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CGA C-8—1985 (OBSOLETE)

STANDARD FOR REQUALIFICATION OF DOT SEAMLESS STEEL CYLINDERS

FIFTH EDITION

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1 Introduction

1.1

The Hazardous Materials Regulations of the U.S. Department of Transportation (DOT) (49 CFR 173.34), and equivalent Canadian regulations, require that cylinders be periodically requalified to assure their suitability for continued safe service. [1][1] The regulations state that a cylinder must be condemned when it leaks, or when internal or external corrosion, denting, bulging, or evidence of rough usage exists to the extent that the cylinder is likely to be weakened appreciably, or when it fails to pass the hydrostatic retest.

1.2

The regulations vary as to the requalification requirements for seamless steel cylinders, depending on design and the type of service (pressure, commodity, etc.) for which they are authorized. All seamless steel cylinders require a periodic visual examination and most require a periodic hydrostatic retest. The retest criteria for acceptance or rejection also vary. For the great majority of steel cylinders, including Specification DOT-3HT cylinders, the limit is that the permanent expansion must not exceed 10% of the total expansion. An additional requirement for DOT-3HT cylinders is that the elastic expansion (total expansion less permanent expansion) at retest must not exceed the elastic expansion at manufacture by more than 5%.

1.3

To define the methods of inspection and testing, and the criteria for acceptance or rejection of the various types of cylinders covered by the regulations, the Compressed Gas Association, Inc. has prepared the following: CGA C-1, *Methods for Hydrostatic Testing of Compressed Gas Cylinders* [2]; CGA C-5, *Cylinder Service Life-Seamless, High Pressure Cylinders* [3] for Specifications DOT-3, DOT-3A, DOT-3AA; CGA C-6, *Standards for Visual Inspection of Steel Compressed Gas Cylinders* [4]; and CGA C-8, *Standard for Requalification of DOT-SHT Seamless Steel Cylinders*. [5]

1.4

Cylinders made in accordance with DOT-3HT specification are similar to those made under specification DOT-3AA in function and methods of fabrication. The major difference is that DOT-3HT cylinders are inside containers for aircraft use only, are made to a higher allowable design stress, and therefore have a thinner wall thickness and a lower weight.

Because DOT-3HT cylinders are more highly stressed than DOT-3A or DOT-3AA cylinders, the quality level and inspection standards for DOT3HT cylinders must be higher. Several additional tests and added quality features are imposed along with a 24-year maximum service life to insure that the higher quality level of DOT-3HT cylinders is maintained.

At the time of manufacture, the surface condition of DOT-3HT cylinders is carefully inspected visually and by the magnetic particle method, to insure a high quality surface and uniformly distributed stress when pressurized. Users, shippers, and testers of these cylinders should exercise a high degree of care to insure the maintenance of surface quality in order to avoid the local stress raising effect of cuts, gouges, and digs, which may in turn have a detrimental effect on the cycle life of the cylinder.

1.5

This standard has been prepared to advise cylinder users and retesters regarding the requirements for establishing their own cylinder inspection procedures and standards. Of necessity, this standard is general in nature although some specific limits are given. Rejection or acceptance for continued use, in ac-

[1] NOTE: References in this document are shown by bracketed numbers and are listed in the order of appearance. See Section 7, References.

cordance with these limits, represents accepted practice which has proven satisfactory for the continuance of these cylinders in service.

1.6

Experience in the inspection of cylinders is an important factor in determining the acceptability of a given cylinder for continued service. Reinspection of cylinders must be performed by a manufacturer of DOT-3HT cylinders or a retester who has been approved by DOT.

2 Shipping

2.1

Filled DOT-3HT cylinders must be shipped in suitable outside containers, such as corrugated cartons or wooden boxes, which are considered sufficient to protect the cylinders from the adverse effects of rough handling during shipment. It is strongly recommended that empty DOT-3HT cylinders also be stored and transported in this same type outside container to prevent damage to the cylinder.

