



U.S. Department  
of Transportation

**Research and  
Special Programs  
Administration**

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

**AUG 1 0 2004**

DOT-E 11692  
(FIFTH REVISION)

EXPIRATION DATE: July 31, 2006

(FOR RENEWAL, SEE 49 CFR § 107.109)

1. GRANTEE: Worthington Cylinder of Canada, Tilbury, Ontario, Canada  
(U.S. Agent: Worthington Cylinder Corporation, Columbus, Ohio)
2. PURPOSE AND LIMITATIONS:
  - a. This exemption authorizes the manufacture, mark, sale and use of a non-DOT specification cylinder conforming in part with DOT Specification 3AA to be used for the transportation in commerce of the materials listed in paragraph 6 below. This exemption provides no relief from the Hazardous Materials Regulations (HMR) other than as specifically stated herein.
  - b. An exemption authorization to manufacture, mark, sell, and transport only represents certification of safety for a package when it is an article of commerce in transportation. The safety analyses performed in development of this exemption only considered the hazards and risks associated with transportation in commerce. The safety analyses did not consider the hazards and risks associated with consumer use, use as a component of a transport vehicle or other device, or other uses not associated with transportation in commerce.
3. REGULATORY SYSTEM AFFECTED: 49 CFR Parts 106, 107 and 171-180.
4. REGULATIONS FROM WHICH EXEMPTED: 49 CFR §§ 173.301(a)(2), 173.301(a)(1), 173.302a, 173.304a and 175.3 in that non-DOT specification cylinders are not authorized, except as specified herein.

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5. BASIS: This exemption is based on the application of Worthington Cylinder of Canada, dated July 26, 2004, submitted in accordance with § 107.109.
6. HAZARDOUS MATERIALS (49 CFR § 172.101):

Proper Shipping Name/ Hazardous Material Description	Hazard Class/ Division	Identi- fication Number	Packing Group
Except as listed below, gases or mixtures of gases authorized in the HMR for DOT-3AA Specification cylinders	2.1 2.2 2.3	As appro- priate	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 sulphides, or containing hydrogen or compressed natural gas;
- c. Any gas mixture containing more than ten 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.

7. SAFETY CONTROL MEASURES:

- a. PACKAGING - Prescribed packaging is a non-DOT specification steel cylinder made in accordance with SCM Technologies drawing E-2015 dated March 4, 1996, and in

compliance with the general requirements for specification cylinders (§ 178.35) and DOT-3AA Specification (§ 178.37) except as follows:

§ 178.35(a) *Compliance and lot definition.*

(1) Compliance required in all details.

(2) 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 of time, temperature and atmosphere during heat treatment;

(vi) 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.

§ 178.35(c) *Duties of inspector.*

(1) and (2) \* \* \*

(3) Verify compliance of cylinders with the terms of this exemption.

(4) \* \* \*

§ 178.35(e) *Safety devices.*

(1) Must be as required by the Hazardous Materials Regulations (HMR) that apply (see §§ 173.301(f) and 173.301(h)).

(2) Pressure relief devices must be in compliance with § 173.302a(b)(1), except as follows:

(i) Cylinders charged with gas mixtures containing gas classed as a Division 2.3, must not be equipped with any pressure relief device.

(ii) Cylinders charged with gas mixtures containing no gas classed as a Division 2.3, 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) *Markings.*

Applies except:

1. Each cylinder must be marked with "DOT-E 11692" in lieu of DOT "3AA".
2. Rejection elastic expansion (REE) in cubic centimeters (CC) near the date of test.
3. Marking must be at least 5mm (3/16") high.

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

Each cylinder must be of seamless construction with the bottom convex to pressure with a maximum water capacity of 5.3 kg (12 pounds). The maximum service pressure must not exceed 138.9 kPa (2015 psig).

§ 178.37(b) *Authorized steel.*

Only basic oxygen or electric furnace steel of uniform quality is authorized. Steel must be aluminum killed and made by a fine grain deoxidation practice. The steel analysis must be in conformance with the following:

CHEMICAL COMPOSITION IN WEIGHT PERCENT

<u>Element</u>	<u>Ladle analyses</u>	<u>Check analyses Tolerance</u>	
		<u>Under</u>	<u>Over</u>
Carbon	.31/.36	0.01	0.02
Manganese	.60/.90	0.03	0.03
Phosphorus	.015 Max.	-	0.01
Sulfur	.010 Max.	-	0.001
Silicon	.15/.35	0.02	0.03
Chromium	.80/1.10	0.03	0.03
Molybdenum	.15/.25	0.01	0.01
Vanadium	.07 to .10	0.01	0.01
Aluminum	.05 Max.		

