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BRITISH STANDARD : AUTOMOBILE SERIES

SPECIFICATION FOR

PLAIN AND REINFORCED HOSES OF RUBBER

FOREWORD

This British Standard, which is published under the authority of the Automobile Industry Standards Committee of the B.S.I., is based upon data-sheet SMMT NM-8D : 1964.

It is intended to meet the needs of the British Motor Industry for coolant resistant, fuel resistant and oil resistant hoses. It makes reference in particular to B.S. AU 106 * for solid rubbers.

SPECIFICATION

SCOPE

1. This British Standard specifies requirements for coolant resistant, fuel resistant and oil resistant plain and reinforced rubber hoses for use in automobiles. It does not cover brake hoses, or hoses for high pressure hydraulic systems.

SECTION ONE: GENERAL REQUIREMENTS

APPEARANCE AND FINISH

2. The hose shall be uniform in quality throughout its length and free from defects, e.g. porosity.

The inner surface of the lining shall be unbroken, smooth and free from extraneous materials, e.g. graphite.

REINFORCEMENT

3. Reinforcement may be included in the construction, depending upon service requirements. Where no reinforcement is called for, the hose shall be made of the lining grade of rubber.

IDENTIFICATION CODE

4. For identification purposes, the type of hose shall be specified by a code.

This code refers only to the performance requirements of lining and cover and not to the material.

The code is in two parts.

a. The first part of the code shall consist of the number of this British Standard, and a suffix, /1 for coolant resistant hose and /2 for fuel and oil resistant hose.

Examples : B.S. AU 108/1 or B.S. AU 108/2.

b. The second part of the code shall consist of two or three symbols indicating class of lining, class of cover and type of reinforcement, if any.

(i) The symbols for lining and cover shall be as follows :

A. *Coolant resistant hose.*

Lining : L1 Lining for arduous conditions.
L2 Lining for normal service.
L3 Lining for light duty only.

* B.S. AU 106, 'Solid rubbers'.

Cover: C1 Neoprene rubber having superior resistance to the natural types of oil, and to underbonnet conditions.
C2 Natural and certain synthetic rubbers for normal service.
C3 Natural and certain synthetic rubbers for light duty only.

B. *Fuel and oil resistant hose.*
Lining: L4 Lining for fuel lines and for oil lines where high resistance is needed.
L5 Lining for oil lines, arduous conditions.
L6 Lining for oil breathers, not severe conditions.
Cover: C4 Cover for superior resistance to underbonnet conditions.
C5 Natural rubber cover.

(ii) The symbols for reinforcement, which shall be common to all types of hose, shall be as follows:
F1 External fabric reinforcement, frictioned with natural rubber.
F2 External fabric reinforcement, frictioned with rubber having good resistance to ozone and oil.
R Reinforcement: fabric, woven or braided.
K Reinforcement: fabric, knitted.
W Reinforcement: wire.
U Unreinforced: plain or moulded hoses.

c. Examples of use of code.

	B.S. AU No./Group - Lining/cover/reinforcement
Coolant resistant hose:	B.S. AU 108/1 - L2/C1/R
Oil and fuel resistant hose:	B.S. AU 108/2 - L4/C4/R

SAMPLES

5. If requested by the purchaser, the manufacturer shall submit representative samples of hose with the original quotation.

If slab samples representative of the individual rubbers are required, this shall be the subject of agreement between the purchaser and the manufacturer.

SECTION TWO: SPECIFIC REQUIREMENTS

The requirements stated in this section for each type of hose are to be read in conjunction with Section One.

COOLANT RESISTANT HOSE (B.S.AU108/1)

MATERIAL

6. *a. Lining.* The lining shall be of a suitable natural or synthetic quality rubber, or blends of the two, provided always that the appropriate lining class requirements are met.

b. Cover. The cover shall be of a suitable natural rubber, or of certain synthetic rubbers, provided that they meet the performance requirements.

DIMENSIONS

6A. Unless otherwise specified by the purchaser the lining thickness and total wall thickness of coolant resistant hose shall be as follows:

Internal diameter	Thickness	
	Lining	Total
	in	in
not exceeding 1½ in	0.10-0.12	0.165-0.195
over 1½ in	0.12-0.14	0.195-0.225

As added May. 1967

PHYSICAL PROPERTIES

7. *a. General characteristics.*
(i) The lining shall have good resistance to hot coolant, and good ageing characteristics.
(ii) The covering shall have good ageing characteristics and resistance to underbonnet conditions.