3 Retest

3.1

At least once every 3 years, DOT-3HT cylinders must be subjected to a retest by hydrostatic pressure in a water jacket for the determination of the expansion of the cylinder. A cylinder must be condemned if the permanent volumetric expansion exceeds 10% of the total expansion, or if the elastic expansion on retest exceeds the marked rejection elastic expansion (REE). The REE is 1.05 times the original elastic expansion at manufacture.

3.1.1

Cylinders manufactured before January 17, 1978 are required to have the original elastic expansion (EE) in cubic centimeters stamped on the cylinder near the original test date. At retest, the cylinder must be restamped to show the REE.

For example:	EE	10.0	7 X 74
	REE	10.5	7 Y 78

where X and Y represent Inspector symbols.

Cylinders manufactured on or after January 17, 1978 are required to have the REE also stamped near the date of the original test. Therefore, at retest, only the retest date and the Inspector's symbol is required.

3.2

Retest dates must be applied by low stress type steel stamping using round-faced stamps to a depth no greater than that of the original marking at the time of manufacture. Stamping on the sidewall is prohibited.

4 Service life

4.1

DOT-3HT cylinders must be removed from service and condemned at the termination of a 24year period following the date of the original test marked on the cylinder, or after 4380 pressurizations, whichever occurs first. If a cylinder is recharged more than once every other day, an accurate record of the number of such rechargings must be maintained by the cylinder owner or his agent.

5 Visual inspection

5.1 Preparation for inspection

Cylinders shall be clean for inspection to permit the interior and exterior surfaces to be clearly observed. This shall include the removal of excessively heavy paint build-up from the exterior. See 5.3.2.1.

5.2 Interior inspection

5.2.1 Corrosion

Corrosion in cylinders involves the loss of wall thickness by corrosive media. Any corrosion observed which has progressed to the point of producing pitting of the walls shall be cause for rejection and the cylinder must be condemned. Superficial corrosion characterized by discoloration of the interior surface, but free from pitting, shall not be cause for rejection.

5.2.2 Coatings

If the cylinder interior is coated, there shall be no evidence of cracking, flaking, lifting, or discoloration of the coating material. If any such defect is observed, the cylinder shall be rejected and returned to the cylinder owner or his agent for further disposition.

NOTE: The number and variety of internal coatings are too numerous to list in this pamphlet, making it impractical to detail rework procedures. Therefore, analysis and repair must be done by individuals or repair facilities who have experience with the particular coating in question. This will most likely be the original manufacturer or another cylinder manufacturer.

5.2.3 Mechanical defects

Under normal circumstances there should be no mechanical defects developed in service beyond those considered acceptable at the time of original manufacture. Should any abnormally severe defects (cuts, digs, gouges, etc.) be observed, the cylinder shall be rejected and returned to the owner or his agent with a recommendation that the cylinder be condemned.

5.3 External inspection

5.3.1 Corrosion

The criteria used for the cylinder interior shall be applicable to the exterior as well, except that repair by removal of any pits by polishing or sanding is permissible. In the case of such repairs, the wall thickness must be checked by ultrasonic means after repair to assure that it is equal to or greater than the design minimum (see 5.3.1.1). Any such repairs must be performed prior to the hydrostatic retest.

5.3.1.1

The design minimum wall thickness (t) may be obtained from the cylinder manufacturer or by calculation using the following formula derived from DOT Specification 3HT found in 49 CFR 178.44-10 [1]:

$$t = \frac{D}{2}\left[1 - \sqrt{\frac{S - 1.3P}{S + 0.4P}}\right]$$

where:

S = wall stress in psi or kPa (105 000 psi maximum; 723 949.48 kPa maximum)

P = 5/3 times service pressure in psi or kPa

D = outside diameter in inches or mm

t = design minimum wall thickness in inches or mm

NOTE: One inch equals 25.4 mm; one psi equals 6.894 757 kPa. When metric equivalents are used, they must be used consistently throughout the formula.

