
**Hydraulic fluid power — Hose
assemblies —**

**Part 2:
Practices for hydraulic hose
assemblies**

Transmissions hydrauliques — Flexibles de raccordement —

Partie 2: Pratiques pour les flexibles de raccordement hydrauliques

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 4, *Connectors and similar products and components*.

This edition cancels and replaces the first edition (ISO/TS 17165-2:2013), which has been technically revised.

The main changes to the previous edition are:

— in 9.2.2, the shelf life of rubber hose in bulk form or hose assembly has been changed.

A list of all the parts in the ISO 17165 series can be found on the ISO website.

Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure within an enclosed circuit.

To allow fluid flow between components, components are interconnected by piping, both rigid (tubes and tube connectors) and flexible (hose assemblies, which consist of hose and hose fittings).

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Hydraulic fluid power — Hose assemblies —

Part 2: Practices for hydraulic hose assemblies

1 Scope

This document provides guidelines for selection, routing, fabrication, installation, replacement, maintenance and storage of hose and hose assemblies for hydraulic fluid power systems which are manufactured from hoses conforming to ISO 1436, ISO 3862, ISO 3949, ISO 4079 and ISO 11237, and hose fittings conforming to the ISO 12151 series.

NOTE 1 Many of these practices also can be suitable for use with other types of hoses and systems.

NOTE 2 [Annex A](#) lists examples of actual failure resulting from improper use of hydraulic hose and hose assemblies.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 5598, *Fluid power systems and components — Vocabulary*

ISO 6605, *Hydraulic fluid power — Test methods for hoses and hose assemblies*

ISO 8330, *Rubber and plastics hoses and hose assemblies — Vocabulary*

ISO 8331, *Rubber and plastics hoses and hose assemblies — Guidelines for selection, storage, use and maintenance*

ISO 17165-1, *Hydraulic fluid power — Hose assemblies — Part 1: Dimensions and requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598, ISO 8330 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

manufacturing date of the hose assembly

date when hose and hose fittings were assembled into a hose assembly

4 Safety considerations

4.1 General

The list of potential conditions and situations that can lead to personal injury or property damage described in 4.2 through 4.8 is not necessarily all-inclusive. Reasonable and feasible means, including those described in this clause, shall be taken into consideration, to reduce the risk of personal injury, property damage or both. Training, including the information in this document, for operators, maintenance personnel, and other individuals working with hose assemblies under pressure is encouraged.

4.2 Fluid injections

Fine streams of escaping pressurized fluid can penetrate skin and enter a human body. These fluid injections can cause severe tissue damage and loss of limb. Various means shall be taken into consideration to reduce the risk of fluid injections, particularly in areas normally occupied by operators. Such means include: careful routing of hose, adjacent components, warnings, guards, shields and training programs. Pressure shall be relieved before disconnecting hydraulic or other lines. All connections shall be tightened before applying pressure. Contact with escaping fluids shall be avoided. All leaks shall be treated as if they were pressurized and hot enough to burn skin. No part of the human body shall be used to check a hose for leaks. If a fluid-injection accident occurs, medical treatment by a doctor shall be sought immediately.

WARNING — Fluid-injection injuries shall be treated without delay and shall not be treated as a simple cut. Any fluid injected into the skin shall be surgically removed *within a few hours*, or gangrene can result. Doctors unfamiliar with this type of injury should consult a knowledgeable medical source.

4.3 Whipping hoses

If a pressurized hose assembly blows apart, the hose fittings can be thrown off at high speed, and the loose hose can flail or whip with great force. This is particularly true in systems that use compressible fluids. When this risk exists, consider guards and restraints to protect against injury.

4.4 Burns from conveyed fluids

Fluid power media (hydraulic fluid) can reach temperatures that can burn human skin. If there is risk of burns from escaping fluid, consider guards and shields to prevent injury, particularly in areas normally occupied by operators.

4.5 Fire and explosions from conveyed fluids

Most fluid power media (hydraulic fluid), including fire-resistant hydraulic fluids, can burn under certain conditions. Fluids that escape from pressurized systems can form a mist or fine spray that can flash or explode upon contact with an ignition source. Consider selecting, guarding, and routing the hose to minimize the risk of combustion (see [Clause 5](#) and ISO 3457).

4.6 Fire and explosions from static-electric discharge

Fluid passing through a hose can generate static electricity, resulting in static-electric discharge. This can create sparks that can ignite fluids in the systems or gases in the surrounding atmosphere. When this potential exists, a hose specifically designed to carry the static-electric charge to ground shall be selected.

4.7 Electrical shock

Electrocution could occur if a hose conducts electricity through a person. Most hoses are conductive. Many contain metal or have metal hose fittings attached. Even nonconductive hoses can be conduits for electricity if they carry conductive fluids. This shall be kept in mind when routing or using a hose near electrical sources. When this cannot be avoided, an appropriate hose shall be selected, and nonconductive hoses should be considered. Hoses that comply with ISO 3949 with orange covers marked "Nonconductive" are available for applications requiring a nonconductive hose.

