
**Pipework — Corrugated metal hoses and
hose assemblies**

Tuyauteries — Tuyaux et tuyauteries métalliques flexibles onduleux

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Published in Switzerland

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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.

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 10380 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 342, *Metal hoses, hose assemblies, bellows and expansion joints*, in collaboration with ISO Technical Committee TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 11, *Metal hoses and expansion joints*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 10380:2003), which has been technically revised.

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Introduction

It was decided to produce an International Standard under the Vienna Agreement on technical cooperation between ISO and the European Committee for Standardization (CEN) in order to maintain a unique EN ISO document.

The major changes in this revision of this International Standard are the following:

- update of the structure of the International Standard;
- update of the test and performance requirements to reflect the practice of the industry at the time of publication;
- introduction of an evaluation of conformity and a system of certification.

This International Standard is a base standard for corrugated metal hoses and hose assemblies for general purpose.

Corrugated metal hoses and metal hose assemblies conforming to all aspects of this International Standard are considered to be designed and manufactured to sound engineering practice.

The requirements of this International Standard are of importance to designers, manufacturers, users, suppliers and importers of corrugated metal hoses.

Non-permanent, detachable connections between hoses and fittings are available in the market. Their design is not covered by this International Standard.

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Pipework — Corrugated metal hoses and hose assemblies

1 Scope

This International Standard specifies the minimum requirements for the design, manufacture, testing and installation of corrugated metal hose and metal hose assemblies.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6208, *Nickel and nickel alloy plate, sheet and strip*

ISO 9328-7, *Steel flat products for pressure purposes — Technical delivery conditions — Part 7: Stainless steels*

ISO 9723, *Nickel and nickel alloy bars*

ISO 9724, *Nickel and nickel alloy wire and drawing stock*

ISO 13585, *Brazing — Qualification test of brazers and brazing operators*

ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

ISO 16143-3, *Stainless steels for general purposes — Part 3: Wire*

EN 287-1, *Qualification test of welders — Fusion welding — Part 1: Steels*

EN 1652, *Copper and copper alloys - Plate, sheet, strip and circles for general purposes*

EN 1779, *Non-destructive testing — Leak testing — Criteria for method and technique selection*

EN 10028-7, *Flat products made of steels for pressure purposes — Part 7: Stainless steels*

EN 10088-1, *Stainless steels — Part 1: List of stainless steels*

EN 10088-3, *Stainless steels — Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes*

EN 10204, *Metallic products — Types of inspection documents*

EN 13133, *Brazing — Brazer approval*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

corrugated metal hose

pressure-tight hose made from tube or from strip, with corrugations, helical or annular to the axis of the hose, made by deforming the metal, its flexibility being obtained by bending the corrugations

NOTE 1 Classified by material, DN, PS at 20° C, bend radius and lifetime.

NOTE 2 In this International Standard, helical is designated “h” and annular is designated “a”.

3.2

nominal size

DN

<for components of a pipework system> alphanumeric designation of size comprising the letters DN followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the bore or the outside diameter of the end connections, and is used as a reference

NOTE 1 This defined number does not represent a measurable value and cannot be used for calculation purposes except where specified in the relevant standard.

NOTE 2 Adapted from ISO 6708.

NOTE 3 Adapted from ISO 7369:2004, definition 4.1.5.

3.3

strand

group of parallel wires that are woven together to form a single layer of braid

3.4

braid pitch

distance measured parallel to the axis of the braid for one complete turn or revolution of a strand

3.5

braided braid

braid that is manufactured from previously braided strands

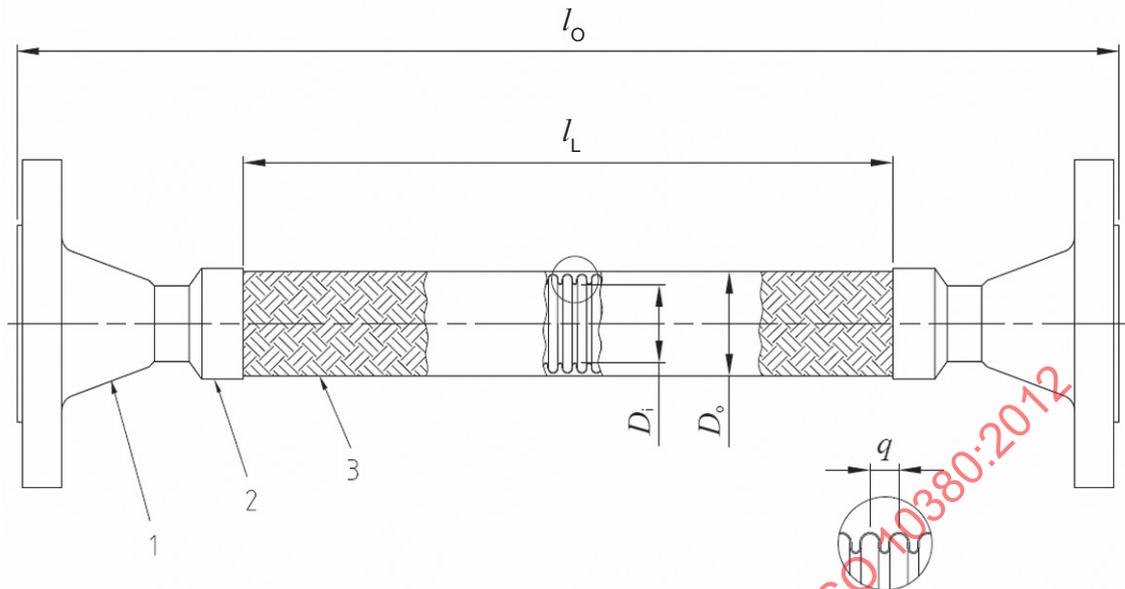
3.6

metal hose assembly

assembly of a corrugated metal hose with its end fittings subjected to internal or external pressure

See Figure 1.

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**Key**

- 1 end fitting
- 2 ferrule
- 3 corrugated metal hose/braid
- D_i internal diameter
- D_o outside diameter
- l_L active live length
- l_o overall length
- q pitch of the hose profile

Figure 1 — Metal hose assembly**3.7****nominal pressure****PN**

numerical designation which is a convenient rounded number for reference purposes

[ISO 7369:2004, definition 3.3]

NOTE 1 This defined number is a dimensionless number indirectly related to a pressure value in bar(s).

NOTE 2 Adapted from ISO 7268. See EN 1333.

3.8**maximum allowable pressure****PS**

p_S

maximum pressure at the operating temperature for which the hose assembly is designed, as specified by the manufacturer

3.9**operating temperature****TS**

extreme operating temperature, positive or negative, for which the hose assembly is designed

3.10
active live length

l_L
corrugated metal hose length to be taken into account for the design of the hose assemblies subjected to repeated movements

3.11
type testing

group of tests to be performed in order to verify that the performance level of the product meets the requirements of a standard

3.12
qualified procedure

manufacturing and design process demonstrated by tests and described in detail in process instructions for the specific manufacturing or design

NOTE For products subject to specific quality surveillance systems, such procedures can be qualified by the required authorities or person.

3.13
third-party conformity assessment activity

conformity valuation activity that is performed by a person or body independent of the person or organization who/which provides the object, and independent of user interests in that object

NOTE 1 Criteria for the independence of conformity assessment bodies and accreditation bodies are provided in the International Standards and Guides applicable to their activities.

NOTE 2 The first-, second- and third-party descriptors used to characterize conformity assessment activities with respect to a given object are not to be confused with the legal identification of the relevant parties to a contract.

3.14
certification

third-party attestation related to products, processes, systems or persons

NOTE 1 Certification of a management system is sometimes also called registration.

NOTE 2 Certification is applicable to all objects of conformity assessment except for conformity assessment bodies themselves, to which accreditation is applicable.

3.15
test pressure

P_T
differential pressure to which the hose assembly or the component is subjected during a test at ambient temperature

NOTE Adapted from ISO 7369:2004, definition 3.8.

3.16
manufacturer

producer of corrugated metal hose or producer of corrugated metal hose and metal hose assemblies

3.17
assembler

fabricator of metal hose assemblies with corrugated metal hose purchased from manufacturers

4 Design requirements

4.1 General

Corrugated metal hoses, braided or unbraided, and their assemblies are designed to allow frequent movement or pliability.

These design requirements shall ensure that the construction of corrugated metal hoses, where properly installed and used correctly, under chemical, mechanical and thermal conditions for general use, provide long-term safe operation without degradation.

Corrugated metal hoses are divided into the following four different types (see Table 7) and tested accordingly, as described in Clause 5:

- type 1-50: corrugated metal hoses of high flexibility with high fatigue life;
- type 1-10: corrugated metal hoses of high flexibility with medium fatigue life;
- type 2-10: corrugated metal hoses of average flexibility;
- type 3: corrugated metal hoses where only pliability is required.