(iii) The complete hose shall have a satisfactory bursting strength, well in excess of service requirements in order to allow for deterioration in this property during service.

b. Physical requirements. The lining, covering and completed component, when tested by the appropriate method, shall comply with the relevant requirements given in Table 1.

TABLE 1. PHYSICAL REQUIREMENTS: COOLANT RESISTANT HOSE (B.S. AU 108/1)

	Linings			Covers			Method of test
	L1	L2	L3	C1	C2	C3	
Material							
Hardness BS°	60-75	60-75	60-75	60-75	60-75	60-75	B.S. AU 106 * Appendix A
Tensile strength lbf/in² (min.)	2000	1000	550	1000	1200	750	B.S. AU 106 * Appendix B
Elongation at break per cent (min.)	450	250	200	200	300	250	B.S. AU 106 * Appendix B
Compression set per cent (max.)	30	30	40	30	30	40	B.S. AU 106 * Appendix E
Oil resistance: volume change per cent (max.) 70 h at 70°C †							
ASTM 1	+ 80 - 0	+ 50 - 0	+ 50 - 0	+ 15 - 10			
Heat ageing: BS° change †	± 5	± 5	± 5	+10 to −5	± 5	± 5	B.S. AU 106 * Appendix K
Component							
Ply adhesion lbf/in width (min.)							
Rubber to fabric reinforcement	15	10	5	10	10	5	Appendix A
Knitted hose-cover to lining	6	6	6	6	6	6	
Rubber to fabric outer cover	6	6	4	-	-	-	
Bursting strength (see Notes) lbf/in² (min.)							
Plain unreinforced	25	25	25	25	25	25	Appendix B
Reinforced or fabric covered	50	50	50	50	50	50	
Coolant and fatigue resistance	shall be in a satisfactory condition after test, not exhibiting undue softening or any signs of cracking or exfoliation cracks						Appendix C
Atmosphere exposure resistance	shall show no cracks after the appropriate exposure period						Appendix E
Ozone resistance	shall not show cracks with a rating greater than 1 unless otherwise agreed						B.S. AU....‡

* B.S. AU 106, 'Solid rubbers'.

† For cover C1 only, where neoprene or nitrile is used, the conditions for oil resistance and heat ageing test are 70 hours at 100°C. The percentage volume change in ASTM 1 oil is +10−5

‡ B.S. AU...., 'Test for ozone resistance of solid and cellular rubber components'. (In course of preparation.)

NOTE 1. The values for bursting strength are appropriate for hoses of sizes and designs commonly employed in automotive practice, but where special conditions dictate different values and the size and design is appropriate, the required value should be quoted on the drawing.

NOTE 2. The 25 lbf/in² minimum value for unreinforced hose applies to straight hoses up to 3 in internal diameter, and bent hoses up to 2 in internal diameter if the wall thickness is not less than ⅛ inch in both cases.

FUEL AND OIL RESISTANT HOSE (B.S. AU 108/2)

MATERIAL

8. *a. Lining.*

(i) Fuel hose. The lining shall normally be of a nitrile rubber or other suitable synthetic material, provided always that the appropriate lining requirements are met.

NOTE. This type of lining will also offer a high resistance to oils.

(ii) Oil hose. The lining shall normally be of neoprene or other suitable synthetic material, provided that the appropriate lining requirements are met.

NOTE. Lining of this type may not be suitable for fuel line applications.

b. Cover. The cover of both fuel and oil hose should generally be a neoprene rubber, but may be a natural rubber provided that the performance requirements are met.

TABLE 2. PHYSICAL REQUIREMENTS: FUEL AND OIL RESISTANT HOSE (B.S. AU 108/2)