4.8 Mechanisms controlled by fluid power

Mechanisms controlled by fluids in hoses can become hazardous when a hose fails. For example, when a hose bursts, objects supported by fluid pressure can fall, or vehicles or machines can lose their brakes or steering. If mechanisms are controlled by fluid power, safe modes of failure that minimize risks of injury or damage shall be considered.

5 Hose selection and routing

5.1 General

A wide variety of interacting factors influence hose service life. The ability of each hydraulic fluid power system to operate satisfactorily, and the combined effects of the influencing factors on service life, are often unpredictable. Therefore, hydraulic hose specification documents should not be construed as design standards. For applications outside the specifications in ISO 1436, ISO 3862, ISO 4079, ISO 11237, ISO 3949 and the ISO 12151 series or other relevant design standards, performance of hose assemblies should be determined by appropriate testing. Each system shall be carefully analysed, and then routings shall be designed and the hose and related components shall be selected to meet the system performance and hose-service-life requirements, and to minimize the risks of personal injury, property damage or both. The factors covered in [5.2](#) through [5.25](#) shall be considered.

5.2 System pressures

Excessive pressure can accelerate hose assembly failure. Steady-state pressures and the frequency and amplitude of pressure surges, such as pulses and spikes, shall be analysed. These are rapid and transient rises in pressure, which many common pressure gauges do not indicate. They can be identified best with high-frequency-response electronic measuring instruments. For maximum hose assembly service life, selection of the hose and hose fittings should be based on a system pressure, including surges, that is less than the maximum working pressure of the hose assembly.

The maximum working pressure of a hose assembly shall not exceed the lower of the maximum working pressure specified for the respective hose and the connection end of the hose fittings.

5.3 Suction

For suction applications, such as inlet flow to pumps, select a hose to withstand both the negative and positive pressures the system imposes on the hose.

5.4 External pressure

In certain applications, such as in autoclaves or under water, external environmental pressures can exceed the fluid pressure inside the hose. In these applications, consider the external pressures and, if necessary, consult the hose manufacturer.

5.5 Temperature

Temperature outside of the hose's ratings can significantly reduce hose life. Select a hose so that the fluid and ambient temperatures, both static and transient, fall within the hose's ratings. The effects

of external heat sources should not raise the temperature of the hose above its maximum operating temperature. Select the hose, heat shields, sleeving, and other methods to meet these requirements, and route or shield hose to avoid hose damage from external heat sources.

5.6 Permeation

Permeation, or effusion, is seepage of fluid through the hose. Certain materials in hose construction are more permeable than others. Consider the effects of permeation, especially of gaseous fluids, when selecting a hose. Consult the hose and fluid manufacturers for permeability information.

5.7 Compatibility between hose materials and system fluids

Variables that can affect the compatibility of system fluids with hose materials include, but are not limited to:

- a) chemical properties,
- b) fluid pressure,
- c) temperature,
- d) concentration level, and
- e) duration of exposure.

Because of permeation (see 5.6), compatibility of system fluids with the hose, tube, cover, reinforcement, and hose fittings shall be considered. Consult the fluid and hose manufacturers for compatibility information.

Rubber hoses should not be painted without consulting the hose manufacturer.

Many fluid/elastomer compatibility tables in manufacturers' catalogues show ratings based on fluids at 21 °C, i.e. room temperature. These ratings can be different at other temperatures. The notes on the compatibility tables should be read carefully and the manufacturer consulted if there is any doubt.

5.8 Environment

Environmental conditions can cause hose and hose fitting degradation. Conditions that shall be evaluated include, but are not limited to:

- a) ultraviolet light,
- b) salt water,
- c) air pollutants,
- d) temperature,
- e) ozone,
- f) chemicals,
- g) electricity,
- h) abrasion, and
- i) paint.

If necessary, the hose manufacturer shall be consulted for more information about the effect of these and other environmental conditions.

5.9 Static-electric discharge

Fluid passing through a hose can generate static electricity, resulting in static electric discharge. This can create sparks that can puncture a hose. If this potential exists, a hose with sufficient conductivity to carry the static-electric charge to ground shall be selected.

5.10 Sizing

The power transmitted by pressurized fluid varies with pressure and flow rate. Select a hose with adequate size, to minimize pressure loss and to avoid hose damage from heat generation or excessive flow rates. Conduct calculations or consult the hose manufacturer for sizing at relevant flow rates.

5.11 Unintended uses

Hose assemblies are designed for the internal forces of fluids conducted. Hose assemblies shall not be pulled or used for purposes that can apply external forces for which the hose or hose fittings were not designed.

5.12 Specifications and standards

When selecting hose and hose fittings for specific applications, applicable government, industry, and manufacturer's specifications and standards shall be referred to.

