TECHNICAL REPORT

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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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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.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.

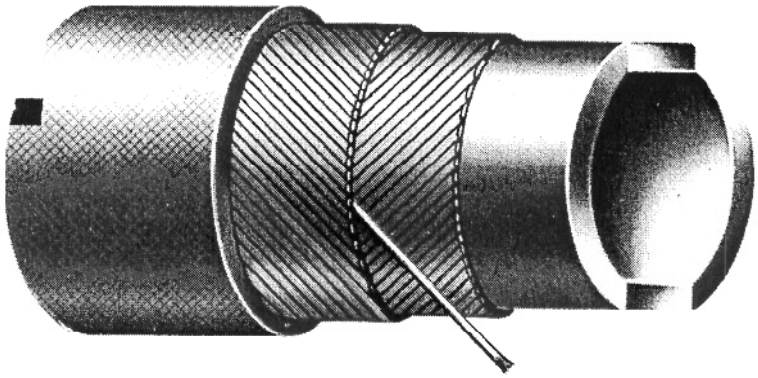

Figure 1 — Hose with metal conducting wires

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.

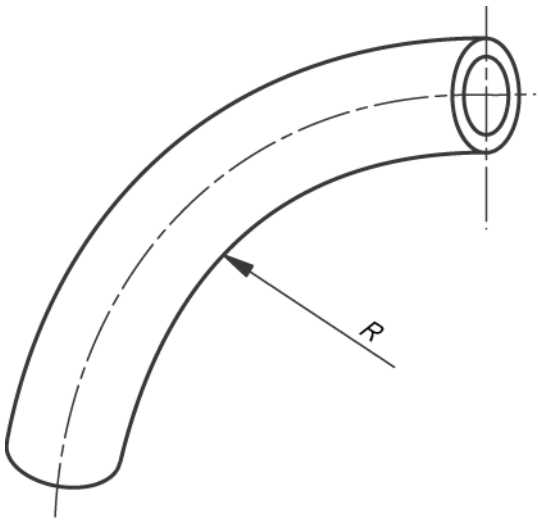

Figure 2 — Bending radius

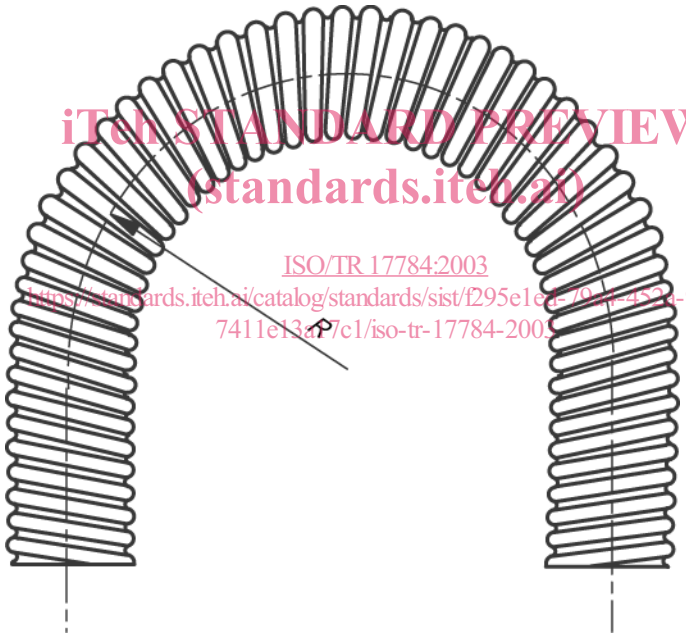

Figure 3 — Bending radius of corrugated hose with spiral

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).

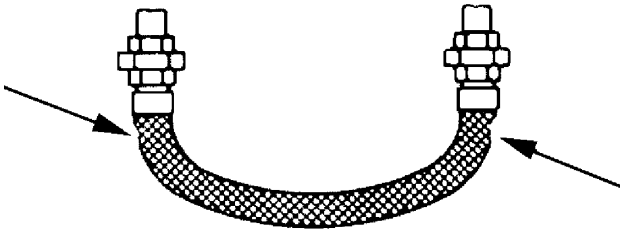

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Figure 4

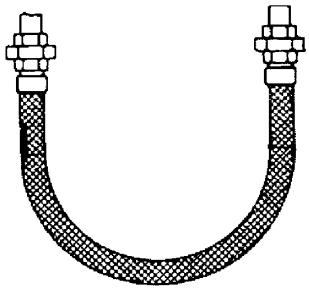

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Figure 5

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.

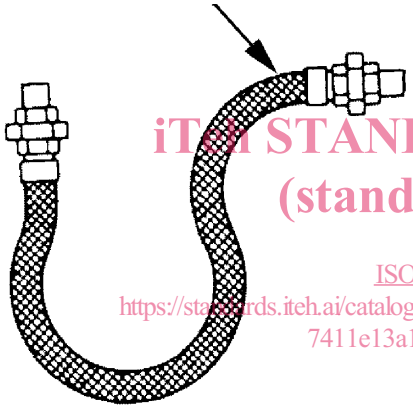

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Figure 6

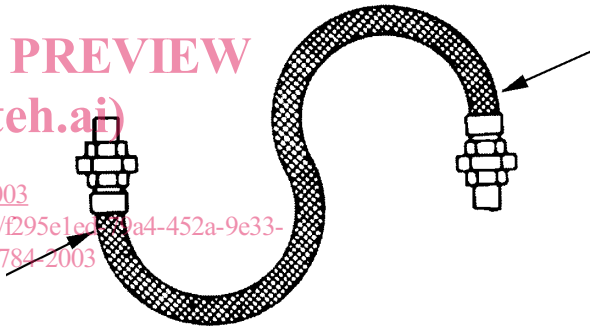

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Figure 7

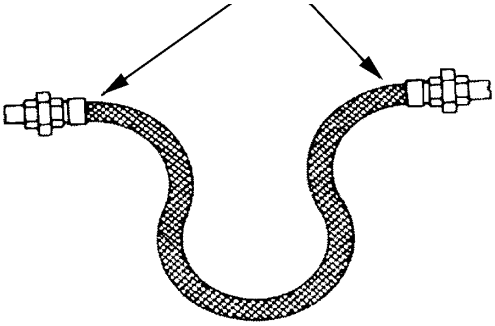

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Figure 8

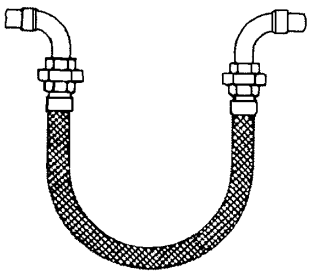

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Figure 9