Corresponding radii for pliability tests are given in Table 6 and corresponding radii for fatigue tests are given in Table 8.

NOTE 1 The fatigue life of a corrugated metal hose is mainly affected by bend radius, pressure and temperature:

- at a given bend radius, fatigue life increases by lowering the working pressure;
- at a given working pressure, fatigue life increases by increasing the bend radius.

NOTE 2 Passing a test does not imply that the minimum or average fatigue life can be reached in circumstances other than those specified in the test procedure.

NOTE 3 Where a user requires a higher fatigue life than given in this International Standard, the manufacturer can be consulted.

NOTE 4 The installation configuration, such as type of movement, pressure characteristics and environmental condition, have a strong influence on the fatigue life of a corrugated metal hose assembly.

NOTE 5 The lubrication condition of the braid influences the fatigue life of a corrugated metal hose. A reduction of lubrication can occur during assembly, cleaning, transportation, storage or in service conditions.

4.2 Nominal sizes, DN

The designation of standard nominal sizes shall be as given in Table 1. The internal diameter of a corrugated metal hose shall not be less than 98 % of its nominal size designation.

Table 1 — Nominal sizes, DN

DN
4
6
8
10
12
15
20
25
32
40
50
65
80
100

Table 1 (continued)

DN
125
150
200
250
300

Other nominal sizes can be produced in accordance with the customer's requirements. Their performance (see Clause 5) should be interpolated from the values for the nearest nominal sizes, as given in Table 1.

4.3 Overall length, l_O

If not explicitly otherwise specified between the manufacturer and purchaser, the overall length, l_O , of a metal hose assembly shall be the length as ordered to a tolerance of +3 % and -1 %.

For short hose assemblies, these tolerances do not apply because often a tolerance of one corrugation is necessary, depending on the attachment technology of fittings. On no account shall the overall length be less than 99 % of the length as ordered.

NOTE For minimum overall length of a braided hose assembly, see 4.6.

4.4 Hose design

The corrugated metal hose shall be made from seamless tube, welded tube or strip. Where welded construction is used, the hose may be butt- or lap-welded, the weld being axial or spiral along the length of the hose and in accordance with qualified welding and forming procedures. Corrugations may be annular or helical.

The corrugation shall be of regular form, continuous and concentric along the length of the hose, and shall be free of defects, such as scores, dents, cuts or weld variations, which can cause premature failure. Where required, a hose can be heat treated after forming.

NOTE Heat treatment influences flexibility, fatigue life and pressure-bearing capacity. It is, therefore, necessary for the manufacturer to provide details on the characteristics affected by this type of treatment.

4.5 Materials

Materials for the manufacture of corrugated metal hoses and metal hose assemblies shall be selected on the basis of their suitability for fabrication (cold forming, welding, etc.) and for the conditions under which they shall be used. A list of suitable materials is given in Table 2.

Alternative equivalent European material designations are given in Table A.3.

Table 2 — Materials

Material of construction	Corrugated metal hose	Braid	End fitting ^a and ferrule
Stainless steel hose assemblies	Austenitic stainless steel in accordance with ISO 9328-7, grades X2CrNi19-11, X6CrNiTi18-10, X2CrNiMo17-12-2, X5CrNiMo17-12-2, X6CrNiMoTi17-12-2, X2CrNiMo18-14-3, X1CrNiMoCuN20-18-7 and X1NiCrMoCu25-20-5	Austenitic stainless steel in accordance with ISO 16143-3, grades X2CrNi19-11, X5CrNi18-9, X6CrNiTi18-10, X2CrNiMo17-12-2, X5CrNiMo17-12-2 and X6CrNiMoTi17-12-2	Austenitic stainless steel in accordance with the composition given in ISO 9328-7, grades X2CrNi19-11, X5CrNi18-9, X6CrNiTi18-10, X2CrNiMo17-12-2, X5CrNiMo17-12-2 and X6CrNiMoTi17-12-2 Carbon steel containing a maximum of 0,05 % sulfur and 0,05 % phosphorus ^b Copper-based alloy, if formed, deep-drawing quality.
Copper-based alloy hose assemblies	Deep-drawing quality phosphor bronze containing a minimum of 95 % copper and 1 % tin.	Phosphor bronze containing a minimum of 95 % copper and 1 % tin.	Copper-based alloy, if formed, deep-drawing quality.
Nickel alloy hose assemblies	Nickel alloy strip in accordance with ISO 6208, grades NiMo16Cr15Fe6W4, NiCu30, NiCr15Fe8, NiCr22Mo9Nb, FeNi32Cr21AlTi and NiFe30Cr21Mo3	Austenitic stainless steel in accordance with ISO 16143-3, grades X2CrNi19-11, X5CrNi18-9, X6CrNiTi18-10, X2CrNiMo17-12-2, X5CrNiMo17-12-2 and X6CrNiMoTi17-12-2 Nickel alloy wire in accordance with ISO 9724, grades NiMo16Cr15 Fe6W4, NiCu30, NiCr15Fe8, NiCr22Mo9Nb, FeNi32Cr21AlTi and NiFe30Cr21Mo3	Austenitic stainless steel in accordance with the composition of ISO 9328-7, grades X2CrNi19-11, X5CrNi18-9, X6CrNiTi18-10, X2CrNiMo17-12-2, X5CrNiMo17-12-2 and X6CrNiMoTi17-12-2 Nickel alloy bar in accordance with ISO 9723, grades NiMo16Cr15 Fe6W4, NiCu30, NiCr15Fe8, NiCr22Mo9Nb, FeNi32Cr21AlTi and NiFe30Cr21Mo3
<p>^a The material specified for end fittings applies only to the parts which are welded or brazed to the hose.</p> <p>^b Carbon steel shall not be used for ferrules.</p>			

4.6 Braiding

Where braided, the corrugated metal hose shall be uniformly covered by wire, either machine-woven around the hose or tightly fitted by hand as a stocking.

Where the braid (see Figure 2) is fitted by hand as a stocking, suitable design and manufacturing measures shall be taken to fit the braid as tightly as possible. However, the performance level of such a braid can still be different from that of a machine-woven braid around the hose. In addition, if machine and hand-fitted braiding are used on the same assembly (double braiding), special care shall be taken regarding the performance of such a combination. Therefore, the performance level shall be verified.

Braid irregularities, such as wire crossings and wire loops, can have an influence on the performance of the product. The manufacturer shall take care to limit such features.

The wires of a strand should all have a similar tension.

The practical burst strength also depends on the method used to attach the braiding to the end fittings and shall be established by burst tests, as described in 5.5.

Braided braid shall be considered appropriate for the large nominal sizes and heavy-duty applications.

Friction between hose and braid has a strong influence on the fatigue life of dynamic hose installations. Manufacturers shall indicate the need for lubrication of specific applications.

Where braid is connected to end fittings, care shall be taken to ensure that all the braid wires are securely bonded to the end fittings.

The breaking of individual braid wires during service reduces the tensile strength of a braid. The manufacturer shall inform the user accordingly and include the check for wire defects in the maintenance instructions for the user.

Braid performance shall always be verified by type testing.

NOTE 1 A theoretical approximate tensile force of a single braid, f , can be calculated using Formula (1) at 20 °C:

$$f = C \cdot W \cdot \left(\frac{d}{2}\right)^2 \cdot \pi \cdot R_m \cdot \cos(\alpha) \quad (1)$$

where

- C is the number of strands;
- W is the number of wires in each strand;
- d is the diameter of individual wire, in millimetres;
- R_m is the tensile strength of the material of the wires;
- α is the braid angle, in degrees.

The theoretical breaking pressure, B , of a single braid is given by Formula (2):

$$B = \frac{f}{A_e} \quad (2)$$

where A_e is the effective thrust area of the hose.