	Linings			Covers		Method of test
	L4	L5	L6	C4	C5	
Hardness BS°	65-75	75-85	65-75	65-75	65-75	B.S. AU 106* Appendix A
Tensile strength lbf/in² (min.)	1000	1000	1000	1000	750	B.S. AU 106* Appendix B
Elongation at break per cent (min.)	200	125	200	200	250	B.S. AU 106* Appendix B
Compression set per cent (max.)	30	40	30	30	40	B.S. AU 106* Appendix E
Petrol fuel resistance: volume change per cent	+25 to-0					B.S. AU 106* Appendix P
Diesel fuel resistance: volume change per cent	+5 to-0					
Oil resistance: volume change per cent (70 h at 100°C)						
ASTM 1	+ 0 to-10	+ 5 to-10	+ 5 to-10	+15 to-10	+50 to-0	
ASTM 3	+10 to- 5	+60 to- 0	+100 to- 0	+80 to- 0		
Heat ageing BS° change	+10 to- 5	+10 to- 5	+ 10 to- 5	+10 to- 5	+10 to-5	B.S. AU 106* Appendix K
Component						
Ply adhesion lbf/in width (min.)						
Rubber to fabric reinforcement		10		10		
Knitted hose-cover to lining		6		6		Appendix A
Rubber to fabric outer covering		6		-		
Bursting strength lbf/in² (min.)						
Plain unreinforced 25) / Reinforced or fabric covered 50)	see Notes 1 and 2					Appendix B
Petrol permeability cm³/in² (max.)	0·15 or as agreed (see Note 3)					Appendix D
Atmospheric exposure resistance	shall not show cracks after the appropriate exposure period					Appendix E
Ozone resistance	shall not show cracks with a rating greater than 1 unless otherwise agreed					B.S. AU ....†

* B.S. AU 106, 'Solid rubbers'.

† B.S. AU ...., 'Test for ozone resistance of solid and cellular rubber components'. (In course of preparation.)

NOTE 1. These values are appropriate for hoses of the sizes and designs commonly employed in automotive practice but, where specified conditions dictate different values, and the size and design is appropriate, the required value should be quoted on the drawing.

NOTE 2. The 25 lbf/in² minimum value for unreinforced hose applies to the straight hoses up to 3 in internal diameter and bent hoses up to 2 in internal diameter if the wall thickness is not less than ⅛ inch in both cases.

NOTE 3. In order to comply with the requirements for petrol permeability, it is advisable for the wall thickness of the fuel hose to be 3/16 in for bores up to 1 in diameter, and ¼ in for bores over 1 in diameter.

PHYSICAL PROPERTIES

9. *a. General characteristics.*

(i) The lining shall have good resistance to the relevant fluids, heat and weathering and low compression set, and shall have low permeability in respect of petrol.

(ii) The covering shall have good ageing characteristics and resistance to underbonnet conditions.

(iii) The complete hose shall have a satisfactory bursting strength, well in excess of service requirements, with low compression set.

b. Physical requirements. The lining, covering and completed component, when tested by the appropriate method, shall comply with the relevant requirements given in Table 2.

APPENDIX A. PLY ADHESION

The method of test for ply adhesion shall be as given in B.S.903, Part A12*, Method B.

APPENDIX B. BURSTING STRENGTH

The method of test for bursting strength shall be as given in B.S.924† Appendix D, except that where necessary tests shall be carried out on actual components (i.e. shorter than 40 in).

The method uses hydraulic pressure, and a warning is given against the use of air for burst testing.

APPENDIX C. COOLANT AND FATIGUE RESISTANCE TEST

Introduction. The test consists essentially of flexing two hose specimens whilst hot coolant is circulated through them under a pressure approximating to that commonly used in vehicle cooling systems.

Apparatus. The test shall be carried out using any apparatus which will accommodate satisfactorily the conditions described under 'Test specimens'.

One form of apparatus which has been found suitable is shown in Fig. 1. Whilst straight lengths of hose are shown with right-angled end fitting at the stationary end, it will be appreciated that angled hoses may be tested by suitable modification to the end fitting. In the form of apparatus shown, the test lengths of hose are arranged to be horizontal.

Coolant. The coolant shall be a 25 per cent v/v solution in water of inhibited ethylene glycol antifreeze complying with B.S.3151‡ unless plain water or any other antifreeze composition is specified by the purchaser.

Test specimens. The specimens tested in pairs shall be complete components if possible, but in certain cases of complicated shapes or excessive lengths, it may be necessary to use a selected portion (to be indicated on the appropriate drawing). In general it is desirable that there shall be not less than 5 in clear length of hose between end fittings.

Procedure. The specimens shall be held stationary at one end and the other end shall be cyclically flexed with an angular amplitude of 12 ± 2° about each side of the neutral axis.

The frequency of flexing shall be 300 ± 25 cycles per minute.

