Transportation of Dangerous Goods Directorate
L'Esplanade Laurier
300 Laurier Avenue West
Ottawa, Ontario
K1A 0N5

Direction générale du transport des marchandises dangereuses
L'Esplanade Laurier
300, avenue Laurier Ouest
Ottawa (Ontario)
K1A 0N5

Equivalency Certificate
(Approval issued by the competent authority of Canada)

Certificate No.: SU 12869

Certificate Holder: Certified Cylinder Services Inc.

Mode of Transport: Road, Rail, Marine, Air

Issue Date: July 31, 2019

Expiry Date: August 31, 2024

LEGEND

For the purposes of this equivalency certificate, documents referred to by an abbreviation have the following meaning:

TDG Act**:** *Transportation of Dangerous Goods Act, 1992*

TDG Regulations**:** *Transportation of Dangerous Goods Regulations*

49 CFR**:** *Title 49 of the "Code of Federal Regulations" of the United States*

CGA C-5-2010**:** Compressed Gas Association Inc. Publication C-5, *Wall Stress Requalification Criteria for High Pressure Seamless Steel Cylinders*, dated 2010

CGA C-6-2013**:** Compressed Gas Association Inc. Publication C-6, *Standards for Visual Inspection of Steel Compressed Gas Cylinders*, dated 2013

CGA C-6.1-2013**:** Compressed Gas Association Inc. Publication C-6.1, *Standards for Visual Inspection of High Pressure Aluminum Compressed Gas Cylinders*, dated 2013

CSA B339**:** CSA Standard B339, "*Cylinders, spheres, and tubes for the transportation of dangerous goods*", published by the Canadian Standards Association (CSA), as amended from time to time

CSA B339-18: CSA Standard B339-18, "*Cylinders, spheres, and tubes for the transportation of dangerous goods*", published by the Canadian Standards Association (CSA), June 2018

CSA B340-18: CSA Standard B340-18 *"Selection and use of cylinders, spheres, tubes, and other containers for the transportation of dangerous goods, Class 2",* published by the Canadian Standards Association (CSA), June 2018

CONDITIONS

1. This equivalency certificate authorizes Certified Cylinder Services Inc. to display the marks prescribed in respect of cylinder requalification in a manner that does not comply with:

   - section 6 of the *TDG Act*

   and authorizes any person to handle, offer for transport, or transport, by road or railway vehicle, by aircraft or by vessel, cylinders in a manner that does not comply with the following requirements:

   - subsection 5.1.1(2) of the *TDG Regulations*,
   - section 5.2 of the *TDG Regulations*,
   - subparagraphs 5.10(1)(a)(ii), 5.10(1)(b)(iii), 5.10(1)(c)(ii), and 5.10(1)(d)(iii) of the *TDG Regulations* but only as it relates to clause 5.1.4 (a) of *CSA B340-18*,

if the following conditions are met:

(a) Each cylinder requalification is performed by Certified Cylinder Services Inc. and is performed in accordance with the documentation filed by the equivalency certificate holder with the Transportation of Dangerous Goods Directorate and in accordance with Appendix A to this certificate;

(b) Subject to condition (c) of this certificate, each time the valve is removed or if there is reason to believe that there is internal contamination or corrosion, the cylinder is subjected to an internal visual inspection, including an inspection of the neck threads, in accordance with *CGA C-6-2013*, or *CGA C-6.1-2013*;

(c) The internal visual inspection of aluminum cylinders may be limited to an inspection of the neck threads, including the transition area from the shoulder to the neck, in accordance with *CGA C-6.1-2013*;

(d) Each cylinder has been manufactured in accordance with:

(i) specification TC-3AM or TC-3AAM set out in the edition of *CSA B339* in force under the *TDG Regulations* at the time of manufacture,

(ii) specification TC-3ANM or TC-3ALM set out in *CSA B339* in force under the *TDG Regulations* at the time of manufacture,

(iii) the requirements of the *Regulations for the transportation of dangerous goods by rail* in force before December 5, 1991, and the cylinder has displayed on it the letters “CRC”, “BTC”, or “CTC”, followed by the letters “3AN” or “3AL”,

