

THE ENGINEERING EQUIPMENT AND MATERIALS USERS' ASSOCIATION

**Pressure equipment testing after repair,
modifications or re-rating:
A guide to the pressure
test waiver**

PUBLICATION 223

Edition 1

Copyright © 2010 The Engineering Equipment and Materials Users' Association.
A company limited by guarantee. Registered in England. Company number 477838.

ISBN 0 85931 180 9

Imprint reference 07-2010

Registered and Trading Address
10-12 Lovat Lane London EC3R 8DN
Telephone: +44 (0)20 7621 0011
Fax: +44 (0)20 7621 0022
E-mail: sales@eemua.org
Website: www.eemua.org



ENGINEERING EQUIPMENT AND MATERIALS USERS' ASSOCIATION

The Engineering Equipment and Materials Users' Association, more commonly known as EEMUA, is a European non-profit membership Association helping companies that own or operate industrial facilities - the *users* of engineering equipment and materials.

EEMUA aims to improve the safety, environmental and operating performance of industrial facilities in the most cost-effective way, thereby demonstrating and pursuing leadership in asset management.

EEMUA Members pursue these aims through collaboration for mutual benefit, sharing engineering experiences and expertise and by promoting their distinct interests as the users of engineering products.

Specifically, the aims of EEMUA Member companies are achieved by:

- providing the organisation within which networking, information sharing and collaboration on non-competitive technical matters can take place;
- influencing the way written regulations are interpreted and applied in practice;
- presenting and promoting Members' views, and encouraging the application of good, sound engineering practices;
- developing user guides, specifications, training and competency schemes;
- facilitating Members' participation in national and international standards making;
- influencing relevant national and European legislation and regulations.

Formed in 1949 as the Engineering Equipment Users' Association, and re-named in 1983 (as a result of taking over the materials association, OCMA), EEMUA has for more than sixty years given companies that own and operate process plants, power stations and other significant industrial facilities, a collaborative voice in addressing technical and engineering related issues that impact on good integrity management and asset management practices. The Association is open to companies of all sizes that meet its 'engineering user' criteria. Further details of current Members of EEMUA is available on the Association's website, www.eemua.org.

EEMUA activities often lead to the production of publications. These are prepared for Members' use and are often offered for sale as well.

A list of EEMUA publications for sale is given at the end of this Publication. The full list is also on the Association's website, including details of on-line shopping facilities.

To enquire about corporate Membership, write to enquiries@eemua.org or call +44 (0)20 7621 0011.

ABOUT THIS PUBLICATION

Legal Aspects

All rights, title and interest in this Publication belong to EEMUA. All rights are reserved. No part of this Publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means: electronic, mechanical, photocopying, recording or other, without the express prior written agreement of the EEMUA Executive Director. Infringement of copyright is illegal and also reduces the Association's income thereby jeopardising its ability to fund the production of future publications.

It has been assumed in the preparation of this Publication that: the user ensures selection of those parts of its contents appropriate to the intended application; and that such selection and application is correctly carried out by appropriately qualified and competent persons for whose guidance this Publication has been prepared. EEMUA and the individual members of the Work Group that prepared this EEMUA publication do not, and indeed cannot, make any representation or give any warranty or guarantee in connection with material contained herein. EEMUA and the individual members of the Work Group that prepared this EEMUA publication expressly disclaim any liability or responsibility for damage or loss resulting from the use or reliance on this Publication. Any recommendations contained herein are based on the most authoritative information available at the time of writing and on current good engineering practice, but it is essential for the user to take account of pertinent subsequent developments and/or legislation.

Any person who encounters an inaccuracy or ambiguity when making use of this Publication is asked to notify EEMUA without delay so that the matter may be investigated and appropriate action taken.

Consultation and Feedback

EEMUA encourages constructive comments on this Publication from both Members of the Association and others.

Comments should be sent on the standard feedback form, a copy of which is provided towards the end of this Publication. An electronic version of the feedback form is available from EEMUA - e-mail your request for a copy to enquiries@eemua.org, telephone your request to +44 (0)20 7621 0011, or download the form from the EEMUA website at www.eemua.org. Submit comments by e-mail (preferred) or post.

Comments are considered by the relevant EEMUA Technical Committee and may be incorporated in future editions of this Publication. New editions are publicised on the EEMUA website.