5.13 Unusual applications

For applications that are not addressed by the manufacturer or by industry standards, special testing can be necessary before the proper hose can be selected.

5.14 Hose assembly cleanliness

The cleanliness requirements of components other than hose assemblies can determine the cleanliness requirements of the application. The component manufacturers' cleanliness information for all components in the system shall be consulted. Hose assemblies vary in cleanliness levels; therefore, hose assemblies with adequate cleanliness for the system shall be specified.

5.15 Hose fittings

Selection of the proper hose fittings for the hose and application is essential for proper operation and safe use of hose and related assembly equipment. Hose fittings are qualified with the hose. Therefore, only hose fittings compatible with the hose for the applications shall be selected. Improper selection of hose fittings or related assembly equipment for the application can result in injury or damage from leaks, or from hose assemblies blowing apart (see [4.3](#), [6.3](#), [6.4](#) and [6.5](#)).

5.16 Vibration

Vibration can reduce hose service life. If required, tests shall be conducted to evaluate the effects of frequency and amplitude of system vibration on a hose assembly. Clamps or other means can be used to reduce the effects of vibration. Consider the vibration requirements when selecting a hose and predicting service life.

5.17 Hose cover protection

The hose cover shall be protected from abrasion, erosion, snagging, and cutting. Special abrasion-resistant hoses and hose guards are available for additional protection. The hose shall be routed to reduce abrasion from hose rubbing other hoses or objects that can abrade it (see [Figure 1](#)).

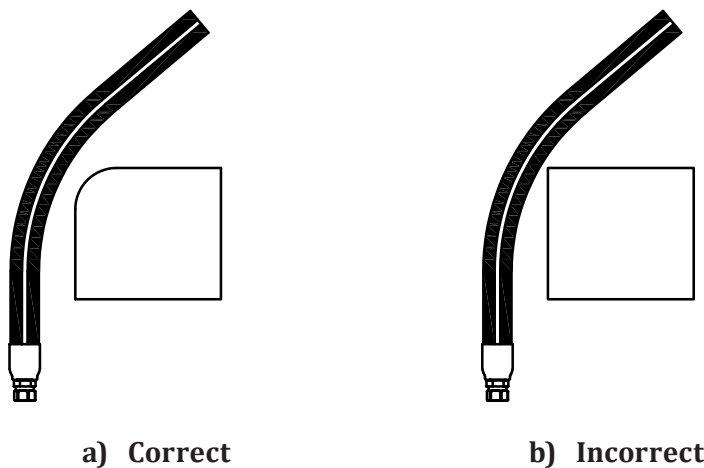


Figure 1 — Prevention of external damage

5.18 External physical abuse

The hose shall be routed to avoid:

- a) tensile loads,
- b) side loads,
- c) flattening of the hose,
- d) damage to threads,
- e) kinking,
- f) damage to sealing surfaces,
- g) abrasion, and
- h) twisting.

5.19 Swivel hose fittings and connectors

Some swivel hose fittings and connectors allow limited rotation after assembly; these do not transfer torque to a hose while they are being tightened. These types of hose fittings and connectors shall be used as needed to prevent twisting of the hose during installation.

5.20 Rotary connectors

If two components in the system are rotating in relation to each other, rotary connectors can be necessary. This type of connector reduces the torque transmitted to the hose.

5.21 Slings and clamps

Slings and clamps shall be used to support a heavy or long hose and to keep it away from moving parts. Clamps shall be used to prevent hose movement that can cause abrasion. Care shall be taken to prevent the sling or clamp from abrading the hose. Overtightening of slings or clamps shall be avoided.

5.22 Minimum bend radius

The minimum bend radius (R) of a hose is defined in the relevant hose standards and hose manufacturer's product literature. Routing during assembly and use at less than minimum bend radius can reduce hose life. Sharp bending at the juncture between the hose and hose fitting can result in leakage, hose rupture, or the hose assembly blowing apart (see 4.3 and Figure 2). A minimum straight length of 1,5 times the hose's outside diameter (D) shall be allowed between the hose fitting and the point at which the bend starts.