(iv) the requirements of the *Regulations for the transportation of dangerous goods by rail* in force before December 5, 1991, and the cylinder has displayed on it the letters “CRC”, “BTC”, or “CTC”, followed by the letters “3A” or “3AA”,

(v) Part 178 of the *49 CFR*, and the cylinder has displayed on it the letters “ICC” or “DOT”, followed by the letters “3A” or “3AA”,

(vi) Part 178 of the *49 CFR*, and the cylinder has displayed on it the letters “ICC” or “DOT”, followed by the letters “3AN” or “3AL”,

(vii) one of the following equivalency certificates, permits for equivalent level of safety, or special permits issued by the Transportation of Dangerous Good Directorate of Transport Canada: SU 4210, SU 4221, SU 4292, SU 4349, SU 4366, SU 4369, SU 4552, SU 4626, SU 4957, SU 7694, or SP 3263-15C, or

(viii) Special Permit 1897, issued under the *Regulations for the Transportation of Dangerous Goods by Rail* in force before December 5, 1991;

(e) The equivalency certificate holder marks the letter “K” immediately following the service pressure marking on any cylinder that was manufactured in accordance with conditions (d)(i) or (d)(vii) of this certificate, that is requalified in accordance with this certificate, and for which the maximum wall stress exceeds the corresponding wall stress limitation specified in Appendix B of *CGA C-5-2010*;

(f) The equivalency certificate holder may mark a “+” sign immediately following the requalification date marking on any cylinder that was manufactured in accordance with conditions (d)(iv), (d)(v), or (d)(viii) of this certificate, that is requalified in accordance with this certificate, and for which the maximum wall stress does not exceed the corresponding wall stress limitation specified in Appendix B of *CGA C-5-2010*;

(g) Subject to condition (h) of this certificate, the requalification period for each cylinder requalified in accordance with this certificate is five years;

(h) The requalification period for each cylinder requalified in accordance with this certificate and meeting the requirements of Clause 24.2.2.1, of *CSA B339-18*, is 10 years and the equivalency certificate holder may mark a five-pointed star immediately following the requalification date;

(i) Cylinders with evidence of having been subjected to the action of fire are not requalified under this certificate;

(j) Aluminum cylinders exposed to a temperature exceeding 175°C are condemned;

(k) The equivalency certificate holder reports to the Executive Director, Regulatory Frameworks and International Engagement, Regulatory Affairs Branch, Transportation of Dangerous Goods Directorate, Transport Canada:

(i) the name and qualifications of each Senior Review Technologist (SRT), qualified tester, and qualified operator, as defined in Appendix A to this certificate,

(ii) the location of each facility where requalification is conducted, and

(iii) once per 12 calendar months, the number of cylinders examined, the specification designation, or the equivalency certificate, permit for equivalent level of safety, or special permit under which each cylinder was manufactured, their serial numbers and respective owners, and the requalification results including the type and size of the defect(s) of each rejected cylinder;

2. This equivalency certificate serves as the registration of Certified Cylinder Services Inc. in accordance with Clause 25.3 of *CSA B339-18*, to requalify cylinders as specified herein. Certified Cylinder Services Inc.'s registered mark is:

"621".

Note 1: Subsection 31(4) of the *TDG Act* stipulates that any non-compliance with the conditions of this equivalency certificate causes the provisions of the Act and Regulations to apply as though this equivalency certificate did not exist.

Note 2: Any other requirement of the *TDG Regulations* applies.

Signature of Issuing Authority

David Lamarche, P. Eng., ing.

David Lamarche, P. Eng., ing.
Chief, Approvals and Special Regulatory Projects

Canada

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(*The following Explanatory Note is for information purposes only and is not part of this certificate.)*

Explanatory Note

The equivalency certificate holder has demonstrated that cylinders requalified by the ultrasonic examination immersion method described in Appendix A to this certificate could be used with a level of safety at least equivalent to those requalified by methods (hydrostatic testing and internal visual inspection) required by the *TDG Regulations*.

