fabric cover;

— textile or braided metal outer cover;

— corrugated cover (circumferential).

These descriptions indicate the way in which the outer covers are finished by the manufacturer.

4.3.6.2 Smooth rubber cover and fluted or ribbed cover

After the outer rubber cover has been applied, a jacket is extruded round it, e.g. of lead, after which it is vulcanized with steam. After vulcanizing, the lead jacket is again removed and made ready for reuse. More environmentally acceptable production processes are now used, including the salt bath process and "free vulcanization" or by extruding a special plastics jacket, instead of a lead jacket, around the cover.

Covers can be extruded directly over the reinforcement. Hoses made by this process appear smooth or slightly fluted on the outside. Hoses of this type can in theory be made in unlimited lengths. The end product is wound on reels and may be several hundred metres in length.

4.3.6.3 Cover with cloth imprint

The hose made on a mandrel has a strip of textile wrapped around it after the outer cover has been applied before vulcanizing. The hose is then "bandaged". The assembly is then vulcanized with steam. This produces the same adhesion between the rubber and reinforcing layers as with the lead or plastics jacket method. The textile wrapping is removed after vulcanizing. See Figure 21.

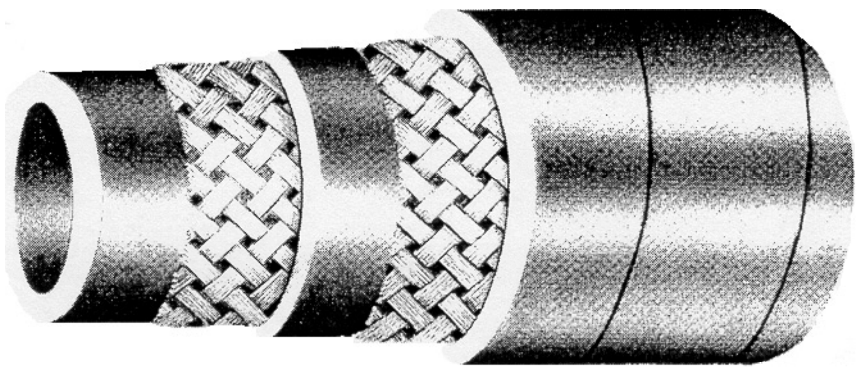

Figure 21 — Cover with cloth imprint

4.3.6.4 Rubber-impregnated textile fabric cover

The cover consists of a fabric impregnated with rubber. The advantage of this outer cover is that the hose weighs less than those already mentioned. Gas is allowed to pass through without the risk of blistering or disbonding of the outer cover. This type of hose is generally used for low pressures, e.g. for automotive fuels.

4.3.6.5 Textile or braided metal outer cover

A braided textile or braided metal cover is applied. A braided metal cover provides good heat conduction. Again, gas is allowed to pass through without risk of blistering or debonding. See Figure 22.

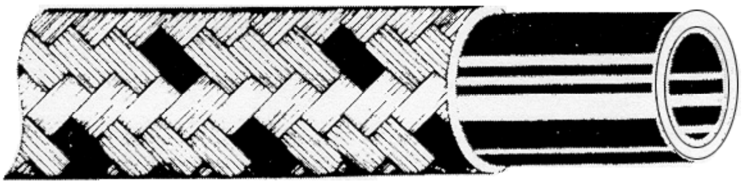

Figure 22 — Cotton outer cover

4.3.6.6 Corrugated cover

This cover consists of a rubber cover over an outer helix.

4.3.7 Pricked cover

Gases have a tendency to permeate through the hose wall, especially at high pressures, thereby escaping to the environment.

The gas first penetrates the lining and may accumulate in the intermediate layers (the reinforcement). If the outer cover has a greater gas tightness than the lining, the gas will form a blister which will burst at a given point. To prevent this, these hoses are pricked during manufacture. This means that very small holes are made in the outer cover of the hose as far down as the reinforcement. If the gas penetrates the lining, it can then escape to the outside through the reinforcing layers and perforations. In this case, pricking can be regarded as a safety measure.

4.4 Identification

4.4.1 General

The hose is normally designed for specific purposes. For certain applications, e.g. for air, oil or water, a multipurpose hose may suffice. For safety reasons, the manufacturer should mark the hose in accordance with the standard to which it is made. In addition, a hose user may also require to have any information placed on the hose concerning its nature to ensure that it is used and handled in a safe way.

WARNING — Use of hoses without identification could result in serious bodily injury and/or damage to property.

4.4.2 Methods of marking

Some standards do not specify a particular method of marking. If the standard prescribes no method, the method of marking is optional. However, it is important that the method of marking used gives a permanent and indelible identification. Some general methods are described below.

Markings may be applied at specific points indicated along the longitudinal direction of the hose wall. These markings should be of such size and shape that they are able to contain the desired text; the circumference of the hose and the equipment for applying the markings at the given point(s) may, however, limit the size of the marking. Markings should conform to the appropriate standard.

4.4.3 Vulcanized markings

4.4.3.1 With metal stamp (mould)

The most permanent types of marking are those applied in relief using a stamped mould made from a metal or plastic plate. This mould is applied to the outer cover of the hose before vulcanization. The mould ensures that the marking is vulcanized in relief on the surface of the hose. The mould is removed after vulcanizing.

The contrary method is where the marking is vulcanized not on but into the outer cover of the hose.

4.4.3.2 With contrasting coloured rubber

A variation to the marking applied in relief is one of a colour contrasting with that of the hose. For this purpose, a layer of non-vulcanized coloured rubber is applied to the hose, after which the stamped mould is imposed. During vulcanization, the coloured rubber layer attaches to the cover of the hose and when the metal mould is removed after vulcanizing, a clear marking in relief is left on the cover. The coloured marking highlights the identifying information. Use of this kind of marking is usually more expensive and normally only used on hoses with built-in couplings.

4.4.3.3 With continuous marking strip

Another variation of the marking applied in relief, used during the process of manufacturing very long hoses, is marking with a continuous strip. This method requires the legend to be applied beforehand in relief on long, narrow metal or plastic strips at fixed intervals.

The strips are attached to the outer surface of the as yet unvulcanized hose, usually at the point where the hose enters the device for applying the lead jacket or that for applying the textile wrappings. The strip is removed after vulcanizing, after which the hose has an ongoing legend in relief throughout its length. A marking of this kind is more visible than individual, separate marking and will probably remain visible longer during the hose's life.

4.4.3.4 Labels

Labels are attached to the unvulcanized outer cover of the hose as a piece of sheet rubber bearing the desired text, and are then vulcanized together with the hose.

4.4.4 Imprinted marking

With this method, the marking is moulded into the surface of the hose with a heated stamp or stamping wheel. This method can therefore be applied only to hoses with a thermoplastic external cover.

4.4.5 Printed identification

Identification is now often printed on the hose because of the low cost, especially during the production of long hoses. With this method, the identification is printed continuously on the outer surface of the hose either before or after vulcanization.

The printing generally appears in the longitudinal direction of the hose, commonly over its full length, without interruption.

This all depends on the equipment with which the hose is marked and the shortest hose length that will be used in practice.

4.4.6 Order of marking

The hose should be marked with the following information, in the following order:

a) manufacturer's name or trademark;

b) number and year of the standard;

c) classification (type, class, etc.);

d) inside diameter or nominal bore;

e) maximum working pressure;

f) quarter and year of manufacture.

An example of the marking is typically given in the hose specification standard and below:

Manufacturer/ISO 2398/7B/50/25 bar/4Q98.

4.5 Storage

All rubber products, including hoses, are subject to alteration of their physical properties during storage, and may ultimately become unusable through the effects of oxygen, ozone, heat, light, moisture, oil, solvents or other corrosive liquids or vapours. Hoses should therefore be stored in cool, dark, and vapour-free areas, which are free of the above effects. Contact with wood impregnated with creosote should be avoided.

Detailed guidance on storage is given in Subclause 2.2 of ISO 8331:1991.

5 Plastics hoses

5.1 Material

The production of a plastics hose is carried out with extrusion and/or wrapping equipment. With extrusion, the process is continuous.