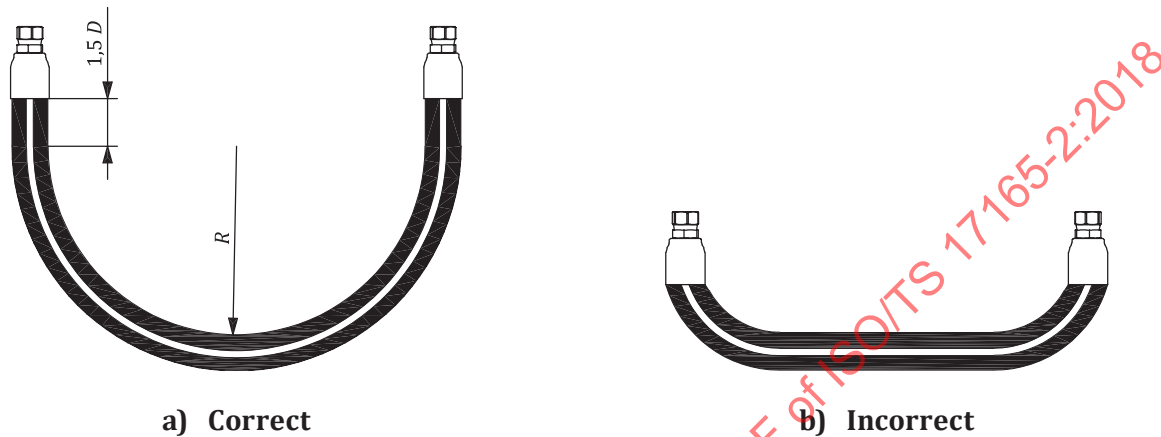


Figure 2 — Minimum bend radius

5.23 Elbows and connectors

In special cases, elbows or connectors shall be used to relieve hose strain (see Figure 3).

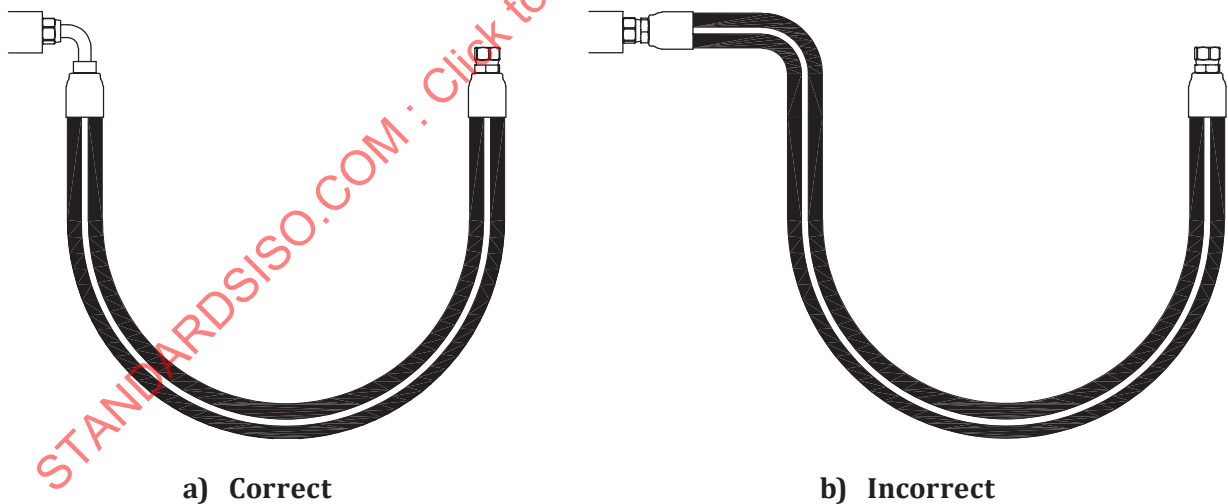


Figure 3 — Elbows and connectors

5.24 Lengths

5.24.1 General

An unnecessarily long hose can increase pressure drop and affect system performance. When pressurized, a hose that is too short can pull loose from its hose fittings or stress the hose fitting connections, causing premature metallic or seal failures. When establishing hose and hose assembly

length, as defined in ISO 17165-1 for the different hose fitting types, [Figures 4, 5, and 6](#) and the practices in [5.24.2](#) through [5.24.4](#) shall be taken into consideration.

5.24.2 Motion absorption

The hose assembly shall be of such length to distribute movement and prevent bends smaller than the minimum bend radius.

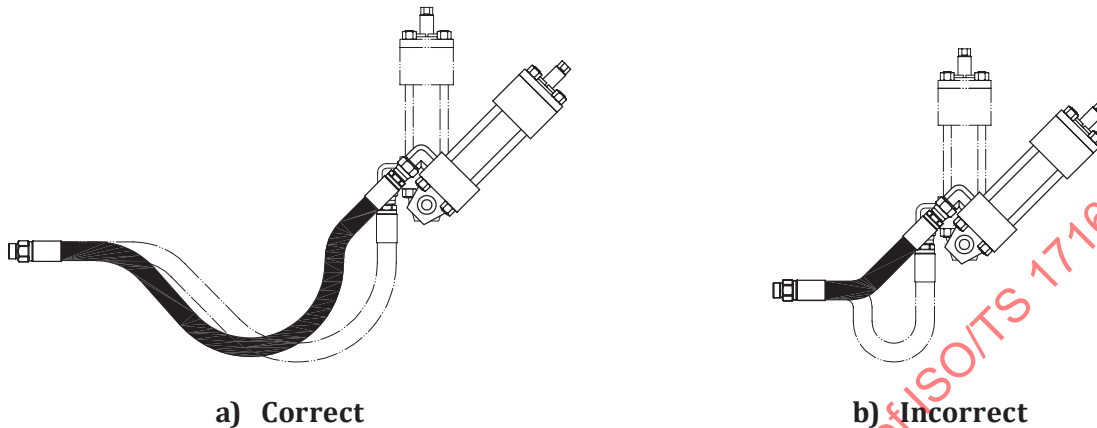


Figure 4 — Motion absorption

5.24.3 Tolerances and machine motion

The hose assembly shall be of such length to allow for tolerances and machine motion.