Contents

Foreword from the HSE	vii
Background	viii
Scope	ix
Definitions.....	x
1. Introduction	1
2. Information Obtained from a Pressure Test	3
2.1 Benefits of a Pressure Test	3
2.2 Limitations of Pressure Testing.....	3
3. Information Obtained from Non-Destructive Examination	5
3.1 Benefits of NDE	5
3.2 Limitations of NDE	5
4. Guidance	7
4.1 Where Pressure Equipment has been Repaired	7
4.2 Where Pressure Equipment has been Modified.....	8
4.3 Where Pressure Equipment has been Re-rated	9
4.4 Where Pressure Equipment is at Risk from Brittle Fracture During the Pressure Test	9
4.5 Where a Pressure Test is Requested as Part of Routine Inspection	10
5. Safety in Pressure Testing.....	11
6. Waiver Form.....	13
7. References and Related Documents	15
7.1 References	15
7.2 Related Documents.....	15
Annex A - Pressure Test Waiver for Existing Equipment.....	16
A1 Waiver Form.....	16
A2 Reasons For and Limitations of Pressure Testing	18
A2.1 Reasons in Favour of Carrying Out a Pressure Test	18
A2.2 Limitations of Pressure Testing	18
A3 Reasons for Permitting a Waiver of Pressure Testing.....	19

Table

Table 1 Pressure Test Waiver Form	17
--	-----------

Foreword

Health and Safety Executive

This guidance has been prepared by the Engineering Equipment and Materials Users' Association (EEMUA) in consultation with the Health and Safety Executive.

The hydrostatic pressure testing of pressure equipment plays a key role in establishing confidence that it is capable of performing the duty for which it was designed; whether it be after manufacture, repair or modification. However, together with EEMUA, we recognise that there are circumstances where such testing may be required by the relevant codes or standards, but is impractical. It is essential that these situations are dealt with in an appropriate manner. Where such pressure tests are waived, it is important to ensure that the decision has a sound technical basis, is clearly documented and that the benefits lost through not performing the test are mitigated by the use of alternative measures.

This document provides guidance on situations where the waiving of a hydrostatic test, required by a code or standard, may be justifiable, together with supporting information on contributions made by hydrostatic and non-destructive testing to integrity assurance and a system for recording such waivers.

This guidance should not be regarded as an authoritative interpretation of the law, but if you follow the advice set out in it, you will normally be doing enough to comply with health and safety law in respect of those specific issues on which the guidance gives advice.

The Health and Safety Executive considers this guidance to provide a sound basis for addressing situations where hydrostatic testing may be impractical and commends its use to industry.

Peter Baker

*Head of Chemical Industries Division, Hazardous Installations Directorate,
Health and Safety Executive*

Background

The safe operation of industrial pressure equipment, in particular fabricated vessels, boilers, heat exchangers and pipework, is ensured during development and manufacture through a combination of good design, the selection of appropriate materials of construction, quality fabrication, inspection and testing. The inspection and testing elements continue in service. The extent to which the various elements are implemented relates to the risks associated with the equipment. It is common practice to pressure test certain newly fabricated pressure vessels and pipework to a pressure higher than that at which it will be used.* This acceptance test is generally an integral part of the design code used, and is intended to give assurance that the equipment has been designed, fabricated and constructed to the required standards. For such equipment, the pressure test is no longer used solely as an acceptance test but is to be considered as part of the fabrication process. It can provide certain advantages in that it can help to redistribute the stress in regions of high stress concentration and also can blunt crack like defects thus increasing the fatigue life.

For other types of newly fabricated pressure equipment, hydrostatic testing could cause damage and therefore would be an inappropriate means to develop safety assurance.

After equipment has entered into service, hydrostatic pressure testing can in certain circumstances play an important role in demonstrating the continuing integrity of the equipment. The in-service pressure test is required in several countries, for example, for the periodic re-qualification of pressure vessels. This can have a negative economic impact as a production unit needs to be taken out of service for a period of time to undertake the test.

A hydrostatic pressure test should generally not be considered as a substitute for the appropriate inspection or non-destructive examination (NDE). There are cases where the pressure test is justified, for example following significant repairs to a vessel or pipe. However there are also cases where the pressure test is impractical, impossible or would subject the plant to excessive risks.

The use of the hydrostatic strength test has been abandoned in many countries and replaced by alternative methods giving an equivalent or better safety level. This has been due to progress in non-destructive testing methods, greater knowledge of metallurgy, risk-based inspection and fitness for service analysis. A summary comparison of the advantages and disadvantages of various inspection techniques is given in EEMUA Publication 168.