During the time that flexing is applied, coolant shall be circulated through the hoses at a temperature of 95 ± 2°C and under a pressure of 7 ± ½ lbf/in², or such other pressure as the purchaser may specify.

The testing shall be carried out for 8 hours each day until 10^6 flexing cycles have been completed or upon such failure of the hoses as causes leakage of the coolant. The testing shall be closely supervised to determine any point of failure.

At the conclusion of the test the specimens shall be examined for general condition and the type of failure (if any) should be noted.

* B.S. 903, 'Methods of testing vulcanized rubber', Part A12, 'Determination of rubber-to-fabric adhesion (ply separation)'.

† B.S. 924, 'Hose of rubber with cotton or rayon woven reinforcement'.

‡ B.S.3151, 'Corrosion-inhibited ethanediol antifreeze for water-cooled engines. Type B. Sodium benzoate and sodium nitrite inhibited'.

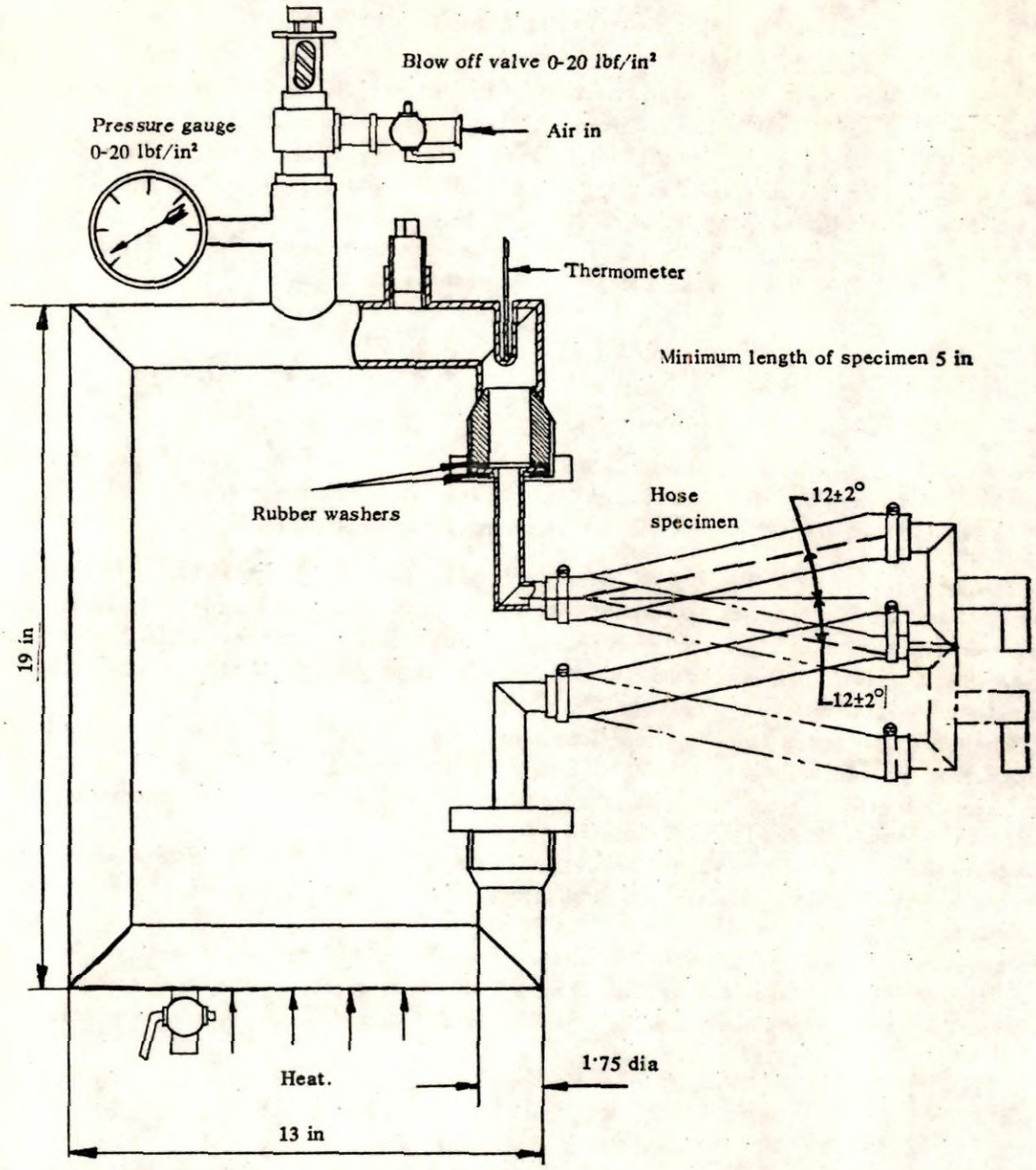

Fig. 1. Coolant and fatigue resistance test rig

APPENDIX D. PETROL PERMEABILITY

A convenient length of hose shall be plugged at one end with a metal plug and filled with reference fuel (Alkylate iso-octane 70 per cent, Toluene 30 per cent). The open end shall then be similarly plugged and the whole assembly weighed (W_1).

The external surface area S of the hose between the plugs shall be determined and the assembly left for 100 hours at 35 ± 2°C. It shall then be cooled and reweighed (W_2), and the permeability determined as the volume in cm^3 of petrol lost per square inch of external surface area of the hose.

$$\text{i.e. permeability} = \frac{W_1 - W_2}{D \times S} \text{ cm}^3/\text{in}^2$$

where W_1 = weight of specimen + original quantity of petrol (grammes);
W_2 = weight of specimen + remaining petrol (grammes);
D = density of petrol (g/cm^3);
S = external surface area (in^2) of hose between the plugs.

APPENDIX E. ATMOSPHERIC EXPOSURE TEST

A sample hose, or a convenient portion of it, shall be suitably strained and mounted on an open wooden frame so that all the surfaces of the test specimen are freely exposed to the atmosphere. The frames shall be placed in a location shielded from direct sunlight.

The exact method of straining cannot be specified since it will vary with the shape, size, etc. of the hose, but care should be taken to ensure that some part of the specimen has a strain in excess of the maximum visualized in the service of the component. In some cases it may be appropriate to use a single overhand knot as described in B.S. AU 112*. In other cases, bending or compression etc. (as in assembly, but to an exaggerated degree) may serve.

