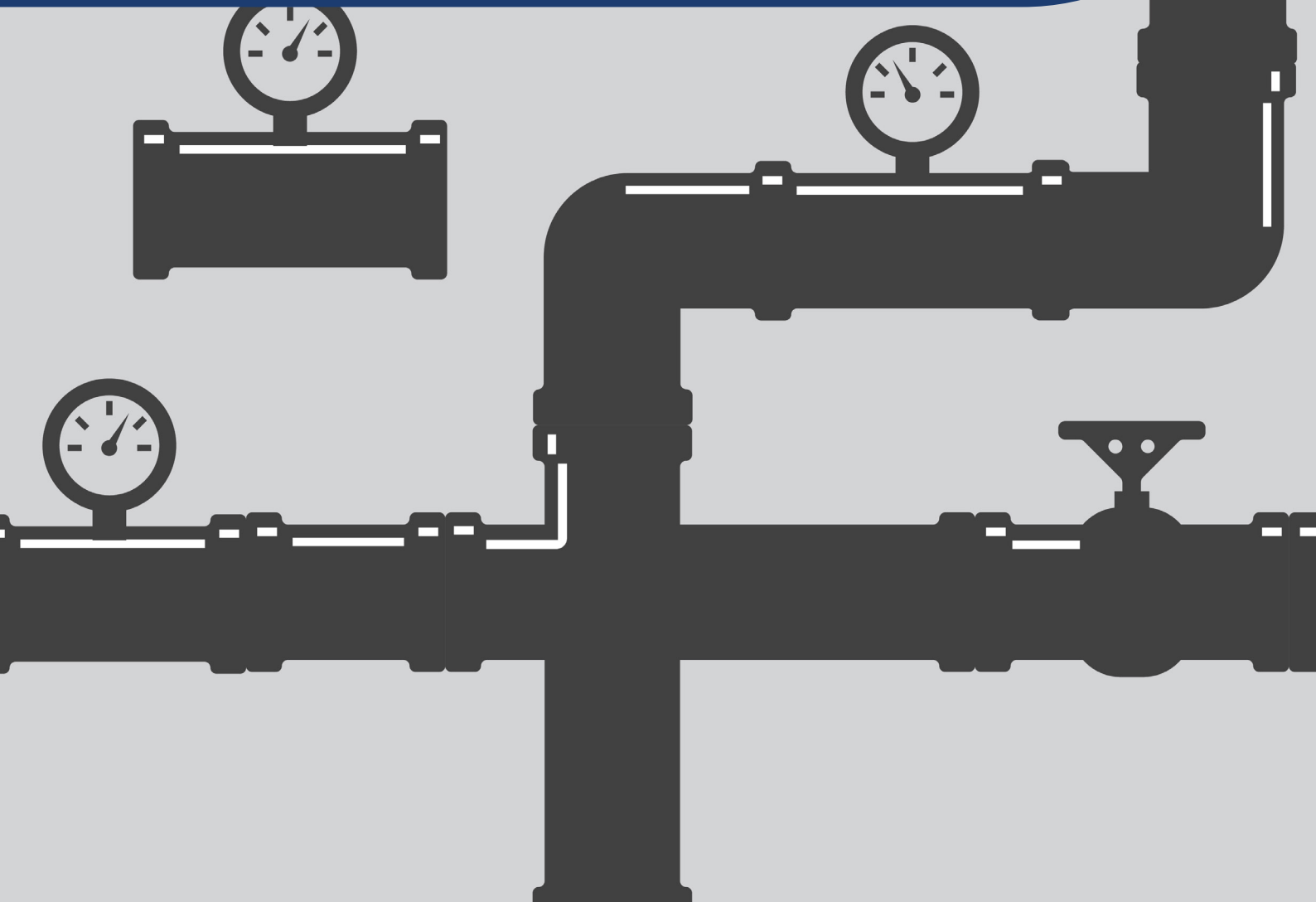


PAS 4442:2024

Material requirements for pipework and fittings used in hydrogen gas installation – Specification



Department for
Energy Security
& Net Zero



Publishing and copyright information

The BSI copyright notice displayed in this document indicates when the document was last issued.