Materials commonly used for plastics hoses include:

— thermoplastic polyamide elastomers;

— thermoplastic polyurethane elastomers;

— thermoplastic polyolefin elastomers;

— thermoplastic polyester elastomers.

The materials from which plastics hoses are made differ widely and in most cases are a combination of various kinds of plastics. The applications for plastics hoses differ greatly. Depending on this, plastics hoses may be made with or without reinforcement layers.

Plastics hoses, like rubber and metal hoses, are important components of various operating systems. They should be as reliable as the pipes, valves and fittings with which they form a unit in the system. These conditions can be met with the right choice of materials and design.

5.2 Design

5.2.1 Lining

The lining is generally an extruded flexible tube which has obtained a very smooth, seamless surface through the extrusion process and can be produced in unlimited lengths.

5.2.2 Reinforcement

The reinforcing layers may consist of various kinds of materials (plastic fibres, textile fibres, steel cord, etc.) in combination with armouring with a steel wire helix or plastic helix.

The hose wall, in combination with the reinforcement, provides resistance to internal pressure, the reinforcing layers taking the majority of the pressure.

5.2.3 Cover

The cover is generally a flexible tube extruded around the reinforcing layers, which serves as protection for the reinforcing layers and flexible inner tube against external influences (mechanical and chemical) and

— enables the hose to be identified by a special colour or markings thereon;

— serves as a seal on end connections.

Like rubber hoses, the outer cover of plastics hoses for gas applications should be pricked (perforated) if the effusion speed of the gas escaping through the inner lining is greater than that through the outer cover.

5.3 Other constructions

5.3.1 "Composite" or "multilayer" hoses for liquids

Composite hoses for liquids consist of layers of thermoplastic foil or sheet and/or thin-walled seamless tubes held together through internal and external metal- and/or plastic helixes. Depending on the application, this type of hose is built up from different materials. See Figure 23.

Internally, PTFE, FEP and layers of polypropene foil or sheet, tubing and fabrics are used for hoses for liquid chemicals. Externally, frequently one or more nylon/PVC-coated fabric layers are used.

Polyamide and/or polyester sheet layers, tubing and fabrics are used internally and externally for hoses for cryogenic liquid gases.

Hot dip galvanized steel, polypropylene-coated steel or austenitic stainless steel (ISO 683-13 type 19 or 20) or equivalent is used for the metal helixes, depending on the application of the hoses.

Typical properties of composite hoses are:

— good universal chemical resistance;

— reasonable mechanical strength;

— small bending radius;

— low mass;

— easy handling;

— easy to apply colour identification.

End connections for composite hoses are specially designed for hoses of this type.

NOTE See 3.2.2 for electrical continuity connections for metal helixes.

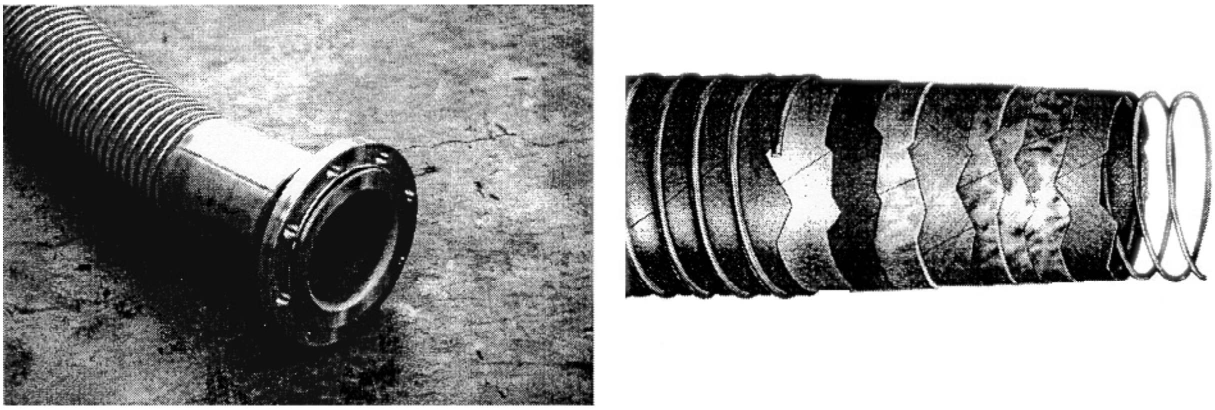

Figure 23 — “Multilayer” or “composite” hose for liquids

5.3.2 Multilayer (composite) hoses for gases and solids

Multilayer hoses for gases and solids consist of layers of cloth and sheet which are sown, welded or glued together with a metal or plastic helix reinforcement (see Figure 24). These hoses are chiefly used in e.g. pneumatic transfer, air-treatment and extraction systems. These hoses are made of various materials depending on the application. Some examples are mentioned below.

a) Synthetic fabric impregnated with plastic and equipped with a helix. The material of this hose should conform to ISO/TR 5924 with regard to fire propagation and flammability. Used in high and low-pressure air treatment systems, this hose is also available in noise-insulated and thermally insulated designs, e.g. by means of glass fibre wrapping and an additional external wall of metallized foil.

b) Wrapped plastic sheet fitted with a helix. Used in air extraction systems in private houses, vapour extraction hoods, etc.

c) Wall of wrapped PVC strip with a PVC-coated steel helix. Used as suction hose for wood-working machines and as a heater hose in car body repair and coach building work shops. A heavier version is used for industrial vacuum cleaners and as an electrical cable protection hose.

d) One or more layers of glass fibre fabric impregnated with chloroprene rubber (CR) with a copper plated spring steel helix, fitted with a CR-covered glass fibre cord on the outside.

   Applications include supply and removal of cold and hot air in aircraft construction, mechanical engineering, the chemical industry and air treatment. For extremely hot air and aggressive vapour (application) fabric and cord are impregnated or covered with silicone rubber;

e) Plastic-impregnated synthetic fabric with a galvanized steel helix and wear strips round the hose. Common versions of this are:

   — polyamide fabric impregnated with PVC;

   — glass fibre fabric impregnated with chloroprene rubber;

   — glass fibre fabric impregnated with silicon rubber.

   Applications include heavy industrial extraction; air, vapour and dust transfer; tank ventilation, hot-air blowers, etc.

f) Rubber-impregnated canvas fabric with embedded steel helix. Used for extraction of vapours, smoke, dust and sawdust, etc., and as an air supply hose for diesel engines.

g) Rubber-impregnated canvas fabric with embedded steel helix and a smooth wear-resistant inner wall. Used for extraction of wood chips and other abrasive substances.

h) Transparent polyurethane foil with embedded metal wire helix. Used for extraction of granulates, chips and abrasive powders and as a ventilation hose in the petrochemical industry.

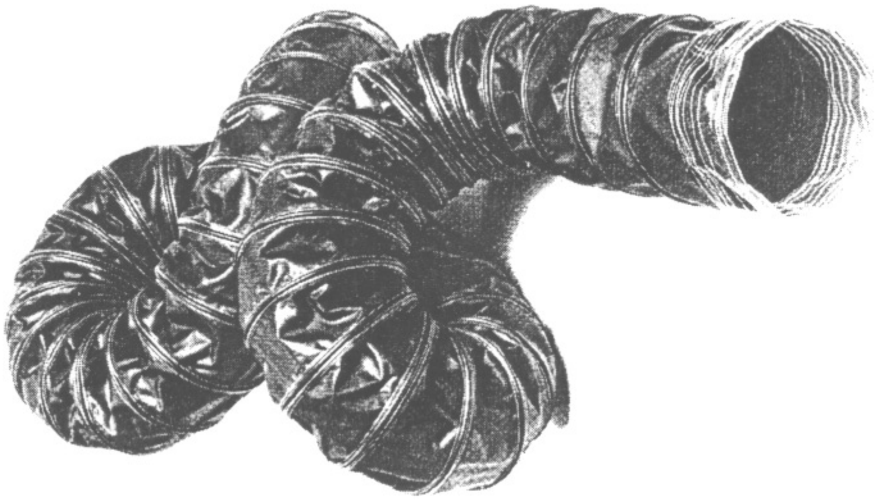

Figure 24 — “Composite” hose for gases and solids

In connection with new technological developments and to conform to specific service requirements, combinations of other materials can also be used in composite hoses.