Where bending is a feasible method of straining, the hose should be bent over a mandrel of appropriate size as follows:

Hose up to 1 in bore:	4 in diameter mandrel
Hose 1 in to 2 in bore:	6 in diameter mandrel
Hose 2 in to 3 in bore:	9 in diameter mandrel
Hose 3 in to 4 in bore:	12 in diameter mandrel

The exposure period shall be as laid down in B.S. AU 112* for the type of rubber used for the cover of the hose.

On completion of the test, the sample shall be examined carefully for evidence of cracking or other deterioration.

APPENDIX F. SUMMARY OF TYPICAL APPLICATIONS

The following summary by code is to assist designers in their choice of hoses for particular applications and to relate the performance requirement code to materials in current use:

Coolant resistant hose. Typical applications are connections between radiator and engine block and on vehicle heating systems.

Applications	Code
Radiator hose:	
Normal service reinforced	B.S. AU 108/1 - L2/C1/R or K or B.S. AU 108/1 - L2/C2/R or K
Normal service moulded	B.S. AU 108/1 - L2/U or L2/F1 or L2/F2
Arduous service	B.S. AU 108/1 - L1/C1/R
Drain tube	B.S. AU 108/1 - L3/C3/R or B.S. AU 108/1 - L3/U
Heater system	B.S. AU 108/1 - L2/C2/R or B.S. AU 108/1 - L2/F1 or L2/F2

* B.S. AU 112, 'Methods for the atmospheric exposure testing of rubber'.

Fuel and oil resistant hose. Typical applications for fuel resistant hose are flexible connections to carburettor, pump and filler pipe connections.

Typical applications for oil resistant hose are oil line connections in regular or intermittent contact with oil and subjected to heat or vacuum, or both.

Applications	Code
Flexible petrol piping	B.S. AU 108/2 - L4/U*
Petrol filler pipe connection	B.S. AU 108/2 - L4/F1 or L4/F2 or B.S. AU 108/2 - L4/C4/R
Oil piping in regular contact with oil and/or subjected to heat or vacuum, or both	B.S. AU 108/2 - L5/C4/R
Oil piping in contact with oily atmosphere, not severe conditions	B.S. AU 108/2 - L6/C5/R

* This tubing may also have an unattached wire braided cover.

This British Standard, having been approved by the Automobile Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council of the Institution on 26th November, 1965.

The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following B.S.I. reference relates to the work on this standard:
Committee reference AUE/-