INTERNATIONAL STANDARD ISO 3996

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

Véhicules routiers — Flexible pour systèmes de freinage hydraulique utilisant un liquide de frein à base non pétrolière

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FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3996 was developed by Technical Committee ISO/TC 22, *Road vehicles*, and was circulated to the member bodies in January 1976.

It has been approved by the member bodies of the following countries :

Austria	Iran	Spain
Belgium	Italy	Sweden
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INTERNATIONAL STANDARD ISO 3996-1978 (E)/ERRATUM

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

ERRATUM

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Sub-clause 7.8.3 :

Replace the first line with the following :

"A tension testing machine conforming to ISO/R 147 shall"

In the fifth line, change "A machine a 4,5 kN" to "A machine of 4,5 kN".

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

1 SCOPE

This International Standard specifies the test procedures for, and performance of, hydraulic brake hose assemblies to be used in the hydraulic braking system of a road vehicle, and the markings to be put on the brake hose.

2 FIELD OF APPLICATION

This International Standard applies to brake hose asemblies made of a hose fabricated from cord and natural or synthetic elastomers and assembled with metal end fittings for use with non-petroleum base brake fluids as specified in ISO 4925.

The nominal internal diameter of the hose shall be one of the following values :

3,2 mm 4,8 mm 6,3 mm

3 REFERENCES

ISO/R 147, *Load calibration of testing machines for tensile testing of steel.*

ISO 3768, *Neutral salt spray test.*

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

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

4 DEFINITIONS

4.1 brake hose assembly : A brake hose equipped with end fittings for use in a brake system.

4.2 brake hose : A flexible conduit manufactured for use in a brake system to transmit and contain the fluid pressure medium used to apply force to the vehicle's brakes.

4.3 brake hose end fittings : Couplings designed for permanent attachment to the ends of a brake hose by crimping or swaging.

4.4 free length : The linear measurement of brake hose exposed between the end fittings of a brake hose assembly while maintained in a straight position.

4.5 leaks; burst : The loss of test fluid through the brake hose assembly other than by the designed inlet(s) and outlet(s).

4.6 cracking : The interruption of a surface due to environment and/or stress.

5 CONSTRUCTION

5.1 The hose shall consist of an elastomeric lining, two or more layers or plies of textile reinforcing cord imbedded in, and/or bonded to, the elastomeric lining and outer cover. The cover must be a black compound, free from sulphur bloom, which will not crack when subjected to long periods of weather ageing. The lining of this hose must be of compound which will effectively resist deterioration by non-petroleum brake fluids as designated in clause 2.

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

6 PERFORMANCE TEST

The performance test for hydraulic brake hose assemblies includes all of the tests listed in table 1. These tests shall be conducted on each internal diameter size and type[1] from each hose manufacturer. A change in hose construction, i.e. a change in material or a change in manufacturing method, shall require a complete performance test. Accordingly, each coupler shall conduct the performance test on each coupling crimp design for each hose construction. A change of coupling crimp design shall require a complete performance test. Variations that do not influence the integrity of the hose coupling joint, such as variation in thread size, port dimensions, hex size and the like, shall not be considered a new design.

1) Various reinforcing cords and/or elastomer(s).

6.1 Retest and rejections

Except for the 100 % pressure test and constriction test, in the event of a failure of one sample in performance testing a double sample retest of that characteristic shall be performed as shown in table 1.

TABLE 1 — **Hydraulic brake hose assembly performance test and quantity of samples required**[1)]

Sample size		Qualification test	Sub-clause
Original	Retest		
All	All	100 % pressure test	7.2
All[2)]	All[2)]	Constriction	7.3
4	8	Volumetric expansion followed by burst	7.4 7.5
4	8	Brake fluid compatibility	7.6
4	8	Whip	7.7
4	8	Tensile	7.8
1	2	Cold bend	7.10
1	2	Ozone	7.11
1	2	Salt spray	7.12
Tests after water absorption			
4	8	Burst	7.9
4	8	Whip	
4	8	Tensile	
31	—	Total quantity of samples	

Failure of any one sample on retest shall be cause for disqualification or rejection of the lot.

