

NOTE.—The Institution desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to comprise all the necessary provisions of a contract.

## British Standards Institution.

Incorporated by Royal Charter.

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*British Standard Specification for Aircraft Material.*

### RUBBER HOSE FOR USE WITH AVIATION FUEL.

1. **Types of Hose.** The following types of hose are covered by this Specification :—

- (1) Ordinary Hose.
- (2) Embedded Wire Hose.

The type of hose required shall be specified on the order.

2. **Materials.** The following materials only shall be used in the construction of both types of hose :—

(a) *Rubber.* The rubber compound shall contain not less than 35 per cent by weight of rubber.

(b) *Canvas.* The canvas shall be cotton and shall have a strength of not less than 80 lb. per linear inch in both warp and weft directions when tested as described in Appendix A.

(c) *Wire.* The wire shall be steel and of the gauge and number of turns per foot run of hose specified in Table 1.

TABLE 1.

| Nominal Internal Diameter of Hose.   | Gauge of Steel Wire. | Number of Turns per foot. |
|--------------------------------------|----------------------|---------------------------|
|                                      | S.W.G.               |                           |
| Up to and including 1 inch ...       | 16                   | 32                        |
| Above 1 inch and up to 1½ inches ... | 14                   | 32                        |
| Above 1½ inches and up to 2½ inches  | 12                   | 24                        |
| Above 2½ inches and up to 3½ inches  | 10                   | 24                        |
| Above 3½ inches ...                  | 9                    | 20                        |

3. **Construction.** (a) *Ordinary Hose.* (i) Ordinary hose shall be made of an inner lining of rubber compound covered with a number of plies of cotton canvas on the bias, which in turn shall be covered with an outer coat of rubber. The whole shall be vulcanised together.

(ii) The rubber inner lining shall be seamless in all hose having an internal diameter of 2 inches or less.

It may be made from rubber sheet in the case of larger hose, and, if so made, shall be formed of at least two whole turns of the sheet.

(iii) The number of plies of canvas shall be in accordance with Table 2. The overlap shall be not less than  $\frac{1}{4}$  inch.

TABLE 2.

| Nominal Internal Diameter of Hose.                               | Number of Plies of Cotton Canvas. |
|--|-----------------------------------|
| Up to and including $\frac{5}{8}$ inch ... ..                    | Two                               |
| Above $\frac{5}{8}$ inch and up to 1 $\frac{1}{2}$ inches ... .. | Three                             |
| Above 1 $\frac{1}{2}$ inches and up to 3 inches ... ..           | Four                              |
| Above 3 inches ... ..  | Five                              |

Each ply of canvas shall be frictioned and topped with rubber in such a way that the plies of canvas shall be separated from one another by a layer of rubber.

(iv) The outer coat of rubber shall be red and of sufficient thickness to bury the overlap.

(b) *Embedded Wire Hose.* Embedded wire hose shall be constructed like ordinary hose as specified in Clause 3 (a), with the addition of a helix of steel wire of the gauge and number of turns per foot specified in Table 1, embedded in the wall between two plies of canvas as follows:—

| Nominal Internal Diameter of Hose           | Position of Embedded Wire.     |
|---|--------------------------------|
| Up to and including $\frac{5}{8}$ inch ...  | Between the plies of canvas.   |
| Above $\frac{5}{8}$ inch and up to 3 inches | ,, ,, second and third plies.* |
| Above 3 inches ... ..                       | ,, ,, third and fourth plies.* |

\* The plies shall be counted from the inside of the hose.

The hose shall be supplied in lengths as specified on the order and each length shall have 3 inches at each end free of wire.

The hose shall show externally the natural corrugations caused by the embedded wire.

4. **Freedom from Defects.** (i) The hose shall be flexible and uniform in quality throughout its length and free from defects.

(ii) The inner lining shall be unbroken, smooth and free from rust.