If multiple braids are used, the tension strengths of the second and third braids are not as high as that of the first braid and are approximately as given by Formulae (3) and (4):

Double braid:

$$f_{2ax} \approx 1,8 \cdot f_{1ax} \quad (3)$$

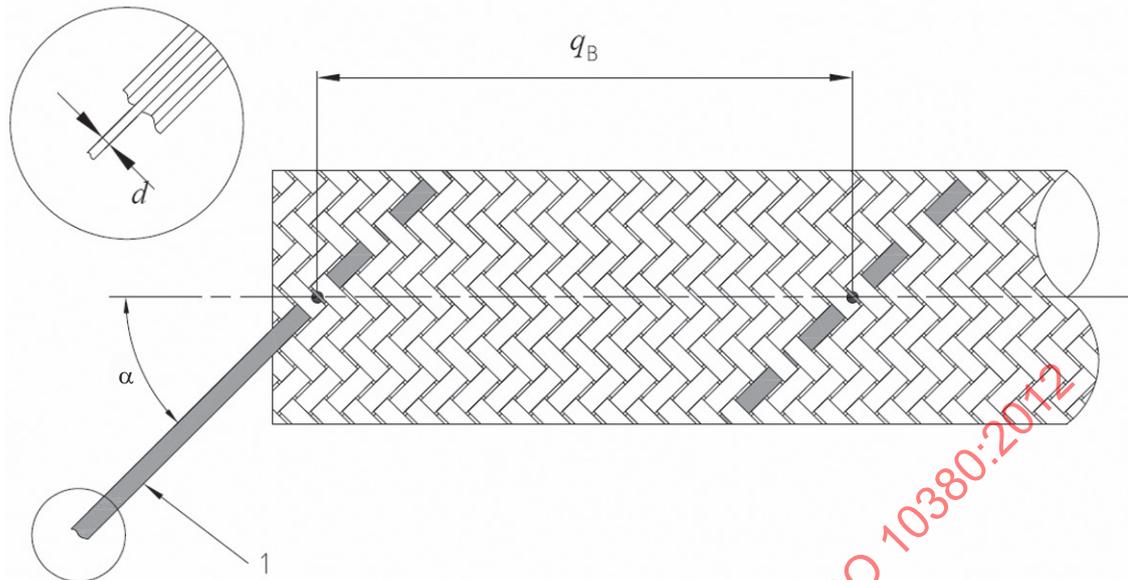
Triple braids:

$$f_{3ax} \approx 2,6 \cdot f_{1ax} \quad (4)$$

where

- f_{1ax} is the theoretical tensile strength of one braid;
- f_{2ax} is the theoretical tensile strength of two braids;
- f_{3ax} is the theoretical tensile strength of triple braids.

NOTE 2 Formulae (3) and (4) are only applicable to braidings of similar characteristics to those of the single braid.

**Key**

- 1 strand
- α braid angle
- d diameter of individual wire
- q_B braid pitch

Figure 2 — Braid

NOTE 3 For pressurized hose assemblies, a braid angle of between 40° and 50° is used.

To meet the characteristics given in this International Standard, braided metal hose assemblies shall be of such a length that there is at least one complete revolution (braid pitch) of braid along the length of the hose.

4.7 Pressure

The maximum allowable pressure of the hose assembly shall be the lowest of any component of a corrugated metal hose assembly.

It is essential that the maximum operating pressure, including surge pressure to which the hose is subjected in service, not exceed the specified maximum allowable pressure.

The permanent elongation of a corrugated metal hose with its ends closed and after being pressurized to its test pressure shall not exceed 1 %.

NOTE 1 The length of a hose assembly under positive pressure increases, and decreases under negative pressure.

NOTE 2 Corrugated metal hoses can be compliant with one of the following PN: 0,5; 1; 2,5; 6; 10; 16; 20; 25; 40; 50; 63; 100; 150; 160; 250; 320; 400 or 450.

4.8 Temperature

The maximum allowable pressure, p_S , of a corrugated metal hose assembly at any temperature is the lowest value of the pressure at 20 °C of each component multiplied by its appropriate derating factor, C_t .

The derating factors, C_t , for the materials are indicated in Table 3.

Alternative derating factors, C_t , for European material designations are given in Table A.4.

Table 3 — Derating factors, C_t , and limiting temperatures

Temperature °C	20	50	100	150	200	250	300	350	400	450	500	550	600	650	
Material	X2CrNi19-11	1	0,87	0,72	0,65	0,59	0,55	0,51	0,48	0,46	0,45	0,44	0,43	—	—
	X5CrNi18-10	1	0,88	0,73	0,66	0,60	0,56	0,52	0,50	0,48	0,47	0,46	0,42	—	—
	X6CrNiTi18-10	1	0,92	0,83	0,78	0,74	0,71	0,67	0,64	0,62	0,61	0,60	0,59	—	—
	X2CrNiMo17-12-2	1	0,88	0,74	0,67	0,62	0,58	0,54	0,52	0,50	0,48	0,47	0,47	—	—
	X5CrNiMo17-12-2	1	0,90	0,78	0,71	0,66	0,62	0,58	0,56	0,53	0,52	0,51	0,51	—	—
	X6CrNiMoTi-17-12-2	1	0,90	0,81	0,76	0,73	0,69	0,65	0,63	0,61	0,59	0,59	0,58	—	—
	X2CrNiMo18-14-3	1	0,88	0,74	0,67	0,61	0,57	0,54	0,52	0,50	0,48	0,47	0,47	—	—
	X1CrNiMoCuN20-18-7	1	0,90	0,77	0,70	0,64	0,61	0,57	0,56	0,54	0,53	0,52	—	—	—
	X1NiCrMoCu25-20-5	1	0,93	0,87	0,82	0,76	0,70	0,65	0,61	0,57	0,54	0,52	0,50	—	—
	— ^a	1	0,97	0,91	0,84	0,77	0,71	0,65	0,60	0,57	0,29 ^b	0,18 ^b	—	—	—
	NiMo16Cr15Fe6W4 ^c	1	0,97	0,92	0,88	0,83	0,79	0,74	0,72	0,70	—	—	—	—	—
	NiCr30 ^c	1	0,94	0,86	0,81	0,77	0,75	0,74	0,74	0,74	0,73	—	—	—	—
	NiCr15Fe8 ^c	1	0,98	0,94	0,92	0,89	0,86	0,83	0,83	0,83	0,82	0,81	0,78 ^b	0,54 ^b	0,36 ^b
	NiCr22Mo9Nb ^c	1	0,95	0,88	0,84	0,80	0,78	0,75	0,73	0,70	0,68	0,65	0,64	0,63	0,5 ^b
	FeNi32Cr21AlTi ^c	1	0,93	0,80	0,74	0,68	0,63	0,58	0,55	0,53	0,51	0,50	0,49	0,48	0,39 ^b
	NiFe30Cr2Mo3 ^c	1	0,95	0,89	0,83	0,77	0,75	0,74	0,72	0,70	0,68	0,67	0,66	—	—

NOTE 1 The derating factor applicable to low temperatures for some of the austenitic materials listed is higher than 1. For further information, contact the manufacturer.

NOTE 2 Stainless steel designations and values are specified in ISO 9328-7 for 1 % proof C product form, carbon steel designations are specified in ISO 6317 and nickel alloy designations are specified in ISO 6208.

^a Typical non-alloyed carbon steel.

^b Values in the creep range (100 000 h).

^c Indicative values from industrial background.

4.9 Corrosion

Corrugated metal hoses and hose assemblies shall have adequate resistance to all the corrosive agents to which they are likely to be exposed during their lifetime.

Special consideration shall be given to pitting corrosion, crevice corrosion, stress corrosion cracking and intergranular corrosion.

All parts of the corrugated metal hose assembly exposed to corrosion shall take into account the corrosion risk, both by the selection of appropriate shapes for the parts used and by the selection of appropriate materials.

NOTE 1 Corrugated metal hoses usually have a substantially smaller wall thickness than all other parts of the system in which they are installed. Hence, they are often manufactured from a material having a higher corrosion resistance than that used in the adjacent components.

For use of materials in corrosive environments, see the specification of the selected material, corrosion resistance tables and/or experience of the corrugated metal hose manufacturer.

NOTE 2 Concerning their corrosion resistance, suitable materials for corrugated metal hoses can be classified as specified in Table 4.

Table 4 — Typical classification of materials for corrosion resistance

Corrosion resistance class	Description	Material grade	Examples
A	Basic corrosion resistance	Stainless steels	X2CrNi19-11 X6CrNiTi18-10
B	Good corrosion resistance	Mo-alloyed stainless steels	X2CrNiMo17-12-2 X5CrNiMo17-12-2
C	Advanced corrosion resistance	Super-alloyed stainless steels	X1CrNiMoCuN20-18-7 X1NiCrMoCu25-20-5
D	High corrosion resistance	Ni-based alloys	NiCr22Mo9Nb (NW 6625)

NOTE 3 If required, the corrosion resistance of a hose can be increased by some form of internal and/or external protection.

NOTE 4 Heat treatment of the corrugated metal hose material improves the corrosion resistance characteristics, but modify the mechanical properties of the metal hose assembly.

4.10 Cleanliness

Hoses and hose assemblies shall be supplied to the purchaser free of water and substantially free of visible residues on inner and outer surfaces.

NOTE 1 Being free of visible residues corresponds to less than 500 mg/m².