7 TESTS

7.1 Test conditions

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

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

Prior to installation of the hose assembly on 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.

The temperature of the testing room shall be between 15 and 32 °C for all tests except cold bend, ozone, salt spray and brake fluid compatibility.

7.2 100 % pressure test

The hose assembly shall be subject to a pressure test, using inert gas, air, water or brake fluid conforming to ISO 4925 as the pressure medium. The test pressure shall be 10,3 MPa minimum, 14,5 MPa maximum for inert gas and air and 20,7 MPa minimum, 24,8 MPa maximum for water and brake fluid. Special care should 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. The pressure shall be held for not less than 10 s and not more than 25 s. Hose assemblies showing leaks under this test shall be rejected and destroyed.

7.3 Constriction test

7.3.1 *Requirements*

The constriction of the hose assemblies shall be measured with a gauge plug as shown in figure 1 and whose *A* dimensions shall be as listed in table 2. The constriction requirements do not apply to that part of the brake hose end fittings which does not contain hose.

TABLE 2 — **Constriction gauge dimensions**

Dimensions in millimetres

Hose internal diameter	Diameter *A* min.
3,2	2,03
4,8	3,05
6,3	4,19

Brake hose assemblies which use a 4,8 mm internal diameter hose due to fitting design and which are used in 3,2 mm internal diameter hose applications (for example applications where volume-flow characteristics of 3,2 mm hose are satisfactory) shall be checked with a 2,03 mm minimum diameter gauge plug.

7.3.2 *Procedure*

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

Some hose assemblies have a fitting so designed that it is impossible to insert the gauge plug externally. For these assemblies, insert a special elongated gauge plug into the opposite fitting as above and pass the probe through

1) 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 end fittings, production type equipment and processes must be used to make the substitute brake hose assemblies.

2) Four brake hose assemblies on original test and eight brake hose assemblies on retest may be used if assemblies must be cut to conduct constriction tests.

the hose, into and through the crimped area of the fitting being tested. 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. The special gauge plug shall meet all the requirements of figure 1, with the exception of the 76 mm length, which must be increased appropriately so that its tip will extend past the hose opening.

Some brake hose assemblies have fittings on both ends which cannot be entered with the gauge plug. Cut these assemblies 50 ± 2 mm from the end of the fitting and then test with the gauge plug (see table 1, footnote 2).

7.4 Expansion test

7.4.1 *Requirements*

The expansion test is designed to measure, by fluid displacement, the volumetric expansion of the free length of a brake hose assembly when subjected to specified internal pressures. The free length is the length measured between the fittings. The maximum expansion of any of the hose assemblies so tested shall not exceed values in table 3.

TABLE 3 — **Maximum expansion of free length hose (cm^3/m)**

Hose internal diameter mm	6,9 MPa		10,3 MPa	
	Regular expansion hose (HR)	Low expansion hose (HL)	Regular expansion hose (HR)	Low expansion hose (HL)
3,2	2,17	1,08	2,59	1,38
4,8	2,82	1,81	3,35	2,36
6,3	3,41	2,69	4,27	3,84

7.4.2 *Procedure*

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

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

7.4.2.3 Bleed all the air from the system 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 moving the hose back and forth. Close the valve to the burette and apply $10{,}3\ ^{0}_{-0{,}14}$ MPa 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. With the valve to the burette closed, apply $6{,}9\ ^{0}_{-0{,}14}$ MPa to the hose assembly and seal this pressure in the hose within 5 ± 3 s.

Within 3 s open the valve to the burette for 10 ± 3 s and allow the water in the expanded hose to rise in the burette. The liquid level in the burette should become constant within that time period.

7.4.2.4 Repeat the preceding step twice, so that the amount of water in the burette will be the total of the three expansions. Measure this burette reading to the nearest 0,05 cm^3.

7.4.2.5 The volumetric expansion is calculated by dividing the burette reading by three and subtracting the calibration factor. This figure divided by the free length in metres will give the volumetric expansion per metre of hose.

7.4.2.6 Readjust the water level in the burette to zero as above and repeat the procedure to obtain the expansion at a pressure of $10{,}3\ ^{0}_{-0{,}2}$ MPa. If the pressure in the hose should inadvertently be raised 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.

