

# INTERNATIONAL STANDARD

**ISO**  
**3996**

Third edition  
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## **Road vehicles — Brake hose assemblies for hydraulic braking systems used with non-petroleum-base brake fluid**

*Véhicules routiers — Flexibles pour dispositifs de freinage hydraulique  
utilisant un liquide de frein à base non pétrolière*



Reference number  
ISO 3996:1995(E)

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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.

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.

International Standard ISO 3996 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 2, *Brake systems and equipment*.

This third edition cancels and replaces the second edition (ISO 3996:1986), of which it constitutes a technical revision.

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# Road vehicles — Brake hose assemblies for hydraulic braking systems used with non-petroleum-base brake fluid

## 1 Scope

This International Standard specifies the test procedures for, and performance requirements and marking of hydraulic brake hose assemblies to be used in hydraulic braking systems of road vehicles of which the nominal inside diameter of the hose is 3,2 mm or 4,8 mm.

It applies to brake hose assemblies made of a hose fabricated from cord and synthetic elastomers and assembled with metal end fittings for use with non-petroleum-base brake fluids in accordance with ISO 4925.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4925:1978, *Road vehicles — Non-petroleum base brake fluid*.

ISO 4926:1978, *Road vehicles — Hydraulic brake systems — Non-petroleum base reference fluids*.

ISO 7500-1:1986, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tensile testing machines*.

ISO 9227:1990, *Corrosion tests in artificial atmospheres — Salt spray tests*.

## 3 Definitions

For the purposes of this International Standard, the following definitions apply.

**3.1 brake hose assembly:** Brake hose equipped with end fittings for use in a brake system.

**3.2 brake hose:** Flexible conduit intended for use in a brake system to transmit and contain the fluid pressure medium used to apply force to the vehicle's brakes.

**3.3 end fitting:** Coupling designed for permanent attachment to the ends of a brake hose assembly by crimping or swaging.

**3.4 free length:** Linear length of brake hose exposed between the end fittings of a brake hose assembly while maintained straight.

**3.5 leaks; burst:** Loss of test fluid through the brake hose assembly other than by the designed inlet(s) and outlet(s).

**3.6 cracking:** Interruption of a surface due to environment and/or stress.

## 4 Construction

### 4.1 Hose

The hose shall consist of an elastomeric lining, two or more layers or plies of reinforcing cord embedded in, and/or bonded to, the elastomeric lining and outer cover. A cushion liner between the reinforcing cords is permitted. The cover shall be a black compound which will not crack when subjected to long periods

of weather ageing. The lining of this hose shall be of a compound which will effectively resist deterioration by non-petroleum-base brake fluids as designated in ISO 4925.

## 4.2 Hose assembly

Each hydraulic brake hose assembly shall have permanently attached end fittings.

## 5 Performance testing for acceptance

The test schedule shall consist of all the tests listed in table 1. The complete test schedule shall be conducted for each separate brake hose assembly design. Any changes in hose construction or materials, coupling crimp or swage design or end fittings shall be deemed to constitute a change in assembly design. Variations that do not influence the integrity of the hose coupling joint such as variation in thread size, port dimensions, hexagon size and the like shall however not be considered a design change.

When the hose assembly configurations are such that it is impractical to conduct tests such as tensile, whip and constriction, hose assemblies produced from equivalent type and fittings, production type equipment and processes shall be used as substitute brake hose assemblies.

## 6 Tests

### 6.1 Test conditions

The hose assemblies for the performance tests shall be new and unused. They shall be at least 24 h old.

For the last 4 h prior to testing, they shall be maintained at a temperature of 15 °C to 32 °C.

Prior to installation of the hose assembly for a whip test or cold bend test, all external appendages such as mounting brackets, spring guards and metal collars shall be removed, or long tubes shortened, or both.

Unless otherwise specified, the temperature of the test room shall be between 15 °C and 32 °C for all tests.

**Table 1 — Hydraulic brake hose assembly performance tests and quantity of samples required**

| Number of samples                                                                                     | Qualification tests                            | Subclause |
|-------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------|
| All                                                                                                   | Hydrostatic pressure test                      | 6.2       |
| All <sup>1)</sup>                                                                                     | Constriction test                              | 6.3       |
| 4                                                                                                     | Volumetric expansion test followed by burst    | 6.4, 6.5  |
| 4                                                                                                     | Brake fluid compatibility                      | 6.6       |
| 4                                                                                                     | Whip test                                      | 6.7       |
| 4                                                                                                     | Tensile strength test                          | 6.8       |
| 4                                                                                                     | Hot impulse strength test                      | 6.12      |
| 2                                                                                                     | Ozone resistance test under dynamic conditions | 6.11      |
| 1                                                                                                     | Cold bend test                                 | 6.10      |
| 1                                                                                                     | Salt spray test                                | 6.13      |
| <b>Tests after water absorption</b>                                                                   |                                                |           |
| 4                                                                                                     | Burst strength test                            | 6.9       |
| 4                                                                                                     | Whip test                                      | 6.9       |
| 4                                                                                                     | Tensile test                                   | 6.9       |
| NOTE — Total quantity of samples: 36                                                                  |                                                |           |
| 1) Four brake hose assemblies may be used if assemblies have to be cut to conduct constriction tests. |                                                |           |

## 6.2 Hydrostatic pressure test

Subject the hose assembly to a hydrostatic pressure test, using inert gas, air, water or brake fluid conforming to ISO 4925 as the pressure medium. The test pressure shall be between 10,3 MPa and 14,5 MPa for inert gas and air, and between 20,7 MPa and 24,8 MPa for water and brake fluid.