* A pressure test involves using an incompressible fluid (usually water, when it can variably be called a hydraulic test, hydrostatic test or hydrotest) or a compressible fluid (air, steam, etc., when it is called a pneumatic test), under high pressure.

Scope

This Publication relates to “in-service” situations, such as testing after major modification, significant repair or re-rating, rather than new build. It has been developed to assist owners and operators of pressure equipment to determine where it may be permissible to waive a hydrostatic pressure test before re-introducing equipment into service and instead rely on other forms of integrity assurance.

As explained in the previous Section, new equipment may or may not be hydrostatically tested. The focus of this Guide is on vessels, pipework and other components which may be found in pressure systems and which **would** traditionally be hydrostatically tested during new build and where today, in service, a pressure test waiver may be justified.

The Guide does not at this stage major on the in-service considerations of plant and equipment where safety assurance during new build is developed by techniques other than hydrostatic testing. However, it is envisaged that such guidance could form part of a future edition of this publication.

The contents of this Guide are primarily relevant to systems and pressure equipment covered by the UK Pressure Systems Safety Regulations (PSSR), but are also applicable to other pressure equipment normally subject to pressure testing to safeguard against loss of containment. This Publication does not cover the special case of atmospheric storage tanks; users are referred instead to the guidance in EEMUA Publication 159.

The key aspects of pressure testing existing (in-service rather than new) pressure equipment are discussed. The relative advantages of pressure testing and non-destructive examination are described. A specimen form is provided to formalise an assessment of the need to pressure test and to record, where applicable, the justification for waiving one.

This publication has been prepared by the Engineering Equipment and Materials Users’ Association, in consultation with the GB Health and Safety Executive.

Definitions

**Creep designed
pressure equipment**

Equipment designed to operate at elevated temperatures where creep and rupture are a design consideration.

**Proof stress designed
pressure equipment**

Equipment designed to operate at temperatures where proof stress is a design consideration.

1. Introduction

On new pressure equipment, pressure testing is a very cost effective means for proving design, materials and fabrication. It is universally specified in the codes and invariably carried out. The pressure equipment is subject to a pressure stress which is greater than that experienced in service. Usually, the test is made with water (hydraulic) but in some exceptional cases it may be with air or nitrogen (pneumatic). The reasons for in-service pressure testing and the benefits of it are well described in EEMUA Publication 168⁽¹⁾.

For existing pressure equipment, where verification of structural integrity is needed, for example after major modification or significant repair, a pressure test will normally be required. However, there may be situations where a pressure test is not reasonably practicable or inappropriate or equivalent verification can be achieved by alternative methods such as non-destructive examination (NDE). In this guide, the key aspects of pressure testing existing pressure equipment are discussed. Guidance is given on how to establish whether or not, in a specific case, a pressure test should be waived in favour of alternative integrity assurance techniques.

Whilst a pressure test should never be assumed to be a substitute for appropriate NDE, it remains the normal integrity test for both new and in-service pressure equipment. There may be circumstances in which making a pressure test is not reasonably practicable, or would subject the plant and its structure to excessive risks. For equipment designed to operate at elevated temperatures where creep and rupture are a design consideration it may be less effective than NDE.

The Pressure Equipment Directive⁽²⁾, which applies to new vessels rather than existing ones, reflects this in the following wording: "where the hydrostatic pressure test is harmful or impractical, other tests of a recognised value may be carried out (Annex 1 Paragraph 3.2.2)."

Similarly – and also applicable to new pressure equipment – EN 13480, Metallic Industrial Pipework⁽³⁾ states that: "In cases where a hydrostatic or pneumatic test of individual welds (connection welds) would be detrimental or impractical they shall be substituted by an appropriate non-destructive test."

The ANSI/API 510 Pressure Vessel Inspection Code⁽⁴⁾ indicates that the requirement to pressure test an existing vessel, which has been repaired, modified or re-rated, is determined by the Inspector; however, it is likely that others, in particular, the Operator will be involved.

In all cases, waiver of a pressure test may only be carried out in justifiable circumstances and it is necessary to critically examine the information that would be obtained from a pressure test and compare it with that from alternative means of inspection. Waiving a pressure test and carrying out suitable inspection must provide an equal or better level of assurance on the safety of the vessel for continued service.

Pressure equipment with internal chambers, which has been subject to modification or repair of the chamber involving welding, would require pressure testing. However if it is not credible that failure of the chamber in service would lead to any safety related incident or imminent danger with the only risk being operational reliability, then consideration for waiver of the pressure test could be