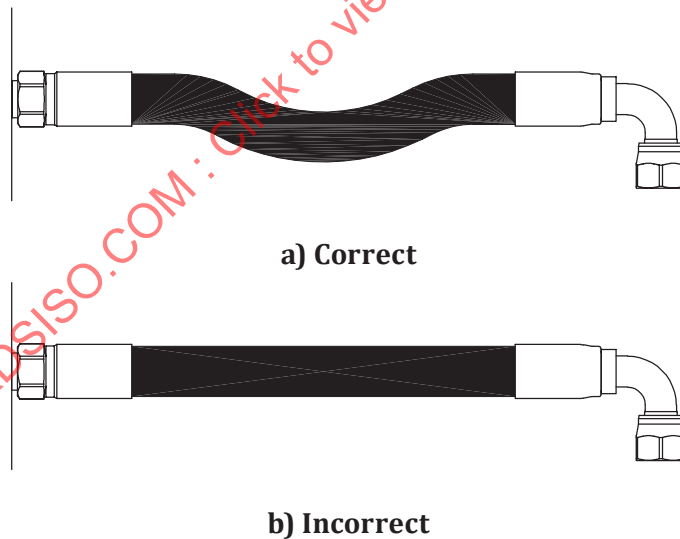
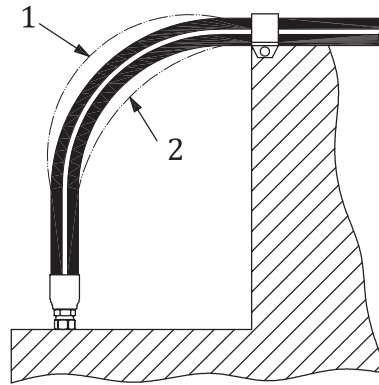


Figure 5 — Hose and machine tolerances

5.24.4 Change in hose length due to changes in pressure

The hose assembly shall be of such length to accommodate changes in length resulting from changes in pressures. Hoses for high- and low-pressure lines shall not be crossed or clamped together, as the difference in changes in length could wear the hose covers.

**Key**

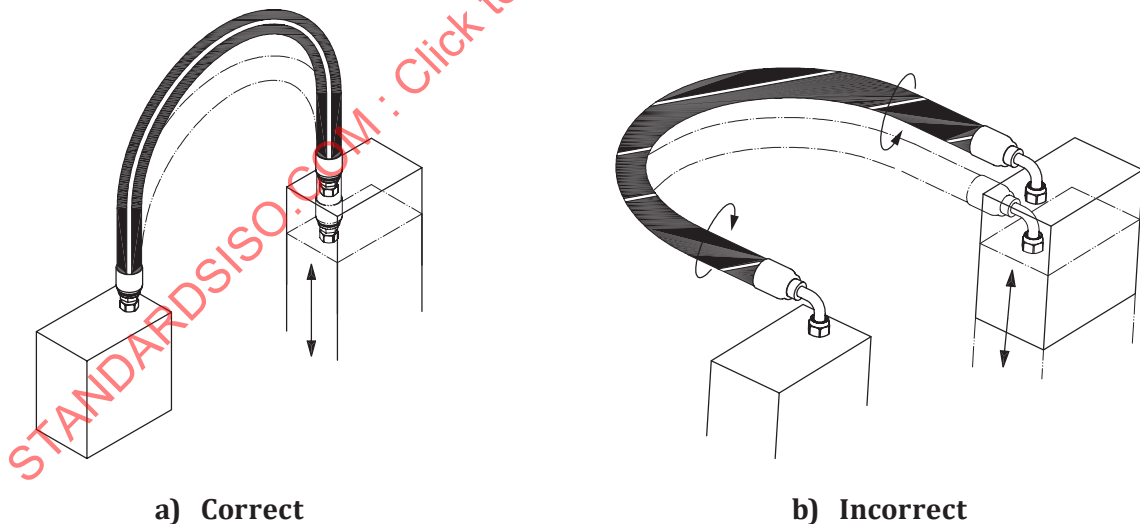
- 1 high pressure
- 2 no pressure

Figure 6 — Change in hose length due to change in pressure

5.25 Hose movement and bending

5.25.1 A hose allows for relative motion between system components. This motion shall be analysed when hose systems are designed. The frequency of motion, i.e. the number of cycles per day, can significantly affect hose life. Movement in multiple planes and twisting shall be avoided. The motion of the hose shall be considered when selecting a hose and predicting service life. In applications that require that a hose moves or bends, [Figures 7](#) and [8](#) and the practices specified below shall be considered.