**WARNING — Special care shall be taken when gas or air is used, as under the pressure specified, gas and air are explosive if a failure should occur in the hose assembly.**

Hold the pressure for between 10 s and 25 s.

Hose assemblies showing leaks under this test shall be rejected and destroyed.

## 6.3 Constriction test

### 6.3.1 Requirements

The constriction of the hose assemblies shall be measured with a gauge plug as shown in figure 1, in that part of the brake hose end fittings which contains the hose. The choice of gauge is left to the operator.

The constriction shall not be less than diameter A min. specified in figure 1.

### 6.3.2 Procedure

The hose assemblies shall be submitted to the appropriate procedure among the following.

**6.3.2.1** Hold the hose assembly vertically at the fitting and insert the A diameter portion of the gauge plug into the end of the fitting for the full length of the probe. Repeat at the other end of the hose assembly.

**6.3.2.2** Some hose assemblies have a fitting so designed that it is impossible to insert the gauge externally. For these hose assemblies, insert a special elongated gauge plug that meets the requirements of figure 1, with the exception of the length, which shall be such that its tip will extend past the hose opening, into the opposite end.

NOTE 1 If the gauge plug becomes misaligned at the entrance to the second fitting, it may be necessary to align the hose to allow the gauge plug to pass through.

**6.3.2.3** Some hose assemblies have fittings on both ends which cannot be entered with the gauge plug. Cut these hose assemblies 50 mm  $\pm$  2 mm from the end of the fitting and then test with the gauge plug in accordance with figure 1.

## 6.4 Expansion test

### 6.4.1 Requirements

The maximum expansion of any hose assembly tested in accordance with 6.4.4 shall not exceed the values in table 2.

### 6.4.2 Apparatus

The apparatus shall basically consist of the following elements (see figure 2):

- source for required fluid pressures;
- test fluid consisting of brake fluid, or water without any additives and free of air or gas bubbles;
- water pressure gauges;
- fittings in which the hose assembly may be mounted vertically for application of pressure under controlled conditions;

**Table 2 — Maximum expansion**

| Hose nominal inside diameter | Test pressure                                   |                                             |                                                 |                                             |
|------------------------------|-------------------------------------------------|---------------------------------------------|-------------------------------------------------|---------------------------------------------|
|                              | 6,9 MPa                                         |                                             | 10,3 MPa                                        |                                             |
|                              | Regular expansion<br>(HR)<br>cm <sup>3</sup> /m | Low expansion<br>(HL)<br>cm <sup>3</sup> /m | Regular expansion<br>(HR)<br>cm <sup>3</sup> /m | Low expansion<br>(HL)<br>cm <sup>3</sup> /m |
| mm                           |                                                 |                                             |                                                 |                                             |
| 3,2                          | 2,17                                            | 1,08                                        | 2,59                                            | 1,38                                        |
| 4,8                          | 2,82                                            | 1,81                                        | 3,35                                            | 2,36                                        |

Dimensions in millimetres

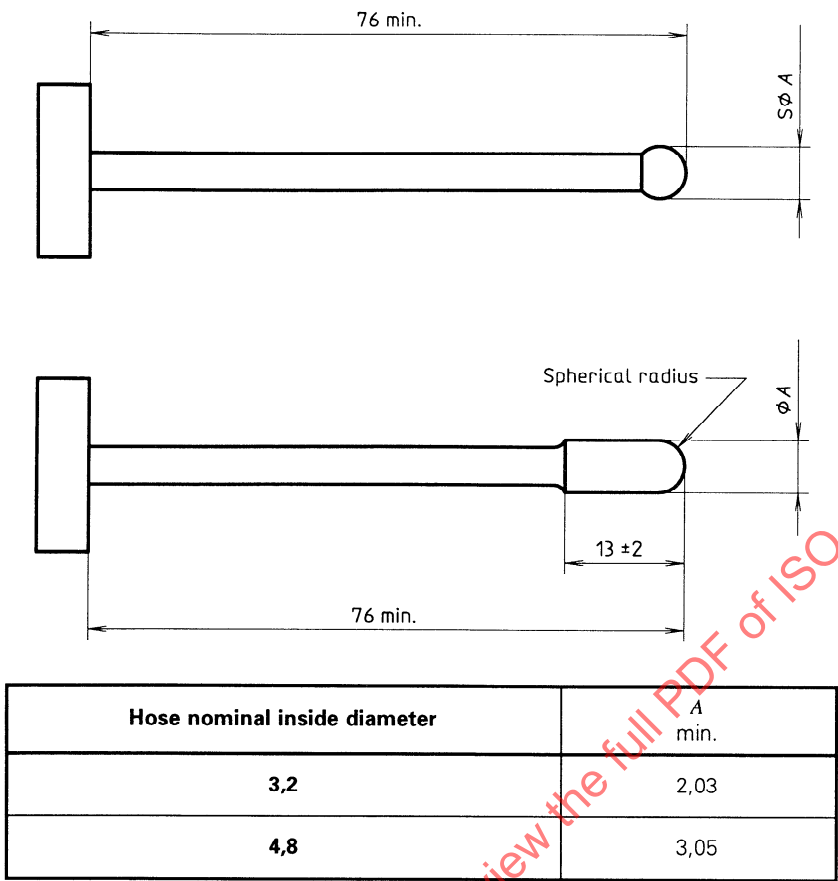


Figure 1 — Gauge plugs for testing constriction of hose bore

- e) graduated burette with 0,05 cm<sup>3</sup> increments for measuring the volume of liquid corresponding to the expansion of the hose under pressure;
- f) plumbing hardware as required.