7.4.3 *Apparatus*

The apparatus shall consist essentially of the following :

a) **a source for required fluid pressures;**

b) **test fluid** consisting of water without any additives and free of air or gas bubbles;

c) **a reservoir for water pressure gauges;**

d) **fittings** in which the hose assembly may be mounted vertically for application of pressure under controlled conditions;

e) **a graduated burette** with 0,05 cm^3 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 be capable of withstanding pressures involved without leakage. See figure 2.

7.4.4 *Calibration of apparatus*

The apparatus shall be tested prior to use to determine its calibration correction factors established at pressures of 6,9 and 10,3 MPa using a simulated hose assembly that shall consist of 1,52 mm guage minimum hydraulic steel tubing with a free length of 305 ± 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 brake

hose fittings in the case of special end configurations. The calibration correction factors shall be subtracted from the expansion readings obtained on the test specimens. The maximum permissible calibration correction factor shall be 0,08 cm^3 at 10,3 MPa.

7.5 Burst strength test

7.5.1 *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 4.

TABLE 4 — **Hold pressure and minimum burst pressure**

Hose internal diameter mm	Pressure hold MPa	Minimum burst pressure MPa
3,2 — 4,8 — 6,3	27,6	34,5

7.5.2 *Procedure*

Connect the specimen to the pressure system and fill completely with water, allowing all air to escape. Removal of air bubbles may be facilitated by moving the hose back and forth. Apply 27,6 $^{0}_{-1,3}$ MPa pressure at the rate specified in 7.5.3 and hold for 2 min $^{0}_{-10}$ s. At the expiration of this "hold period", increase the pressure at 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 as the bursting strength of the hose assembly.

7.5.3 *Apparatus*

The apparatus shall consist of a suitable pressure system in which the hose 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. Provision shall be made for filling the hose with water and allowing all air to escape through a relief valve prior to the application of pressure. This is important as a safety measure. The pressures shown in table 4 shall be applied at a rate of 172,5 ± 69 MPa/min.

Since this type of hose withstands a minimum bursting pressure of 34,5 MPa, care must be taken that all piping, valves, and fittings are sufficiently rugged and adapted to high pressure work. The apparatus described for the expansion test may be used when it conforms to these requirements.

7.6 Brake fluid compatibility, constriction and burst strength test

7.6.1 *Requirements*

After having been subjected to a temperature of 93 $^{+5}_{0}$ °C for 70 to 72 h while filled with compatibility brake fluid as specified in ISO 4926, a hydraulic brake hose assembly shall meet the constriction requirements. It shall then withstand water pressure of 27,6 MPa for 2 min $^{0}_{-10}$ s and then shall not burst at less than 34,5 MPa.

7.6.2 *Preparation*

7.6.2.1 Attach a hose assembly or manifold to which multiple hose assemblies may be attached, below a 0,5 l reservoir filled, as shown in figure 3, with 100 ml of compatibility brake fluid.

7.6.2.2 Fill the hose assembly with brake fluid, seal the lower end, and place the test assembly in an oven in a vertical position.

7.6.3 *Procedure*

7.6.3.1 Condition the hose assembly at 93 $^{+5}_{0}$ °C for 70 to 72 h.

7.6.3.2 After completion of the test period, remove the hose assembly and cool at room temperature for 30 ± 5 min.

7.6.3.3 Drain the brake hose and within 10 min verify the constriction requirements according to 7.3.1 and 7.3.2.

7.6.3.4 The brake hose assembly shall be burst within 3 h using the test described in 7.5.2.

7.7 Whip test

7.7.1 *Requirements*

The minimum life on the flexing machine shall be 35 h for any one of the sample hose assemblies with free lengths ranging from 200 to 600 mm for a 3,2 mm internal diameter hose and 250 to 400 mm for a 4,8 and 6,3 mm internal diameter hose.

7.7.2 *Procedure*

7.7.2.1 Measure the free length of hose assembly with the assembly in a vertical position with a mass of 567 ± 3 g attached to one end. Use a Vernier caliper scale or equivalent, and report the length between the fittings to 0,5 mm.