5.25.2 A hose should be bent in only one plane to avoid twisting.

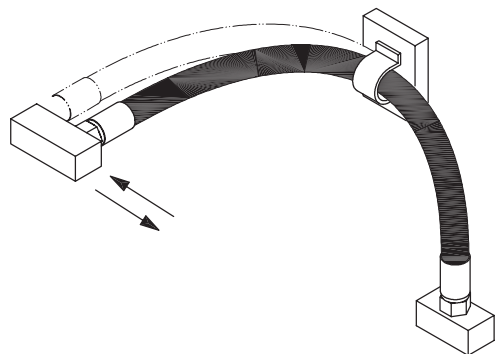


a) Correct

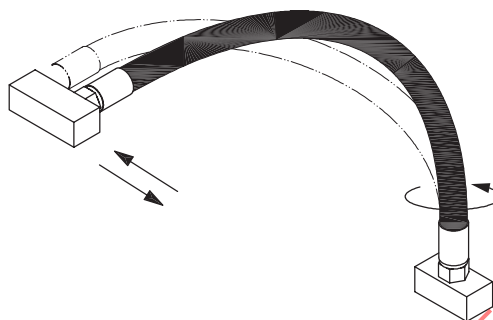
b) Incorrect

Figure 7 — Illustration of bending in only one plane to avoid twisting

5.25.3 A hose should not be bent in more than one plane. If a hose follows a compound bend, it shall be coupled into separate segments or clamped into segments that each flex in only one plane.



a) Correct



b) Incorrect

Figure 8 — Illustration of how to prevent hose bending in more than one plane

6 Hose assembly fabrication

6.1 General

Persons fabricating hose assemblies should be trained in the proper use of equipment and materials. The manufacturers' instructions and the practices listed in 6.2 through 6.11 shall be followed. Properly assembled hose fittings are vital to the integrity of a hose assembly. Improperly assembled hose fittings can separate from the hose and can cause serious injury or property damage from a whipping hose, or from fire or explosion of vapour expelled from the hose.

6.2 Component inspection

Prior to assembly, components shall be inspected for:

- a) style or type,
- b) cleanliness,
- c) loose covers,
- d) corrosion,
- e) nicks, dents, scores, burrs or sharp edges,
- f) size,
- g) inside obstructions,
- h) visible defects,
- i) damage,
- j) length, and
- k) blisters.

6.3 Hose fitting parts

Hose fitting parts (e.g. hose nipple, ferrule, shell) from one manufacturer are usually not compatible with hose fitting parts supplied by another manufacturer. If hose fitting parts from different manufacturers are used in the same hose assembly, the performance of the hose assembly shall be verified by testing in accordance with ISO 6605. Information on proper hose fitting parts to be used shall be provided.

6.4 Compatibility between hose and hose fittings

Care shall be taken to determine proper compatibility between the hose and hose fitting. Selection shall be based on the manufacturers' recommendations, substantiated by testing to relevant standards for the hose and hose fittings. A hose from one manufacturer is not usually compatible with hose fittings from another. A hose from one manufacturer and hose fittings from another manufacturer shall not be intermixed without approval from both manufacturers.

6.5 Hose assembly equipment

Equipment for fabricating hose assemblies from one manufacturer is usually not interchangeable with that from another manufacturer. Hoses and hose fittings from one manufacturer shall not be assembled with the hose assembly equipment of another manufacturer, unless approved by the hose fitting manufacturer.

6.6 Safety equipment

During fabrication, proper safety equipment, including eye protection, respiratory protection, and adequate ventilation, shall be used.

6.7 Condition of hose assembly parts

6.7.1 Hose assemblies shall be made from:

- a) a hose that is undamaged and unused, and
- b) hose fittings that are undamaged and either unused or intended to be reused.

6.7.2 The following hose assembly parts shall not be reused:

- a) field-attachable hose fittings that have blown or pulled off a hose;
- b) any part of hose fittings that were permanently crimped or swaged to a hose;
- c) a hose that has been in service after system checkout (see [7.8](#)).

6.8 Cleanliness of hoses and hose assemblies

Hose assemblies can be contaminated during fabrication. Hoses and hose assemblies shall be cleaned to specified cleanliness levels (see [5.14](#)).

6.9 Temperature

The fabrication of hose assemblies should be performed at an ambient temperature over 0 °C unless otherwise recommended by the manufacturer.

6.10 Assembly inspection

After assembly, examine a hose assembly for visible defects and interior obstructions, e.g. tube bulges.

6.11 Marking

Hose assemblies shall be marked in accordance with ISO 17165-1. Marking shall remain legible.

7 Hose installation and replacement

7.1 General

The practices specified in 7.2 through 7.8 shall be used when installing hose assemblies in new systems or replacing hose assemblies in existing systems. The manufacturer should make available additional instructions on mounting, storage and operating conditions.

