NFPA Recommended Standard
NFPA/T3.6.37 R1-2010 (R2015)
Second edition
7 September 2010

AN INDUSTRY STANDARD FOR FLUID POWER

Hydraulic fluid power — Cylinders — Method for determining the buckling load

(Revision of ANSI/(NFPA)T3.6.37-1991)

Descriptors: buckling load, buckling test, Hoblit method, hydraulic fluid power.

published by

NATIONAL FLUID POWER ASSOCIATION, INC.

6737 W. Washington St., Ste. 2350 / Milwaukee, WI 53214 USA
PHONE: +1 414 778 3344 / FAX: +1 414 778 3361 / E-mail: nfpa@nfpa.com

All standards, recommended practices, information reports, and bibliographies (collectively, “NFPA Documents”) are advisory only. Use thereof by anyone for any purpose is entirely voluntary and in any event without risk of any nature to the National Fluid Power Association (NFPA), its officers, directors or authors of such work. There is no agreement by or between anyone to adhere to any NFPA Document. In formulating and approving NFPA Documents, NFPA and/or its councils and committees will not investigate or consider citations, references or patents which may or may not apply to such subject matter since prospective users of such NFPA Documents alone are responsible for establishing necessary safeguards in connection with utilization of such matters, including technical data, proprietary rights or patentable materials.

The information and data contained in NFPA Documents has been obtained from sources believed to be reliable. However, it should not be assumed that all acceptable or applicable sources of information, procedures, methods or techniques are contained in NFPA Documents, or that additional measures may not be required under certain circumstances or conditions.

NFPA Documents and/or policies and procedures are subject to periodic review and may be changed without notice. NFPA Documents are only current as of their publication date. NFPA Documents, after publication, may be revised or withdrawn at any time and current information on all NFPA Documents may be received by calling or writing NFPA. Additionally, the various codes and regulations referenced in NFPA Documents may be amended from time to time and it should not be assumed that the versions referenced therein are the most current versions of such codes and regulations. Please consult the appropriate regulatory authorities for the most up-to-date versions.

NFPA Documents imply a consensus of those substantially concerned with their scope and provisions and are intended as a guide to aid the manufacturer, the consumer and the general public. The publication of NFPA Documents does not in any respect preclude anyone, whether they have participated in the development of or approved such NFPA Documents or not, from manufacturing, marketing, purchasing, or using of products, processes or procedures not conforming to the NFPA Documents. NFPA Documents do not constitute or indicate a warranty of any sort, express or implied, including but not limited to a warranty or representation as to quality, merchantability or fitness for a particular use or purpose.

Participation by federal agency representative(s) or person(s) affiliated with the industry is not to be interpreted as government or industry endorsement of an NFPA Document(s).

NOTICE

NFPA Documents do not express or imply any judgment, certification or endorsement of or with respect to, the safety, design or performance of any product, component, or its use.

NFPA does not examine, investigate, test, recommend, or certify the design, use or safety of any product or component, even those which may incorporate one or more NFPA Documents. NFPA Documents therefore have no application to and do not express or imply any recommendation, representation or warranty, with respect to the safety, design, use, performance, or functional interchangeability of components or products which incorporate NFPA Documents.

Foreword

This Foreword is not part of *Hydraulic fluid power - Cylinders - Method for determining the buckling load*, NFPA/T3.6.37 R1-2010.

A Title, Scope and Purpose (TSP) for the revision of ANSI/(NFPA)T3.6.37-1991 was approved by NFPA/T3.6 on 23 July 2007 via the NFPA online committee forums. Lido Boni, Parker Hannifin Corp. agreed to serve as project group chair.

The NFPA Technical Board approved the TSP at its meeting on 9 August 2007.

The project group met on 11 March 2008 and approved a motion to update the document to include the Hoblit article and disclaimer, and to request NFPA/T3.6's approval to circulate it for general review. NFPA/T3.6 gave its approval on 11 March 2008.