Legend for Certificate Number

SH - Road, SR – Rail, SA - Air, SM - Marine
SU - More than one Mode of Transport
Ren. - Renewal

APPENDIX A

1. REQUALIFICATION METHOD

Each cylinder shall be visually inspected externally and be subjected to an ultrasonic examination (UE). For aluminum cylinders manufactured from the alloy 6351 used in self-contained underwater breathing apparatus (SCUBA), self-contained breathing apparatus (SCBA), and oxygen services, the valve shall be removed and an inspection of the cylinder neck region, including the neck threads, shall be performed. In addition, an examination of the cylinder neck region, including the neck threads, for sustained load cracking (SLC) by the use of an eddy current device shall be performed.

1.1 Applicable Standards

CSA-B339-18, *Cylinders, spheres, and tubes for the transportation of dangerous goods*, June 2018 (*CSA B339-18*).

Compressed Gas Association Inc. (CGA) Publication C-5-2010, *Wall Stress Requalification Criteria for High Pressure Seamless Steel Cylinders*, dated 2010 (*CGA C-5-2010*).

Compressed Gas Association Inc. (CGA) Publication C-6-2013, *Standards for Visual Inspection of Steel Compressed Gas Cylinders*, dated 2013 (*CGA C-6-2013*).

Compressed Gas Association Inc. (CGA) Publication C-6.1-2013, *Standards for Visual Inspection of High Pressure Aluminum Compressed Gas Cylinders*, dated 2013 (*CGA C-6.1-2013*).

CAN/CGSB-48.9712-2014 / (ISO 9712:2012, IDT), *Non-destructive Testing – Qualification and Certification of Personnel*, dated 2014 (*CAN/CGSB-48.9712-2014 / (ISO 9712:2012, IDT*)).

ASTM E1316-18, *Standard Terminology for Nondestructive Examinations*, dated 2018 (*ASTM E1316-18*).

ASTM E213-14, *Standard Practice for Ultrasonic Examination of Metal Pipe and Tubing*, dated 2014 *(ASTM E213-14*).

ASNT SNT-TC-1A, *Recommended Practice No. SNT-TC-1A – Non Destructive Testing*, dated 2016 (*SNT-TC-1A-2016*).

ANSI/ASNT CP-189-2011, *ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel*, dated 2011 (*ANSI/ASNT CP-189-2011*)

2. EXTERNAL VISUAL INSPECTION

The cylinder shall be visually inspected externally in accordance with *CGA C-6-2013* or *CGA C-6.1-2013*, as applicable.

3. EDDY CURRENT EXAMINATION WITH INTERNAL VISUAL INSPECTION

3.1 Scope of Examination

Each cylinder manufactured from aluminum alloy 6351 used in self-contained underwater breathing apparatus (SCUBA), self-contained breathing apparatus (SCBA), and oxygen services, shall be subjected to an examination of the cylinder neck for sustained load cracking (SLC) by the use of an eddy current device. The cylinder neck shall be examined in accordance with section 3 of this appendix. Any eddy current indication of a feature shall be visually verified. Any cylinder with a crack verified visually shall be condemned. Any cylinder with a fold in the shoulder area extending into more than one continuous full neck thread shall be condemned.

Note: Referencing *CGA C-6.1-2013* may be helpful in determining the cylinders manufactured from aluminum alloy 6351.

3.1.1 Examination Procedure

Each facility performing eddy current examination with visual inspection shall develop, update, and maintain a written examination procedure applicable to the test equipment it uses to perform eddy current examinations.

3.1.2 Visual examinations

Internal visual examinations of the neck and shoulder area of the cylinder shall be conducted in accordance with publication *CGA C–6.1-2013*.

3.1.3 Eddy Current Equipment

A reference ring and probe for each cylinder thread manufactured of aluminum alloy 6351 to be examined shall be available at the examination facility. Eddy current equipment shall be capable of accurately detecting the notches on the standard reference ring.

3.1.4 Eddy Current Reference Ring

The reference ring shall be produced to represent each cylinder thread size to be examined. The reference ring shall include artificial notches to simulate a neck crack. The size of the artificial notch (depth and length) shall have a depth less than or equal to 1/3 of the wall thickness of the neck and a length greater than or equal to two threads. The standard reference shall have a drawing that includes the diameter of the ring, and depth and length of each notch.

3.1.5 Condemnation Criteria

A cylinder shall be condemned if the eddy current examination combined with visual examination reveals any crack in the neck or shoulder area. A cylinder with folds that enter into more than one continuous full neck thread shall be condemned.