7.7.2.2 Equip the non-rotating header to permit attachment of each hose assembly with individual adjustment for length. When mounted in the whip test machine, the projected length of hose assembly shall be less than the free length by the amount indicated as slack in table 5.

7.7.2.3 Since the whip test results are very sensitive to error in setting this length, the projected length on the machine shall be within the limits specified. Take the projected length parallel to the axis of the rotating head.

7.7.2.4 Install the test specimen assemblies in the apparatus without any twist. Apply the water pressure and bleed all hose and passages to eliminate air pockets or bubbles. Start the motor rotating the movable head and note the duration of the test. Periodically check the rate of rotation. Failure of the specimen by water leakage and consequent loss of pressure constitutes a failure of the test.

TABLE 5 – **Free length and slack for whip test**

Dimensions in millimetres

Internal diameter	Free length	Slack hose
3,2	200 ⩽ 400	44 ± 0,40
	> 400 ⩽ 480	32 ± 0,40
	> 480 ⩽ 600	19 ± 0,40
4,8 and 6,3	250 ⩽ 400	25 ± 0,40

7.7.3 *Apparatus*

The apparatus shall provide the following motion to the specimens :

A movable header consisting of a horizontal bar mounted at each end on vertically rotating disks through bearings with centres placed 100 mm from the disk centres, and an adjustable stationary header parallel to the movable header in the same horizontal plane as the centres of the disks. The headers are each provided with end connections in which the hose assemblies are mounted in parallel. The disks are rotated at a frequency of $800 \pm 10\ min^{-1}$, whereby the hose ends fastened to the moving header are rotated at this frequency through a circle 203,2 ± 0,25 mm in diameter, while the opposite hose end remains stationary. The end connections on the movable header are tightly capped, while those on the stationary header are open to a manifold through which water pressure is supplied by a suitable means. The hose assemblies are subjected during testing to a constant water pressure which shall be maintained between 1,55 and 1,72 MPa. A limit switch shall be used to stop the machine when the water pressure drops, as in the case of hose failure, since it is essential that the machine stop if the pressure drops. An elapsed time indicator shall be provided.

7.8 Tensile test

7.8.1 *Requirements*

The hose assembly is fixed in the testing machine and pulled at a speed of approximately 25 mm/min. All the hose assemblies so tested shall withstand a minimum pull of 1 446 N without the end fittings pulling off or rupture of the hose.

7.8.2 *Procedure*

Apply an increasing tensile load at a speed such that the moving head of the testing machine travels at the rate of 25 ± 3 mm/min until failure. Record the total load at the time of failure and the type of failure.

7.8.3 *Apparatus*

A machine of 4,5 kN will be found suitable. The specimen be used for the tension test of the hose assembly. The machine shall be provided with a recording device to give the total pull in newtons at the conclusion of the test. A machine a 4,5 kN will be found suitable. The specimen shall be so held that the hose and fittings shall have a straight centre line corresponding to the direction of the machine pull.

7.9 Water absorption test

7.9.1 *Requirements*

Coupled assemblies, after 70 to 72 h total immersion in water at room temperature, shall pass all requirements for burst strength (7.5.1), whip (7.7.1), and tensile load (7.8.1), as outlined for non-aged brake hose coupled assemblies.

7.9.2 *Preparation*

Coupled assemblies shall have 28,6 ± 2 mm of the cover removed from the centre so that the outer braid is exposed. Care must be taken during removal of the cover that the outer yarn is not damaged, nor shall the hose be elongated during the removal.

7.9.3 *Procedure*

7.9.3.1 Immerse the assembly with the portion of cover removed in water at room temperature for a period of 70 to 72 h.

7.9.3.2 All tests, except the whip test, shall be made within 10 min of removal from the water.

7.9.3.3 The whip test shall be started within 10 to 30 min after removal from the water.

7.10 Cold bend test

7.10.1 *Requirements*

After conditioning in accordance with 7.10.3.1 and without removal from the cold box, the brake hose shall be bent around the mandrel specified in 7.10.2. The hose cover shall not crack (visible without magnification) or break.