NOTE 2 A more stringent cleanliness level can be required depending on the application.

Water used for cleaning procedures shall contain a maximum chlorine level of 30 mg/dm³.

4.11 Electrical conductivity

Under certain conditions, flowing media in corrugated metal hoses can cause an electrostatic charge, which can result in sparking. Sparks can perforate the hose wall or create explosions or fire in dangerous environments.

Metal hose assemblies, which are made exclusively out of metal, have adequate conductivity to discharge occurring currents where being grounded. If grounding is not possible, stray current shall be avoided.

With metal hose assemblies having one or more non-metallic component(s) (insulation, gasket, internal liner, etc.), suitable measures shall be taken to discharge the assembly, for instance through the use of materials with sufficient discharge capacity. Electrical fields caused by electrostatically charged media shall be shielded from the hose assembly.

4.12 Flow velocity

Flow velocity shall be considered in the design of a hose assembly.

Flow velocity is given by:

$$V = \frac{Q_v \cdot 4}{\pi \cdot D_i^2} \tag{5}$$

or

$$V = \frac{Q_m \cdot 4}{\rho \cdot \pi \cdot D_i^2} \tag{6}$$

where

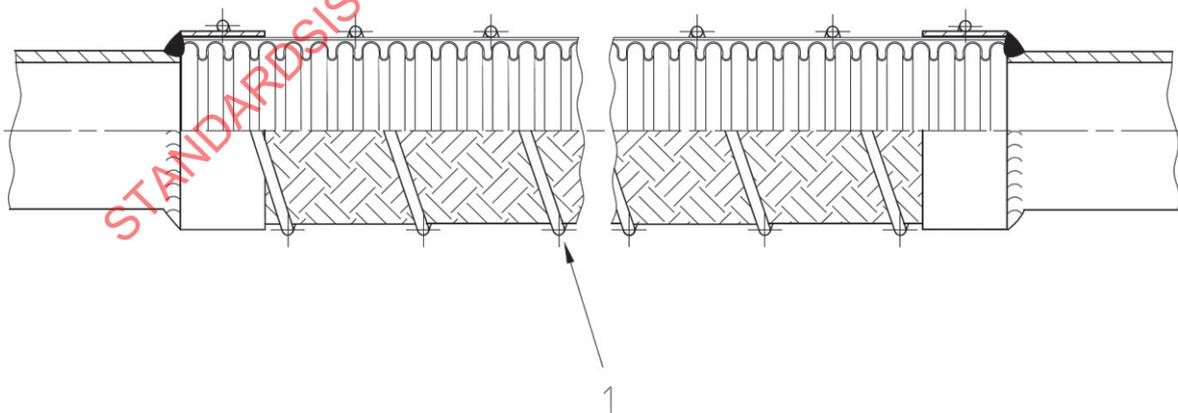
- V is the flow velocity;
- Q_v is the volumetric flow rate;
- Q_m is the mass flow rate;
- D_i is the internal diameter of the corrugated hose, in millimetres;
- ρ is the medium density.

NOTE High velocities can force the corrugations into resonant vibration, resulting in premature failure. Such failure can be prevented through the use of an internal liner or change of the nominal size, DN. The critical speed is mostly influenced by the medium conveyed and its working conditions, the shape of the corrugations and hose bending. It can start from 5 m/s for liquids and 30 m/s for gases. For higher values, it is intended that the manufacturer be consulted.

4.13 Additional protection

Where required, corrugated metal hose assemblies shall be provided with additional internal or external protection to prevent mechanical damage. This shall be provided by the following:

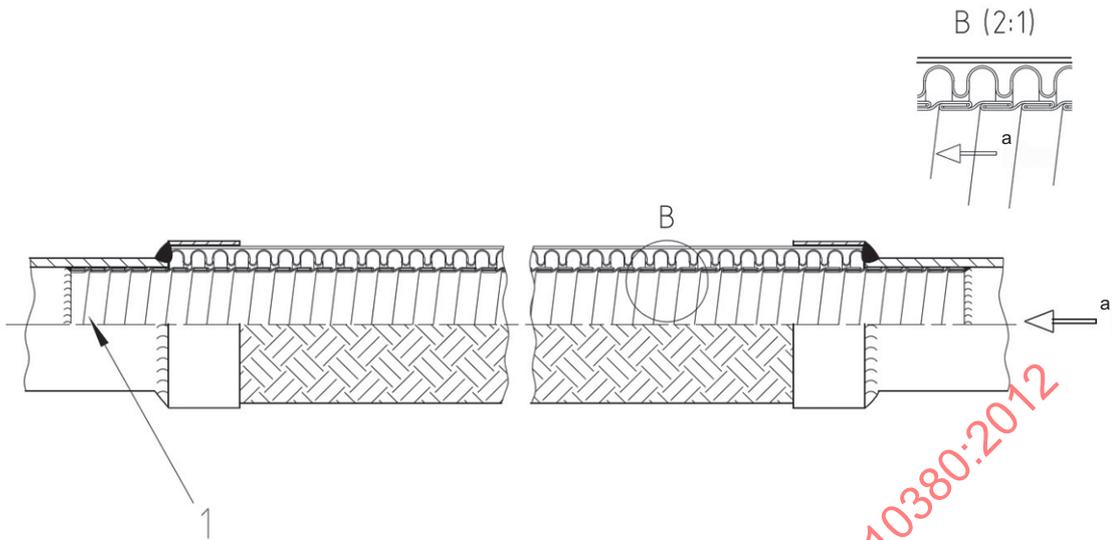
- an anti-abrasion protective coil of metal or non-metal material suitable for the operation conditions envisaged [see Figure 3 a)];
- an additional inner or outer sleeve resistant to wear, weathering and abrasion [see Figures 3 b) and c)];
- other means of protection, such as heat shielding, fire protection and local overbending protection [see Figure 3 d)].



Key

- 1 anti-abrasion protective coil

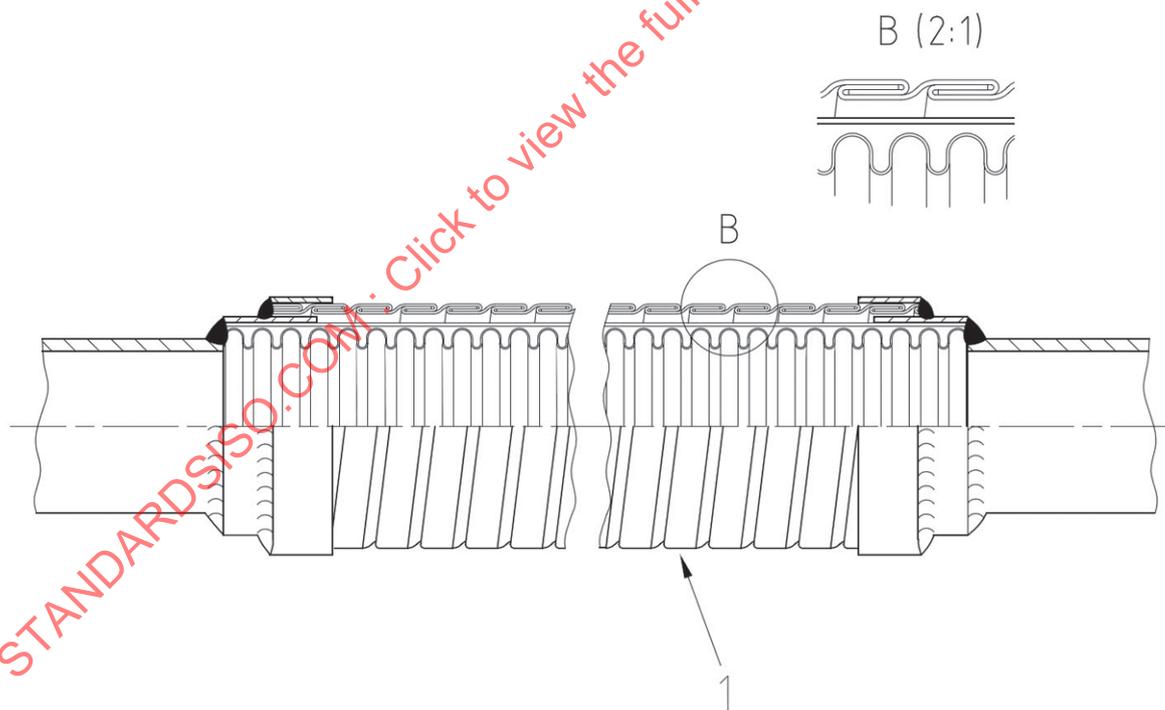
a) Anti-abrasion protective coil



Key

- 1 additional sleeve resistant to tear
- a Direction of flow.

