U.S. Department
of Transportation

**Research and
Special Programs
Administration**

400 Seventh Street, S.W.
Washington, D.C. 20590

DEC 22 2000

DOT-E 9421
(SEVENTH REVISION)

EXPIRATION DATE: November 30, 2002

(FOR RENEWAL, SEE 49 CFR § 107.109)

1. GRANTEE: Taylor-Wharton Gas Equipment Division (Taylor-Wharton), Harsco Corporation
Harrisburg, PA

2. PURPOSE AND LIMITATIONS:

a. This exemption authorizes the manufacture, marking, sale and use of a non-DOT specification cylinder conforming with all regulations applicable to a DOT-3AA specification cylinder, except as specified herein, for the transportation in commerce of the materials authorized by this exemption. This exemption provides no relief from any Hazardous Materials Regulation (HMR) other than as specifically stated herein.

b. The safety analyses performed in development of this exemption only considered the hazard and risks associated with transportation in commerce.

3. REGULATORY SYSTEM AFFECTED: 49 CFR Parts 106, 107 and 171-180.

4. REGULATIONS FROM WHICH EXEMPTED: 49 CFR §§ 173.34(a)(1), 173.301(h), 173.302, 173.304, 175.3, in that a non-DOT specification cylinder is not authorized except as prescribed herein; §§ 173.34(e)(1),(3),(4), and (8) in that ultrasonic examination is authorized as an alternative to a hydrostatic pressure test and internal visual inspection.

5. BASIS: This exemption is based on the applications of Taylor-Wharton dated December 13, 2000, submitted in accordance with accordance with § 107.109.

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6. HAZARDOUS MATERIALS (49 CFR § 172.101):

Hazardous materials description -- proper shipping name	Hazard Class/ Division	Identi-fication Number	Packing Group
Gases or mixtures of gases authorized in the HMR to be shipped in DOT-3AA specification cylinders *	2.1 2.2 2.3	Various	N/A

* The following materials may not be shipped under the terms of this exemption:

a. Hydrogen, compressed natural gas, hydrogen sulphide, or carbon monoxide;

b. Any gas mixture containing hydrogen sulphide or other free sulfides, or containing hydrogen or compressed natural gas;

c. Any gas mixture containing more than 10 percent (10%) carbon monoxide;

d. Any gas mixture containing carbon monoxide and having a dew point of minus 52°F or higher at one (1) atmosphere;

e. Any gas or mixture of gases which does not remain in a gaseous state when contained in the cylinder at filling pressure at 70°F; and

f. Any mixture of gases, the quantity of one or more of which is capable of combining chemically with other gases in such mixture or of combining chemically with the cylinder steel so as to significantly reduce the effectiveness of the cylinder.

g. Any gas may that cause embrittlement in steel.

7. SAFETY CONTROL MEASURES:

a. PACKAGING - Packaging prescribed is a non-DOT specification steel cylinder made in accordance with Taylor-Wharton Cylinders drawing numbers 50043 Rev.3 and 38761 on file with the Office of Hazardous Materials exemptions and Approvals (OHMEA) and in conformance with §§ 178.35 and 178.37) except as follows:

§ 178.35(c) *Duties of inspector.*

(1) and (2) * * *

(3) * * *

(v) Witness all tests except the fracture toughness test (§ 178.37(j)) provided the test is performed by a facility acceptable to the Inspector and a certified report of the test results is furnished to the Inspector by the test facility.

* * *

(ix) Verify that design qualification tests prescribed in § 178.37(d)(5) have been performed with satisfactory results.

§ 178.35(e) *Pressure relief* devices and protection for valves and pressure relief devices.

* * * (Add) Pressure relief devices must be in compliance with § 173.302(c)(1), except as follows:

(1) Cylinders charged with gas mixtures containing a gas toxic by inhalation, must not be equipped with any pressure relief device.

(2) Cylinders charged with gas mixtures containing no gas classed as toxic by inhalation, may be equipped with a combination rupture disk and fusible plug pressure relief device in compliance with CGA Pamphlet S-1.1.

§ 178.35(f) *Marking.*

Applies except using "DOT-E 9421" in lieu of "DOT-3AA" followed by the service pressure. Test pressure to be marked following or near service pressure. The letters "TP" preceding test pressure is optional. Rejection elastic expansion (REE) in cubic centimeters (CC) near the date of test.

§ 178.37(a) *Type, size and service pressure.*

Packaging prescribed is a seamless steel cylinder having: a maximum service pressure of 4,500 psig; a maximum water capacity of 120 pounds; and either a nominal inside diameter of 8.50 inches and a 0.252 inch minimum wall thickness or a nominal inside diameter of 8.75 inches and a 0.260 inch minimum wall thickness.