5. **Diameter of Hose.** (a) The nominal diameter of all hose shall be in accordance with Table 3, the measurements being taken at that part of the hose which is free from overlap. When ordering, the internal diameter of the hose shall be stated.

TABLE 3.

| Nominal Diameter of Hose. |                       | Nominal Diameter of Hose. |                       |
|---------------------------|-----------------------|---------------------------|-----------------------|
| Internal.                 | External.             | Internal.                 | External.             |
| in.<br>$\frac{3}{16}$     | in.<br>$\frac{7}{16}$ | in.<br>$\frac{3}{4}$      | in.<br>$1\frac{1}{8}$ |
| $\frac{1}{4}$             | $\frac{1}{2}$         | $\frac{7}{8}$             | $1\frac{1}{4}$        |
| $\frac{5}{16}$            | $\frac{9}{16}$        | 1                         | $1\frac{3}{8}$        |
| $\frac{3}{8}$             | $\frac{5}{8}$         | $1\frac{1}{8}$            | $1\frac{1}{2}$        |
| $\frac{7}{16}$            | $1\frac{1}{16}$       | $1\frac{1}{4}$            | $1\frac{5}{8}$        |
| $\frac{1}{2}$             | $\frac{3}{4}$         | $1\frac{3}{8}$            | $1\frac{3}{4}$        |
| $\frac{5}{8}$             | $\frac{7}{8}$         | $1\frac{1}{2}$            | $1\frac{7}{8}$        |
|                           |                       | $1\frac{5}{8}$            | 2                     |

(b) Larger sizes shall be supplied in multiples of  $\frac{1}{4}$  inch internal diameter with the external diameter  $\frac{1}{2}$  inch greater than the internal, *i.e.*, with a wall thickness of  $\frac{1}{4}$  inch, and containing not less than four plies of canvas as specified in Clause 3 (a).

(c) The internal and external diameters of all hose shall not vary from the nominal dimensions by more than the following tolerances:—

| Nominal Internal Diameter.                            | Tolerance.            |
|---|-----------------------|
| Up to and including $\frac{5}{8}$ in.     ...     ... | $\pm\frac{1}{64}$ in. |
| Over $\frac{5}{8}$ in.     ...     ...                | $\pm\frac{1}{32}$ in. |

| Nominal External Diameter.                                    | Tolerance.            |
|---|-----------------------|
| Up to and including 2 in.     ...     ...                     | $\pm\frac{1}{32}$ in. |
| Over 2 in. and up to and including $3\frac{1}{2}$ in.     ... | $\pm\frac{3}{64}$ in. |
| Over $3\frac{1}{2}$ in.     ...     ...                       | $\pm\frac{1}{16}$ in. |

6. **Provision of Test Pieces.** (a) A test piece 24 inches long shall be taken from the first length of hose made from each Manufacturer's lot or batch of rubber mixture, for the Chemical analysis, Permeability to Aviation Fuel and Accelerated Ageing tests specified in Clause 7 (a), (b) and (c).

If the hose is of the embedded wire type, the test piece for the Permeability to Aviation Fuel test shall contain the wire, but the other test pieces shall be free of wire.

(b) An additional test piece 3 inches long (free of wire) shall be taken from each end of each length of hose for the Resistance to Benzol test specified in Clause 7 (d).

7. **Tests on the Finished Hose.** The following tests shall be carried out to the satisfaction of the Inspector on the test pieces selected as specified in Clause 6.

(a) *Chemical Analysis.* The acetone extract of the vulcanised rubber compound (excluding the canvas) when determined by the method described in Appendix B, shall, after the deduction of free sulphur, not exceed 3.0 per cent by weight. The amount of free sulphur in the vulcanised rubber compound (excluding the canvas) shall not exceed 2.0 per cent by weight when determined by the method described in Appendix C.

(b) *Permeability to Aviation Fuel.* The permeability to aviation fuel shall be such that, when tested by the method described in Appendix D, the loss of aviation fuel during the third 24 hours shall not exceed 200 ml. per square foot of the original internal surface of the hose.