5.3.3 Corrugated plastic hose

Another type of hose from the “smooth” straight plastic hose described in 5.3.2 is the so-called “corrugated” plastic hose which is generally made of polytetrafluoroethylene (PTFE). This type of hose may be extruded or wrapped, the hose being given a corrugated (a spiral or a parallel corrugation) profile as with metal hoses.

Advantage: The hose is very flexible so that a smaller bending radius is achieved.

Disadvantage: Hoses with parallel corrugation are (like metal hoses with this type of corrugation) more difficult to clean because the medium can remain in the corrugations.

5.3.4 “Lined” end connections

Sometimes it is necessary to avoid contact between aggressive media and metal parts, i.e. couplings, and hose nipples with welded or loose (rotating) flanges. Metal parts can be protected with plastic for this purpose. This is done by extending the inner plastic lining over the sealing surfaces of the flanges. This also ensures that the flanges cannot come into contact with the medium. The flange jointing can then be omitted when assembling the hose. This kind of protection is called “soft-lined”. See Figure 25.

Figure 25 — Protected coupling and sealing surface

Another method of protecting the metal parts is by “coating”. The coating is applied to the metal parts of the end connections by paint-spraying equipment.

5.3.5 Plastic-lined hose

A plastic-lined hose is a rubber hose with a plastic lining. A lined metal hose is produced in much the same way as a corrugated metal hose. A plastic tube is inserted in a metal pipe with controlled dimensions after which the corrugated profile and braiding are applied. See Figure 26.

Plastic hoses can be made in the following way for certain operating conditions: a preformed plastic hose is strengthened with synthetic yarn or stainless-steel wire braiding, after which it is covered with rubber.

The whole is vulcanized with internal pressure in the hose, by “open” steam. The vulcanizing temperature is such that the plastic (inner) hose remains undamaged during the vulcanizing process. During vulcanization, the rubber also impregnates the braiding.

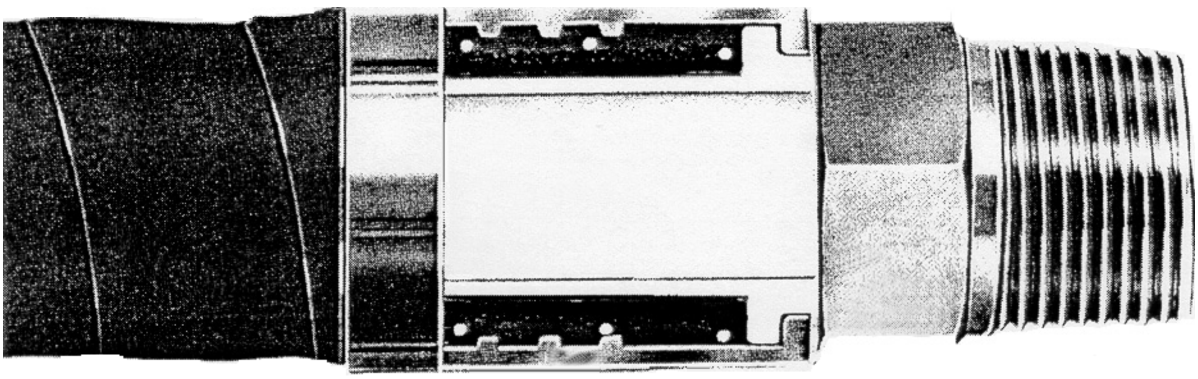

Figure 26 — Plastic inner lining and rubber cover

5.4 Identification

5.4.1 General

The hose is normally designed for specific purposes. For certain applications, e.g. for air, oil or water, a multipurpose hose may suffice. For safety reasons, the manufacturer should mark the hose in accordance with the standard under which it is made. In addition, a hose user may also require to have any information placed on the hose concerning its nature to ensure that it is used and handled in a safe way.

WARNING — Use of hoses without identification could result in serious bodily injury and/or damage to property.

5.4.2 Methods of marking

Some standards do not specify a particular method of marking. If the standard prescribes no method, the method of marking is optional. It is important that the method of marking used gives a permanent and indelible identification. Some general methods are given below.

a) Markings may be applied at specific points indicated along the longitudinal direction of the hose wall. These markings should be of such size and shape that they are able to contain the desired legend; the circumference of the hose and the equipment for applying the markings at the given point(s) may, however, limit the size of the marking. Markings should conform to the appropriate standard.

b) Plastics hoses with smooth outer covers such as high-pressure hoses may be identified by a special paint marking applied to the hose in longitudinal direction.

c) Composite hoses or corrugated plastics hoses with stainless-steel braiding, for example, may be identified on one or both end connections by die-stamping or on a small tag welded to the rear of the flanges.

5.4.3 Order of marking

The hose should be marked with the following information, in the following order:

a) manufacturer's name or trademark;

b) number and year of the standard;

c) classification (type, class etc);

d) inside diameter or nominal bore;

e) maximum working pressure;

f) quarter and year of manufacture.

An example of the marking is typically given in the hose specification standard, and below:

Manufacturer/ISO 5774C/25/16 bar/4Q98.

5.5 Storage

Plastics hoses should be stored in cool, dark and vapour-free areas. They should not be exposed to UV radiation. Different types of plastics should not be placed in contact with each other.

Detailed guidance on storage is given in Subclause 2.2 of ISO 8331:1991.

Hoses should never be hung across a beam or pipe but should preferably be suspended vertically.

6 Applications of rubber and plastics hoses and hose assemblies

NOTE Reference should always be made to the specific safety regulations in place in individual countries.

6.1 Hydraulic hoses

Hydraulic hoses are used for low to very high pressures and should meet the requirements set out in the relevant product standards, e.g. ISO 1436, ISO 3862-1, ISO 3949, ISO 4079-1 and ISO 11237. The minimum burst pressure of a quality manufactured hydraulic hose may be around 180 MPa (1 800 bar). As with other hose types, the construction of the hose determines the working pressure for which the hose may be used.

The maximum working pressure, together with the operating conditions, is decisive for the choice of hose. The pressure ranges desired determine the type of reinforcement used in order to reinforce the lining. The reinforcement material can be cotton or synthetic fibre yarns that are braided or spirally wound round the lining. In some cases, copper, bronze or steel(brass-coated or stainless) wire may be used.

For a particular pressure range, flexibility and dimensions are important when choosing the reinforcing materials and the method of applying them over the liner. The reinforcement may also have to be made with fabric and a spirally wrapped layer in order to achieve the desired pressure range for a hose. Two spiral wrappings use just as much space as a braided reinforcing layer by braiding the wires “into each other”. By using two spiral wrappings in combination with a braided reinforcing layer instead of two reinforcing layers, the pressure range of a hose is increased while the same hose end connection can be used on either type of hose.

Plastics hydraulic hoses (like rubber hoses) are used in various hydraulic systems. The choice of plastic or rubber is decided by, amongst others, the following operating conditions and criteria:

— *chemical resistance*: this varies greatly over a sizeable range of chemicals. The supplier should be consulted;

— *mass*: this is lower for plastics because of lower material density (up to 70 % less than rubber hose);

— *temperature*: the maximum and minimum permissible operating temperatures of reinforced plastic hoses are, respectively, higher and lower than those of rubber hoses with reinforcement.

The end-use of a hose should decide whether rubber or plastics is more suitable, since the chemical resistance (temperature resistance) of the materials is different.

Spirally wrapped and braided reinforcing layers should strengthen each other in order to resist pressure. This is achieved by setting the wire at the right tension and by selecting the mutual angle of the wires of reinforcement during manufacture. See Figure 27.

Figure 27 — Hydraulic hose with two spirally wrapped reinforcing layers and one braided reinforcing layer

A hydraulic hose with a number of spirally wrapped layers is shown in Figure 28. This means that a spiral wrapping is laid in one direction and the next spiral wrapping in the opposite direction. Each spiral wrapping or braided reinforcing layer stretches in a previously calculated way when the hose is put under pressure. A rubber intermediate layer is applied between each reinforcing layer of the stated types of hose reinforcement, which ensures adhesion of the different layers and also fills up the open gaps between the wires.