§ 178.37(b) *Authorized steel*

(1) Basic oxygen or electric furnace steel of uniform quality is authorized. The steel analysis must be in conformance with the following:

CHEMICAL COMPOSITION IN WEIGHT PERCENT

Element	Ladle Analysis	Check Analysis Tolerance Under	Over
Carbon	.32/.36	0.01	0.02
Manganese	.60/.90	0.03	0.03
Phosphorus	.025 Max.	-	0.01
Sulphur	.010 Max.	-	0.00
Silicon	.15/.35	0.02	0.03
Chromium	.80/1.10	0.03	0.03
Molybdenum	.15/.25	0.01	0.01
Vanadium	.10 Max.	0.01	0.01
Aluminum	.01/.05	-	0.00
Copper	.20 Max.	-	0.00

Note 1: Steel must be treated with calcium to provide the following J-K microcleanliness rating per ASTM Standard E-45, Method A.

A (Sulfides)		B (Alumina)		C (Silicates)		D (Oxides)	
Thin	Heavy	Thin	Heavy	Thin	Heavy	Thin	Heavy
2.0	1.5	2.0	1.0	1.0	0.5	2.5	1.5

Certificate from the material manufacturer must certify that the material was calcium treated and must include in such certification the J-K microcleanliness rating for each heat of steel.

Note 2: Steel must be aluminum killed and made by a fine grain deoxidation practice.

§ 178.37(d) *Manufacture.*

* * *

(1) Metal removal for any purpose other than removal of isolated defects and threading must be done prior to hydrostatic and ultrasonic tests. The thickness of treated areas must be measured and may not be less than the minimum prescribed thickness.

(2) Each cylinder must be of seamless construction manufactured by the backward extrusion method with integrally formed heads and bottoms.

(3) The thickness of the bottoms of cylinders must not be less than two times the minimum wall thickness of the cylindrical shell; such bottom thickness to be measured within an area bounded by a line representing the points of contact between the cylinder and floor when the cylinder is in a vertical position.

(4) Shape and thickness of the cylinder bottom and sidewall adjacent to the bottom must be such that failure during the cyclic pressure test occurs in the sidewall of the cylinder.

(5) The design authorized herein must be qualified for production by subjecting at least three prototype samples to pressure cycling tests and burst tests as follows:

(i) Cycle Test. The cycle test must be performed on the completed cylinder after hydrostatic test by subjecting the cylinder to successive hydrostatic pressurizations from the lower cyclic pressure to the upper cyclic pressure at a rate not to exceed 10 cycles per minute. Adequate recording instrumentation must be provided if equipment is to be left unattended for any period of time. Lower cyclic pressure must not exceed 10 percent of the upper cyclic pressure. Upper cyclic pressure must be at least equal to the minimum prescribed test pressure.

(ii) Burst Pressure Test. The burst pressure test must be performed on the completed cylinder by hydrostatically pressurizing the cylinder to destruction. Rate of pressurization must not exceed 200 psi per second.

§ 178.37(e) *Welding or brazing.*

Welding or brazing is prohibited.

§ 178.37(f) *Wall thickness.*

(1) Delete

(2) The minimum wall thickness must be such that the wall stress at the minimum specified test pressure does not exceed 67 percent of the minimum tensile strength of the steel as determined by the mechanical tests required in § 178.37(k). A wall stress of more than

104,000 psi is not permitted. The wall thickness must not be less than 0.252 inch for cylinders with nominal inside diameter of 8.50 inches and 0.260 inch for cylinders with nominal inside diameter of 8.75 inches.

(3) Applies except P, the minimum test pressure, is at least 3/2 service pressure instead.

§ 178.37(g) *Heat treatment.*

The completed cylinders must be uniformly and properly heat treated prior to tests. Heat treatment of cylinders must be as follows:

(1) The furnace must be equipped with recording infrared pyrometers capable of determining cylinder temperature in both the austenitizing and tempering sections at the beginning and end of each soak zone. The furnace must have fault controls providing uniform temperature in each control zone and proper function of the feed mechanism.

(2) Each cylinder must be heated and held above the upper critical temperature (Ac3) for at least one hour per inch of thickness based on the maximum thickness of the cylinder and then quenched in a suitable liquid medium having a cooling rate not in excess of 80 percent of water. The steel temperature on quenching must be above the Ac3 temperature, but not higher than 1700°F.