All piping and connections shall be smooth-bore without recesses or offsets, so that all air may be freely removed from the system before running each test. Valves shall withstand the pressures involved without leakage.

6.4.3 Calibration of apparatus

The apparatus shall be tested prior to use to determine its calibration correction factors established at pressures of 6,9 MPa and 10,3 MPa using a simulated hose assembly that shall consist of at least 1,52 mm wall hydraulic steel tubing with a free length of 305 mm ± 6 mm and an outside diameter of 6,3 mm. All fittings and adaptors used in the testing of the hose assembly shall be in this system. This may require the attachment of the tubing to the fit-

tings in the case of special end configurations. The calibration correction factors shall be subtracted from the expansion readings obtained on the test samples.

The calibration correction factor shall not exceed 0,08 cm<sup>3</sup> at 10,3 MPa.

6.4.4 Procedure

6.4.4.1 If the sample to be used in this test has been subjected to pressure above 10,3 MPa using any medium prior to this test, allow it to recover for 15 min.

6.4.4.2 Measure the free length of brake hose assembly with it vertical and a mass of 567 g ± 3 g attached to the lower end.

6.4.4.3 Carefully thread the hose assembly into the adaptors designed to seal in the same manner as in actual use. Do not twist the hose assembly. Maintain the hose assembly vertical and straight without tension while under pressure.

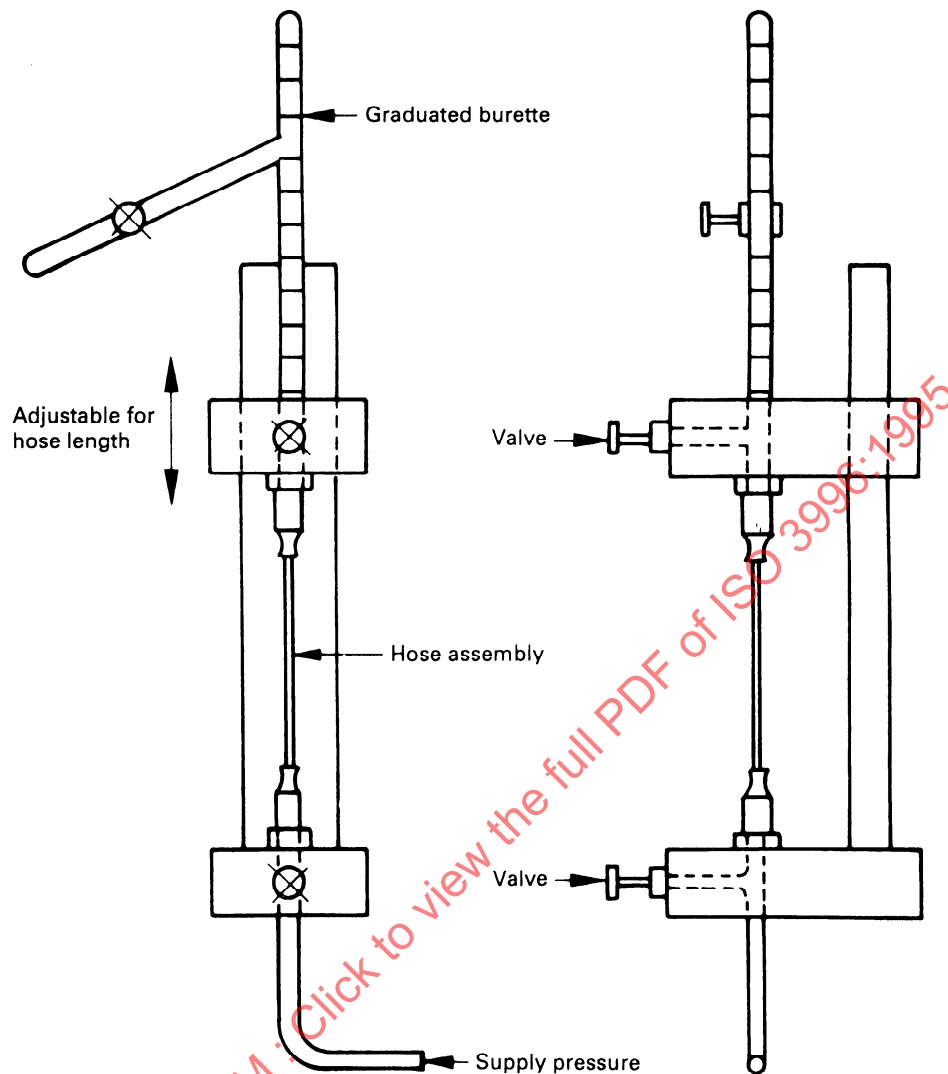


Figure 2 — Expansion test apparatus

**6.4.4.4** Bleed all the air from the apparatus by allowing approximately 0,25 l of water to flow from the reservoir tank through the hose assembly and into the burette. Removal of air bubbles may be facilitated by shaking the hose assembly.