Figure 28 — Hydraulic hose with four spirally wrapped layers

For a choice of end connection type, the supplier's or manufacturer's advice should be sought. A wrong choice can result in human injury and/or material damage. An example of a hydraulic hose with connections is given in Figure 29.

Figure 29 — Hydraulic hose with connections

6.2 Offshore hoses

Offshore hoses are used for charging and discharging crude oil and oil products in the open sea by single point mooring (SPM) or conventional buoy mooring (CBM) installations. In some cases, other products may also be transferred.

There are two main types of offshore hoses, namely “floating” hoses (see Figure 30) and “submarine” hoses (see Figure 31).

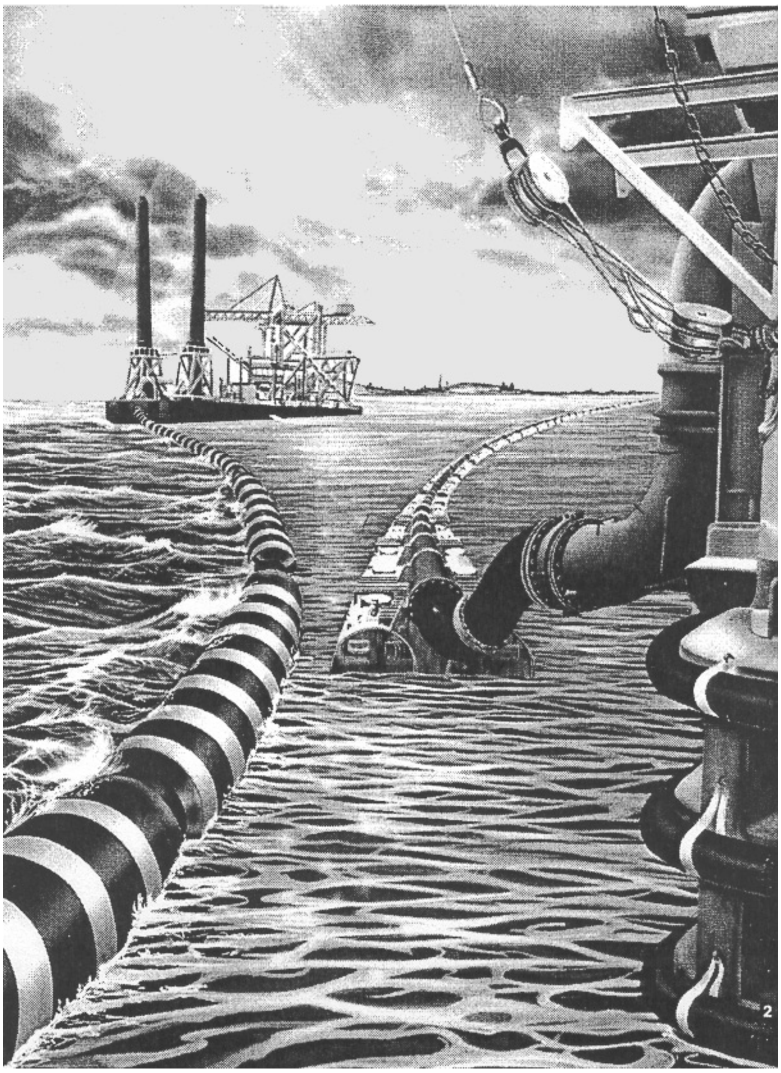

Figure 30 — Floating (off-shore) hose (in service)

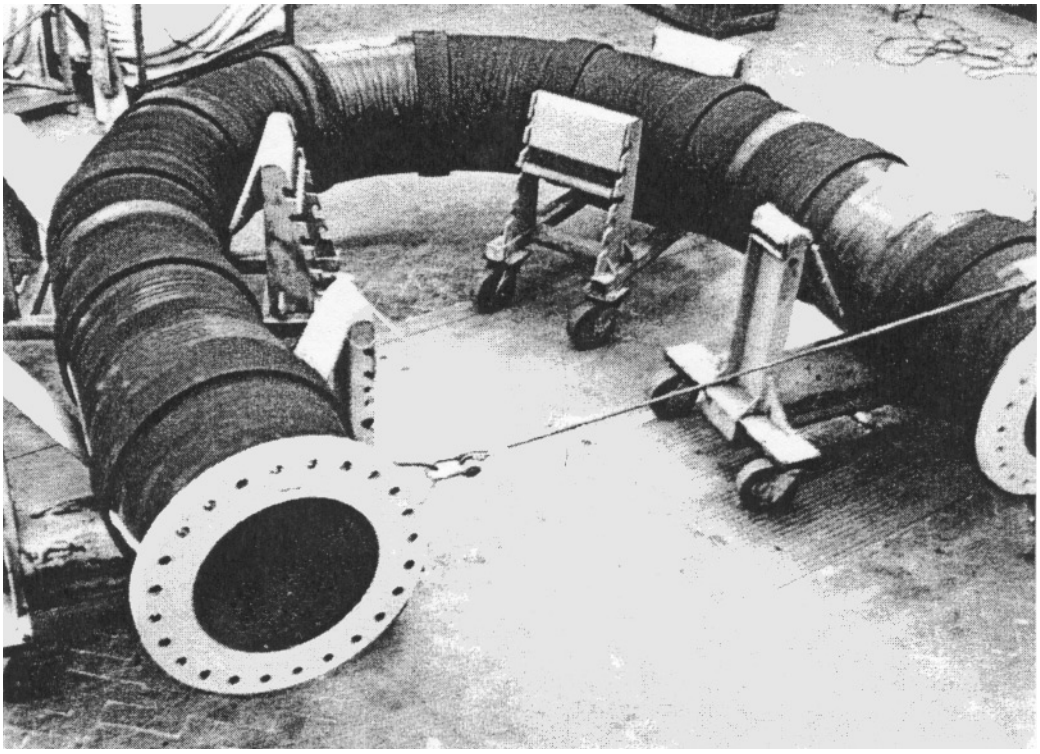

Figure 31 — Submarine (offshore) hose (during bend test in factory)

These hoses (with the exception of certain hoses for special products such as LPG, ammonia and the like) have a smooth liner (so no unbonded internal helical wire) and may be provided with one, two or three incorporated helixes, or may be entirely without a helical wire. In the latter case, the function of the helical wire is taken over by extra layers of reinforcement wrapped at a particular angle.

Floating hoses generally have an integral flotation unit (vulcanized to the carcass or glued to it) which is so calculated that approx. 20 % of the hose, filled with sea water, projects above the surface. "Submarine" hoses are not provided with a flotation unit but sometimes have collars vulcanized to the hose to which separate floats can be attached that keep the hose suspended in the water.

Hose end connections for virtually all designs of offshore hoses are vulcanized to the lining in order to ensure the greatest possible leak tightness. The hose nipples are fitted with "welding neck" type flanges welded to them as standard, while a rotating flange may be fitted to one end of the hose for certain applications ("underbuoy" or "PLEM" hoses). An alternative construction also exists which is made with built-up flanges from carcass material, reinforced with steel rings as a standard design. The diameters of between ± 150 mm and ± 600 mm (6 inch to 24 inch) are generally to OCIMF specification "Guide to Purchasing, Manufacturing and Testing of Loading and Discharge Hoses for Offshore Moorings"[92].

The standard rated pressure is 15 bar but 19 bar also occurs if specially requested by the user. The safety factor is five times the rated pressure (with a holding time of 15 min at five times design pressure, before pressure can be raised to burst). The test pressure (in the factory and in the field) is always equal to the rated pressure, with a holding time of 10 min, but an additional test pressure of 1,5 times the rated pressure may be required by the purchaser during a short period of time (5 min). Bend tests, vacuum test, adhesion test, electrical resistance measurements are also a standard OCIMF requirement. A kerosene test may also be required by the purchaser.

Each hose should be supplied with a complete set of documents and a detailed test certificate. The OCIMF publication "OCIMF Guide for Handling, Storage, Inspection and Testing of Hoses in the Field"[93] is recommended for the inspection of hoses used.