(c) *Accelerated Ageing.* The resistance to accelerated ageing shall be such that no test piece when tested by the method described in Appendix E shall split right across its width.

(d) *Resistance to Benzol.* The resistance to benzol shall be such that, when tested by the method described in Appendix F:—

(i) The area of the bore, determined by means of rod gauges, shall not differ from the original area by more than 25 per cent for hose above  $\frac{1}{4}$  inch internal diameter or by more than 35 per cent for hose  $\frac{1}{4}$  inch internal diameter or less and

(ii) The rubber shall show no tendency to separate from the canvas and shall not be friable, *i.e.*, in such a condition that it can readily be disintegrated.

8. **Protection of Cut Ends.** The cut ends of each length of hose shall be sealed with hard paraffin wax with a melting point of not less than 140° F. (60° C.).

#### APPENDIX A.

##### Method for the Determination of Strength of Canvas.

A sample 18 inches long by the full width of the canvas shall be selected by the Inspector from at least one web of each warper's beam, where it can be shown that the consignment can be correlated with the warper's beam. In other cases a sample shall be selected from each roll or piece at the Inspector's discretion.

Six specimens shall be cut from the test sample in the following manner:—

Three specimens shall be cut in the direction of the warp and three in the direction of the weft. No two specimens cut in the same direction shall contain the same longitudinal threads.

The specimens shall be  $2\frac{1}{2}$  inches wide, the threads being frayed out from each side to reduce the width to 2 inches. The specimens shall be soaked in water at room temperature for half an hour and the excess of adhering water drained off, after which they shall be placed evenly in the jaws of a suitable testing machine so that the unstretched length of the fabric between the jaws is 7 inches and shall be broken without delay. The rate of traverse of the moving jaw of the machine shall be uniform and approximately 18 inches per minute. If a specimen breaks in or at the jaws at a load much lower than that required, or if a break proceeds unevenly across a test piece at a load much lower than that required, a duplicate test shall be made on another test piece including the same longitudinal threads.

#### APPENDIX B.

##### Method for the Determination of Acetone Extract.

Four grammes of rubber compound reduced to pieces approximately one cubic millimetre in size shall be placed in a fat-free extraction thimble in one of the forms of Soxhlet apparatus which can be used as a hot extractor.

The thimble shall be nearly filled with re-distilled acetone (B.S. Specification D.22, latest issue) care being taken that the amount of acetone is insufficient to cause syphoning. If any signs of caking occur silver sand should be added. After standing overnight and the addition of a further amount of acetone sufficient to cause syphoning to start, at least 30 hot extractions shall be carried out during the period of six hours.

The acetone shall then be distilled from the soluble matter in the flask and the residue dried at 90° C. for two hours and weighed.

**APPENDIX G.**

**Method for the Determination of Free Sulphur.**

To the dried acetone extract, obtained as described in Appendix B, 30 ml. of pure concentrated nitric acid shall be added, and the flask shall then be covered with a watch-glass and heated on a steam bath for four hours, or, if necessary, for a longer period until most of the organic matter present is destroyed. After the end of the first hour  $2\frac{1}{2}$  grammes of potassium chlorate shall be added in small quantities at intervals to accelerate the process of oxidation. The contents of the flask shall now be evaporated to dryness; 15 ml. of concentrated hydrochloric acid shall then be added, and the contents again evaporated to dryness. The residue shall be taken up with 50 ml. of hot distilled water and 5 ml. of dilute (2N) hydrochloric acid, freed by filtration from any traces of undestroyed organic matter, and made up to 250 ml. by adding distilled water. The solution shall be brought to the boil, and 30 ml. of a boiling solution of barium chloride (3 grammes in 100 ml.), to which a few drops of dilute (2N) hydrochloric acid have been added, shall be slowly run in with constant stirring. The completeness of the precipitation of the barium sulphate should be confirmed by subsequently testing the filtrate to make sure that it contains excess of barium chloride. After precipitation the beaker and contents shall be allowed to stand overnight, and the precipitate shall then be removed by filtration, thoroughly washed, dried, and ignited in a weighed crucible. The contents shall be moistened with a drop of concentrated nitric acid and a drop of concentrated sulphuric acid, and the crucible shall be again ignited and re-weighed. From the weight of barium sulphate so determined the percentage of free (acetone-extractable) sulphur in the rubber shall be calculated in the usual way. Allowance must be made for any sulphate present in the reagents used, this being determined by a blank experiment using the same quantities of reagents as stated above.