**6.4.4.5** Close the valve to the burette and apply  $10,3 \text{ MPa } \begin{smallmatrix} 0 \\ -0,14 \end{smallmatrix}$  MPa pressure to the hose assembly. Within 10 s, inspect the hose assembly for leaks at the connections and then release the pressure completely in the hose. Adjust the water level in the burette to zero.

**6.4.4.6** With the valve to the burette closed, apply  $6,9 \text{ MPa } \begin{smallmatrix} 0 \\ -0,14 \end{smallmatrix}$  MPa to the hose assembly and maintain this pressure in the hose for  $5 \text{ s} \pm 3 \text{ s}$ .

Within 3 s, open the valve to the burette. For  $10 \text{ s} \pm 3 \text{ s}$ , allow the water in the expanded hose to

rise in the burette. The water level in the burette shall become constant within this time period.

**6.4.4.7** Repeat the test in 6.4.4.6 twice, so that the amount of water in the burette is the total of the three expansions. Measure this burette reading to the nearest  $0,05 \text{ cm}^3$ .

**6.4.4.8** Calculate the volumetric expansion,  $E$ , in cubic centimetres per metre of free length

$$E = \frac{\frac{V}{3} - C}{l}$$

where

$V$  is the total volume of three expansions, in cubic centimetres, read on the burette;

- C* is the correction factor, in cubic centimetres;
- l* is the free length of sample, in metres.

**6.4.4.9** Readjust the water level in the burette to zero as above and repeat the procedure given in 6.4.4.6 and 6.4.4.7, to obtain the expansion at a pressure of 10,3 MPa  $^{+0}_{-0,14}$  MPa. If the pressure in the hose inadvertently rises to a value above that specified, but not above 24 MPa, completely release the pressure and allow the hose to recover for at least 15 min and then repeat the test. If the hose was subjected to a pressure above 24 MPa, then repeat the test using a new brake hose. If, at any time during the test, an air bubble flows out of the hose, repeat the test after allowing at least 5 min for the hose to recover.

6.5 Burst strength test

6.5.1 Requirements

When tested under hydraulic pressure, each sample of hose assembly shall withstand a pressure hold of 2 min at the specified pressure and shall withstand the minimum burst pressure as shown in table 3.

Table 3 — Hold pressure and minimum burst pressure

| Hose nominal<br>inside diameter<br>mm | Pressure hold<br>MPa | Minimum burst<br>pressure<br>MPa |
|---------------------------------------|----------------------|----------------------------------|
| 3,2                                   | 27,6                 | 49,0                             |
| 4,8                                   | 27,6                 | 34,5                             |

6.5.2 Apparatus

The apparatus consists of a suitable pressure system in which the hose assembly is so connected that controlled and measured fluid pressure may be applied internally. The pressure shall be obtained by means of a hand- or power-driven pump or an accumulator system and shall be measured with a calibrated gauge.

As a safety measure, provision shall be made for filling the hose assembly with water or brake fluid and allowing all air to escape through a relief valve prior to the application of pressure.

The pressures shown in table 3 shall be applied at a rate of (172,5 ± 69) MPa/min.

Since this type of hose assembly withstands a minimum bursting pressure as shown in table 3, care shall be taken that all piping, valves and fittings are sufficiently rugged and adapted to high pressure work. The apparatus described in 6.4.2 may be used when it conforms to these requirements.

6.5.3 Procedure

Connect the sample to the pressure system and fill completely with water or brake fluid, allowing all air to escape. Removal of air bubbles may be facilitated by shaking the hose. Apply 27,6 MPa  $^{+0}_{-0,13}$  MPa pressure at the rate specified in 6.5.2 and hold for 120 s  $^{+0}_{-10}$  s. At the expiration of this hold period, increase the pressure at a rate of (172,5 ± 69) MPa/min until the hose bursts. Read the maximum pressure obtained on the calibration gauge to the nearest 0,69 MPa and record it as the bursting strength of the hose assembly.

6.6 Brake fluid compatibility

6.6.1 Requirements

After having been subjected to a temperature of 120 °C  $^{+5}_{-0}$  °C for 70 h to 72 h while filled with compatible non-petroleum-base brake fluid as specified in ISO 4926, the hose assembly shall meet the constriction requirements specified in 6.3.1. It shall then withstand a pressure of 27,6 MPa for 120 s  $^{+0}_{-10}$  s and shall not burst at less than 34,5 MPa. In addition, under the conditions in 6.6.3.3, the hose assembly shall burst within 3 h.

6.6.2 Preparation

**6.6.2.1** Attach a hose assembly or manifold to which multiple hose assemblies may be attached, below a 0,5 l reservoir filled (see figure 3), with 100 ml of compatible non-petroleum-base brake fluid as specified in ISO 4926.

**6.6.2.2** Fill the hose assembly with compatible non-petroleum-base brake fluid as specified in ISO 4926 and seal the lower end.

6.6.3 Procedure

**6.6.3.1** Place the hose assembly vertically in an oven. Condition the hose assembly at 120 °C  $^{+5}_{-0}$  °C for 70 h to 72 h, then cool to room temperature for 30 min ± 5 min.