The document was circulated for general review on 15 August 2008. The voting resulted in three approval votes, zero disapprovals and two abstentions. The comments were satisfactorily resolved. At its meeting on 8 January 2009, the Technical Board approved a motion to circulate the document for simultaneous NFPA final and ANSI approval ballots.

However, as a result of a decision made by the NFPA Board of Directors at its meeting on 27 June 2009, NFPA discontinued its activities as an ANSI Accredited Standards Developer. Therefore, the document designation was changed to NFPA/T3.6.37 R1-20xx.

The document was circulated for final ballot on 19 May 2010. The voting resulted in nine approval votes, zero disapprovals and one abstention, with no comments. On 18 August 2010, a motion was approved by NFPA/T3.6 via the online forums to ask the NFPA Technical Board for permission to publish the document. The Technical Board gave its permission to publish via the online forums on 7 September 2010.

Project Group Members who developed this standard:

Lido Boni
Project chair
Parker Hannifin Corp.

Pete Molloy
Section chair
SMC Corporation

Bryan Nelson
Caterpillar, Inc.

Dan Rosinski
Bosch Rexroth Corp.

Charles Woodin
Milwaukee Cylinder

Carrie Tatman Schwartz
Program Manager
National Fluid Power Association

/cts

Introduction

Historically, cylinder manufacturers in the fluid power industry have experienced very few rod buckling failures, due very likely to the conservative factors of safety employed in the designs and factors of safety recommended to their users. Larger companies have developed their own in-house methods and some have acquired and use Oklahoma State University's computerized SACREG program. Under these circumstances, the small or non-industry designer is left with the use of Euler or the Johnson formulas with their well-known limitations.

The Hoblit method presented in this standard has been found to compare favorably with a limited series of test results and has also shown comparable results with Oklahoma State's computerized SACREG method. Accordingly, NFPA/T3.6 believes this standard would be a valuable aid to the designers of fluid power cylinders.

There are, however, other conditions that might affect results which have not been included for simplicity.

Hydraulic fluid power — Cylinders — Method for determining the buckling load

1 Scope and field of application

1.1 This standard establishes a method to calculate the theoretical critical column buckling load of a loaded fluid power cylinder. Having the knowledge of the point at which, under ideal theoretical conditions, a hydraulic fluid power cylinder would fail, the designer can then apply an appropriate factor of safety for a safe design.

1.2 This standard applies only to pin-mounted (clevis mounts) fluid power cylinders and does not apply to trunnion mounted cylinders.

1.3 The method specified in this standard has been compared favorably in several buckling tests of fluid power cylinders in the range of three- to six-inch bores with one- to two-inch piston rods. Accordingly, the application of the method specified in this standard to larger- or smaller-sized cylinder designs should be approached with caution, and traditional methods should be used and compared in order to assure a safe design.

1.4 All cylinder installations have some added loads imposed beyond the calculated system pressure. These extra loads are often due to misalignment, friction and weight. As a result, such factors shall be taken into account. In addition, the Hoblit method (see Annex A) provides a theoretical result and as such produces a critical buckling load higher than attainable in controlled laboratory tests. Accordingly, adequate factors of safety shall be applied to ensure that the actual working load is well below the critical buckling load.

2 Normative references

The following normative document contains provisions which, through reference in this text, constitute provisions of this NFPA document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this NFPA document are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referenced applies. NFPA maintains registers of currently valid NFPA Standards. Standards development organization contact information and links can be found on the NFPA website **(www.nfpa.com).**

“Critical Buckling Loads for Hydraulic Actuating Cylinders,” by Fred Hoblit, *Product Engineering*, July 1950.

ISO 5598 (latest edition), *Fluid power systems and components – Vocabulary*

ISO/TS 13725 (latest edition), *Hydraulic fluid power — Cylinders — Method for determining the buckling load*