
**HOME OFFICE**

# SPECIFICATION FOR SEAMLESS ALLOY STEEL CYLINDERS FOR THE CONVEYANCE OF COMPRESSED GASES

**HOS**

**Specifications for Seamless Alloy Steel Cylinders for the Conveyance of Compressed Gases**

Cylinders manufactured to these specifications shall be manufactured by a cylinder manufacturer on the Home Office list of recognised manufacturers of alloy steel cylinders. The steel from which the cylinders are made shall have been manufactured by a steel manufacturer on the Home Office list of recognised manufacturers of steel for cylinders. The method of manufacture and the testing of the cylinders at the works of the cylinder manufacturer shall be carried out to the satisfaction of an inspecting authority on the Home Office list of recognised inspecting authorities.

The cylinders shall only be made by a process which has been shown to produce cylinders free from cracks.

Cylinders shall not be filled with gas unless steps have been taken to ensure that, at the time of filling, the gas is as far as is reasonably practicable, free from moisture.

Cylinders shall not be filled with carbon monoxide, coal gas, hydrogen or methane unless steps have been taken to ensure that, at the time of filling, the gas is free from hydrogen sulphide and is, as far as is reasonably practicable, free from organic sulphur impurities.

## SPECIFICATION S

*Quality of Material*

1. The steel used in the manufacture of the cylinders shall have been made by the acid or basic open-hearth process or in an electric furnace, by a steel manufacturer who affords to the cylinder manufacturer facilities for inspection of the steel at the steel manufacturer's works.

*Chemical Composition*

2. The steel used in the manufacture of the cylinders shall on analysis give one of the following results:

(i) *Manganese Molybdenum Steel**

| | |
|---|---|
| Carbon . . . . . | not less than 0.25 per cent and not more than 0.40 per cent |
| Silicon . . . . . | not less than 0.10 per cent and not more than 0.35 per cent |
| Manganese . . . . . | not less than 1.30 per cent and not more than 1.80 per cent |
| Molybdenum . . . . . | not less than 0.20 per cent and not more than 0.40 per cent |
| Sulphur . . . . . | not more than 0.05 per cent |

| | | |
|---|---|---|
| Phosphorus | . . . . . | not more than 0.05 per cent |

(ii) *Chromium Molybdenum Steel*

| | | |
|---|---|---|
| Carbon | . . . . . | not more than 0.37 per cent |
| Silicon | . . . . . | not less than 0.10 per cent and not more than 0.35 per cent |
| Manganese | . . . . . | not less than 0.40 per cent and not more than 0.90 per cent |
| Nickel (residual) | . . . . . | not more than 0.50 per cent |
| Chromium | . . . . . | not less than 0.80 per cent and not more than 1.20 per cent |
| Molybdenum | . . . . . | not less than 0.15 per cent and not more than 0.25 per cent |
| Sulphur | . . . . . | not more than 0.05 per cent |
| Phosphorus | . . . . . | not more than 0.05 per cent |

(iii) *Nickel Chromium Molybdenum Steel*

| | | |
|---|---|---|
| Carbon | . . . . . | not less than 0.27 per cent and not more than 0.35 per cent |
| Silicon | . . . . . | not less than 0.10 per cent and not more than 0.35 per cent |
| Manganese | . . . . . | not less than 0.50 per cent and not more than 0.70 per cent |
| Nickel | . . . . . | not less than 2.30 per cent and not more than 2.80 per cent |

(ii) *Nickel Chromium Molybdenum Steel (Cont'd)*

| | | |
|---|---|---|
| Chromium | . . . . . | not less than 0.50 per cent and not more than 0.80 per cent |
| Molybdenum | . . . . . | not less than 0.40 per cent and not more than 0.25 per cent |
| Sulphur | . . . . . | not more than 0.05 per cent |
| Phosphorus | . . . . . | not more than 0.05 per cent |

* Manganese molybdenum steel in accordance with BS. 970:1955, EN 16 conforms with these requirements except that this specification restricts the carbon content to a minimum of 0.30 per cent, and the maximum molybdenum content to 0.35 per cent.

Chromium molybdenum steel in accordance with BS T.59: 1948 conforms with these requirements except that this specification restricts the carbon to a maximum of 0.26 per cent.