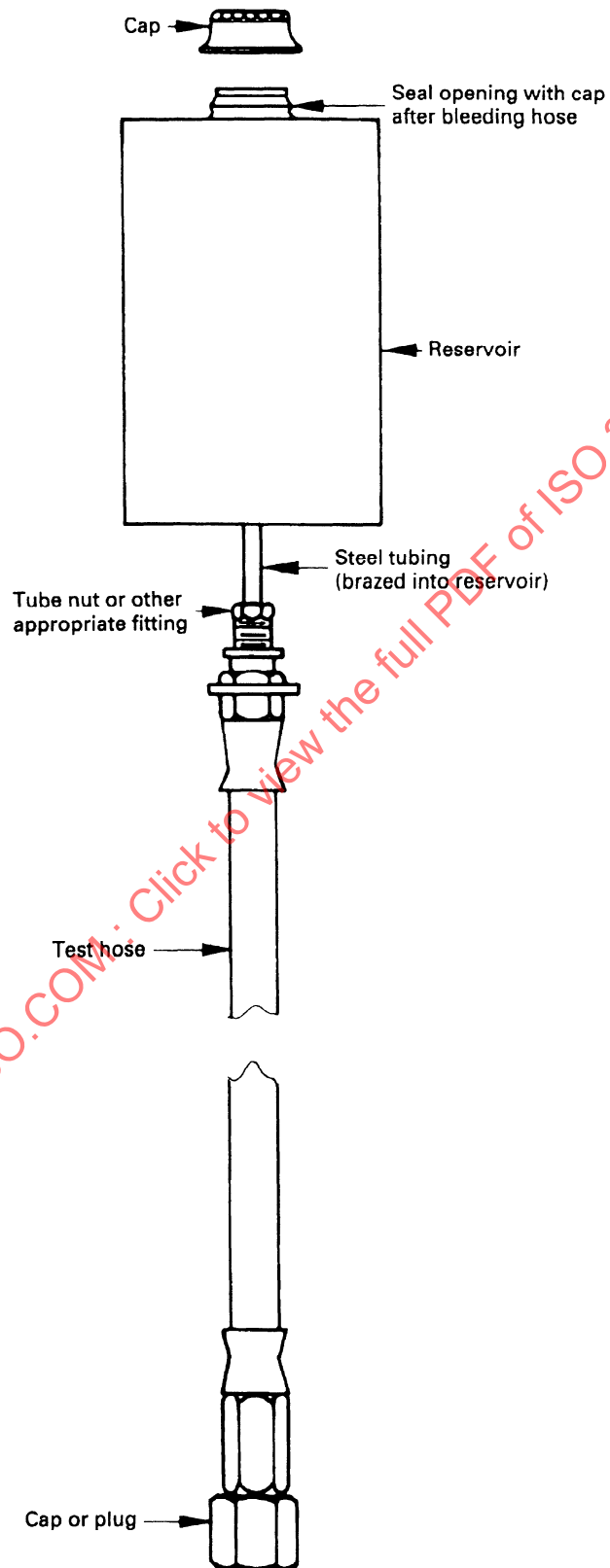


Figure 3 — Brake fluid compatibility test apparatus

**6.6.3.2** Drain the hose assembly and within 10 min verify the constriction requirements according to 6.3.1 and 6.3.2.

**6.6.3.3** Then subject the hose assembly to a test as in 6.5.3.

**6.7 Whip test**

**6.7.1 Requirements**

The minimum life on the whip test apparatus shall be 35 h for any one of the sample hose assemblies with free lengths, in accordance with figure 5.

**6.7.2 Apparatus**

The apparatus (see figure 4) shall consist of a rotating header consisting of a horizontal bar mounted at each end on vertically rotating discs through bearings with centres placed 100 mm from the disc centres, and an adjustable non-rotating header parallel to the rotating header in the same horizontal plane as the centres of the discs. The headers are each provided with end connections in which the hose assemblies are mounted in parallel. The discs are rotated at a frequency of  $800\text{ min}^{-1} \pm 10\text{ min}^{-1}$ , whereby the hose ends fastened to the rotating header are rotated at this frequency through a circle 203,2 mm  $\pm$  0,25 mm in diameter, while the opposite hose end remains stationary. The end connections on the rotating header are tightly capped, while those on the non-rotating header are open to a manifold through which water pressure is supplied by a suitable means. A limit switch shall be used to stop the apparatus when the water pressure drops, as in the case of hose failures, since it is essential that the apparatus stop if the pressure drops. An elapsed time indicator shall be provided.

**6.7.3 Procedure**

**6.7.3.1** Measure the free length of each hose assembly with the assembly vertical with a mass of 567 g  $\pm$  3 g attached to the lower end, using a vernier calliper scale or equivalent. Report the length between the fittings to 0,5 mm.

**6.7.3.2** Equip the non-rotating header to permit attachment of each hose assembly with individual setting for length. When mounted in the whip test apparatus (see figure 4), the projected length of each hose assembly shall be less than the free length by the amount indicated as slack in figure 5.

Since the whip test results are very sensitive to error in setting this length, the projected length of each hose assembly on the whip test apparatus shall be within the limits specified. Take the projected length parallel to the axis of the rotating header.

**6.7.3.3** Install the hose assemblies in the apparatus without any twist. Apply the water or brake fluid pressure held between 1,55 MPa and 1,72 MPa and bleed all hose and passages to eliminate air pockets or bubbles. Start the motor rotating the rotating head and note the duration of the test. Check the rate of rotation periodically.

Failure of the hose assembly by leakage and consequent loss of pressure terminates the test.

