



**CGA C-5—2022**  
**WALL STRESS**  
**REQUALIFICATION CRITERIA**  
**FOR HIGH PRESSURE**  
**SEAMLESS STEEL CYLINDERS**  
**EIGHTH EDITION**

**PLEASE NOTE:**

The information contained in this document was obtained from sources believed to be reliable and is based on technical information and experience currently available from members of the Compressed Gas Association, Inc. and others. However, the Association or its members, jointly or severally, make no guarantee of the results and assume no liability or responsibility in connection with the information or suggestions herein contained. Moreover, it should not be assumed that every acceptable commodity grade, test or safety procedure or method, precaution, equipment or device is contained within, or that abnormal or unusual circumstances may not warrant or suggest further requirements or additional procedure.

This document is subject to periodic review, and users are cautioned to obtain the latest edition. The Association invites comments and suggestions for consideration. In connection with such review, any such comments or suggestions will be fully reviewed by the Association after giving the party, upon request, a reasonable opportunity to be heard. Proposed changes may be submitted via the Internet at our website, [www.cganet.com](http://www.cganet.com).

This document should not be confused with federal, state, provincial, or municipal specifications or regulations; insurance requirements; or national safety codes. While the Association recommends reference to or use of this document by government agencies and others, this document is purely voluntary and not binding unless adopted by reference in regulations.

A listing of all publications, audiovisual programs, safety and technical bulletins, and safety posters is available via the Internet at our website at [www.cganet.com](http://www.cganet.com). For more information, contact CGA at Phone: 703-788-2700, ext. 799. E-mail: [customerservice@cganet.com](mailto:customerservice@cganet.com).

Work Item 21-054  
Cylinder Specifications Committee

NOTE—Technical changes from the previous edition are underlined.

NOTE—Appendix A (Informative) is for information only.

NOTE—Appendices B and C (Normative) are requirements.

EIGHTH EDITION: 2022  
REAFFIRMED: 2016  
SEVENTH EDITION: 2010  
SIXTH EDITION: 2005  
REAFFIRMED: 1995

© 2022 The Compressed Gas Association, Inc. All rights reserved.

All materials contained in this work are protected by United States and international copyright laws. No part of this work may be reproduced or transmitted in any form or by any means, electronic or mechanical including photocopying, recording, or any information storage and retrieval system without permission in writing from The Compressed Gas Association, Inc. All requests for permission to reproduce material from this work should be directed to The Compressed Gas Association, Inc., 8484 Westpark Drive, Suite 220, McLean, VA 22102. You may not alter or remove any trademark, copyright or other notice from this work.

<b>Contents</b>	<b>Page</b>
1 Introduction.....	1
2 Scope .....	1
3 Definitions.....	1
4 Basic considerations .....	2
5 Rejection elastic expansion values .....	3
6 Sources of K factors .....	3
7 Determination of rejection elastic expansion limits.....	4
7.1 Indirect method.....	4
7.2 The Bach formula .....	4
7.3 The Clavarino formula .....	4
7.4 Example of determining the elastic expansion rejection limit .....	5
7.5 Simplified way to determine the rejection elastic expansion limit.....	6
7.6 K factors and rejection elastic expansion limits in Table 1 .....	6
8 References .....	11
 <b>Tables</b>	
Table 1—Standard elastic expansion and K factor limits.....	7
1a—Industrial high pressure seamless steel cylinders .....	7
1b—Medical high pressure seamless steel cylinders .....	8
1c—High pressure seamless steel tubes.....	9
Table 2—Solutions of Bach stress formula .....	10
 <b>Appendices</b>	
Appendix A—Flow chart for service life control (Informative) .....	12
Appendix B—DOT Hazardous Materials 49 CFR 173.302a(b) special filling limits (Normative) .....	13
Appendix C—TC Requirements (Normative).....	15

## 1 Introduction

Compressed gas cylinders manufactured in accordance with U.S. Department of Transportation (DOT) or Transport Canada (TC) specifications can remain safe unless damaged by corrosion, accident, or abuse.<sup>1</sup> A cylinder shall be accepted or rejected for special filling limits on the basis of the criteria set forth in this publication. Other methods for qualification may be used such as the satisfactory completion of an ultrasonic examination or acoustic emission test, conducted in accordance with a current DOT special permit or TC equivalency certificate.

## 2 Scope

This publication contains detailed methods of determining average wall thickness that can be applied to the requalification of seamless, high pressure cylinders conforming to Specifications ICC-3, ICC/DOT-3A, DOT-3AX, DOT-3AA, DOT-3AAX, and DOT-3T as well as the equivalent Canadian specifications. The water jacket hydrostatic test shall be performed in accordance with CGA C-1, *Methods for Pressure Testing Compressed Gas Cylinders and Tubes* [1].<sup>2</sup> The visual inspection shall be performed in accordance with CGA C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders* [2].

The flow chart contained in Appendix A graphically illustrates the service life control procedures described in this publication. The procedures required to qualify cylinders for special filling limits in accordance with DOT and TC regulations are provided in Appendices B and C, respectively.

The suggestions contained in this publication do not apply to cylinders manufactured under specification DOT-3HT, CTC-3HT, or TC-3HTM. Because of the special provisions of this specification, separate recommendations covering service life and standards for visual inspection of these cylinders are contained in CGA C-8, *Standard for Requalification of DOT-3HT, CTC-3HT, and TC-3HTM Seamless Steel Cylinders* [3].

## 3 Definitions

For the purpose of this publication, the following definitions apply.

### 3.1 Publication terminology

#### 3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

#### 3.1.2 Should

Indicates that a procedure is recommended.

#### 3.1.3 May

Indicates that the procedure is optional.

#### 3.1.4 Will

Is used only to indicate the future, not a degree of requirement.

#### 3.1.5 Can

Indicates a possibility or ability.

### 3.2 Technical definitions

#### 3.2.1 Requalification

Test(s) required to be performed on a cylinder to determine its suitability for continued service.

---

<sup>1</sup> In 1967, DOT was established and, among other things, assumed responsibility for the safety regulations formerly administered by the Interstate Commerce Commission (ICC) over explosives and other dangerous articles. These are now known as the Hazardous Materials Regulations of DOT and specifications for cylinders are included in these regulations. Wherever reference is made to DOT cylinders, it is equally applicable to similar cylinders marked ICC and the same cylinders made to Canadian regulations, which may be marked TC, CTC (Canadian Transport Commission), BTC (Board of Transport Commissioners for Canada), or CRC (Canadian Railway Commission).

<sup>2</sup> References are shown by bracketed numbers and are listed in order of appearance in the reference section.