**APPENDIX D.**

**Method for the Determination of Permeability to Aviation Fuel.**

A sample of the hose (including wire if the hose is of the embedded wire type) 14 inches long shall be plugged at one end. The other end shall be fitted with a glass tube about 18 inches long, leaving 12 inches of rubber hose between the plug and the glass tube. The hose shall be held vertically and filled with aviation fuel (D.T.D. 224\*) to a level of 12 inches above the bottom of the glass tube. The top of the glass tube shall be loosely closed with a cork.

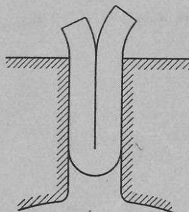
The loss of petrol shall be made good by frequent additions so that the level of aviation fuel shall never fall more than approximately 3 inches during the first 48 hours. The temperature of the test room shall be not less than 60° F. (15·6° C.) or more than 70° F. (21·1° C.)

**APPENDIX E.**

**Method for the Determination of Resistance to Accelerated Ageing.**

A sample of the hose 3 inches long shall be suspended in a thermostatically controlled air oven and maintained continuously at a uniform temperature of 70° C.  $\pm$  1° C. for 150 hours. The air in the oven shall be circulated by means of a fan in order to maintain uniformity of temperature throughout the oven. Provision shall be made for a continuous slow change of air of not less than 1 litre per hour per specimen in the oven during this treatment. At the conclusion of the ageing period the samples shall be removed from the oven and suspended for 24 hours at a temperature of 15° to 20° C. shielded from direct sunlight.

Six rings each  $\frac{3}{8}$  inch wide shall then be cut from the test sample, care being taken that the cut edges are not torn. The end pieces of the original test sample shall be discarded. Each ring shall then be cut longitudinally at a different point on the circumference relative to the original hose for each ring and pressed flat in a vice as shown in the sketch below and in such a manner that the inner lining of rubber is on the outside of the bend. The pressure of the vice shall be sufficient to keep the rings flat but without more than very slight compression of the rubber. The samples shall be kept in this position for five minutes and then examined visually.



\*Specification No. D.T.D. 224 can be obtained from His Majesty's Stationery Office at the following addresses:—  
Adastral House, Kingsway, London, W.C. 2; 120 George Street, Edinburgh; 2 York Street, Manchester, 1;  
1 St. Andrew's Crescent, Cardiff; 15 Donegall Square West, Belfast, or through any Bookseller, price 1/- net.

**APPENDIX F.**

**Method for the Determination of Resistance to Benzol.**

A sample of the hose 3 inches long shall be boiled for one hour, using a reflux condenser, in 90's benzol. The apparatus shall then be allowed to cool down, and the hose removed 24 hours later and examined at once. The examination to determine whether the rubber shows any tendency to separate from the canvas shall be carried out on the middle 2 inches of the test sample, after  $\frac{1}{2}$  inch lengths have been cut from each end.

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This Specification having been approved by the Aircraft Industry Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council as a British Standard on 9th November, 1936.

NOTE.

*In order to keep abreast of progress in the Industries concerned, the British Standard Specifications are subjected to periodical review.*

*Suggestions for improvements, addressed to the British Standards Institution, 28 Victoria Street, London, S.W. 1, will be welcomed at all times. They will be recorded and in due course brought to the notice of the Committees charged with the revision of the Specifications to which they refer.*