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ASD 4067-26-2-15

SEP 27 1991

Mr. John Walters
Technical Director
Chesterfield Cylinders Limited
Chesterfield, Derbyshire
S40 2EA
England

Subject: Special Permit SP3263 - M15C for high strength cylinders

Dear Mr. Walters:

Thank you for your letter of September 9, 1991 regarding Appendix C to the above certificate of registration which had been sent to you with our letter of July 8, 1991.

Your pertinent comments were very much appreciated and as a result, you will find attached a copy of the revised Appendix C which was modified in accordance with your comments.

Yours truly,

Jean Bouchard
for: J.R. Monteith
Director,
Regulatory Affairs Branch

attach.

Canada

APPENDIX "C" TO CERTIFICATE OF REGISTRATION NO. M15

The following requirements apply to cylinders made in accordance with drawing No. 48760 P included in Chesterfield Cylinders Limited's application dated June 15, 1990 and additional design and performance data on file with this directorate.

The cylinders shall comply with CTC specification 3AA except as follows:

1. Compliance and lot definition.
 - (a) Compliance required in all details.
 - (b) Lot definition. In this Appendix, a "lot" means a group of cylinders successively produced and having the same:
 - (1) Size and configuration;
 - (2) Specified material of construction;
 - (3) Process of manufacture and heat treatment;
 - (4) Equipment of manufacture;
 - (5) Conditions of time, temperature and atmosphere during heat treatment.

In no case may the lot size exceed 200 cylinders, but any cylinder processed for use in the required destructive testing need not be counted as being one of the 200.

2. Type, size and service pressure.
 - (a) Seamless, 9.0625 inches nominal outside diameter, 0.251 inch minimum wall thickness, 115 pounds maximum water capacity, 4500 psig maximum service pressure.
 - (b) Not applicable.
4. Duties of inspector.

add: (e) Verify that design qualification tests have been performed with satisfactory results.

5. Authorized steel.

- (a) High toughness chromium - molybdenum steel of uniform quality derived from ASTM 4130 X made by the electric arc or basic oxygen process. The steel analysis must be in conformance with the following:

<u>Element</u>	<u>Weight %</u>	<u>Check Analysis Tolerance</u>	
		Under	Over
Carbon	0.32 - 0.36	0.01	0.02
Silicon	0.15 - 0.35	0.02	0.03
Manganese	0.60 - 0.90	0.03	0.03
Sulphur	0.005 max	-	-
Phosphorus	0.010 max	-	.005
Chromium	0.80 - 1.10	0.03	0.03
Molybdenum	0.40 - 0.50	0.01	0.01
Aluminium	0.010 - 0.050	-	0.00

8. Manufacture

- (a) *****. 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.
- (b) Each cylinder must be of seamless construction manufactured by the backward extrusion method with integrally formed heads and bottoms.
- (c) The thickness of the bottoms of cylinders is, under no condition, to 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.



- (d) 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.
- (e) Each new design and any significant change to any accepted design must be qualified for production by testing prototype cylinders as follows:
 - 1- Three cylinders shall be pressure cycling tested at test pressure in accordance with the procedure described in section 4.13.4 of CAN/CSA - B339-88 standard.
 - 2- Three cylinders shall be burst tested by hydrostatically pressurizing the cylinder to destruction in accordance with the procedure described in section 4.13.5 b (ii) of CAN/CSA - B339-88 standard.
 - 3- Three cylinders shall be subjected to a flawed cylinder burst test in accordance with the following procedure:

The artificial flaw to be located longitudinally on the outside surface, in the central region, and produced by machining with a circular cutter. Flaw length to be 10 times wall thickness and of depth to cause failure at a pressure within +/- 20% of marked service pressure. The rate of pressurization shall not exceed 200 psi per second.

All cylinders used for design qualification test shall be made of the same heat of material and with the same procedure, quality control, tools, and machinery that are to be used for their production and shall come from the same lot.

9. Welding or brazing.

Welding or brazing for any purpose whatsoever is prohibited.

10. Wall thickness.

(a) 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 prescribed mechanical tests nor 104,000 psi, whichever is the lesser. In no case may wall thickness be less than .251 inch.

(b) Calculation must be made by the formula:

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

where

S = wall stress in ponds per square inch;

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

D = outside diameter in inches;

d = inside diameter in inches.

11. Heat treatment

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

(1) The furnace shall be equipped so that the cylinder temperatures in both the austenitizing and tempering sections at the beginning and end of each soak zone can be monitored and controlled. The austenitizing and tempering temperatures shall be controlled to plus or minus 18°F.

(2) Each cylinder must be treated 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 oil. The steel temperature on quenching must be between 1616 to 1652°F.

(3) After quenching, each cylinder must be reheated to a temperature below the transformation range but not less than 1058°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.

12. Openings.

- (b) All openings must be threaded. Threads must be in compliance with the following:
- (1) Each thread must be clean cut, even, without checks, and to gauge.
 - (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), Sections 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.
13. Pressure relief devices and protection for valves and pressure relief devices.
- (a) Must be as required by Sections 73.34 (d) and 73.301 (g).
 - (b) Pressure relief devices must be in compliance with Section 73.302 (c) (1) except as follows:
 - (i) Cylinders charged with gas mixtures containing gas requiring placards with a square background must not be equipped with any pressure relief device.
 - (ii) Cylinders charged with gas mixtures containing no gas requiring placards with a square background may be equipped with a combination rupture disk and fusible plug pressure relief device in compliance with CGA Pamphlet S-1.1.
14. Hydrostatic test.
- (a) Applies except water jacket method only is authorized.