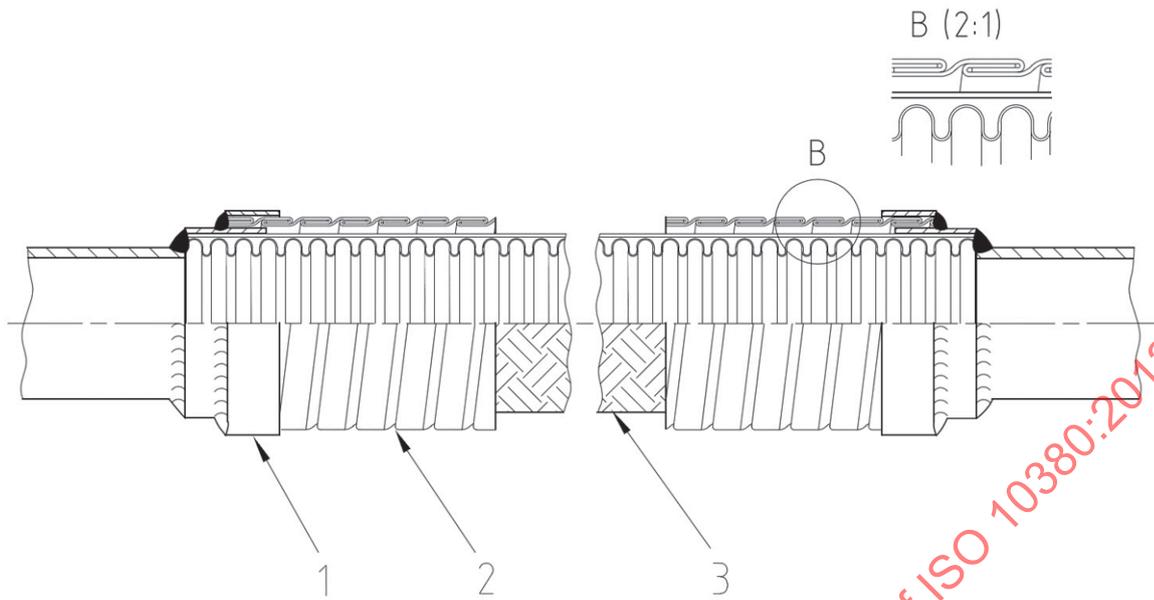
b) Internal liner



Key

- 1 additional sleeve resistant to tear

c) Outside protection using strip-wound hose



- Key**
- 1 ferrule
 - 2 local overbending protection
 - 3 metal hose assembly

d) End protection against overbending using strip-wound hose

Figure 3 — Possible protective solutions

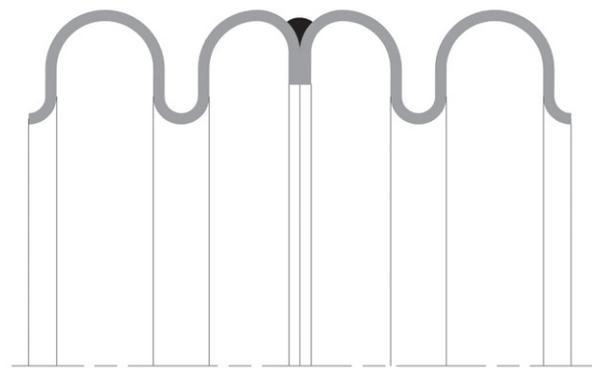
Where additional protection affects the bend radii given in Table 6 and Table 8 or negatively influences the fatigue life of the hose assembly, the manufacturer shall notify the purchaser accordingly.

Where a protective coating is used on a stainless steel hose, it shall not contain zinc, lead or tin.

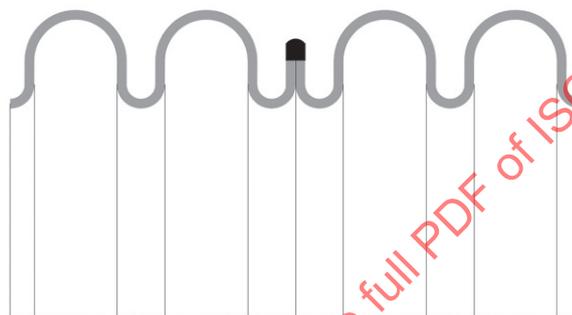
Where the material of a synthetic cover contains corrosive agents, such as chlorine or sulfur, care shall be taken to ensure that such agents are not released during the manufacturing process or in service.

4.14 Hose joining

Where a manufacturer uses hose joints in order to increase the hose length, such joints shall be either butt-welded or edge-welded, as shown in Figure 4, and shall be in accordance with qualified procedures.



a) Butt-welded



b) Edge-welded

Figure 4 — Details of butt-welded and edge-welded hose joints

4.15 Attachment of end fittings to hose

Corrugated metal hoses are attached to many standardized and custom-designed fittings.

Standardized end fittings shall be of the material given in Table 2. Their ends shall be shaped and prepared in such a way that they allow correct welding or brazing to the hose.

NOTE For example, ISO 10806 can be applicable.

Where custom-designed fittings are used, methods and performance of the connection between corrugated metal hose and fittings shall be determined between the manufacturer or assembler and user.

The connection between the corrugated metal hose and the end fitting shall be made by a method resulting in a permanent non-detachable connection, which can only be detached by irreparably damaging the hose or the end fitting. The connection shall ensure leaktightness and shall withstand all the tests specified in Clause 5.

All joining methods used in the manufacturing of metal hose assemblies shall be qualified.

Welder qualifications and welding procedure qualifications shall be in accordance with EN 287-1 and ISO 15614-1; brazer qualification and brazing procedure qualification shall be in accordance with EN 13133 and ISO 13585.

Where welding penetration reduces the internal diameter, the flow performance shall be verified.

Where crevice- and burr-free connections are required, they shall be specified by the purchaser.

4.16 Design parameters for corrugated metal hoses and metal hose assemblies

4.16.1 The following information is required for the correct design of the metal hoses:

- a) nominal size, DN;
- b) flexibility type;
- c) minimum and maximum operating pressures;
- d) working temperature range;
- e) materials.

4.16.2 The following additional information is required for the correct design of the metal hose assemblies:

- a) medium to be conveyed;
- b) maximum operating pressure;
- c) maximum operating temperature;
- d) minimum bend radius;
- e) overall length;
- f) type of fittings of the hose assembly;
- g) service life expected.

4.16.3 Depending on the application, the following additional information may be required:

- a) flow rate;
- b) type of movement or vibration;
- c) requirements for cleanliness;
- d) special conditions (e.g. water hammer);
- e) requirements for test certificates;
- f) indication of whether vacuum or any additional testing is required;
- g) any special requirements for packaging.

5 Performance requirements and tests

5.1 General

Metal hose assemblies shall be representative of production and made in accordance with the requirements of this International Standard; they shall be tested following the sequence set out in Tables 11 and 12.

All samples of each size shall pass the following tests within the test sequence schedule given in Clause 6. The tests shall be performed under ambient conditions. If not otherwise stated, the functional tolerances indicated in Table 5 shall apply to the test equipment.

Table 5 — Functional tolerances of the test equipment

Pressure	±5 %
Ambient temperature	±5 °C
Volume	±5 %
Time	±5 %

Water used for testing shall contain a maximum chlorine level of 30 mg/dm³.

5.2 Leaktightness

5.2.1 Requirements

Metal hose assemblies shall be leaktight where tested in accordance with the methods given in 5.2.2.

The leaktightness test of metal hose assemblies shall be performed before any external protection, if used, is fitted. In the final leaktightness test for type testing, it shall be demonstrated by suitable measures that external protection does not contribute to the achievement of the given leakage rate.

The test sample shall be completely dried before being leak tested.

5.2.2 Test

The leaktightness test shall be performed in accordance with one of the test methods described in EN 1779.

The following is an example of bubble test method.

EXAMPLE The test pressure shall be 10 % of the maximum allowable pressure, p_S , but not more than 2 bar¹⁾ for safety reasons (see 5.3.2) and the test medium air. The test pressure shall be applied and the metal hose or metal hose assembly shall be held completely under water for a period long enough to permit a visual inspection without any disturbance resulting from bubbles trapped on the surfaces of the hose or hose assembly. The metal hose or metal hose assembly shall then not exhibit any air bubbles (single or as a constant stream) for a period of at least 2 min.

NOTE 1 The maximum leakage rate is considered to be equivalent to 1×10^{-3} mbar·l/sec. A more stringent leakage level can be required depending on the application. Comparable leak testing methods, e.g. pressure gradient leak testing or helium testing, can be used.