6.3 Welding hoses

6.3.1 General

In addition to the recommendations of 3.7, 4.5 and 5.5 concerning inspection, maintenance and storage, the recommendations in this subclause should be observed. They apply to hoses for oxyacetylene welding and similar processes, such as cutting, soldering and flame-spraying, with working pressures of up to 20 bar for oxygen and 10 bar for acetylene.

It is particularly important that the correct hose is selected for the fuel gas to be used. Hoses that are suitable for use with acetylene or oxygen may be affected if used for LPG, propane, propene or similar gases. A special class of hose for the latter gases may be recommended by the manufacturer. See also ISO 3821. These hoses are sometimes combined to form a twin hose. See Figure 32.

Figure 32 — Twin hose (welding hose)

Every quarter-year, welding hoses should be checked for leakage, damage or serious deterioration. The hoses should be visually inspected for damage to the outer cover, tearing or disbonding of intermediate layers [reinforcement(s)] and for safety of the end connections' attachment.

Hoses displaying serious damage, tears, blisters, distortions or disbonding of intermediate layers should be immediately withdrawn from service. Loose or dislocated couplings should be firmly attached before the hose is taken back into service. In case of doubt, a pressure test should be carried out as described in 3.7.3. The supplier may also be consulted.

6.3.2 Safety measures

To restrict the escape of gas through the hose wall, the gas container valve should be closed after the supply to the gas burner has been cut off.

NOTE The gas container valve should never be closed before the supply to the gas burner has been cut off, to prevent flashback in the hose.

As gas penetration through the hose wall (effusion) always occurs, concentrations of explosive gas mixtures or gas concentrations harmful to health should be avoided, and the spaces where equipment is stored or used should always be properly ventilated.

Consult the Labour Inspectorate Publications[94] or the national directives of the individual country involved.

6.4 Butane, propane and LPG hoses

6.4.1 General

If saddle clamps, band clamps or safety clamps (shell type) are used for assembly, they should be free of sharp edges or other surface defects. Clamps should not be fixed too tightly. The latter may result in unnecessary rapid deterioration of hoses in the immediate vicinity of the connections.

Hoses and tubes in regular use should be tested twice a year. A hose or tube should be replaced if, on visual inspection, it is found to be seriously damaged or displays blisters, distortion, weak or soft spots, or if the incorporated reinforcement has disbonded.

6.4.2 Safety measures

As gas will always permeate through the hose wall, concentrations of explosive gas mixtures of gas concentrations harmful to health should be avoided.

LPG is denser than air so that there is a risk of concentrations accumulating, e.g. in hollow spaces in boats or under the floors of caravans. It is therefore essential that after a period during which the equipment has not been used, the space is properly ventilated in order to avoid any accumulation of gas, before an appliance is lit.

6.5 Steam hoses

Further to the criteria indicated under 5.7 and 6.5, the recommendations in this subclause should be followed for steam hoses designed for working pressures of up to 16 bar and temperatures of up to 204 °C. They apply to hoses with an internal diameter of up to 50 mm.

Hose clamps should always be checked before a steam hose is taken into service, but also when the hose is in use. Extra attention should be paid to collars and safety clamps on the couplings if the hose is fitted with such devices. It should be ensured that the fingers of the safety clamps have been securely fitted over the collar and that the coupling parts are securely fastened to each other. The clamps should be regularly checked and, if necessary, the bolts tightened in connection with possible creep or shrinkage in the rubber material of the hose.

If necessary, the bolts should be uniformly re-tightened. If the clamp halves touch each other through long-term use in combination with the same steam hose, the deformed hose part should be cut off and coupling and clamps should be re-assembled on the new undamaged hose ends.

Steam hoses that are in normal use should be tested once every six months in the first year of use. The steam hose should be assessed visually and pressure-tested in accordance with ISO 6134.

After one year it is recommended that the hoses are tested more frequently. Steam hoses that are subject to intensive use and are e.g. dragged over rough surfaces, that have been stored with a tight bending radius or continuously exposed to the weather, will have deteriorated faster than those which have been treated with care. It is advisable that hoses used very intensively be tested once a month, after installation (see 3.7.3).

6.6 Refrigerant hose

Refrigerant hoses are hoses used in cooling installations, they are designed to keep the loss of refrigerant (Freon, Caltron, etc.) through effusion (measured in kg per m hose length per year) as low as possible.

6.7 Paint-spraying hose

Paint-spraying hoses are intended to transfer the medium to be sprayed under pressure. A distinction is made between:

— “air” spraying: low-pressure paint spraying by compressed air (max. 9 bar);

— “airless” spraying: this requires a plastic hose that is resistant to high pulsating pressures (up to 200 bar).

6.8 Fire-fighting hose

Fire-fighting hoses should be flexible (under pressure) and when rolled out should have a “manageable” mass with a small diameter. Requirements regarding resistance to pressure, wear and ageing are laid down in various standards.

The fire-fighting hose is built up from a woven jacket provided with a water-tight lining and a wear resistant outer cover. Inner linings and outer covers should be made of a compound guaranteeing a high degree of resistance to ageing. One method of manufacturing is by simultaneous extrusion around and through the fabric (to ensure maximum adhesion between the components).

Besides resisting wear, the outer cover should also be heat-resistant to a high degree. The outer covers of hoses whose inner linings and outer covers are extruded in a single production pass may be pricked to prevent blistering. The outer cover may be provided with a ribbed profile in the longitudinal direction of the hose to reduce wear (fluted cover).

Both inner linings and outer covers of a fire-fighting hose should as far as possible be resistant to oils, greases and chemicals as well as against the effects of ozone and UV radiation.

It may be possible to repair a fire-fighting hose in such a way that it again meets at least the primary requirements following repair.

Fire-fighting hoses laid over traffic carriageways during use should be protected by hose bridges.

7 Couplings

7.1 General

All kinds and types of hoses can have “permanent” end connections fitted. The range of types, varieties and models include quick-acting couplings, claw type couplings, threaded couplings and flanges (welded, or not, to the hose nipples). All hose end connections should be suitable for the design pressure of the system to which the hoses are connected. The coupling material should also be suitable for the medium transferred. The end connections should conform to international and, when applicable, national standards concerning nominal diameters, types of materials and pressure classes.

The most common end connections are:

— flange connections;

— threaded connections;

— quick-acting couplings.

All assemblies where nut-and-bolt connections are used should be regularly checked. If nuts are loose, the connection efficiency is lost and leaking will result.

7.2 Flange connections

7.2.1 General

Rubber and plastics hoses may be fitted with flange connections, although the kinds of hoses mentioned here may be constructed differently. A flange connection is assembled with a rubber hose by means of a hose nipple (see Figure 33) which is inserted into the hose. This hose nipple is ribbed to prevent it slipping from the hose. Rubber hoses may also be fitted with vulcanized hose nipples. The nipples are built into the hose ends during manufacture of the hoses before they are vulcanized.

The nipple may include a fixed or swivel flange. A hose should preferably be fitted with a fixed flange at one end and a swivel flange at the other end. During assembly, the connection with the fixed flange is fitted to the piping system first and the swivel flange afterwards. The swivel flange prevents the occurrence of torsion in the hose. The assembly of hoses with non-vulcanized nipples is completed by applying the clips (clamping strips (7.2.4), swage sleeves (7.2.3) or safety clamps (shell type) (7.2.2, see Figure 34).

Figure 33 — Hose nipple with beads for assembly by vulcanizing or with clamps

7.2.2 Flange connection with safety clamps (shell type)

Shell type clamps are preferable, especially for larger hose diameters. These clamps are grooved on the inside so they can grip the outer wall of the hose as the pertaining hexagonal cylinder head screws (socket screws) are tightened. These clamps are also equipped with a collar, which fits over a collar on the nipple when the bolts are tightened, in this way preventing the coupling from being pulled out of the hose. One of the advantages of shell type clamps is that when a hose is withdrawn from service for any reason, the shells and nipple with flange can easily be disassembled and reused. See Figures 34 and 35.