© The British Standards Institution 2024.
Published by BSI Standards Limited 2024.

ISBN 978 0 539 21119 1

ICS 91.140.40; 23.040

No copying without BSI permission except as permitted by copyright law.

Publication history

First published March 2024

Contents

Foreword	iii
Introduction	v
1 Scope	1
2 Normative references	2
3 Terms, definitions and symbols	5
3.1 Terms and definitions	5
3.2 Symbols	7
4 Gas classification	8
4.1 General	8
4.2 Gas category	8
4.3 Hydrogen gas	8
4.4 Supply pressures	10
5 Construction	11
5.1 Materials	11
5.2 Withdrawn standards	16
6 Performance	17
6.1 Gas tightness	17
7 Type tests and test gases	18
8 Marking and instructions	19
8.1 Marking	19
8.2 Instructions	19
8.3 General declaration	19
Annexes	
Annex A Jointing compounds (informative)	20
Bibliography	21
List of figures	
Figure 1 – Interrelationship between PASs for typical hydrogen 4th family gas installation	vi
List of tables	
Table 1 – Hydrogen test gas characteristics – gas dry at 15 °C and 1 013.25 mbar (absolute)	8
Table 2 – Hydrogen distributed gas	9
Table 3 – Gas supply pressure – 4th Family Gas	10
Table 4 – Maximum design pressure loss	10

This page is deliberately left blank.

Foreword

This PAS was sponsored by The Department for Energy Security and Net Zero (DESNZ). Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on 31 March 2024.

Acknowledgement is given to Andy Durber, Blue Flame Associates Ltd., as the technical author, and the following organizations that were involved in the development of this PAS as members of the Steering Group:

- Association of British Certification Bodies (ABCB)
- Blue Flame Associates
- British Metal Tubes and Fittings Association (BMTFA)
- BSI Assurance UK Ltd
- Cadent Gas
- Consumer and Public Interest Network (CPIN)
- Continental
- CRS Gas Solutions
- Department for Energy Security and Net Zero (DESNZ)
- Energy Networks Association
- Enertek
- Health and Safety Executive
- Industrial and Commercial Heating Equipment Association (ICOM)
- Institution of Gas Engineers and Managers (IGEM)
- Kiwa
- Mott MacDonald
- National Grid Metering
- National Physical Laboratory
- Office of Gas and Electricity Markets (OFGEM)
- Steer Energy
- Tata Steel
- Teesside University
- TWI Ltd

Acknowledgement is also given to the members of a wider review panel who were consulted in the development of this PAS.

The British Standards Institution retains ownership and copyright of this PAS. BSI Standards Limited as the publisher of the PAS reserves the right to withdraw or amend this PAS on receipt of authoritative advice that it is appropriate to do so. This PAS will be reviewed at intervals not exceeding two years.

This PAS is not to be regarded as a British Standard. It will be withdrawn upon publication of its content in, or as, a British Standard.

The PAS process enables a specification to be rapidly developed in order to fulfil an immediate need in industry. A PAS can be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or international standard.

Relationship with other publications

This PAS is related to the following standards:

- PAS 4441, *Components used in hydrogen gas metering – Specification*¹⁾
- PAS 4443, *Assessment criteria: Ancillary valves, devices and components used in hydrogen gas installations – Specification*²⁾
- PAS 4444, *Hydrogen-fired gas appliances – Guide*

Information about this document

This publication can be withdrawn, revised, partially superseded or superseded. Information regarding the status of this publication can be found in the Standards Catalogue on the BSI website at bsigroup.com/standards, or by contacting the Customer Services team.

Where websites and webpages have been cited, they are provided for ease of reference and are correct at the time of publication. The location of a webpage or website, or its contents, cannot be guaranteed.

Presentational conventions

The provisions of this PAS are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the *Shorter Oxford English Dictionary* is used (e.g. “organization” rather than “organisation”).

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient’s own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

Compliance with a PAS cannot confer immunity from legal obligations.

¹⁾ In preparation.

²⁾ In preparation.