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

<u>A (Sulfides)</u>		<u>B (Alumina)</u>		<u>C (Silicates)</u>		<u>D (Oxides)</u>	
<u>Thin</u>	<u>Heavy</u>	<u>Thin</u>	<u>Heavy</u>	<u>Thin</u>	<u>Heavy</u>	<u>Thin</u>	<u>Heavy</u>
2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

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

§ 178.37(d) *Manufacture.*

- (1) Metal removal for any purpose other than removal of isolated defects and threading must be done prior to hydrostatic test. 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 cold drawing and ironing processes.
- (3) The thickness of the bottom of cylinders may 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) Each new design and any significant change to an acceptable design, must undergo design qualification tests. The design authorized herein must be qualified prior to production by subjecting at least three prototype samples to pressure cycling and burst tests as follows:
  - (i) Cycle test. The cycle test must be performed on completed cylinders after hydrostatic test by subjecting the cylinder to successive hydrostatic pressurization from the lower cyclic pressure to 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 may 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 may not exceed 200 psi per second.

(iii) Flawed burst Test. The flawed cylinder test must be performed on a complete cylinder. An external flaw shall be machined longitudinally, approximately at mid-length of the cylindrical portion. The flaw must be located at minimum wall thickness ( $t_m$ ) of the mid-section based on thickness measurement at four points around the cylinder. The flaw cutter must have an angle of 45° inclusion and a maximum tip radius on 0.008". The flaw length must be at least 10 times the design minimum wall thickness ( $t_d$ ). The flaw depth shall be sufficient to cause a failure by leakage and be in conformance with § 178.37(m)(3).

(6) In this exemption "significant change" means a 10 percent or greater change in cylinder wall thickness; service pressure; or diameter; a 50% or greater change in water capacity; any change in material chemical analysis specification; over 100% increase in size of opening; or any change in the number of openings.

(7) After all shell forming operations and prior to closing in, the cylindrical section of each shell must be ultrasonically examined in accordance with ASTM Standard E213 using the shear wave to detect any flaw. The equipment must be calibrated to identify and measure a notch equal or smaller than 10% of the minimum wall thickness (0.0058" or 0.147 mm).

§ 178.37(e) *Welding or brazing.*

Welding or brazing is prohibited.

§ 178.37(f) *Wall thickness.*

(1) Not applicable.

(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(j) and § 178.37(k). A maximum wall stress of more than 90,500 psi (6,242 Pa) at minimum test pressure is not permitted. In no case the wall thickness be less than 0.059"

(1.5 mm).

(3) Calculation must be made by the formula:

$$S = P(1.3D^2 + 0.4d^2)/(D^2 - d^2)$$

where:

S = wall stress in pounds per square inch;

P = minimum test pressure, at least 3/2 service pressure;

D = outside diameter in inches;

d = inside diameter in inches.

§ 178.37(g) *Heat treatment.*

(1) Each completed cylinder must be uniformly heat treated prior to tests as follows:

(i) Each cylinder must be heated at the proper temperature for at least one hour per inch of maximum thickness on the cylinder and then quenched in a suitable liquid medium having a cooling rate not to exceed 80% of water. The steel temperature on quenching must be less than 1750°F.

(ii) After quenching, each cylinder must be reheated to a temperature below the transformation range but not less than 1050°F, and held at this temperature for at least one hour per inch of thickness based on the maximum thickness of the cylinder.

(2) through (7) Not applicable.

§ 178.37(i) *Hydrostatic test.*

(1) to (3) \* \* \*

(4) Each cylinder must be tested to at least 3/2 times its service pressure.

§ 178.37(j) *Flattening test.*

Between knife edges, wedge shaped, 60 degree angle, rounded to 1/2 inch radius. The holder must perform the flattening test during the design process to ensure proper ductility and fracture toughness in the new cylinder design. Longitudinal axis of the cylinder must be at approximately a 90-degree angle to knife edges.

§ 178.37(k) *Physical tests.*

(1) \* \* \*

(2) Each tensile specimen must have a minimum gauge length 24 times wall thickness, width maximum 6 times wall thickness. The specimen, exclusive of grip ends, must not be flattened. Heating of specimen for any purpose is not authorized.

(3) \* \* \*

(4) The tested cylinders need represent only one of the heats in a lot provided the other heats in the lot have been tested and have passed the test.