(3) After quenching, each cylinder must be reheated to a temperature below the transformation range but not less than 1000°F, and must be held at this temperature for at least one hour per inch of thickness based on the maximum thickness of the cylinder. Each cylinder must then be air cooled.

§ 178.37(h) *Openings.*

Openings are permitted in the cylinder head only. All openings must be threaded. Threads must be in compliance with the following:

(1) * * *

(2) Taper threads, when used, must be in compliance with one of the following:

(i) American Standard Pipe Thread (NPT) type must be in compliance with the requirements of Federal Standard H-28 (1978), Section 7.

(ii) National Gas Taper Thread (NGT) type must be in compliance with the requirements of Federal Standard H-28 (1978), Section 7 and 9.

(iii) Other taper threads in compliance with other standards may be used provided the length is not less than that specified for NPT threads.

(3) Straight threads when used must be in compliance with one of the following:

(i) National Gas Straight Thread (NGS) type must be in compliance with the requirements of Federal Standard H-28 (1978), Sections 7 and 9.

(ii) Unified Thread (UN) type must be in compliance with the requirements of Federal Standard H-28 1978),Section 2.

(iii) Controlled Radius Root Thread (UNJ) type must be in compliance with the requirements of Federal Standard H-28 (1978) Section 4.

(iv) Other straight threads in compliance with other recognized standards may be used provided that the requirements in (4) below are met.

(4) All straight threads must have at least 6 engaged threads, a tight fit, and a factor of safety in shear of at least 10 at the test pressure of the cylinder. Shear stress must be calculated by using the appropriate thread shear area in accordance with Federal Standard H-28 (1978), Appendix A5, Section 3.

§ 178.37(i) *Hydrostatic test.*

(1),(2) and (3) * * *

(4) Each cylinder must be tested to at least 1.5 times service pressure.

(5) A rejection elastic expansion limit (REE) must be developed as specified in CGA pamphlet C-5. If the elastic expansion of any cylinder, at test pressure, exceeds the limit so developed, that cylinder must be rejected.

§ 178.37(j) *Toughness, ductility tests and ultrasonic examination.*

(1) Fracture toughness test. At least two plane-strain fracture toughness KIC data points must be obtained on one cylinder after heat treatment taken from each heat of steel. The valid KIC data must be obtained via the J-integral test method prescribed in ASTM Standard E813. The specimen must be so tested at room temperature in the TL orientation as defined in ASTM Standard E399. The specimen must be prepared only from material removed from the cylindrical portion of the cylinder. Flattening of the material without heating is allowed for preparing the test specimens.

(2) Flattening test. Between knife edges, wedge shaped, 60-degree angle, rounded to ½ inch radius; test 1 cylinder taken at random out of each lot of 200 or less cylinders. Longitudinal axis of the cylinder must be at approximately a 90-degree angle to knife edges.

(3) Impact tests.

(i) Three Charpy impact specimens must be tested from one heat-treated cylinder taken from each 500 or less successively produced.

(ii) Each impact specimen must be Charpy V-notch type size 10mm X 4mm or 10mm X 5mm taken in accordance with ASTM Standard A-370-77.

(iii) Each specimen must be taken from the sidewall of the cylinder. The longitudinal axis of the specimen must be at 90 degrees to the longitudinal axis of the cylinder.

(4) Hardness measurement: A hardness measurement must be performed on the cylindrical section of each cylinder after heat treatment. At a minimum, one reading must be taken in the cylindrical section approximately three inches from either the shoulder or bottom of each cylinder. The result must be recorded.

(5) Flawed cylinder pressure test. One cylinder must be selected from each heat of steel and subjected to a preflaw pressure test. A sharp part through longitudinal flaw must be introduced into the test cylinder by a means that will not affect the mechanical or metallurgical properties of the cylinder. The flaw must be at least 2-inches long and have a depth that

will cause the cylinder to fail when pressurized to not less than 90 percent and not more than 125 percent of the stress at service pressure. The cylinder must be hydrostatically pressurized to failure at a rate not in excess of 200 psi per second.

(6) Ultrasonic Examination.

Each cylinder must be examined after heat treatment and hydrostatic proof testing by shear wave ultrasonic equipment which has been calibrated to give an indication greater than the equivalent of a 5% of wall thickness by 1" long notch. Procedures must be in accordance with ASTM E213-83, and supplements S1.1 and S2, using the immersion method. Ultrasonic test results must be recorded by individual cylinder serial numbers and maintained as long as the cylinders are in service.