Introduction

The Hydrogen Skills and Standards for Heat programme is developing technical standards for domestic and non-domestic hydrogen gas installations, as well as associated competence frameworks and training specifications for installers. These aim to enable the existing natural gas system to be repurposed for use with 100% hydrogen downstream of the emergency control valve (ECV).

The standards developed define the required criteria to safely repurpose existing natural gas equipment for hydrogen, to design and install new hydrogen safe pipework and appliances, and to train a workforce of competent hydrogen gas installers. This work intends to contribute evidence informing strategic decisions in 2026 on the role of hydrogen in heat decarbonisation. The programme forms part of the Department for Energy Security and Net Zero's Net Zero Innovation Portfolio (NZIP) and Clean Heat Directorate – Hydrogen Heating.

As part of this programme, BSI have developed a series of PAS standards that codify an agreed set of principles, requirements and guidance on the functionality, safety, installation, operating and servicing requirements for hydrogen meters, pipework, fittings, and ancillary devices.

The Hydrogen Skills and Standards for Heat programme PASs are:

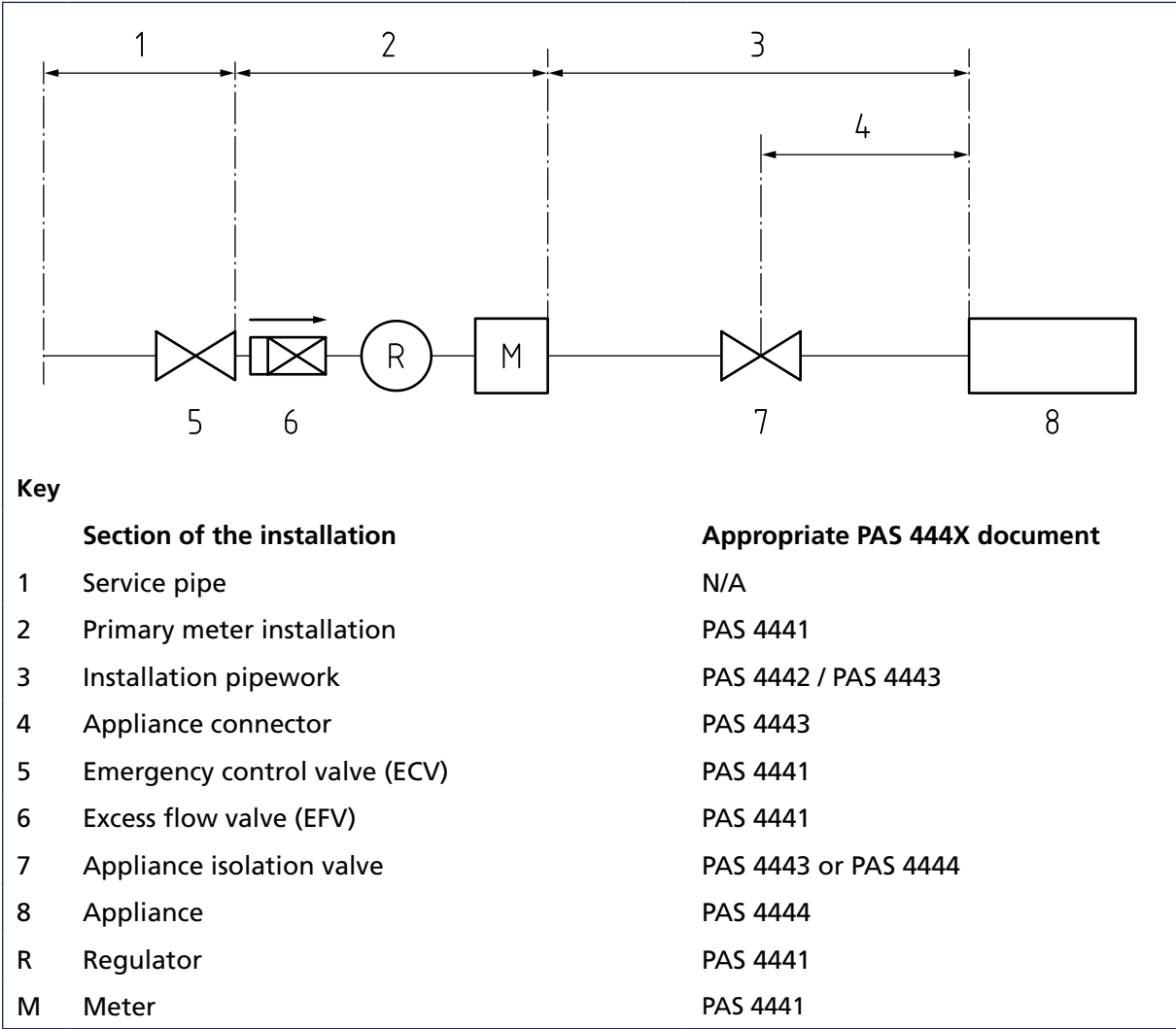
- PAS 4441, *Components used in hydrogen gas metering – Specification*³⁾
- PAS 4442, *Material requirements for pipework and fittings used in hydrogen gas installation – Specification*
- PAS 4443, *Assessment criteria: Ancillary valves, devices and components used in hydrogen gas installations – Specification*⁴⁾