**6.8 Tensile strength test**

**6.8.1 Requirements**

All the hose assemblies shall withstand the minimum load as indicated in table 4 without the end fittings pulling off or rupture of the hose.

**Table 4 — Tensile separation rate and minimum load**

| Hose nominal<br>inside diameter<br>mm | Tensile<br>separation rate<br>mm/min | Minimum load<br>N |
|---------------------------------------|--------------------------------------|-------------------|
| <b>3,2 or 4,8</b>                     | 25 $\pm$ 3                           | 1446              |
|                                       | 50 $\pm$ 3                           | 1646              |

**6.8.2 Apparatus**

A tensile test apparatus conforming to ISO 7500-1 and having a capacity of 4,5 kN is suitable. The apparatus shall be provided with a recording device to give the total pull at the conclusion of the test. The sample shall be so held that the hose and fittings have a straight centreline corresponding to the direction of the apparatus pull.

**6.8.3 Procedure**

Fit the hose assembly in the test apparatus, then apply an increasing tensile load at a speed specified in table 4 until failure. Record the total load at the time of failure and the type of failure.

Dimensions in millimetres

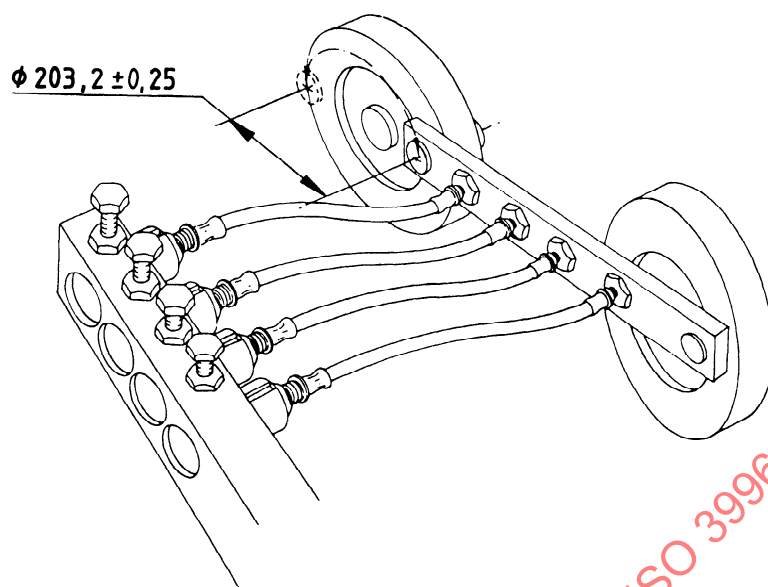
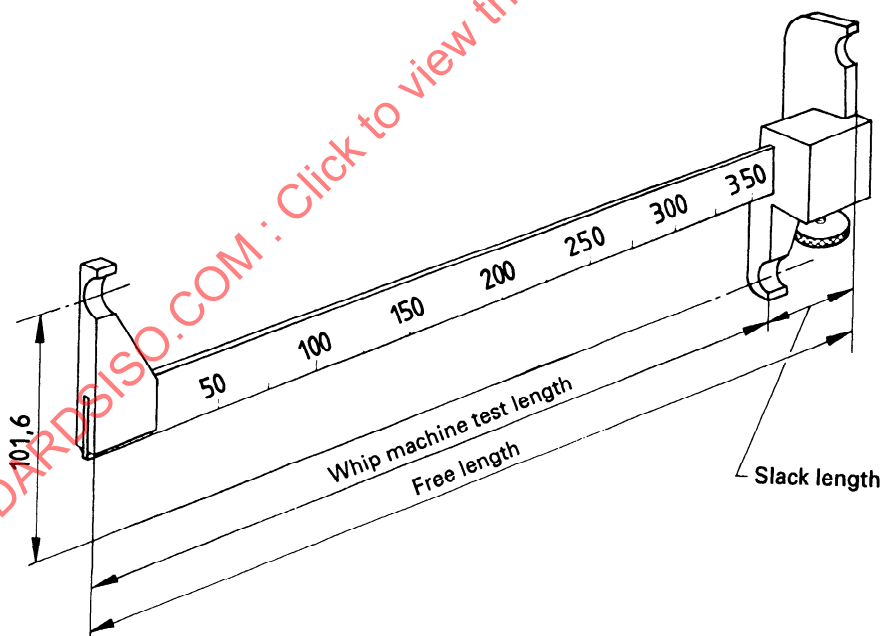


Figure 4 — Whip test apparatus

Dimensions in millimetres



| Hose nominal inside diameter | Free length<br>$l$    | Slack           |
|------------------------------|-----------------------|-----------------|
| 3,2                          | $200 \leq l \leq 400$ | $44,45 \pm 0,4$ |
|                              | $400 < l \leq 480$    | $31,75 \pm 0,4$ |
|                              | $480 < l \leq 600$    | $19,05 \pm 0,4$ |
| 4,8                          | $250 \leq l \leq 400$ | $25,4 \pm 0,4$  |

Figure 5 — Whip test slack setting fixture

## 6.9 Water absorption test

### 6.9.1 Requirements

Separate samples of hose assemblies, after immersion in water, shall pass all requirements for burst strength (see 6.5.1), whip (see 6.7.1), and tensile strength (see 6.8.1) as indicated for non-aged brake hose assemblies.

### 6.9.2 Procedure

**6.9.2.1** Immerse the suitably closed off hose assembly in water heated at  $85\text{ °C} \pm 2\text{ °C}$  for 70 h to 72 h.