7.10.2 *Apparatus*

Mandrel having a diameter of $76{,}2\ ^{+\ 1}_{\ 0}$ mm for 3,2 mm hose and $88{,}9\ ^{+\ 1}_{\ 0}$ mm for 4,8 and 6,3 mm hose.

7.10.3 *Procedure*

7.10.3.1 Condition the hose in a straight position, together with a mandrel of the diameter specified in 7.10.2, in air at − 45 to − 48 °C for 70 to 72 h. Then, while still at this temperature, bend the hose at least 180° around the mandrel at a steady rate in a period of 3 to 5 s.

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

7.11 Ozone resistance test

7.11.1 *Requirements*

The outer cover of the hose shall show no cracking when examined under 7 X magnification, ignoring the areas immediately adjacent to, or within, the area covered by the binding.

7.11.2 *Procedure*

7.11.2.1 Bend the brake hose around a cylinder, the diameter of which shall be eight times the nominal outside diameter of the brake hose, and bind the ends. The cylinder and binding shall be made of metal or a material that minimizes the consumption of ozone. If the hose collapses when bent around the cylinder, provide for internal support of the hose.

7.11.2.2 Condition the hose, on the cylinder, for 24 ± 0,5 h at room temperature, and then place in an exposure chamber containing air mixed with ozone in the proportion of 50 ± 5 parts of ozone/100 million parts of air by volume, for 70 to 72 h. Ambient air temperature in the chamber during the test shall be 40 ± 3 °C.

7.11.2.3 Examine the cover of the hose for cracks under 7 X magnification, ignoring the areas immediately adjacent to, or within, the area covered by the binding.

7.12 Salt spray test

7.12.1 *Requirements*

The hose assembly end connections shall withstand 24 h exposure to salt spray according to the conditions specified in ISO 3768. Following the 24 h exposure test, samples shall have no base metal corrosion. The area of the fitting where crimping or the application of labelling information has caused the displacement of the protective coating is exempt from the corrosion requirements. As brass fittings have adequate corrosion resistance, salt spray testing of brass fittings is not required.

7.12.2 *Apparatus*

Use the apparatus described in ISO 3768. The salt spray chamber shall be constructed so that :

7.12.2.1 the construction material does not affect the corrosiveness of the spray;

7.12.2.2 the hose assembly is supported or suspended between 15° and 30° from the vertical and in the principal direction of the horizontal flow of spray through the chamber;

7.12.2.3 the hose assembly does not contact any metallic material or any material capable of acting as a wick;

7.12.2.4 condensation which falls from the assembly does not return to the solution reservoir for respraying;

7.12.2.5 condensation from any source does not fall on the brake hose assemblies or the solution collectors;

7.12.2.6 spray from the nozzles is not directed onto the hose assembly.

7.12.3 *Preparation*

7.12.3.1 Plug each end of the hose assembly.

7.12.3.2 Mix a salt solution 5 ± 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 % of sodium iodide and not more than 0,3 % total impurities. Ensure that the solution is free of suspended solids before the solution is atomized.

7.12.3.3 After atomization at $35 \pm {}^{1}_{0}$ °C ensure that the collected solution is in the pH range of 6,5 to 7,2. Make the pH measurements at 25 ± 3 °C.

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

7.12.4 *Procedure*

7.12.4.1 Subject the brake hose assembly to the salt spray continuously for $24 \, {}^{+0,2}_{0}$ h.

7.12.4.2 Regulate the mixture so that each collector will collect from 1 to 2 ml of solution per hour for each 80 cm² of horizontal collecting area.

7.12.4.3 Maintain the exposure zone temperature at 35 ± 2 °C.

7.12.4.4 Upon completion, remove the salt deposit from the surface of the hoses by washing gently or dipping in clean running water not warmer than 37 °C and then drying with air within 2 min.

7.12.4.5 Examine the brake hose end fitting for base metal corrosion and record results.

8 IDENTIFICATION AND MARKING

8.1 Hose identification

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

NOTE – Marker yarn colour and the name and/or trade mark on cover designations for each brake hose manufacturer shall be registered with ISO/TC 22.