7.2 Pre-installation inspection

Before installing hose assemblies, the following should be examined:

- a) hose length and routing, for compliance with original design;
- b) hose assemblies, for correct style, size, length, and visible nonconformities;
- c) hose fitting sealing surfaces, for burrs, nicks, or other damage.

When replacing hose assemblies in existing systems, verify that the replacement hose assembly is of equal quality to the original assembly.

7.3 Handling during installation

The hose shall be handled with care during installation. Kinking the hose, or bending it at less than its minimum bend radius, can reduce hose life. Sharp bending at the hose/fitting juncture shall be avoided (see 5.22 and 5.23). Before and during installation, hose assemblies should be at a temperature above 0 °C.

7.4 Twist angle and orientation

Pressure applied within a twisted hose can shorten the life of the hose or loosen the connections. To avoid twisting, the hose lay line or marking can be used as a reference if the lay line or marking is parallel to the axis of the hose (see Figure 9). Twisting can also be avoided through the use of two wrenches during the installation of swivel connectors.

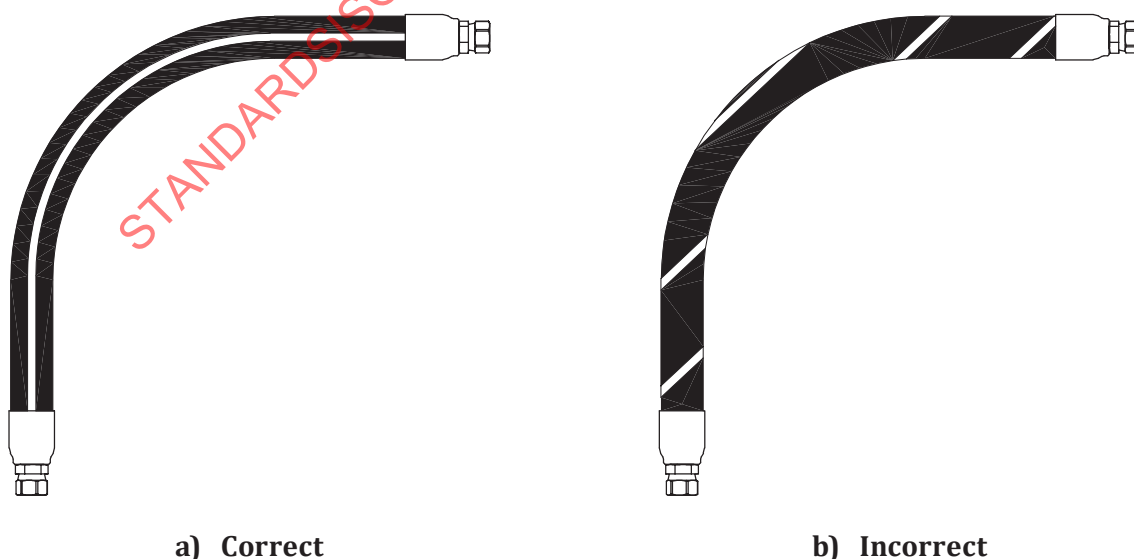


Figure 9 — Twist angle and orientation

7.5 Securing and protection

Necessary restraints and protective devices shall be installed. It shall be determined that such devices do not create additional stress or wear points.

7.6 Routing

Review proper routing practices provided in [Clause 5](#), and make appropriate corrections to obtain optimum performance.

7.7 Assembly torque

The connection end of a hose fitting is normally threaded to obtain a tight pressure seal when attached to a port or another connector. Sometimes bolts or screws provide the threaded connection. Each size and type of connection requires different torque values, and these can vary due to type of material, exterior coating, lubrication or any combination of these. Follow appropriate torquing instructions to obtain proper pressure sealing without over torquing. A properly calibrated torque wrench should be used to tighten each connection, except when the hose fitting manufacturer specifies tightening a specified number of hex flat turns beyond finger tight to obtain a seal.

7.8 System checkouts

In hydraulic or other liquid systems, all entrapped air shall be eliminated after installation is complete. The manufacturers' instructions shall be followed to test the system for possible malfunctions and leaks. To avoid injury during system checkout:

- a) do not touch any part of the system when checking for leaks (see [4.2](#)),
- b) stay out of potentially hazardous areas while testing hose systems (see [Clause 4](#)), and
- c) relieve system pressure before tightening connections.

8 Maintenance inspection

8.1 General

A hose and hose fitting maintenance program can reduce equipment downtime, maintain peak operating performance, and reduce the risk of personal injury, property damage or both. The user should design and implement a maintenance program that suits the specific application and each specific hose in that application. For additional information on inspection, see [Table 1](#).

8.2 Inspection frequency

Factors such as the nature and severity of the application, past history, and manufacturers' information shall be evaluated to establish the frequency of visual inspections and functional tests.

8.3 Visual inspection (hose and hose fittings)

Hose and hose fittings shall be inspected for the items listed in [Table 1](#), which also gives information as to the main causes and corrective actions to be taken for each item.