**6.9.2.2** Carry out the tensile strength and burst strength tests within 10 min after removal from hose assemblies of the water, and start the whip test within 10 min to 30 min after removing the hose assemblies from the water.

## 6.10 Cold bend test

### 6.10.1 Requirements

The hose cover shall not crack visibly to the naked eye without magnification, nor break.

### 6.10.2 Apparatus

The apparatus consists of a mandrel having a diameter of  $76,2\text{ mm}^{+1}_0\text{ mm}$  for hose inside diameter  $3,2\text{ mm}$  and  $88,9\text{ mm}^{+1}_0\text{ mm}$  for hose inside diameter  $4,8\text{ mm}$ .

### 6.10.3 Procedure

**6.10.3.1** Condition the hose in a straight position, together with a mandrel of the diameter specified in 6.10.2 in air at  $-45\text{ °C}$  to  $-48\text{ °C}$ , for 70 h to 72 h. Then, while still at this temperature, bend the hose evenly at least  $180^\circ$  around the mandrel within 3 s to 5 s.

**6.10.3.2** Examine the cover of the brake hose with the naked eye for cracks or breaks.

## 6.11 Ozone resistance test under dynamic conditions

### 6.11.1 Requirements

The outer cover of the hose shall not show cracks visible to the naked eye without magnification at the worst stress condition, ignoring the areas immediately adjacent to or within the area covered by the band clamps.

### 6.11.2 Apparatus

Use the apparatus illustrated in figure 6.

### 6.11.3 Preparation

Precondition all the samples of hose assembly in a non-stressed condition heated at  $27\text{ °C} \pm 6\text{ °C}$  for at least 24 h prior to the start of the test.

### 6.11.4 Procedure

**6.11.4.1** Assemble the samples of hose assembly on the dynamic ozone test apparatus so that they meet the relative position and flex parameters shown in figure 6. Install the hose assembly,  $218\text{ mm} \pm 3\text{ mm}$  long, over the fixture pins until the hose assembly has bottomed out. Use band clamps to retain the hose assembly on the pins securely.

**6.11.4.2** Install the test apparatus and the hose assembly in a stabilized ozone chamber containing air mixed with ozone at an ozone partial pressure of  $100\text{ mPa} \pm 10\text{ mPa}$  [ $(100 \pm 10)$  parts of ozone per 100 million parts of air by volume]. The air temperature in the chamber shall be  $40\text{ °C} \pm 3\text{ °C}$ .

**6.11.4.3** Start the cycling test when the chamber reaches the specified ozone concentration but no later than 1 h after putting the test apparatus in the chamber. The flex rate shall be  $0,3\text{ Hz} \pm 0,05\text{ Hz}$ . The stroke shall be  $76,2\text{ mm} \pm 2,5\text{ mm}$ . The cycling test duration shall be  $48\text{ h}^{+1}_0\text{ h}$ .

**6.11.4.4** Examine the outside cover of the hose assembly for cracks.

## 6.12 Hot impulse strength test

### 6.12.1 Requirements

After having withstood impulsing for 150 cycles without leakage, a brake hose assembly shall withstand a 2 min pressure hold at  $27,6\text{ MPa}$  without leakage and shall not burst at less than  $34,5\text{ MPa}$ .

Dimensions in millimetres

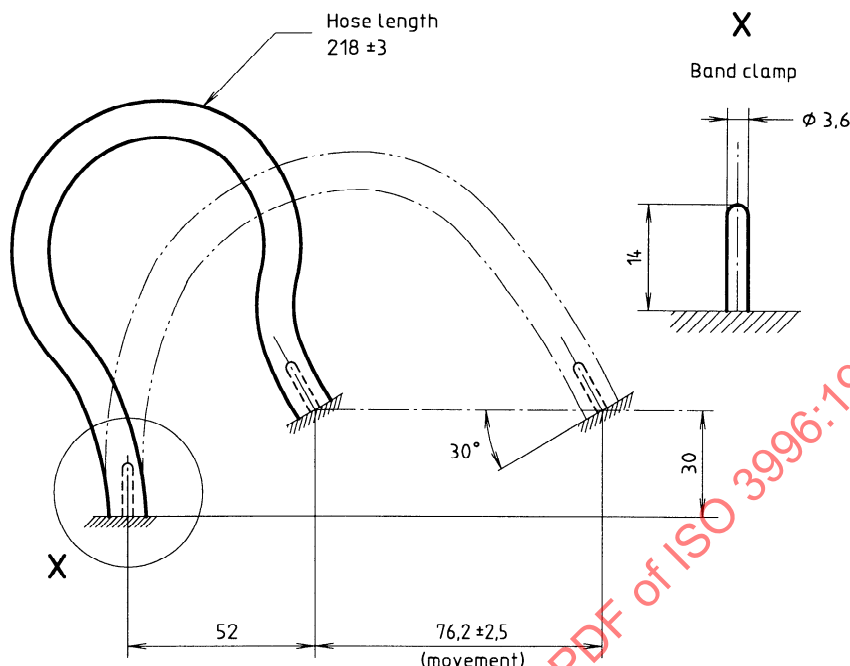


Figure 6 — Ozone strength test apparatus

## 6.12.2 Apparatus

**6.12.2.1** The pressure cycling apparatus shall be capable of applying a pressure of 11 MPa. It shall have automatic control of the time for the pressure apply/release cycle.