3.1.6. Examination equipment records

Records of eddy current examination equipment shall contain the following information:

(a) Equipment manufacturer, model number, and serial number; and

(b) Probe description and unique identification (e.g., serial number and part number).

3.1.7 Eddy current examination reporting and record retention requirements

Daily records of eddy current examinations shall be maintained by the person who performs the requalification. These records shall be made available for inspection by a representative of Transport Canada on request. Eddy current examination records shall contain the following information:

(a) Specification of each standard reference ring used to perform the eddy current examination;

(b) Specification, Equivalency Certificate, Permit for Equivalent Level of Safety, or Special Permit number of the cylinder; manufacturer's name or symbol; owner's name or symbol, if present; serial number; and, date of manufacture;

(c) Name of person performing the eddy current examination;

(d) Date of eddy current examination;

(e) Acceptance/condemnation results (i.e., pass or fail); and

(f) Requalifier's registered mark.

3.1.8 Personnel Qualification Requirements

Each person who performs eddy current and visual examinations, and evaluates and certifies retest results, shall be certified by the employer that he/she has been properly trained and tested in the eddy current and visual examination procedures.

3.1.9 Training Records

A record of eddy current training must be maintained for each employee who performs eddy current and visual examinations.

4. ULTRASONIC EXAMINATION

4.1 Scope of Examination

The cylinder shall be examined using ultrasonic straight-beam and shear angle-beam waves so that 100% of the cylindrical section of the cylinder is examined. The coverage shall extend at least 76.2 mm (3 inches) into the sidewall-to-base transition area.

4.2 Ultrasonic Examination System

The UE equipment shall incorporate a single channel or multi-channel immersion system arranged to perform straight and angle beam examinations. The ultrasonic pulses shall enter into the cylinder wall in both longitudinal (opposing) directions, both circumferential (opposing) directions, and normal to the cylinder wall to ensure 100 percent coverage of the cylinder wall. The system shall be set up to perform longitudinal ultrasonic angle beam examinations from the cylinder shoulder down to the cylinder base including the sidewall-to-base transition (SBT) area and from the cylinder base up to the cylinder shoulder.

Also, the system shall be set up to perform circumferential ultrasonic angle beam examinations in both clockwise and counter clockwise rotation around the cylinder. All defects such as but not limited to isolated pits, line corrosion, cracks, and folds shall be detected. The transducer or cylinder shall be arranged so that the ultrasonic beams enter into the cylinder wall and measure thickness and detect the sidewall and SBT area flaws. The immersion UE system shall have a high-speed board to digitize and capture each A-scan and C-scan during examination of the cylinder. Search units shall be able to resolve the thickness measurements and detect all flaws. A manual contact shear or longitudinal search unit may be used for confirmation and sizing of an indicated defect. If manual UE is used, it shall be performed by at least a Level II operator (qualified tester) and in accordance with *ASTM E213-14*.

4.3 Ultrasonic Examination System Calibration

4.3.1 Calibration of the ultrasonic examination system shall be performed at the beginning of each work shift (cal-in), when the cylinder under examination has

dimensions that exceed the allowable ranges of the calibration cylinder, when there is a change of operator(s), if any equipment that affects the UE results are replaced or altered (such as but not limited to a search unit or coaxial cable), or if a loss of power occurs, and at the end of each work shift (cal-out). Additionally, UE system calibration (cal-out) shall be performed after the examination of 200 cylinders or four hours, whichever occurs first. This cal-out may be considered the cal-in for the next examination interval during continuous operation. Cylinders examined during the interval between cal-in and cal-out shall be quarantined until an acceptable cal-out has been performed. A cal-out shall be deemed acceptable when the calibration cylinder is examined and all required features are revealed without changing examination settings. If an acceptable cal-out does not occur, all cylinders examined since the last successful calibration shall be re-examined. Calibration of the UE system shall be performed by at least a Level II operator (qualified tester).

4.3.2 Prior to examining a cylinder, the cylinder's specification designation, or the equivalency certificate, permit for equivalent level of safety, or special permit under which it was manufactured shall be identified. The UE system shall be calibrated for examining the identified cylinder by using a calibration cylinder. Calibration of the UE system shall be performed by using a relevant calibration cylinder that is described in section 4.3.3 of this certificate.