5.3.2 Mechanical defects

The outside of the cylinder takes the brunt of any rough handling damage and the condition of the external finish (paint or plating) is a good indication as to the usage to which a cylinder has been subjected. Excess paint can also mask defects and in such instances, must be removed for proper inspection.

5.3.2.1 Steel surface finish

The uncoated surface finish must not exceed a 250 microinch (6.35 micrometer) root mean square (rms or RMS), except minor surface variations due to slight imperfections are acceptable.

5.3.2.2 Dents

Dents are rounded deformations caused by the cylinder coming into severe contact with a blunt object without any reduction in wall thickness. Dents whose greatest dimension exceeds 10% of the cylinder diameter, or a depth exceeding 1% of the cylinder diameter, shall be rejected and returned to the owner or his agent with a recommendation that the cylinder be condemned. See Fig. 1.

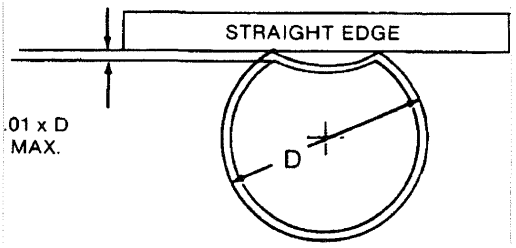

Figure 1—Dent depth measurement

5.3.2.3 Cuts, digs, or gouges

Cuts, digs, or gouges are deformations caused by the cylinder coming into severe contact with a sharp object wherein the material is upset and the wall thickness is reduced. Such defects are cause for rejection. The defect must be removed by polishing, sanding, or filing. In such cases, the wall thickness must be checked by ultrasonic means after repair to assure that it is equal to or greater than the design minimum (see 5.3.1.1). Any such repairs must be performed prior to the hydrostatic retest. Cylinders having a wall thickness below the design minimum shall be rejected and returned to the owner or his agent with a recommendation that the cylinder be condemned.

5.3.3 Bulges

Bulged cylinders shall be rejected and returned to the owner or his agent with a recommendation that the cylinder be condemned.

5.3.4 Fire damage

Fire damage to cylinders is usually indicated by (a) charring or burning of the paint or other protective coat, (b) burning or sintering of the metal, (c) distortion of the cylinder, (d) functioned pressure relief devices, (e) melted valve parts. Cylinders showing evidence of fire damage shall be rejected and returned to the owner or his agent with a recommendation that the cylinder be condemned.

6 Disposition

6.1

The retesting agency shall advise the owner, in writing, of rejected cylinders. With the expressed consent of the owner, the cylinder shall be rendered incapable of further service by an appropriate method set forth in CGA C-2, *Recommendations for the Disposition of Unserviceable Compressed Gas Cylinders With Known Contents*. [6]

7 References

[1] *Code of Federal Regulations*, Title 49 CFR Parts 100-179 (Transportation), U.S. Department of Transportation. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

[2] CGA C-1, *Methods for Hydrostatic Testing of Compressed Gas Cylinders*, Compressed Gas Association, Inc., 1725 Jefferson Davis Highway, Arlington, VA 22202-4102.

[3] CGA C-5, *Cylinder Service Life-Seamless, Steel, High Pressure Cylinders*, Compressed Gas Association, Inc., 1725 Jefferson Davis Highway, Arlington, VA 22202-4102.

[4] CGA C-6, *Standards for Visual Inspection of Steel Compressed Gas Cylinders,* Compressed Gas Association, Inc., 1725 Jefferson Davis Highway, Arlington, VA 22202-4102.

[5] CGA C-8, *Standard for Requalification of DOT-3HT Seamless Steel Cylinders*, Compressed Gas Association, Inc., 1725 Jefferson Davis Highway, Arlington, VA 22202-4102.

[6] CGA C-2, *Recommendations for the Disposition of Unserviceable Compressed Gas Cylinders with Known Contents,* Compressed Gas Association, Inc., 1725 Jefferson Davis Highway, Arlington, VA 22202-4102.