**6.12.2.2** An insulated circulating air oven with a suitable thermostatically controlled heating system is required to maintain a temperature of  $143\text{ °C} \pm 3\text{ °C}$ .

**6.12.2.3** The pressure hold and burst strength test apparatus shall be as described in 6.5.2.

## 6.12.3 Procedure

**6.12.3.1** Connect the hose assemblies to a pressure cycling apparatus capable of producing a pressure of 0 to 11 MPa.

**6.12.3.2** Fill the pressure cycling apparatus and hose assemblies with ISO 4926 compatible non-petroleum-base brake fluid, and bleed free of air.

**6.12.3.3** Place the hose assemblies in a circulating air oven and within 30 min attain an oven temperature of  $143\text{ °C} \pm 3\text{ °C}$ .

**6.12.3.4** Subject the hose assemblies to a cycling internal pressure of 11 MPa  $^{+0,5}_0$  MPa for  $60\text{ s} \pm 6\text{ s}$  then 0 MPa for  $60\text{ s} \pm 6\text{ s}$ . Pressures shall be attained within 2 s. Pressure cycle the assemblies for at least 150 cycles.

**6.12.3.5** Remove the hose assemblies from the oven. Disconnect the hose assemblies from the apparatus, and drain the fluid. Cool the hose assemblies in air at room temperature for at least 45 min.

**6.12.3.6** Subject the hose assemblies to the pressure hold and burst test described in 6.5.

## 6.13 Salt spray test

### 6.13.1 Requirements

Following the 24 h exposure test, samples shall have no base metal corrosion. The areas of the end fitting where crimping or the application of labelling information has caused the displacement of the protective coating are exempt from the corrosion requirements. As brass end fittings have adequate corrosion resistance, salt spray testing of brass end fittings is not required.

### 6.13.2 Apparatus

Use the apparatus described in ISO 9227. The salt spray chamber shall be constructed so that

- a) the construction material does not affect the corrosiveness of the spray;
- b) the hose assembly is supported or suspended between 15° and 30° from the vertical (see figure 7) and contained in a vertical plane parallel to the principal direction of the horizontal flow of spray through the chamber;
- c) the hose assembly does not contact any metallic material or any material capable of acting as a wick;
- d) condensation which falls from the hose assembly does not return to the solution reservoir for re-spraying;
- e) condensation from any source does not fall on the hose assemblies or the solution collectors;
- f) spray from the nozzles is not directed on to the hose assemblies.

### 6.13.3 Preparation

**6.13.3.1** Plug each end fitting of the hose assembly.

**6.13.3.2** Mix a salt solution ( $5 \pm 1$ ) parts by mass of sodium chloride to 95 parts of distilled water, using sodium chloride substantially free of nickel and copper, and containing on a dry basis not more than 0,1 % (m/m) of sodium iodide and not more than 0,3 % (m/m) total impurities. Ensure that the solution is free of suspended solids before it is atomized.

**6.13.3.3** After atomization at  $35 \text{ °C} \pm \frac{1}{2} \text{ °C}$ , ensure that the collected solution is in the pH range of 6,5 to 7,2. Make pH measurements at  $25 \text{ °C} \pm 3 \text{ °C}$ .

**6.13.3.4** Maintain a compressed air supply to the nozzle free of oil and dirt, and between 68,9 kPa and 172,4 kPa.

### 6.13.4 Procedure

**6.13.4.1** Subject the hose assembly to the NSS test in ISO 9227 continuously for  $24 \text{ h} \pm \frac{12}{0} \text{ min}$ .

**6.13.4.2** Regulate the mixture so that each collector will collect from 1 ml to 2 ml of solution per hour for each  $80 \text{ cm}^2$  of horizontal collecting area.

**6.13.4.3** Maintain the exposure zone temperature at  $35 \text{ °C} \pm 2 \text{ °C}$ .

**6.13.4.4** Upon completion, remove the salt deposit from the surface of the hose assemblies by washing gently or dipping in clean running water not warmer than  $37 \text{ °C}$  and then drying with air within 2 min.

**6.13.4.5** Examine the end fitting for base metal corrosion and record results.

## 7 Identification and marking

### 7.1 Brake hose

#### 7.1.1 Identification by coloured marker yarn(s)

The hoses of each manufacturer shall be identified by one or more coloured marker yarn(s) incorporated in the construction. Embossed or imprinted (three-dimensional) marking on the hose cover may be used in lieu of marker yarn identification.

Codes for marker yarn colour designations for each hose manufacturer shall be registered with the international agency acting under authorization from ISO: RMA — Rubber Manufacturers' Association, 1400 K Street, N.W., Washington, D.C. 20005, USA.

#### 7.1.2 Marking of hose

**7.1.2.1** Each hose shall have at least two clearly identifiable stripes of a colour other than green<sup>1)</sup> of at least 1,6 mm width, placed on opposite sides of the hose parallel to its longitudinal axis. One stripe may be interrupted by the information required by 7.1.2.2 and the other stripe may be interrupted by additional information at the manufacturer's option.

The marking of the hose need not be present on the hose after it has become part of a hose assembly or after it has been installed in a motor vehicle.

1) Green labelling is used for hoses used with petroleum-base hydraulic fluid in accordance with ISO 6120, *Road vehicles — Brake hose assemblies for hydraulic braking systems used with petroleum-base brake fluid*.