National Fluid Power Association

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Fluid Power components – Method for verifying the fatigue and establishing the burst pressure ratings of the pressure containing envelope of a metal fluid power component

(Revision of NFPA/T2.6.1 R1-1991)

A NATIONAL INDUSTRY STANDARD FOR FLUID POWER

Approved by Committee ASC B93,
accredited by the American National Standards Institute (ANSI)

Descriptors: fluid power components method verifying fatigue burst pressure ratings envelope metal test statistical data verification capability aluminum magnesium steel iron copper based alloys cobalt titanium stainless nickel monel

Developed and published by

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Foreword

This Foreword is not part of National Fluid Power Association Recommended Standard *Fluid power components – Method for verifying the fatigue and establishing the burst pressure ratings of the pressure containing envelope of a metal fluid power component*, ANSI/(NFPA)T2.6.1 R2-2001 (Revision of NFPA/T2.6.1 R1-1991).

NFPA/T2.6.1 was granted final approval by the NFPA Board of Directors on 18 February 1974. On 18 January 1977 the NFPA Pressure Rating Coordinating Committee voted to initiate a revision to NFPA/T2.6.1. Shortly thereafter, another NFPA project group (NFPA/T2.6.2) was organized in 1978 to evaluate fundamental aspects of fatigue testing, such as consistency among labs and whether endurance life was affected by the length of time a component is subjected to test pressure. Data from a round robin test program was analyzed by a professional statistical consultant and a conclusion was reached in February 1986 that pulse duration was a factor in fatigue life results, necessitating its control during a test.

During the period of 1984-1987, Chair Berninger developed the mathematical analysis for the basic theory and reviewed it several times with committee members, especially former Chair Skaistis who had used it intuitively in the earlier edition. This was eventually published in the proceedings of the NCFP in October 1988.

The Technical Board granted final approval to NFPA/T2.6.1 R1 on 9 May 1991.

At the 26 September 1996 meeting of T2.6 it was decided to revise the NFPA/T2.6.1 R1-1991 document. The TSP was approved at the 5 December 1996 Technical Board meeting. Draft No. 1 of the revised document was reviewed at the 11 February 1997 T2.6 meeting. It was agreed at this meeting that with a few additional changes that the document be sent out for General Review. The updated document was received at Headquarters on 4 April 1997. The document was sent out for General Review on 17 April 1997. A number of comments were received and some changes were accordingly made.

Before proceeding to ballot draft, however, a TSP to update the individual component standards to correspond with the new R2 level of NFPA/T2.6.1 had been approved by the Technical Board at its 10 April 1997 meeting. All 10 of the component standards were updated and sent to the individual component committees for their review at the September 1998 cluster meeting, along with a draft of the updated NFPA/T2.6.1 R2. At the 17 November 1998 Technical Board meeting, it was agreed to submit these drafts for general review, along with the updated NFPA/T2.6.1 R2 for a concurrent second general review.

All documents were sent out for general review on 30 December 1998. Comments were then reviewed at the 9 February 1999 meeting of T2.6 and further changes made, especially to the burst testing section. The Technical Board gave approval for a ballot draft on 8 April 1999 and headquarters prepared the ballot draft on 26 July 1999. the T2.6 committee reviewed the comments and negative ballots at the 22 September 1999 meeting Explanations were sent to the commentators. All but three of the negative balloters changed their votes; the remaining three were reviewed by the Technical Board at its meeting of 18 November 1999 and the negatives were overridden. The standard was then approved by the Technical Board.

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ANSI/(NFPA)T2.6.1 R2-2001 was approved by ANSI's Board of Standards Review on 5 March 2001.

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Introduction

In fluid power systems, power is transmitted and controlled through a fluid (liquid or gas) under pressure within an enclosed circuit. During operation, components in a system may be loaded from internal pressure, gravity, inertia, thermal variations and external forces. The nature of these loads can vary from a single static application, to continuously varying amplitudes, repetitive loadings and even shock.

It is important to know how well a component can withstand these loads but this standard addresses only the loading due to internal pressure.

There are many ways in which internal pressure loads are imposed upon a component. This standard considers a broad range of waveforms but within prescribed time limits, temperatures, environmental conditions and only upon certain metals. It is anticipated that these limitations could still provide sufficient common ground for comparing products. This rating method, therefore, provides the system designer with certain information to assist in a selection of components for an application. The designer still has the responsibility to consider the other loading characteristics described above and to determine how they might affect the component's ultimate pressure retaining capability.

There are many standards already in existence for pressure rating individual components (e.g. maximum allowable operating pressure) and this standard is not intended to displace them. Instead, a method of fatigue verification is provided.

This standard serves as a universal “verification test” to give credibility to the many in-house and other methods of determining component pressure ratings. The credibility is based upon the fundamental nature of fatigue of metals with its statistical treatment, and a mathematical development of the theory is included. Nevertheless, design knowledge of the component population and its representative samples, including consistency in materials, shapes, fabrication techniques, etc. is necessary to maximize accuracy in the verification method.

This standard establishes a common set of requirements for fluid power components listed below, but does not specify the details for any particular one. Therefore, application of the verification method requires the use of NFPA standards written specifically for the particular type of component as follows:

Accumulators	NFPA/T3.4.7 R2-2000
Hydraulic valves	NFPA/T3.5.26 R2-2000
Cylinders, Tie rod or bolted	NFPA/T3.6.29 R2-2000
Cylinders, Telescopic and non-bolted	NFPA/T3.6.31 R2-2000
Pumps and motors	NFPA/T3.9.22 R2-2000
Hydraulic filters & separators	NFPA/T3.10.5.1 R2-2000
Pneumatic FRL	NFPA/T3.12.10 R2-2000
Quick-action couplings	NFPA/T3.20.8 R2-2000

Pneumatic valves	NFPA/T3.21.4 R2-2000
Pressure switches	NFPA/T3.29.2 R2-2000

This version of NFPA/T2.6.1 R2 replaces the earlier editions and utilizes the same basic theory. However, products rated under the first earlier edition NFPA/T2.6.1 may not be rated to the same values as under editions NFPA/T2.6.1 R1 or NFPA/T2.6.1 R2. See 13.1 for the differences in rating identification.

Fluid power components – Method for verifying the fatigue and establishing the burst pressure ratings of the pressure containing envelope of a metal fluid power component

1 Scope

1.1 This standard provides:

– test and statistical methods for generating fatigue distribution data;

– test and statistical methods for conducting a verification of the pressure ratings on fluid power components;

– common requirements and an industry-wide philosophy in judging one type of pressure capability for fluid power components;

– uniform methods of product comparison.

1.2 This standard limits conditions as follows:

– constant amplitude, pressure induced loading of the elements that constitute or maintain the pressure containing envelope;

– product life of at least 100,000 cycles;

– defined conditions for pressure levels and pulse durations;

– temperatures from the charpy impact transition temperature to the threshold of creep sensitivity;

– environments which are chemically compatible with the materials of the pressure containing envelope;

– materials that are aluminum, magnesium, steel, iron, copper based alloys, cobalt, titanium, stainless steels, nickel steels and monel. Specifically excluded are creep sensitive materials such as: zinc, plastic, rubber and sealing devices.

1.3 This standard encourages manufacturers to use this common method to enhance the credibility of their pressure ratings.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this document. At the time of publication, the editions indicated were valid. All documents are subject to revision, and parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below. NFPA maintains registers of currently valid NFPA/ANSI standards.

ANSI/(NFPA)T2.12.1-1993, *Hydraulic fluid power – Systems and products – Method of measuring average steady-state pressure.*