NOTE 2 As leak testing with air under water (bubble test) is a subjective method, qualified and reliable test personnel are required. The qualified personnel can be certified according to EN 473 or equivalent.

5.3 Pressure resistance

5.3.1 Requirements

Corrugated metal hoses, braided or unbraided, and corrugated metal hose assemblies shall be capable of withstanding the test pressure without any deformation, leakage or other mode of failure.

1) 1 bar = 0,1 MPa = 10⁵ Pa; 1 MPa = 1 N/mm².

5.3.2 Test

The test pressure, P_T , shall be applied and maintained for a sufficient length of time to permit a visual examination of all surface joints, but in any case, for not less than 1 min for hoses of DN = 50, 2 min for hoses 50 < DN = 100 and 3 min for hoses of DN > 100. The test pressure is defined as:

$$p_T = 1,43 \cdot p_S \quad (7)$$

or

$$p_T = 1,25 \cdot \frac{p_S}{C_t} \quad (8)$$

whichever result from Formula (7) or (8) is greater,

where

C_t is the temperature derating factor according to Table 3 and Table A.4.

NOTE Formula (8) applies to derating factors, C_t , smaller than 0,83, corresponding to a maximum operating temperature (TS), T_S , of approximately 100 °C for standard austenitic materials.

If the test is performed with air or nitrogen under water, the leaktightness test in 5.2 and this pressure proof test may be combined.

Pneumatic testing is a more dangerous operation than hydraulic testing, in that, irrespective of size, any failure during the test is likely to be of a highly explosive nature. Therefore, precautions shall be taken and rules regarding such a test method shall be observed.

5.4 Elongation

5.4.1 Requirements

The permanent elongation of a metal hose assembly subjected to its test pressure shall, after release of the pressure, not exceed 1 % of its initial length.

5.4.2 Test

The live length of a braided test sample shall be of at least one complete revolution of the braid (lay) with its ends closed by appropriate fittings. An unbraided test sample shall have a live length, l_L , of 0,5 m or $3 \times DN$, whichever is greater.

It shall be laid in a straight position on a flat surface. The exact value of the live length shall be recorded to a tolerance of ± 1 mm. Fixed at one end, it shall then be hydraulically pressurized to 1,5 times its maximum allowable pressure and the pressure held for 1 min. Release the pressure, measure the new length and calculate the permanent elongation.

5.5 Burst pressure

5.5.1 Requirements

The burst pressure of a corrugated metal hose assembly shall not be less than four times the maximum allowable pressure at room temperature.

5.5.2 Test

The live length, l_L , of a braided test sample shall be equivalent to at least one complete revolution of the braid or an unbraided test sample shall have a live length of 0,5 m or $3 \times DN$, whichever is greater. The test sample shall be closed by appropriate fittings and fixed at one end, lying horizontally on a surface. It shall be hydraulically

pressurized to 1,5 times its allowable pressure and such pressure held for 1 min. The pressure shall then be increased gradually with a minimum of 10 increments to four times its maximum allowable pressure and the pressure held at this level for 1 min. At this pressure level, the assembly shall not fail by visible leakage or rupture of any of the components. A deformation of the corrugations shall not be regarded as a failure of the test.

The test shall be performed for each method of assembly used (TIG welding, MIG welding, brazing, etc.).

NOTE The pressure can be increased further until the burst occurs. This pressure can be recorded and a safety margin noted.

5.6 Pliability

5.6.1 Requirements

A corrugated metal hose shall be capable of being bent 10 times to a small radius in accordance with Table 6 without leakage.

5.6.2 Test

The sample shall be subjected to a bend test as shown in Figure 5. Samples of types 1 and 2 shall be braided; type 3 shall be unbraided. With one hose end rigidly fixed, the other shall be moved in a circular arc around a mandrel whose radius is calculated from the bend radius, r (pliability test), as given in Table 6, until the hose is in intimate contact with the former through an arc of 90°.

Table 6 — Bend radii for pliability test

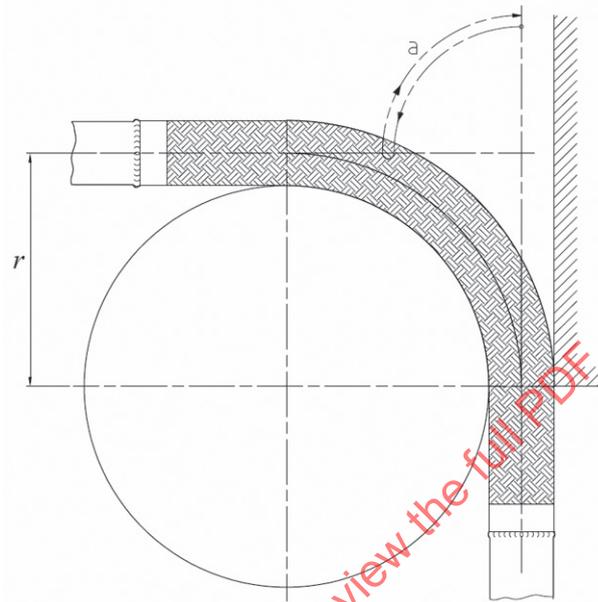
DN	Pliability test	
	Types 1 and 2 (braided)	Type 3 (unbraided)
	Bend radius mm	
4	25	11
6	25	12
8	32	16
10	38	20
12	45	25
15	58	25
20	70	30
25	85	45
32	105	60
40	130	80
50	160	100
65	200	115
80	240	130
100	290	160
125	350	—
150	400	—
200	520	—
250	620	—
300	720	—

NOTE The dimensions listed in this table can be used for design purposes; see the manufacturer for confirmation.

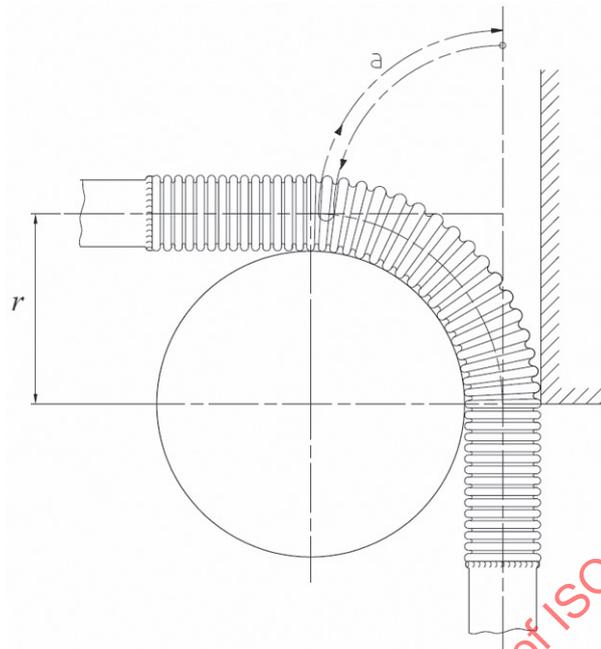
There shall not be any excessive horizontal force other than that used for bending the assembly around the mandrel.

One cycle comprises one bend and return movement to the straight position. The test shall consist of the assembly being flexed through the 10 cycles specified without pressure. The test frequency shall be between 5 cycles/min and 15 cycles/min.

After the test, the assembly shall be dried and subjected to the leaktightness test specified in 5.2. There shall be no visible leakage or any other mode of failure.



a) Sample braided without outside protection



b) Sample unbraided without outside protection

Key

- r bend radius
 a One cycle.

Figure 5 — Pliability test**5.7 Fatigue****5.7.1 General**

Type 1 and type 2 corrugated metal hoses shall permit repeated flexing under pressure for reasonably expected life cycles of the product. The performance of the products shall be tested by representative cycle tests according to Table 7. Depending on the performance level, the cycle requirements shall be:

- Type 1-50: 50 000 cycles
- Type 1-10: 10 000 cycles
- Type 2-10: 10 000 cycles

Where tested in accordance with 5.7.2, high-cycle-life hoses shall have an average life of 50 000 cycles, but no sample below 40 000 cycles.

Where tested in accordance with 5.7.2, standard-cycle-life hoses shall have an average life of 10 000 cycles, but no sample below 8 000 cycles.

Table 7 — Requirements for fatigue

Hose type	Standard cycle 10 000 cycles	High cycle 50 000 cycles
1-50	—	x
1-10	x	—

Table 7 (continued)

Hose type	Standard cycle 10 000 cycles	High cycle 50 000 cycles
2-10	x	—
3	Pliable, no fatigue requirement	Pliable, no fatigue requirement

NOTE These representative cycle tests give a comparative quality level of the products and mostly do not allow direct reference to practical applications in the field. For very specific applications, the purchaser can consult the manufacturer about their specific experience or special tests.

