



BSI Standards Publication

Gas cylinders — Guidance for design of composite cylinders

Part 3: Calculation of stress ratios

National foreword

This Published Document is the UK implementation of ISO/TR 13086-3:2018.

The UK participation in its preparation was entrusted to Technical Committee PVE/3/3, Gas containers - Transportable gas containers - Cylinder design, construction and testing at the time of manufacture.

A list of organizations represented on this committee can be obtained on request to its secretary.

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© The British Standards Institution 2018
Published by BSI Standards Limited 2018

ISBN 978 0 580 98767 0

ICS 23.020.35

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This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 October 2018.

Amendments/corrigenda issued since publication

Date	Text affected
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TECHNICAL
REPORT

ISO/TR
13086-3

First edition
2018-09-20

**Gas cylinders — Guidance for design
of composite cylinders —**

**Part 3:
Calculation of stress ratios**

*Bouteilles à gaz — Recommandations pour la conception des
bouteilles en matière composite*



Reference number
ISO/TR 13086-3:2018(E)

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Contents

Page

Foreword.....	iv
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	1
4 Background.....	1
5 Stress ratio determination.....	2
6 Stress ratio development and calculation.....	2
6.1 General.....	2
6.2 Use of pressure ratios.....	4
6.3 Type 4 evaluation with hybrid construction.....	4
6.4 Analysis of Type 2 and Type 3 designs.....	5
6.5 Direct measurements methods.....	14
6.6 Design limits.....	15
6.7 Test methods.....	15
7 Verification and validation.....	16
8 Conclusions.....	16
Annex A (informative) Examples of direct measurement methods.....	17
Bibliography.....	23

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Subcommittee SC 3, *Cylinder design*.

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Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Gas cylinders — Guidance for design of composite cylinders —

Part 3: Calculation of stress ratios

1 Scope

This document addresses the topic of calculation of stress ratios when analyzing filament wound composite cylinders. This document is applicable to cylinders of Types 2, 3, and 4. The calculation of stress ratios supports the development and revision of standards for fibre reinforced composite pressurized cylinders.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

4 Background

Stress rupture, also known as static fatigue, is the broadly defined mechanism where a material fails under sustained static load. Stress ratio, the ratio of maximum fibre stress at minimum cylinder design burst pressure divided by the maximum fibre stress at cylinder working pressure, allowing assessment of the likelihood of stress rupture of the reinforcing fibres. Other performance may be affected by the amount of fibre on the part, as reflected by the stress ratio, but there are other means to accomplish improvements in other performance areas (e.g. drop, impact, gunfire, flaw resistance), and performance testing is a better means to assess other performance factors. It is assumed that a time-based relationship between the applied static load and the breakdown of the material can be defined. The goal of defining a mathematical relationship between applied stress and time to failure is to make accurate predictions of the material's performance for safe use. In the simplest of terms, the greater the sustained load, the sooner the occurrence of failure (stress rupture). A full and accurate understanding of the material's working stress state in service is imperative in order to assure that the stress ratios are calculated accurately, and therefore the reliability of the cylinder in service is known.

Burst ratios and stress ratios are theoretically the same for Type 4 cylinders with a single structural reinforcing fibre, but not for Type 2 or Type 3 cylinders due to the effect of autofrettage. While use of a burst ratio for Type 2 and Type 3 cylinders is normally conservative, poor design and autofrettage practice may cause higher stress in the reinforcing fibre, causing premature failure by rupture. This unsafe condition can result when using non-traditional materials, very thick liner and/or thin composite materials, and/or high autofrettage pressures. Some amount of calculation is also required for Type 4 cylinders using hybrid construction, which is the use of more than one structural reinforcing fibre (see 6.3).