- (b) * * *
- (c) * * *
- (d) Each cylinder must be tested at least 3/2 times service pressure.
- (e) A rejection elastic expansion limit (REE) must be developed as specified in CGA Pamphlet C-5. The average wall stress limitation to be used in calculations shall not exceed 99800 psi. If the elastic expansion of any cylinder, at test pressure exceeds the limit so developed, that cylinder must be rejected.

15. Toughness and ductility test.

- (a) Flattening test. Between knife edges, wedge shaped, 60-degree angle, rounded to $\frac{1}{2}$ 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.
- (b) Impact tests
 - (1) Three Charpy impact specimens must be tested from one heat-treated cylinder taken from each 200 or less successively produced.
 - (2) Each specimen to be Charpy V notch type, 10mm deep by thickness depending on cylinder wall, in accordance with ASTM Standard A-370-77. Cross sectional size of specimen to be stated on mechanical test certificate.
 - (3) 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.
- (d) Hardness measurement. A hardness measurement must be performed on the cylindrical section of each cylinder after heat treatment. The thickness of the wall at the point of indentation shall not be reduced below the minimum design thickness.

- (e) Flawed cylinder burst test. One cylinder must be selected from each heat of steel and subjected to the test prescribed in section 8 (e) (3).

17. Ultrasonic examination.

- (a) Each cylinder shall be examined after heat treatment 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 E-213-83, and supplements S1.1 and S2, using the immersion method.

18. Acceptable results of tests and inspections.

- (a) 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.
- (b) Impact test. The Charpy V-notch impact properties for the three impact specimens which must be tested at -50°F or colder must not be less than the values shown below:

Average of 3	50 J/cm ²
Minimum of 3	40 J/cm ²

- (c) Hardness measurement. The tensile strength equivalent of the hardness number obtained may not be more than 182,000 psi; Hardness 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.
- (d) Flawed cylinder burst test. The failure must be by leakage without crack extension, or by plastic fracture with visible evidence of bulging.
- (e) Mechanical tests.

- (e) Mechanical tests.
 - (1) Tensile strength at least 155,000 psi and not more than 175,000 psi.
 - (2) Elongation at least 12 percent for gauge length 2 inches with width not over 1½ inches.
 - (3) Yield stress (0.2% proof test) at least 139,000 psi.
- (f) Ultrasonic examination. Any cylinder having a discontinuity greater than the equivalent of a 5 percent of wall thickness by 1 inch long notch must be rejected.
- (g) Cycle test. Cylinders subjected to design qualification cycling test must withstand at least 10,000 cyclic pressurization without distortion or failure. At least one cylinder must be cycled using water as the pressurizing medium.
- (h) 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. The fracture shall be of ductile appearance.

19. Rejected cylinders.

- (a) Flattening test. Reheat treatment authorized; subsequent thereto, acceptable cylinders must pass all prescribed tests.
- (b) Impact tests. Reheat treatment authorized; subsequent thereto, acceptable cylinders must pass all prescribed tests.
- (c) Hardness measurement. Rejected cylinders may be reheat treated; subsequent thereto, acceptable cylinders must pass all prescribed test.

- (d) Flawed cylinder pressure test. Reheat treatment authorized; subsequent thereto, acceptable cylinders must pass all prescribed tests.
- (e) Mechanical tests. Reheat treatment authorized; subsequent thereto, acceptable cylinders must pass all prescribed tests.
- (f) Ultrasonic examination. Rejected cylinders may be requalified subject to the conditions prescribed in this Appendix.

20. Marking.

(a) * * *

- (1) "TC SP 3263-M15C" in lieu of "CTC 3AA" followed by the service pressure.
- (2) Not applicable.
- (3) A serial number and the manufacturer's symbol.
- (4) * * *
- (5) Rejection elastic expansion (REE) in cubic centimetres near the date of test.

22. Inspector's report.

Applies except that "CTC 3AA" shall be replaced by "TC SP 3263-M15C:."

SPECIAL REQUIREMENTS

- (a) The cylinders shall be maintained and used in accordance with applicable sections of the "Regulations for the Transportation of Dangerous Commodities by Rail" and filled only with gases authorized in CTC 3AA specification cylinders except for the following:

- (1) Hydrogen, compressed natural gas, hydrogen sulphide, or carbon monoxide;
- (2) Any gas mixture containing hydrogen sulphide or other free sulphides, or containing hydrogen or compressed natural gas;
- (3) Any gas mixture containing more than ten percent (10%) carbon monoxide;
- (4) Any gas mixture containing carbon monoxide and having a dew point of minus 52°F or higher at one (1) atmosphere;
- (5) Any gas or mixture of gases which does not remain in a gaseous state when contained in the cylinder at the service pressure and 70°F; and
- (6) 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.

(b) Reports

- (1) Prior to the initial shipment of cylinders made to any specific design, a report of the design qualification test results shall be submitted to the Director, Regulatory Requirements for acceptance.
 - (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.
- (c) Filling limits specified in Section 73.302(c) are not authorized. Under no circumstances are these cylinders to be filled to a pressure exceeding the marked service pressure at 70°F.

- (d) A copy of the Inspector's report for each lot produced, shall be submitted to the Director, Regulatory Affairs.
- (e) Each cylinder must be requalified for use every five years in accordance with Section 73.34 as prescribed for CTC-3AA. Cylinders requalified after having been subjected to the action of fire, must be reported to the Director, Regulatory Affairs prior to being placed back in service.
- (f) The Director, Regulatory Affairs shall be advised of any change in design of the cylinder.
- (g) The Director, Regulatory Affairs shall be advised of any incident involving loss of contents and shall be provided with a summary of experience on a yearly basis.