(5) Physical tests must be conform to the requirements specified in § 178.37(1).

(6) One cylinder per lot of 200 or less must be subject to a "Flawed Cylinder Burst Test". The flawed cylinder test must be performed on a complete cylinder. An external flaw shall be machined longitudinally, approximately at mid-length of the cylindrical portion. The flaw must be located at minimum wall thickness ( $t_m$ ) of the mid-section based on thickness measurement at four points around the cylinder. The flaw cutter must have an angle of 45° inclusion and a maximum tip radius on 0.008. The flaw length must be at least 10 times design minimum wall thickness ( $t_d$ ). The flaw depth must be sufficient to cause a failure by leakage and be in conformance with § 178.37(m) (3) of this exemption.

(7) 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.

(8) Drop Test - One cylinder per heat of steel must be drop tested in accordance with procedure report submitted to the DOT with this application dated October 28, 1996 [Report of Findings and Results of Testing Conducted on Light Weight Medical E Size Cylinders Proposed for DOT and TC Exemption DN:E-2015]. The drop test must guarantee the adequacy of fracture toughness and leak before rupture of the cylinders.

§ 178.37(1) Acceptable results for tests.

(1) Maximum tensile strength is 1069 Mpa (155,000 psig) and minimum elongation is 9 percent for 24t X 6t specimens.

(2) Burst tests - Cylinders subjected to design qualification 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.

(3) Flawed Cylinder Burst tests - The flawed cylinder must fail by leaking at a pressure greater than ratio of the  $(t_m/t_d)$  times service pressure in which  $t_d$  and  $t_m$  are measured and minimum wall thicknesses. The total flaw length measured on the external surface must not exceed 1.1 times original machined flaw length. If a leak occurs below the specified pressure or failure occurs at a pressure greater than 1.25 times the service pressure, a new test may be performed with a different flaw depth. When the test results do not meet the requirements specified, the lot must be rejected.

(4) Cycle test. Cylinders subjected to design qualification cycling tests must withstand at least 10,000 cyclic pressurization without distortion or failure.

b. TESTING - Each cylinder must be requalified for use every five years in accordance with § 173.301 as prescribed for DOT-3AA cylinders, except that the minimum retest pressure must be 3/2 times the service pressure. Cylinders requalified after having been subjected to the action of fire, must be reported to the Office of Hazardous Materials Exemptions and Approvals (OHMEA) prior to being placed back in service.

c. OPERATIONAL CONTROLS -

(1) Cylinders manufactured under the authority of this exemption may not be used for transportation of gases that cause hydrogen embrittlement.

(2) Filling limits specified in § 173.302a(b) are not authorized. Under no circumstances are these cylinders to be filled to a pressure exceeding the marked service pressure at 21°C (70°F).

8. SPECIAL PROVISIONS:

a. 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.

b. A person who is not a holder of this exemption, but receives a package covered by this exemption, may reoffer it for transportation provided no modification or change is made to the package or its contents and it is offered for transportation in conformance with this exemption and the HMR.

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

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 for a specific manufacturing facility.

e. A current copy of this exemption must be maintained at each facility where the package is manufactured under this exemption. It must be made available to a DOT representative upon request.

f. Reports

(1) Prior to the initial shipment of cylinder made to any specific design, a report of test results specified in § 178.37(d) must be submitted to 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.

g. Transportation of Division 2.1 (flammable gases) and Division 2.3 materials (gases which are poisonous by inhalation) are not authorized aboard cargo vessel or aircraft unless specifically authorized in the Hazardous Materials Table (§ 172.101).

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

10. MODAL REQUIREMENTS: A current copy of this exemption must be carried aboard each cargo vessel or aircraft used to transport packages covered by this exemption. The shipper shall furnish a copy of this exemption to the air carrier before or at the time the shipment is tendered.

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:

- o All terms and conditions prescribed in this exemption and the Hazardous Materials Regulations, Parts 171-180.
- o Persons operating under the terms of this exemption must comply with the security plan requirement in Subpart I of Part 172 of the HMR, when applicable.
- o 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.

*Robert A. McGuire*  
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 Robert A. McGuire  
 Associate Administrator for  
 Hazardous Materials Safety

**AUG 1 0 2004**  
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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.

Copies of this exemption may be obtained by accessing the Hazardous Materials Safety Homepage at <http://hazmat.dot.gov/exemptions> Photo reproductions and legible reductions of this exemption are permitted. Any alteration of this exemption is prohibited.

PO: MT/AM