A calibration cylinder with a machined simulated defect made to represent area corrosion (minimum wall thickness measurement) shall be placed in the UE system. The UE system shall be calibrated to indicate rejection for an area equal to or greater than the machined surface for the relevant specification of cylinder (see section 4.3.3 for flaw sizes by specification). Where the wall thickness is reduced below the minimum design wall thickness (td), a straight ultrasound beam (longitudinal) shall be used to measure the wall thickness of the machined area.

If a calibration cylinder with a machined flat-bottom hole (FBH) made to represent an isolated pit is placed in the UE system, the FBH shall be detected by a minimum of two shear wave beams that strike the FBH from opposite sides (i.e. the first shear wave direction shall be from top to bottom of the cylinder and the second shear wave direction shall be from the bottom to top). The UE gain shall be increased until the signal from the FBH is maximized at 80% of the screen height (reference threshold).

A calibration cylinder with machined notches to represent circumferential sidewall flaws shall be placed in the UE system. The notches shall be detected by the system with a minimum of two (2) shear wave beams, except for the sidewall-to-base (SBT) notch in steel and nickel cylinders that may be detected by the system with a minimum of one (1) shear wave beam. The UE gain shall be increased until the signal from the notches is maximized at 80% of the screen (reference threshold).

A calibration cylinder with machined notches to represent longitudinal sidewall flaws shall be placed in the UE system. The notches shall be detected by the system by a minimum of two (2) shear wave beams. The UE gain shall be increased until the signal from the notches is maximized at 80% of the screen height (reference threshold).

4.3.3 The calibration cylinders shall be a representative set of cylinders with machined defects. For cylinders less than or equal to 152 mm (6 inches) in diameter, the calibration cylinder shall have the same nominal diameter as the cylinder being testing. For cylinders greater than 152 mm (6 inches) in diameter, the calibration cylinder standard shall conform to allowable size ranges established in Table 1. The calibration cylinder shall have similar acoustic properties, surface finish, and metallurgical condition as the cylinders to be examined. Also, the calibration cylinder shall have a known minimum design wall thickness (td) that is less than or equal to that of the cylinders being examined.

Table 1

Calibration cylinder		
OD mm (in)	Minimum OD mm (in) (0.9 x Cal. Cyl.)	Maximum OD mm (in) (1.5 x Cal. Cyl)
177.8 (7.00)	160.0 (6.30)	266.7 (10.50)
190.5 (7.50)	171.5 (6.75)	285.8 (11.25)
228.6 (9.00)	205.7 (8.10)	342.9 (13.50)
235 (9.25)	211.5 (8.33)	352.4 (13.88)
254.0 (10.00)	228.6 (9.00)	381.0 (15.00)
304.8 (12.00)	274.3 (10.80)	457.2 (18.00)
355.6 (14.00)	320.0 (12.60)	533.4 (21.00)
362.0 (14.25)	325.8 (12.83)	542.9 (21.38)
457.2 (18.00)	411.5 (16.20)	685.8 (27.00)
558.8 (22.00)	502.9 (19.80)	838.2 (33.00)
609.6 (24.00)	548.6 (21.60)	914.4 (36.00)

OD – Outside Diameter

For steel and aluminum specification cylinders, the machined defects shall be in accordance with Table 2 or Table 3 of this equivalency certificate, except that aluminum cylinders shall not require a simulated defect for line corrosion in the sidewall-to-base transition area on the inner surface (SBT).

For steel and aluminum specification cylinders in class 2.3 gas service, the machined defects shall be in accordance with Table 3 and the UE gain shall be increased by 6 dB after the system has been initially calibrated to establish the reference threshold specified in section 4.3.2 of this Appendix.