§ 178.37(l) *Acceptable results of tests and inspections.*

(1) Fracture toughness test. Each KIC value must be at least 85 ksi in$^{1/2}$.

(2) Flattening test. Flattening required without cracking to 10 times wall thickness. Maximum degree of flattening attained without cracking must be entered on the inspector's report.

(3) Impact tests. The Charpy V-notch impact properties for the three impact specimens which must be tested at 0.0°F or colder must not be less than the values shown below:

Size (mm)	Avg. value for acceptance 3 specimens	Min. value 1 specimen only of the three
10 X 5 or 10 X 4	13.0 ft. lbs.	10.0 ft.lbs.

(4) Hardness measurement. The tensile strength equivalent of the hardness number obtained may not be more than 182,000 psi; Rc 40 (Brinell 371). When the result of a hardness test exceeds the maximum permitted, two or more retests may be made; however, the hardness number obtained in each retest may not exceed the maximum permitted.

(5) Flawed cylinder pressure test. The failure must be by leakage without crack extension, or by plastic fracture (fully ductile fracture with visible evidence of bulging.

(6) Mechanical tests.

(i) Tensile strength at least 155,000 psi and not more than 175,000 psi.

(ii) Elongation at least 12 percent for gauge length 2 inches with width not over 1 ½ inches.

(7) Ultrasonic examination. Any cylinder having a discontinuity indication greater than the equivalent of a 5 percent of wall thickness by 1 inch long notches must be rejected. Any cylinder with rejectable ID indication must be scrapped and destroyed.

(8) Cycle tests. Cylinders subjected to design qualification cycling tests must withstand at least 10,000 cyclic pressurizations without distortion or failure. All cycle tests must be performed using water as the pressurizing medium.

(9) Burst tests. Cylinders subjected to design qualification burst tests must withstand a pressure of at least 2.25 times the service pressure without failure. Failure must initiate in the sidewall in a longitudinal direction, and the cylinder must remain in one piece.

§ 178.37(n) *Rejected cylinders.*

(1) Lot definition. In this exemption, a "lot" means a group of cylinders successively produced and having the same:

(i) Size and configuration;

(ii) Specified material of construction;

(iii) Process of manufacture and heat treatment;

(iv) Equipment of manufacture and heat treatment;

(v) Conditions on time, temperature and atmosphere during heat treatment.

(2) The lot size may not exceed 200 cylinders, but any cylinder processed for use in the required destructive testing need not be counted as being one of the 200. If any lot in an already accepted heat fails any of the qualification tests as prescribed in §§ 178.37(d), 178.37(j) or 178.37(k) of this exemption, that lot may

be subjected to one repeated heat treatment. Any lot subjected to second heat treatment is considered as equivalent to new heat and therefore must meet, at a minimum, the requirements specified below. If any lot subjected to a second heat treatment fails any of the prescribed mechanical tests, the cylinders from that lot may not be used under the terms of this exemption.

(3) Lot re-qualification:

(i) The second heat treatment procedure must be in accordance with that prescribed in § 178.37(g) of this exemption.

(ii) The lot is identified in the heat treatment records appropriately indicating repeated heat treatment.

(iii) Fracture toughness test: Acceptable lot must pass all prescribed tests per §§ 178.37(j)(1) and 178.37(l)(1) of this exemption.

(iv) Flattening tests: Acceptable lot must pass all prescribed tests per §§ 178.37(j)(2) and 178.37(l)(2) of this exemption.

(v) Impact tests: Acceptable lot must pass all prescribed tests per §§ 178.37(j)(3) and 178.37(l)(3) of this exemption.

(vi) Hardness measurements: Acceptable lot must pass all prescribed tests per §§ 178.37(j)(4) and 178.37(l)(4) of this exemption.

(vii) Flawed cylinder tests: At a minimum one cylinder must pass the tests prescribed per §§ 178.37(j)(5) and 178.37(l)(5) of this exemption.

(viii) Mechanical tests: Acceptable lot must pass all prescribed tests per §§ 178.37(j)(6), 178.37(k) and 178.37(l)(6) of this exemption.

(4) Cylinder re-qualification:

(i) Metal removal for any purpose is not permitted.

(ii) Each cylinder must be subjected to hydrostatic test to 3/2 times rated service pressure as prescribed in § 178.37-14 of this exemption.

(iii) Elastic and plastic expansion at the proof test pressure must not exceed rejectable limits as prescribed in § 178.37(i)(5) of this exemption.

