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AN INDUSTRY STANDARD FOR FLUID POWER

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

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

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NATIONAL FLUID POWER ASSOCIATION, INC.
3333 N. Mayfair Road / Milwaukee, WI 53222-3219 USA
PHONE: +1 414 778 3344 / FAX: +1 414 778 3361 / E-mail: nfpa@nfpa.com

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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

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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*