Table 2

Description of Machined Defect and Notation Symbol	Length	Width	Depth	Orientation
Simulated defect for reduction in wall thickness (area corrosion) on inner surface (MWP)	21.4 mm (0.84 in.)	21.4 mm (0.84 in.)	Remaining wall thickness (below defect) is known and is less than or equal to 95% of t_d	N/A
Simulated defect for line corrosion in the sidewall-to-base transition area on inner surface (SBT)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.10 of t_d	Transverse
Simulated defect for longitudinal sidewall crack on inner surface (L1)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.10 of t_d	Longitudinal
Simulated defect for longitudinal sidewall crack on outer surface (L2)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.10 of t_d	Longitudinal
Simulated defect for circumferential sidewall crack on inner surface (T1)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.10 of t_d	Transverse
Simulated defect for circumferential sidewall crack on outer surface (T2)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.10 of t_d	Transverse
Simulated defect for an isolated pit on inner surface (FBH)	diameter less than or equal to 2 times t_d		1/3 of t_d	N/A

t_d – Minimum design wall thickness

Table 3

Description of Machined Defect and Notation Symbol	Length	Width	Depth	Orientation
Simulated defect for reduction in wall thickness (area corrosion) on inner surface (MWP)	21.4 mm (0.84 in.)	21.4 mm (0.84 in.)	remaining wall thickness (below defect) is less than or equal to 95% of t_d	N/A
Simulated defect for line corrosion in the sidewall-to-base transition area on inner surface (SBT)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.10 of t_d	Transverse
Simulated defect for longitudinal sidewall crack on inner surface (L1)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.05 of t_d	Longitudinal
Simulated defect for longitudinal sidewall crack on outer surface (L2)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.05 of t_d	Longitudinal
Simulated defect for circumferential sidewall crack on inner surface (T1)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.05 of t_d	Transverse
Simulated defect for circumferential sidewall crack on outer sidewall (T2)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.05 of t_d	Transverse

t_d –minimum design wall thickness

For nickel cylinders and cylinders manufactured under an Equivalency Certificate, a Permit for an Equivalent Level of Safety, or a Special Permit, the machined defects shall be in accordance with Table 4 or Table 5.

For nickel cylinders and cylinders manufactured under an Equivalency Certificate, a Permit for an Equivalent Level of Safety, or a Special Permit in class 2.3 gas service, the machined defects shall be in accordance with Table 4 and the UE gain shall be increased by 6 dB after the system has been initially calibrated to establish the reference threshold specified in section 4.3.2 of this Appendix.

Table 4

Description of Machined Defect and Notation Symbol	Length	Width	Depth	Orientation
Simulated defect for reduction in wall thickness (area corrosion) on inner surface (MWP)	12.7 mm (0.5 in.)	12.7 mm (0.5 in.)	remaining wall thickness (below defect) is less than or equal to 95% of t_d	N/A
Simulated defect for line corrosion in the sidewall-to-base transition area on inner surface (SBT)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.10 of t_d	Transverse
Simulated defect for longitudinal sidewall crack on inner surface (L1)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.06 of t_d	Longitudinal
Simulated defect for longitudinal sidewall crack on outer surface (L2)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.06 of t_d	Longitudinal
Simulated defect for circumferential sidewall crack on inner surface (T1)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.06 of t_d	Transverse
Simulated defect for circumferential sidewall crack on outer surface (T2)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.06 of t_d	Transverse
Simulated defect for an isolated pit on inner surface (FBH)	6.4 mm (0.250 in.) in diameter		1/4 of t_d	N/A

t_d –minimum design wall thickness

Table 5

Description of Machined Defect and Notation Symbol	Length	Width	Depth	Orientation
Simulated defect for reduction in wall thickness (area corrosion) on inner surface (MWP)	12.7 mm (0.5 in.)	12.7 mm (0.5 in.)	remaining wall thickness (below defect) is less than or equal to 95% of t_d	N/A
Simulated defect for line corrosion in the sidewall-to-base transition area on inner surface (SBT)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.10 of t_d	Transverse
Simulated defect for longitudinal sidewall crack on inner surface (L1)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.05 of t_d	Longitudinal
Simulated defect for longitudinal sidewall crack on outer surface (L2)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.05 of t_d	Longitudinal
Simulated defect for circumferential sidewall crack on inner surface (T1)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.05 of t_d	Transverse
Simulated defect for circumferential sidewall crack on outer surface (T2)	25.4 mm (1 in.)	0.5 mm (0.02 in.)	0.05 of t_d	Transverse

t_d –minimum design wall thickness

A certification statement signed by a person certified to Level III in accordance with *CAN/CGSB-48.9712-2014 / (ISO 9712:2012, IDT), ANSI/ASNT CP-189-2011, SNT-TC-1A-2016*, or a person holding a PhD degree in a discipline of engineering or physics with documented evidence of experience in non-destructive examination (NDE) of pressure vessels or pipelines using the ultrasonic examination technique or research/thesis work and authoring/co-authoring of technical papers published, in recognized technical journals, in the fields of ultrasonic examination methods shall be available for each calibration cylinder at each site where ultrasonic examination is performed. In addition, the certification statement shall include a drawing indicating the dimensions and locations of the machined defects.