(iv) Following hydrostatic proof testing, each cylinder must pass ultrasonic examination as prescribed in § 178.37-17(j)(6) of this exemption.

b. TESTING - Each cylinder must be requalified for use every five years in accordance with § 173.34 as prescribed for DOT-3AA cylinders or by ultrasonic examination. Cylinders requalified after having been subjected to the action of fire, must be reported to OHMEA prior to being placed back in service.

(1) Hydrostatic pressure test - Each cylinder must be tested in accordance with § 173.34(e) except

(i) Each cylinder must be tested to at least 3/2 times the marked service pressure.

(ii) A rejection elastic expansion (REE) limit must be developed as specified in CGA Pamphlet C-5.

(2) Ultrasonic Examination - As an alternative, each cylinder may be requalified by ultrasonic examination in accordance with DOT-E 12022 by a retest facility approved by OHMEA for ultrasonic examination.

(i) The retest results for the ultrasonic examination must be submitted to OHMEA annually.

(ii) A cylinder that has been exposed to fire or to excessive heat (temperatures of 1000 °F or greater) may not be retested by ultrasonic examination.

c. OPERATIONAL CONTROLS - Filling limits specified in § 173.302(c) are not authorized. These cylinders may not be filled to a pressure exceeding the marked service pressure at 70°F.

8. SPECIAL PROVISIONS:

a. Reports:

(1) Prior to the initial shipment of cylinders made to any specific design, or from a repeat heat treated lot, a report of test results specified in §§ 178.37(d)(5) and/or 178.37(n) must be submitted to the Office of Hazardous Materials Exemptions and Approvals (OHMEA).

(2) The maker of the cylinder under this specification must retain the test reports required by this specification indefinitely as long as these cylinders are authorized.

b. A copy of the Inspector's report for each of the first three lots produced must be submitted to the OHMEA prior to shipment.

c. A person who is not a holder of this exemption, but receives a package covered by this exemption, may use the packaging authorized by this exemption for the transportation of hazardous materials specified in paragraph 6, only in conformance with the terms of this exemption.

d. Each packaging manufactured under the authority of this exemption must be marked with a registration symbol designated by the Office of Hazardous Materials Exemptions and Approvals Program for a specific manufacturing facility.

e. A copy of this exemption, in its current status, must be maintained at each manufacturing facility at which this packaging is manufactured and must be made available to a DOT representative upon request.

f. In accordance with the provisions of Paragraph (b) of § 173.22a, persons may use the packaging authorized by this exemption for the transportation of the hazardous materials specified in paragraph 6, only in conformance with the terms of this exemption.

g. A current copy of this exemption must be maintained at each facility where the package is offered or reoffered for transportation.

9. MODES OF TRANSPORTATION AUTHORIZED: Motor vehicle, rail freight, and cargo vessel.

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10. MODAL REQUIREMENTS: A current copy of this exemption must be carried aboard each cargo vessel used to transport packages covered by this exemption.

11. COMPLIANCE: Failure by a person to comply with any of the following may result in suspension or revocation of this exemption and penalties prescribed by the Federal hazardous materials transportation law, 49 U.S.C. 5101 et seq:

    - All terms and conditions prescribed in this exemption and the Hazardous Materials Regulations, Parts 171-180.

    - Registration required by § 107.601 et seq., when applicable.

    Each "Hazmat employee", as defined in § 171.8, who performs a function subject to this exemption must receive training on the requirements and conditions of this exemption in addition to the training required by §§ 172.700 through 172.704.

    No person may use or apply this exemption, including display of its number, when the exemption has expired or is otherwise no longer in effect.

12. REPORTING REQUIREMENTS: The carrier is required to report any incident involving loss of packaging contents or packaging failure to the Associate Administrator for Hazardous Materials Safety (AAHMS) as soon as practicable. (Sections 171.15 and 171.16 apply to any activity undertaken under the authority of this exemption.) In addition, the holder(s) of this exemption must also inform the AAHMS, in writing, as soon as practicable of any incidents involving the package and shipments made under this exemption.

Issued in Washington, D.C.

for Robert A. McGuire
Associate Administrator
for Hazardous Materials Safety

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(DATE)

Address all inquiries to: Associate Administrator for Hazardous Materials Safety, Research and Special Programs Administration, Department of Transportation, Washington, D.C. 20590. Attention: DHM-31.

The original of this exemption is on file at the above office. Photo reproductions and legible reductions of this exemption are permitted. Any alteration of this exemption is prohibited.

Copies of exemptions may be obtained from the AAHMS, U.S. Department of Transportation, 400 7th Street, Washington, DC 20590-0001, Attention: Docket Section, 202-366-5046.

PO: MM Toughiry/sln