Figure 34 — Shell type clamps

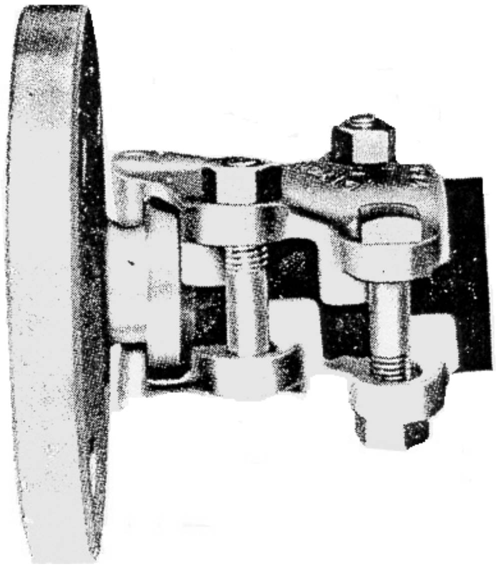

Figure 35 — Shell type clamps with bolts and nuts

Also widely used is the hose/flange/hose nipple assembly with the hose nipple fixed with clamps tightened with nuts and bolts. These clamps have a “grip” on the one side which fits behind a “collar” on the hose nipple, when the nuts are tightened. The nuts should not be tightened in such a way that the hose end is “pinched”, so weakening the leaktight connection. Clamp shells are commonly made of light metal alloy, brass or cast steel. Brass clamps are generally used for loading and unloading terminals in order to prevent sparking.

7.2.3 Flange connection with swaged sleeve

An entirely different way of creating a flanged connection is by a “sleeve” swaged round the hose over the nipple connection. The advantage of this swaged sleeve is that there are no projecting parts at the end of the hose. See Figure 36.

Figure 36 — Flanged connection with externally swaged sleeve

7.2.4 Flange connection with clamping strips

Less efficient than the previous types of hose-nipple connections is the fastening method with clamping strips. The strips sometimes work loose and the (dangerously) sharp ends of the strip may cause injury. It often happens that of the customary three strips, only one is still functional, the other two strips having ceased to function. If a hose with a particular end connection is calculated for a pressure that may prevail within the hose and the piping system, the safety of the user and surroundings may be jeopardized if the connection weakens.

7.2.5 Stainless-steel hoses with connections or rubber and plastics hoses with welded connections

Stainless-steel hoses fitted with end connections generally have a welded-on pipe with collar. The hose ends are welded. It is recommended that welds on hoses with these hose end connections are inspected before commissioning. See Figures 37 and 38.

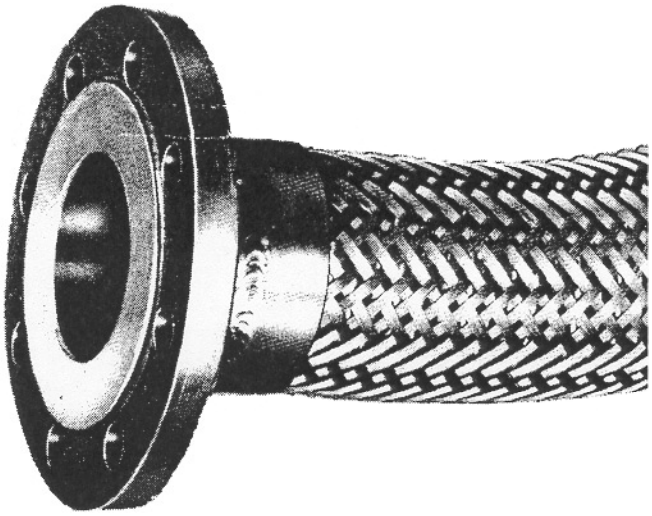

Figure 37 — Welded flange

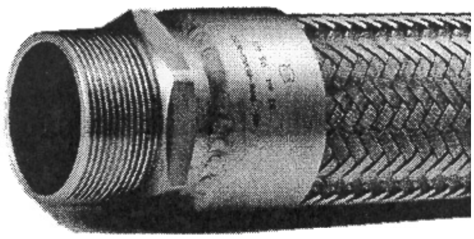

Figure 38 — Welded threaded connection

7.2.6 Threaded connections on plastic-lined hoses

Metal hoses lined with plastic are not welded to the nipples. This threaded connection is swaged onto the hose by a special machine. The compression force of this machine is so adjusted that an effective seal is obtained. See Figures 39 and 40.

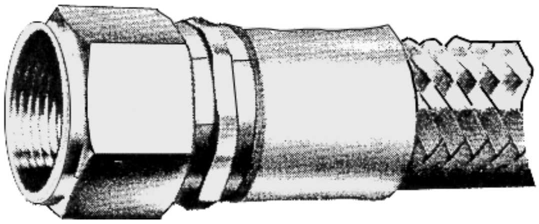

Figure 39 — Plastic hose with swaged-on threaded connection

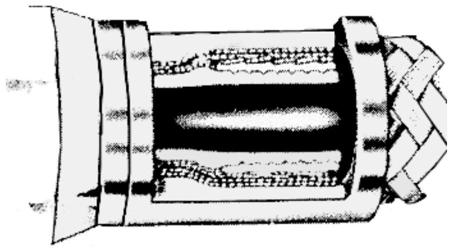

Figure 40 — Detail of swaged-on connection

7.2.7 Swaged couplings

Another type of high-pressure coupling is the so-called swaged coupling which is used for high and very high pressures. When this type of coupling is assembled, the hose end is specially treated, after which the coupling is swaged onto the hose in a press. The heavy pressure exercised on the coupling/hose connection during swaging produces a leak-proof connection. This is a permanent coupling and cannot be disassembled.

7.2.8 Threaded connections on rubber hoses

Certain types of high-pressure couplings on high-pressure rubber hoses are detachable and suitable for re-use. This type of coupling is also sometimes called a “screwed fitting”. See Figure 41.

Threaded sleeve fittings are an alternative to swaged sleeve couplings for high-pressure rubber hoses (see Figure 41). They should be expertly fitted. This can often be done on site with simple tools. A disadvantage is that this connection can be unscrewed by non-experts.

Figure 41 — Threaded sleeve coupling

7.3 Threaded connections

Instead of a flange connection, a threaded connection may be fitted. When assembling a threaded connection to hoses, the same kind of problems arise as described for flanged connections. The materials from which threaded connections are made may differ greatly: stainless steel, aluminium, brass, cast steel, etc. A great variety of types of threaded connection is also available and suitable.

7.4 Quick-acting couplings

7.4.1 General

To make a hose connection quickly, a “quick-acting coupling” can be used. The choice for this kind of coupling is particularly wide. Some types of quick-acting coupling are briefly described here.

NOTE It is not claimed that the couplings described here are preferable to other types which are not mentioned.

When purchasing and using quick-acting couplings, it should be remembered that the couplings are fitted with sealing rings, which may be made of various kinds of rubber or plastic. The choice of hose and connections, as well as the seals in the couplings depends on the temperature and working pressure of the medium.

Coupling and uncoupling quick-acting couplings in pressure systems may be dangerous.

7.4.2 Spigot and socket type

Spigot and socket couplings are used especially for connecting hoses for pressurized air, gases, water and steam. Spigot and socket couplings are used in combination with high-pressure guns for cleaning work. See Figures 42 and 43.

With a spigot and socket type of coupling, the spigot slides into the socket. It is latched by a bayonet or by spring loaded balls.

There are types of spigot and socket couplings where the spigot is so designed that it fits only into certain sockets in order to avoid dangerous mistakes. These couplings are used where the mixing up of connections could have potentially fatal consequences.