4.4 Examination Method

During the examination, each cylinder shall be examined by the calibrated UE system using a relevant set-up that is described in section 4.3.2 of this certificate.

For each cylinder examined, all 5-pass scans shall be performed as they are described in section 4.3.2.

When examining steel and aluminum specification cylinders, the UE system that is set up to perform a 5-pass scan may perform a 3-pass scan if the longitudinal (descending from the cylinder shoulder down to SBT) and circumferential (clockwise) angle beam scans do not detect a rejectable flaw.

For each steel cylinder having a bottom that is concave to pressure, the thickness of the bottom at the centre shall be measured manually with a normal ultrasonic transducer. This measurement shall be greater than or equal to the minimum design wall thickness, except that the point of closure of cylinders closed by spinning (i.e., cylinders marked “SPUN”) shall not be less than 2 times the minimum design wall thickness.

A copy of the operating examination procedure for performing ultrasonic examination of cylinders under the terms of this certificate shall be at each facility performing ultrasonic examination. At a minimum, this procedure shall include a description of the examination set-up; examination parameters; transducer model number, frequency, and size; transducer assembly used; system calibration procedures and threshold gain used during the examination; and other pertinent information.

The equipment shall not allow examination of a cylinder unless the system has been properly calibrated, as described in section 4.3.2.

The rotational speed of a calibration cylinder shall be such that all simulated defects are detected, measured and recorded.

The rotational speed of the cylinder under UE shall not exceed the rotational speed used during the calibration of the system.

The pulse rate shall be adjusted to ensure a minimum of 10% overlap for each helix.

The area of ultrasonic examination (UE) coverage shall be 100% of the cylindrical section and shall extend at least 76.2 mm (3 inches) into the sidewall-to-base transition area.

The external surface of the cylinder to be examined shall be free of loose material such as scale, non-adhering paint, and dirt.

4.5 Interpretation of Results and Disposition

A cylinder shall be rejected if:

(1) the measured wall thickness is less than the calculated minimum design wall thickness for the cylinder specification under examination, or

(2) any defect indication such as but not limited to an isolated pit or sidewall crack produces a signal with an amplitude which crosses the applicable reference threshold specified in section 4.3.2 of this appendix.

Rejected cylinders shall either be subjected to follow-up non-destructive examination by personnel certified to Level II of *CAN/CGSB-48.9712-2014 / (ISO 9712:2012, IDT)*, *ANSI/ASNT CP-189-2011*, or *SNT-TC-1A-2016*, for defect confirmation and characterization, or condemned.

If follow-up examination is performed, a cylinder shall be condemned when the dimensions of the defect require the cylinder to be condemned according to *CGA C-6-2013* or *CGA C-6.1-2013*, as applicable.

5. ULTRASONIC EXAMINATION PERSONNEL

5.1 The ultrasonic examination shall be carried out by a Senior Review Technologist (SRT), or under the general supervision of an SRT, either by a qualified tester or by a qualified operator operating an automated apparatus. Such an automated apparatus shall have been designed by an SRT and programmed to identify defects in accordance with this certificate.

5.2 An SRT shall be a person who provides written UE procedure, supervisory training, examinations (Level I and II) and technical guidance to operators, and reviews and verifies the examination results. An SRT shall have a thorough understanding of the *TDG Regulations* pertaining to the manufacture and requalification of cylinders that are authorized under this certificate and shall possess:

(a) a Level III certification in accordance with *CAN/CGSB-48.9712-2014 / (ISO 9712:2012, IDT)*, *ANSI/ASNT CP-189-2011*, or *SNT-TC-1A-2016* in ultrasonic examination;

(b) a Professional Engineer (PE) License with a documented experience for a minimum of 2 years experience in Non-Destructive Evaluation (NDE) of pressure vessels or pipelines using the ultrasonic examination technique; or,

(c) a PhD degree in a discipline of engineering or physics with documented evidence of experience in non-destructive examination (NDE) of pressure vessels or pipelines using the ultrasonic examination technique or research/thesis work and authoring/co-authoring of technical papers

published, in recognized technical journals, in the fields of ultrasonic examination methods.