Table 1 — Items related to visual inspection of hose and hose fittings

Item		Main cause	Corrective actions to be taken
Leakage from threaded connection		Defective connection seat due to presence of flaw, dirt or other foreign objects	Clean connection seat
		Loose connection or O-ring wear	Tighten the connection or replace O-ring
		Mismatching of seat surface	Replace the connection as necessary
Leakage from flange connection		Loose fixture bolt or deterioration of O-rings or other seals	Tighten the bolt or replace O-rings or other seals
Leakage from hose/connection assembly, hose fitting slippage on hose		Deterioration of hose (due to heat, oil, long use, etc.)	Replace the hose
		Improper routing	Avoid sharp bending at the assembly part
Deformation	Kink or dent	External impact	Prevent or protect from impact
	Swell or bulge	Oil spillage (leak)	Replace the hose
Visible defect (damaged, cut or abraded cover; exposed reinforcement; kinked, crushed, flattened, or twisted hose; blistered, soft, degraded, or loose cover; cracked, damaged, or badly corroded hose fittings; wear flaws; scratch, etc.)		Component interference External impact	Prevent or protect from impact Replace the hose
Visible external cracks		Ozone, radiation, paint, other fluids	Protect the exterior Replace the hose
Unusual hose movement at starting of operation		Improper hose length	Replace the hose
		Improper hose routing	Correct routing or use adaptive devices
Hardening/softening, heat cracked, or charred hose		Deterioration due to fluid or temperature mismatch.	Replace the hose as necessary
Unusual noise, odour, heat		Improper circuitry	Check the circuit
Corrosion of hose fittings		Sand, dust, water, air salinity	Use protective paint (but not on the exterior surface of the hose) Replace with improved corrosion-resistant materials or better protecting coating
Product lifetime (useful service life has been reached)		Deterioration and wear	Replace hose or hose assembly or both, based on criteria defined in Clause 8

8.4 Visual inspection (all other components in the system)

When visually inspecting hose and hose fittings, inspect for related items including:

- leaking ports,
- damaged or missing hose clamps, guards, or shields,
- excessive dirt and debris around hose, and
- system fluid: level, type, contamination, condition, and air entrainment.

If any of these are found, they shall be addressed appropriately.

8.5 Functional tests

Functional tests determine if systems with hose assemblies are leak-free and operating properly. Functional tests shall be carried out in accordance with the equipment manufacturer's instructions.

9 Storage

9.1 General

Age control and the manner of storage can affect hose life. The practices for storing a hose specified in 9.2 and 9.3 shall be followed.

9.2 Age control

9.2.1 Shelf life

A system of age control shall be maintained to ensure that a hose is used before its shelf life has expired. Shelf life is the period of time when it is reasonable to expect the hose to retain full capabilities for rendering the intended service. A hose shall be stored in a manner that facilitates age control and first-in, first-out usage based on the manufacturing date on the hose or hose assembly.

9.2.2 Storage period

The storage period should be kept to a minimum. Rotation of stock is therefore essential and the "first-in first-out" rule applied. For long-term storage, the following maximum storage periods are recommended, unless otherwise specified in the respective product standard or as specified by the hose supplier:

- for bulk hoses (without fittings attached), maximum of four years;
- for hose assemblies, maximum of two years.

These two periods can be interpreted as consecutive for a maximum storage duration of six years (four years as bulk hose + two years as hose assembly).

9.3 Storage conditions

9.3.1 Hose and hose assemblies shall be stored in accordance with the storage conditions defined in ISO 8331. When storing a hose, care shall be taken to avoid damage that could reduce hose life, and to ensure that the manufacturers' information for storage and shelf life is followed. Examples of factors that can adversely affect hose and hose assemblies in storage are:

- a) temperature,
- b) ozone,
- c) oils, petrol (gasoline), kerosene or their vapours,
- d) corrosive liquids and fumes,
- e) rodents,
- f) humidity,
- g) ultraviolet light,

- h) solvents,
- i) insects,
- j) radioactive materials,
- k) direct sun or heat rays,
- l) acids, alkalis,
- m) sharp edges and abrasive surfaces,
- n) electric or strong magnetic fields, and
- o) mould and fungi.

9.3.2 If there are questions regarding the quality or usability of hose or hose assemblies, the hose or hose assemblies shall be evaluated as follows:

- a) Flex the hose to the minimum bend radius, and compare it with a new hose. After flexing, examine the cover and tube for cracks. If any appear, no matter how small, the hose shall be rejected.
- b) If the hose is wire-reinforced, and the hose is unusually stiff, or a cracking sound is heard during flexing, check for corrosion of wires by cutting away a section of the cover from a sample. If corrosion is apparent, the hose shall be rejected.
- c) If doubt still persists, contact the hose assembler to conduct proof-pressure tests or any other tests needed to verify hose assembly quality.