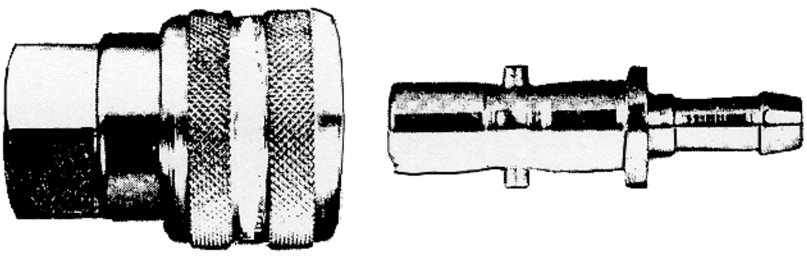

Figure 42 — Spigot and socket coupling

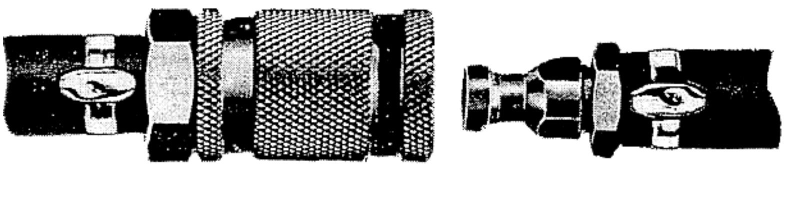

Figure 43 — Spigot and socket coupling with a different coupling principle

Figure 44 shows five examples where the coupling sockets all differ. In other words, five different media can be transferred, each with its “own” end connection.

Figure 44 — Coupling sockets

Depending on service requirements, couplings can be designed with a built-in stop-valve. The advantage of this is that, upon breaking the connection, leakage can be stopped if a quick-acting coupling is fitted immediately behind a valve. Spigot and socket couplings can similarly be designed with a relief facility. This can prevent the hose remaining under pressure after uncoupling it from the system.

7.4.3 Claw type couplings

7.4.3.1 General

Because of the simplicity of coupling systems associated with claw type couplings, these are the most commonly used. Coupling/uncoupling occurs, in all cases, by rotating the coupling halves a quarter turn against each other. Standardized spaces between the projections in the claw enable coupling sections of different diameters, but not of different types, to be connected to each other. Claw couplings of the “DIN” type have higher retaining lugs than those of the “USA” type. Differences of this kind can be overcome with the aid of a file because the coupling sections can then be made to fit each other reasonably well. See Figures 45 and 46.

WARNING — This practice should be avoided. In the event of torsion in the hose, the connection will virtually always be broken because the retention lug has been removed.

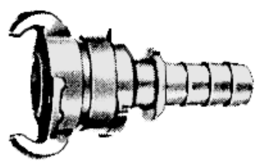

Figure 45 — Adjustable claw type

Figure 46 — Claw type coupling

Summarizing, the following actions should be observed:

— The retaining pin on couplings whose retention is so secured should always be used. The coupling can never become undone if the pin is fitted. Metal wire should never be used as this produces an unreliable connection.

— Make sure that the claw recess coincides with the second retaining lug on coupling connections secured by these lugs.

— With adjustable couplings retained by a nut on the screw thread connection, tighten the nut fast against the housing so that both halves of the coupling are in maximum contact with each other.

— Never make a connection with coupling sections where the retention lugs have been wholly or partly filed away.

— Use a safety cable or chain across two couplings for critical applications. This prevents “whiplash” in the hoses should the claw connections inadvertently open.

Generally known and applicable almost everywhere are “claw type couplings” available in various dimensions of hose end connection and designs, such as:

- the “DIN” coupling (7.4.3.2); not in accordance with ISO standards;
- the “USA” coupling (7.4.3.3); not in accordance with ISO standards;
- the adjustable “DIN” coupling (7.4.3.4); not in accordance with ISO standards.

The difference between the DIN types and the USA type concerns the dimensions. The couplings may be made of brass, cast steel or cast iron. Sealing rings are made of rubber, PTFE or copper.

7.4.3.2 DIN coupling (not in accordance with ISO standards)

This type of coupling conforms to DIN 3481[1)], DIN 3482[1)] and DIN 3483[1)]. The material is galvanized cast iron.

The two coupling ends are retained by projections in the housing that fit into a slot in the claw, which prevents the two halves of the coupling becoming undone.

7.4.3.3 USA coupling (not in accordance with ISO standards)

The USA coupling is not standardized and is very similar to the DIN coupling, but *the two are not interchangeable*. Primary security is however obtained by fitting a retaining spring pin in two opposing holes made in the two halves of the coupling.

A disadvantage of this retaining method is that one may forget to fit the retaining spring pin when the two halves are coupled. This means that the coupling connection could be broken while the hose is in use and under pressure, through the hose turning (twisting). The couplings should therefore always be secured by means of the retaining pin (see Figure 47).

Figure 47 — Retaining pin

1) No known equivalent ISO standards available.

7.4.3.4 Adjustable coupling

Similarly produced according to the DIN standards is the “adjustable” coupling. This coupling has a retaining feature almost identical to that of the DIN coupling described in 7.4.3.2. An effective connection is obtained by tightening a screw threaded connection fitted behind one of the coupling halves. By this means, the two halves are joined more easily than with two non-adjustable claw couplings.

The advantages of this type of coupling are:

a) easy coupling and uncoupling;

b) less wear on the lugs and sealing rings;

c) a safe seal because it cannot work loose as a result of external forces, e.g. torsion.

7.4.4 Fire hose couplings

These couplings are used as universal connections for fire extinguishing water systems (System Storz) in many European countries. They consist of a cam ring, a hose connecting nipple, a grooved rubber sealing ring and a securing clamp ring. See Figure 48.

Figure 48 — Fire hose coupling

The connecting pieces are fitted with an internal or external pipe thread connection. Fire hose connections should conform to the national standards or regulations of the individual country. The couplings are generally made of brass or aluminium.

At present, there are no ISO or CEN standards for fire hose couplings, and each country uses their own choice of connectors (e.g. DIN 86200, BS 336, NEN 3374 and other national standards).

To prevent soiling of the couplings and the piping in the system, they should be sealed with a blank cap when not in use. See Figure 49.

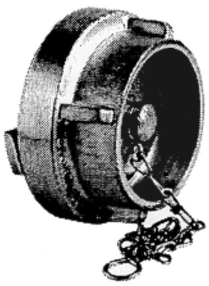

Figure 49 — Blank cap for fire hose connection

7.4.5 Quick-acting coupling with valve

Road tankers are being increasingly equipped with a discharge and loading connection with a quick-acting coupling and valve attached. Hoses used at filling stations are therefore equipped with quick-acting couplings with valves. This coupling has two functions: firstly as a coupling and secondly as a valve. The quick-acting coupling has a built-in spring-loaded valve which is opened on coupling. During disconnection this valve, as well as the valve on the counter connection, closes. See Figure 50.

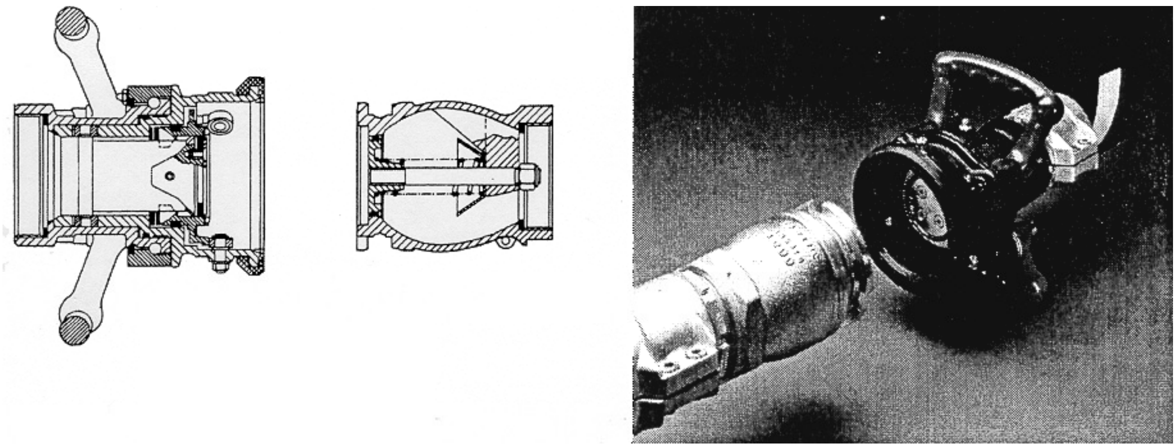

Figure 50 — Quick-acting coupling with valve and blank cap

The advantage of the coupling is that it permits a rapid connection to be made. The disadvantage is that a high-pressure peak is produced in the loading system and therefore also in the hoses to which the coupling is fitted when the hose is disconnected and the valve closes. Hose and coupling remain filled with medium under pressure after use. This means that on warm days, pressure will build up within the hose. It is therefore recommended that hoses be so stored after use that they are not exposed to sunlight. The materials from which couplings may be made are: aluminium bronze, brass, stainless steel, monel, aluminium, bronze and cast steel. The choice of materials and seals depends on the medium to be transferred.