5.7.2 Test requirements

The tests shall be conducted with the hose at the relevant maximum allowable pressure. The bench test shall be equipped with a leakage detection system allowing the identification of the occurrence of the leak during the test cycle. The bend radius shall be chosen from Table 8 and shall be recorded before the start of the test with the hose at the relevant maximum allowable pressure.

Table 8 — Bend radii for fatigue test

DN	Fatigue test	
	Types 1	Type 2
	Bend radius mm	
4	100	120
6	110	140
8	130	165
10	150	190
12	165	210
15	195	250
20	225	285
25	260	325
32	300	380
40	340	430
50	390	490
65	460	580
80	660	800
100	750	1000
125	1000	1250
150	1250	1550
200	1600	2000
250	2000	2500
300	2400	3000

NOTE The dimensions listed in this table can be used for design purposes; see the manufacturer for confirmation.

No lubricant shall be added before or during the test.

Failure shall be defined as

- leakage of the hose, and/or
- a localized reduction of the hose radius (as measured at the start of the test) of more than 50 % during the test.

5.7.2.1 Test for DN sizes up to and including DN 100 (U-bend test)

The test shall be conducted using metal hose assemblies mounted to form a vertical loop as shown in Figure 6. The active live length, l_L , of the assembly shall be as given in Formula (9).

The distance between the axes of the end fittings shall be equal to twice the bend radius (fatigue test) given in Table 8.

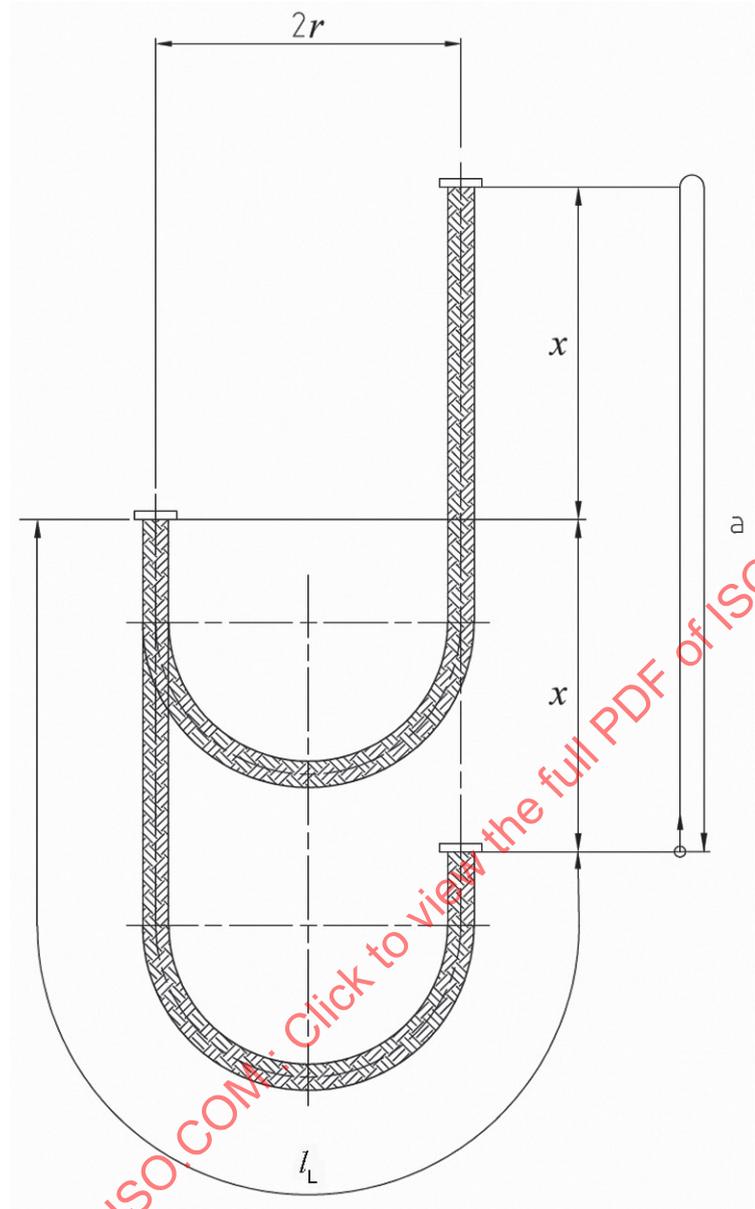
The metal hose assembly shall be subjected to repeated sinusoidal flexing at a rate of 5 cycles/min to 30 cycles/min in a direction parallel with the axis of the hose through a motion of $2x$ and where the active live length, l_L , is given by Formula (9):

$$l_L = 4r + x \quad (9)$$

where

- r is the bend radius, in millimetres (fatigue test);
- x is $4 \times \text{DN}$, in millimetres, or 125 mm, whichever is the greater;
- DN is the nominal size, in millimetres.

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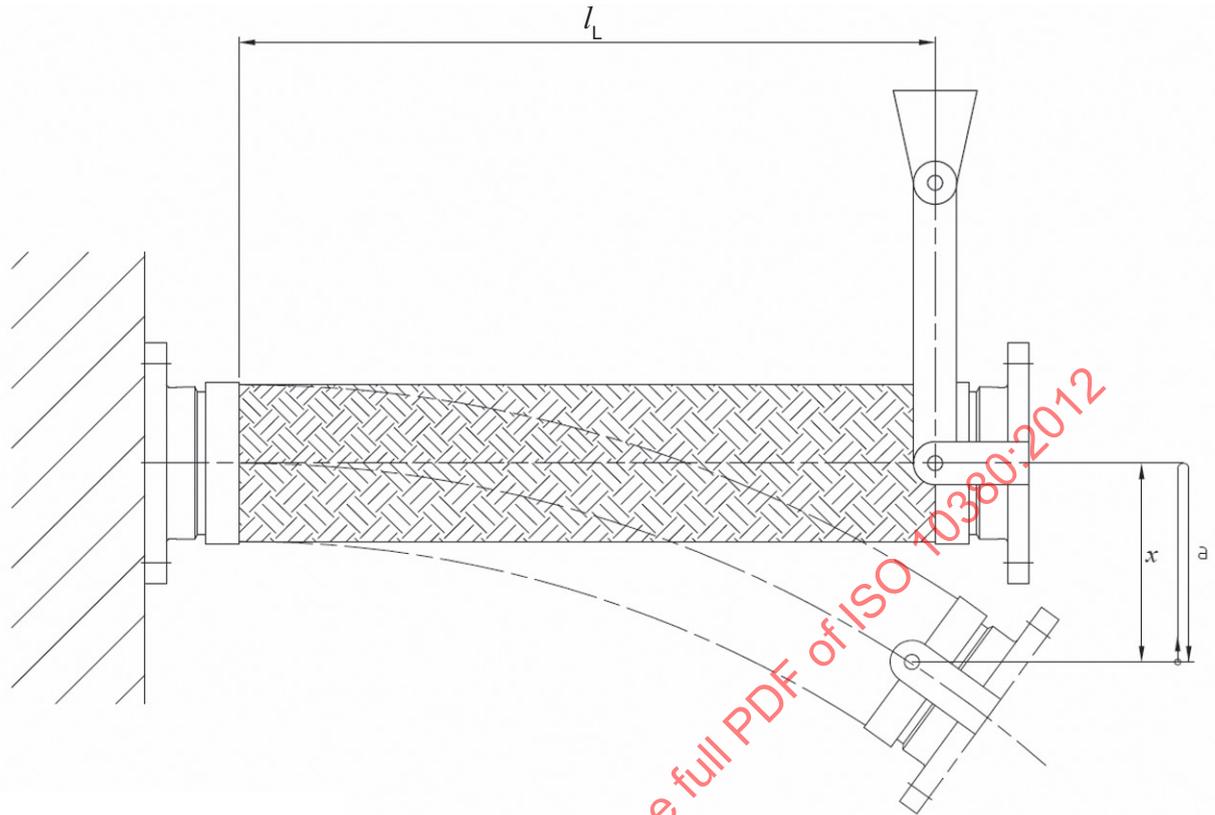
Key
 x motion
 a One cycle.

Figure 6 — Fatigue test

5.7.2.2 Test for DN sizes over DN 100 (Cantilever bend test)

The metal hose assembly shall be rigidly fixed at one end as shown in Figure 7. The other end shall be moved by means of a lateral force, so that a lateral deflection, x , as given in Table 9, is achieved. The active live length, l_L , shall be six times the nominal size.

The hose shall be subjected to repeat sinusoidal flexing at a rate of 3 cycles/min to 15 cycles/min in a lateral direction to the axis of the hose.



Key

- x lateral deflection
- l_L active live length
- a One cycle.