Nickel chromium molybdenum steel in accordance with BS 970: 1955, EN 25 conforms with these requirements.

*Steel Maker's Certificate*

3. The cylinder manufacturer shall have obtained from the steel manufacturer a certificate that the material from which the billets specified in the certificate have been produced has been made by one of the processes specified in paragraph 1 and giving details of the chemical analysis.

*Marking of Steel*

4. The steel shall be marked and records shall be kept so as to enable the material from which any cylinder is made to be identified.

*Manufacture of Cylinders*

5. The cylinders shall be of an approved shape and shall be solidly drawn or made from seamless steel tube.

*Thickness of Cylinder Walls*

6. The thickness of the cylinder wall shall be not less than the value of t (in inches) given by the following formulae whichever is the greater:-

$$t = \frac{pDi}{2f - p} \quad * \qquad t = 0.027 \surd Di$$

where p = the maximum working pressure in lbs per square inch
f = the maximum stress of 44,800 lbs per square inch
Di = internal diameter in inches.

For the permanent gases the maximum working pressure shall be the pressure to which it is intended to fill the cylinder at 60°F.

---

Nickel chromium molybdenum steel in accordance with BS 970: 1955, EN 25 conforms with these requirements.

* Alternatively the formula $t = \frac{pDe}{2f + p}$ may be used in which De refers to the external diameter of the cylinder in inches.

For the high pressure liquefiable gases a normal pressure of 1980 lbs per square inch shall be assumed for the maximum working pressure.

For the low pressure liquefiable gases the maximum working pressure shall be the vapour pressure of the gas at 45°C for those cylinders which are to be used in temperate climates or 65°c for those cylinders which are to be used in or conveyed through tropical climates.

*Examination of Cylinder before Closing-in*

7. Each cylinder shall be examined before the closing-in operations for maximum and minimum thickness and for external and internal surface defects. The wall thickness shall be not less than the design thickness at any point.

*Heat Treatment*

8. Each cylinder after manufacture shall be hardened by cooling in air or in oil from the appropriate temperature as stated in BS 970: 1955 or BS T.59 : 1948. Each cylinder after hardening shall be tempered at a temperature not exceeding 660°C and shall then be cooled in air The method of cooling shall be chosen by means of hardenability tests so as to ensure that a cylinder is adequately hardened throughout.

*Examination for Internal Folds in the Neck*

9. One finished cylinder in every batch constructed or, when the number in any batch exceeds 100, one cylinder in every 100 shall be examined for the presence of internal folding in the neck. Cylinders shall not be regarded as in a single batch unless they are of similar analysis and heat-treated in the same manner at the same temperature $\pm$ 20°C. The cylinder selected for examination may be used for the tensile test (paragraph 11), the impact test (paragraph 12 and the bend test (paragraph 13).

A thin sheet ring of internal diameter equal to two thirds of the outside diameter of the parallel portion of the cylinder shall be placed over the cylinder neck which shall be sectioned at right angles to the longitudinal axis of the cylinder at the position where the ring rests on the neck. The depth of folds in the section shall be measured by an approved method (eg magnetic crack detection). The maximum depth of any fold in the section shall not exceed 15 per cent of the cylinder wall thickness in the section in cases where the minimum design thickness of the parallel portion of the cylinder does not exceed 0.3 inch. For cylinders of minimum design thickness of the parallel portion of the cylinder does not exceed 0.3 inch. For cylinders of minimum design thickness t greater than 0.3 inch the maximum depth of fold in the section shall not exceed 15 x 0.3 per cent of the cylinder wall thickness t in the section. In no case shall the wall thickness at the section, after deduction of the permissible depth of fold stated, be less than the design thickness of the parallel portion of the cylinder.

Where the cylinder fails to pass the test, the batch shall be rejected and no further production batches shall be made until the process of manufacture has been examined and corrected to the satisfaction of the inspecting authority.

In the case of cylinders of large capacity where the number of cylinders in each batch is small and where the inspecting authority has agreed under paragraph 11 that no destructive tests on actual cylinders shall be carried out, the next of each completed cylinder shall be thoroughly examined by approved non-destructive means, eg ultrasonic examination by trained personnel. The criteria for the acceptance of each design of cylinder will be laid down by HM Inspector of Explosives.