7.4.6 Screw coupling (with lug swivel)

Screw couplings are used for loading and unloading rail tankers, and for so-called "off-shore" work consist of one half with a threaded piece with an internal and external thread, while the other half consists of an internal thread which is finished conically. The connection can be made through a loose, lug-type swivel.The materials from which couplings are made include steel, stainless steel and bronze. The latter material is commonly used at locations where sparking has to be avoided. As an aid during coupling, a bronze hammer may be used. Couplings can withstand pressures of 70 bar to 1 000 bar depending on their design and the type of material. This type of coupling is subject to various API standards. See Figure 51.

Figure 51 — Screw coupling (Hammerlug-Union)

7.4.7 Quick-acting coupling (cam and groove)

Another type of quick-acting coupling consists of a coupling piece and an adapter. The coupling may be made of various kinds of material such as stainless steel, bronze, aluminium and polypropylene. The coupling piece, which is generally fitted with two levers and retaining rings, can be connected up in various ways, e.g. to a hose nipple, internally or external threaded. It is very easy to operate; the adapter is inserted into the coupling piece, the levers are lifted, and the securing can take place. See Figures 52 and 53.

Figure 52 — Coupling piece

Figure 53 — Adapter

7.4.8 Road/rail tanker coupling

The tanker coupling, also known as the "German coupling", is often used as a road/rail tanker (R/RT) connection. This coupling is easily recognized by the "crown ring" in the coupling piece. Coupling pieces are fitted to the pipe system by means of special assembly wrenches. See Figures 54, 55 and 56.

Figure 54 — Coupling piece

Figure 55 — Adapter

Figure 56 — Assembly wrenches

7.4.9 The “ball” type coupling

The ball type coupling is a kind of coupling which, before it is connected, can, to some extent, follow the misalignment of the hose. The coupling consists of three parts, namely a ball, a clamp and a so-called cup. The coupling's concave and convex conical design can follow the misalignment. The two halves of the coupling are kept together by the clamp. The material from which the coupling is made is cold-rolled steel which is black (weldable) or galvanized [either hot-dip or not (not weldable)]. See Figures 57 and 58.

Figure 57 — Cup piece and clamp

Figure 58 — Ball

7.4.10 “French” coupling or “Guillemin” coupling

A symmetrical coupling made of stainless steel or aluminium or polypropylene is known as the “French” coupling.

The coupling is closed by placing the two coupling pieces together and giving them a quarter turn. It is secured by tightening a nut located behind one of the coupling pieces. This does not mean that a retaining nut is a standard item on this type of coupling. The supplier should be consulted. See Figures 59 and 60.

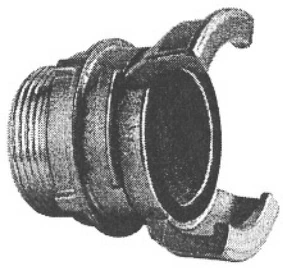

Figure 59 — “French” coupling half with external thread

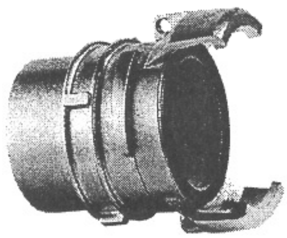

Figure 60 — “French” coupling half with internal thread

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[3] ISO 1402, *Rubber and plastics hoses and hose assemblies — Hydrostatic testing*

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[5] ISO 1436-1, *Rubber hoses and hose assemblies — Wire-braid-reinforced hydraulic types — Specification — Part 1: Oil-based fluid applications*

[6] ISO 1746, *Rubber or plastics hoses and tubing — Bending tests*

[7] ISO 1823-1, *Rubber hoses and hose assemblies — Part 1: On-shore oil suction and discharge — Specification*

[8] ISO 1823-2, *Rubber hoses and hose assemblies — Part 2: Ship/dockside discharge — Specification*

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[26] ISO 4639-2, *Rubber tubing and hoses for fuel circuits for internal-combustion engines — Specification — Part 2: Oxygenated fuels*

[27] ISO 4639-3, *Rubber tubing and hoses for fuel circuits for internal-combustion engines — Specification — Part 3: Oxidized fuels*

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[29] ISO 4642, *Rubber products — Hoses, non-collapsible, for fire-fighting service*

[30] ISO 4671, *Rubber and plastics hoses and hose assemblies — Methods of measurement of dimensions*

[31] ISO 4672, *Rubber and plastics hoses — Sub-ambient temperature flexibility tests*

[32] ISO 5031, *Continuous mechanical handling equipment for loose bulk materials — Couplings and hose components used in pneumatic handling — Safety code*

[33] ISO 5359, *Low-pressure hose assemblies for use with medical gases*

[34] ISO 5771, *Rubber hose and hose assemblies for transferring anhydrous ammonia — Specification*

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[36] ISO 5774, *Plastics hoses, textile reinforced, for compressed air — Specification*

[37] ISO/TR 5924, *Fire tests — Reaction to fire — Smoke generated by building products (dual-chamber test)*

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[43] ISO 6801, *Rubber or plastics hoses — Determination of volumetric expansion*

[44] ISO 6802, *Rubber and plastics hose and hose assemblies with wire reinforcements — Hydraulic impulse test with flexing*

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[55] ISO 7326, *Rubber and plastics hoses — Assessment of ozone resistance under static conditions*

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[57] ISO 7662, *Rubber and plastics hoses — Determination of abrasion of lining*

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[61] ISO 8030, *Rubber and plastics hoses — Method of test for flammability*

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[76] ISO 10960, *Rubber and plastics hoses — Assessment of ozone resistance under dynamic conditions*

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[78] ISO 11425, *Rubber hoses and hose assemblies for automobile power-steering systems — Specification*

[79] ISO 11758, *Rubber and plastics hoses — Exposure to a xenon arc lamp — Determination of changes in colour and appearance*

[80] ISO 11759, *Rubber hoses and hose assemblies for dispensing liquefied petroleum gases (LPGs) — Specification*

[81] ISO 12170, *Gas welding equipment — Thermoplastic hoses for welding and allied processes*

[82] ISO 13774, *Rubber and plastics hoses for fuels for internal-combustion engines — Method of test for flammability*

[83] ISO 14113, *Gas welding equipment — Rubber and plastics hoses assembled for compressed or liquefied gases up to a maximum design pressure of 450 bar*

Other standards (used internationally)

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[85] BS 5958-1, *Code of practice for control of undesirable static electricity — Part 1: General considerations*

[86] BS 5958-2, *Code of practice for control of undesirable static electricity — Part 2: Recommendations for particular industrial situations*

[87] DIN 86200, *Fire extinguishing and wash deck installation — Hose couplings, armatures, hoses, accessories — Summary of types for shipbuilding*

[88] NEN 3374, *Fire fighting equipment — Fire hose couplings and ancillary equipment*

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[89] *Prevention of serious accidents due to dangerous materials*, Document No. AI-25, published by Directorate-General of Labour, Dutch Ministry of Social Affairs[2)]

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[92] *Hose standards — Guide to purchasing, manufacturing and testing of loading and discharge hoses for offshore moorings*, 4th edition, 1991, Oil Companies International Marine Forum (OCIMF), distributors: Witherby & Co Ltd, 32 Aylesbury Street, London EC1R 0ET, UK

[93] *Hose standards — Guide to the handling, storage, inspection and testing of hoses in the field*, Oil Companies International Marine Forum (OCIMF), distributors: Witherby & Co Ltd, 32 Aylesbury Street, London EC1R 0ET, UK

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2) In Dutch.

3) In German; it is possible that a later edition exists.

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