Figure 7 — Cantilever bend test

Table 9 — Cantilever bend test

Nominal size DN	Flexibility	
	Types 1	Type 2
	Lateral deflection, x mm	
125	65	50
150	70	55
200	80	65
250	90	70
300	100	80

NOTE In this table, the lateral deflection represents approximately the bend radius defined for the fatigue test, as given in Table 8, and is based on test experience.

After the fatigue test, the test sample shall be dried and the leaktightness test performed in accordance with 5.2.

5.8 Electrical conductivity

5.8.1 Requirements

A corrugated metal hose shall be electrically conductive. The electric resistance of a corrugated metal hose shall not exceed 1 Ω/m.

5.8.2 Test

A corrugated metal hose of 1 m nominal length shall be connected between copper dummy fittings. These dummy fittings shall be connected for a maximum of 1 min to a current of 25 A supplied by a generator whose open-circuit voltage does not exceed 12 V.

The voltage drop shall be measured between the dummy fittings. The resistance shall be calculated from the voltage drop and the related current, both measured to an accuracy of ±2 %.

The electrical resistance of the cables shall not be included in the measurement.

6 Evaluation of conformity

6.1 Declaration of products relating to the conformity assessment method

A manufacturer or an assembler may use a third-party conformity assessment or he/she can choose not to. Depending on the assessment method (see Table 10), they shall declare their products as follows.

- Corrugated metal hose manufacturers using certification shall declare the products as “corrugated metal hose certified to ISO 10380”.
- Corrugated metal hose manufacturers having internally tested their products without third-party conformity assessment shall declare their products as “corrugated metal hose in accordance with ISO 10380”. In that case, the manufacturer shall be capable of demonstrating to a customer or third party that the tests required by this International Standard were successfully performed.
- Assemblers using third-party conformity assessment for their assembling method and using “corrugated metal hose certified to ISO 10380” shall declare the metal hose assemblies as “metal hose assemblies certified to ISO 10380”.
- Assemblers using “corrugated metal hose in accordance with ISO 10380” or “corrugated metal hose certified to ISO 10380” together with assembling methods internally assessed shall declare the metal hose assemblies as “metal hose assemblies in accordance with ISO 10380”. In that case, the assembler shall be capable of demonstrating to a customer that the tests required by this International Standard were successfully performed.

Table 10 — Declaration for products versus conformity assessment method

Assessment for corrugated metal hose	Assessment for metal hose assemblies	Type of declaration for products
Certification	Certification	“Product certified in accordance with ISO 10380”
Certification	Internal procedure	“Product in accordance with ISO 10380”
Internal testing	Certification	

6.2 General

The conformity of corrugated metal hose and metal hose assemblies to the requirements of this International Standard and with the stated values shall be demonstrated by the following:

- initial type testing;
- factory production control;
- product/procedure assessment.

For the purposes of testing, corrugated metal hose and metal hose assemblies can be grouped into families of the same nominal size DN and similar design, which shall mean that the declared performance of the tested characteristics are representative of the family.

Brazed and welded corrugated metal hose assemblies shall be considered part of the same family with the exception of the burst tests performance (see 5.5.2).

NOTE A similar family, as an example, can be a hose assembly made out of the same corrugated metal hose type and the same assembling method, but a different end fitting design.

6.3 Initial type testing

6.3.1 General

An initial type testing shall be performed to show conformity to this International Standard on the first use of a corrugated metal hose being placed on the market and at the beginning

- of the production of a modified corrugated metal hose design and, where relevant, where component materials changes are taking place, and
- of a new braid or modified braid design.

NOTE 1 A change in fitting material is not considered a “change in component materials” as long as a qualified welding or brazing method is used.

NOTE 2 Materials in the same corrosion resistance class given in Table 4 are considered materials of the same family.

6.3.2 Performance requirements and test sequence schedule

Initial type testing shall be performed on samples of corrugated metal hose types according to 4.1 and shall be chosen at random from a production lot.

Manufacturers conforming to 3.16 shall carry out the tests given in Table 11 and assemblers conforming to 3.17, the tests given in Table 12.

If one sample fails, the respective testing sequence shall be repeated with three additional samples. All three additional samples shall fulfil the requirements. If this additional testing is not successful, a product improvement is required and initial type testing shall be repeated.

Table 11 — Test sequence schedule for manufacturers of corrugated metal hose and metal hose assemblies

Test	Subclause	Sample number		
		1 to 3	4 and 5	6 to 11 ^a
Leaktightness	5.2	x	x	x
Pressure resistance	5.3	x	x	x
Elongation	5.4	x	—	—
Electric conductivity	5.8	x	—	—
Burst pressure	5.5	x	—	—
Pliability	5.6	—	x	—
Fatigue	5.7	—	—	x
Leaktightness	5.2	—	x	x ^b

^a Tests only applicable to types 1 and 2.
^b Leakage detection system to be integrated in the test bench, as described in 5.7.2.

Table 12 — Test sequence schedule for assemblers using corrugated metal hose

Test	(Sub)clause	Sample number		
		1 to 3	4 and 5	6 to 11
Leaktightness	5.2	x	x	x
Elongation	5.4	x	x	x
Burst pressure	5.5	x	—	—

A product from a manufacturer or an assembler using corrugated metal hose and braid separately supplied and combined shall be subjected to certification in order to declare the resulting product a “product certified to ISO 10380”.

Performance tests carried out on behalf of customer requirements and subjected to a third-party conformity assessment shall be recognized by any other third parties.

The result of all tests shall be recorded and held for at least 10 years after the date of the type test of the relevant product.

6.4 Subsequent type testing

Subsequent type testing shall be performed upon modification of product or production characteristics and shall be performed in the sequence given in Tables 11 and 12.

NOTE 1 The number of samples and/or the test sequence of subsequent type testing can be reduced if it is established that performance characteristics compared with the already tested corrugated metal hoses are the same.

NOTE 2 Using a braid from a different manufacturer, even if of the same specification, or a braid of different specification is considered a modification of product.

6.5 Factory production control (FPC)

6.5.1 General

The manufacturer and the assembler shall establish, document and maintain FPC systems conforming to a quality management system standard, e.g. ISO 9001, to ensure that the products placed on the market conform to the declared performance characteristics. The FPC systems shall consist of written procedures (works handbook), regular inspections and tests, and the results shall serve to control raw and other incoming materials or components, equipment, the production process and the product. Records shall remain legible, readily identifiable and retrievable.

Assembling procedures shall be described in detail in order to ensure repeatability. Manufacturing records shall be kept, thus enabling comparison between the procedure in use and defined manufacturing procedures.

The results of inspections or tests requiring action shall be recorded, as shall any action taken. The action to be taken where control values or criteria are not met shall be recorded and retained for the period specified in the manufacturer's FPC procedures.

6.5.2 FPC requirements for manufacturers and assemblers

The manufacturer shall establish procedures to ensure that the given production tolerances for the corrugated metal hose are in conformity with the declared values, derived from the initial type testing.

Variances in critical production tolerances, which directly influence the product characteristics (elongation, burst pressure, pliability and fatigue life) shall be continuously tracked (in-process control, SPC, etc.) and shall be maintained within the defined tolerances.

The conformity of corrugated metal hoses and metal hose assemblies with the results of initial type testing shall be demonstrated with type testing as part of the FPC at regular intervals, as given in Table 13.

Table 13 — Minimum frequency of tests for type testing as part of FPC

Property	Subclause, indicating the relevant test	Minimum test samples	Minimum frequency of test
Elongation	5.4	Every hose size and type of same design (or family) produced by unmodified method.	Once every three years
Burst pressure	5.5		Once every three years
Pliability	5.6		Once every three years
Fatigue (types 1-50, 1-10 and 2-10)	5.7	Number of test samples (for each) in accordance with Table 11.	Once every five years

Technically equivalent tests performed on specific customer request can be considered part of the FPC programme (see Table 13).

If a single sample of the test batch fails, a further sample batch consisting of a minimum of twice the original sample batch from the same manufacturing lot shall be repeated; in addition, if one of the new samples fails, appropriate measures shall be taken.

The manufacturer and the assembler shall record the results of the tests specified above. The records shall, as a minimum, include the following information:

- identification of the corrugated metal hose lot tested,
- the date of testing,
- the test method performed,
- the test result,
- the authorized person responsible.

6.5.3 Manufacturer-specific FPC system requirements

6.5.3.1 Personnel

The responsibility, authority and relationship between the personnel managing, performing or verifying work affecting product conformity, shall be defined. This applies, in particular, to personnel that needs to initiate actions to prevent product non-conformities from occurring, and actions in the event of non-conformities and to identify and register product conformity problems. Personnel performing work affecting product conformity