5.3 A qualified tester (certified to Level II in accordance with *CAN/CGSB-48.9712-2014 / (ISO 9712:2012, IDT)*, *ANSI/ASNT CP-189-2*011, or *SNT-TC-1A-2016*) shall be a person who has at least:

(a) two years continuous experience of a technical nature involving cylinders;

(b) 40 hours of training or instruction in ultrasonic examination of cylinders or other pressure vessels; and

(c) 40 hours of experience in ultrasonic examination of cylinders under the general supervision of an SRT.

5.4 A qualified operator (certified to Level I in accordance with *CAN/CGSB-48.9712-2014 / (ISO 9712:2012, IDT)*, *ANSI/ASNT CP-189-2011*, or *SNT-TC-1A-2016*) shall be a person who has at least:

(a) a secondary school diploma; and

(b) 40 hours of training or instruction in the operation of the automated apparatus from an SRT. Such training or instruction shall cover calibration and verification of the equipment, as well as the examination procedure.

6. RECORDS

A record shall be prepared documenting the examination conditions and requalification results including:

(a) a reference to this certificate number;

(b) the specification, Equivalency Certificate, Permit for Equivalent Level of Safety, or Special Permit to which the cylinder was manufactured and its marked service pressure;

(c) the cylinder size (water capacity, or outside diameter and length);

(d) the cylinder serial number;

(e) the name or registered mark of the manufacturer

(f) the original manufacturing test date;

(g) the cylinder owner or operator;

(h) the requalification facility location;

(i) the requalification date;

(j) the external visual inspection results;

(k) the internal visual inspection and eddy current examination results, as applicable;

(l) a record of system calibration before and after cylinder ultrasonic examination, as well as a description of the calibration cylinder used;

(m) the ultrasonic examination results, including:

(i) measured ultrasonic events as a function of location on the cylinder, and

(ii) location of any defects on the cylinder where the indication exceeded the reference threshold as specified in section 4.3.2 of this appendix;

(n) reports of any follow-up examinations carried out at areas of defects on the cylinder where the indication exceeded the reference threshold as specified in section 4.3.2.

(o) if applicable, the average wall thickness measured;

(p) a statement regarding the acceptability of the cylinder for continued service; and

(q) the name of the qualified SRT who performed or supervised the ultrasonic examination, as well as identification of the persons who performed the external visual inspection, or the internal visual inspection and eddy current examination, as applicable.

7. MARKING

Each cylinder requalified according to this certificate shall be marked in accordance with Clause 24.6 of *CSA B339-18*. The procedure symbol shall be “UE”. In addition, cylinders successfully requalified in accordance with section 3 shall be marked with the procedure symbol “VE” following the procedure symbol “UE”.

When a cylinder is required to be condemned, the specification designation and service pressure markings shall be removed (e.g. by peening out or stamping over with a series of Xs), or the word “CONDEMNED” shall be permanently and legibly stamped on the shoulder, top end, or neck.

8. REPORTS

For the purposes of customer reporting, the following requirements apply in respect of a report of requalification:

(a) the person who prepares the report must give a copy of it to the owner of the means of containment;

(b) the person who prepares the report and the owner must each keep a copy of the report for 10 years; and

(c) the owner must, during the 10-year period, give a copy of the report to any person to whom ownership of the means of containment is transferred.

For the ultrasonic examination, the minimum information to be contained in the report are items (a) to (g), (i) to (k), (m), (o) and (p) from section 6 of this appendix, the gas usage of the cylinder, and the date and time of requalification.

The format of the requalification report may be modified to fit the requirements of the customer, but at a minimum all information listed above for the ultrasonic examination shall be incorporated or attached. The report may be given to the customer in either hardcopy or electronic format.