The interrelationship between PAS 4441, PAS 4442, PAS 4443 and PAS 4444 and their applicability to a typical hydrogen 4th family gas installation is illustrated in Figure 1.

³⁾ In preparation.

⁴⁾ In preparation.

Figure 1 – Interrelationship between PASs for typical hydrogen 4th family gas installation



1 Scope

This PAS specifies the requirements for materials that are suitable for use with hydrogen and form part of the gas installation pipework, fittings and associated components that are for use with hydrogen 4th family gas downstream of the emergency control valve (ECV) and up to the appliance connection.

NOTE 1 Clause 4 sets out the requirements for the 4th family gas and the associated hydrogen gas concentrations covered by the scope of this PAS. The installation, repurposing and maintenance requirements are covered by IGEM/HI2 [1] and IGEM/HI3 [2]. Details of requirements for appliances that are suitable for hydrogen can be found within PAS 4444 or for hydrogen appliances, plant and equipment not covered by PAS 4444 from the appliances, plant and equipment manufacturer.

This PAS covers gas pipework installations in domestic and non-domestic premises conforming to BS 6891:2015+A1:2019 and IGEM/UP/2, Edition 3 [N1].

The maximum nominal operating pressure of the installations covered by this PAS is 250 millibar (gauge) with a maximum gas flow rate through the installation of 1 076 m³/h.

NOTE 2 Reference conditions for units of volumetric gas flow (m³) are 15 °C and 1 013.25 mbar (absolute).

NOTE 3 For a hydrogen fed installation this gas flow rate would supply appliances/equipment connected to it with an approximate maximum heat input of 3 050 kW (net) or 3 600 kW (gross).

This PAS applies to gas installation pipework and fittings designed to be installed on hydrogen-fed premises.

The PAS is intended to be used to determine requirements for hydrogen-fed installations as a supplement to existing standards and assumes that any default performance requirements align with those of equivalent pipework and fittings utilised on 2nd family gas installations unless specifically stated otherwise.

This PAS is for use by the manufacturers of gas installation pipework and fittings designed to be installed on hydrogen-fed premises.

The PAS may also be of interest to:

- a) approved bodies;
- b) architects;
- c) consultants;
- d) designers;
- e) gas emergency service or network operators;
- f) government regulators;
- g) installers;
- h) manufacturers;
- i) specifiers.

This PAS is intended for use within Great Britain (which encompasses England, Scotland and Wales) but may be used internationally under local gas regulations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions, or limits the application, of this document⁵⁾. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 10, *Specification for flanges and bolting for pipes, valves and fittings*

BS 143 and 1256, *Threaded pipe fittings in malleable cast iron and cast copper alloy*

BS 1560-3, *Circular flanges for pipes, valves and fittings (Class designated) – Steel, cast iron and copper alloy flanges – Specification for cast iron flanges*

BS 1640, *Specification for steel butt-welding pipe fittings for the petroleum industry – Wrought carbon and ferritic alloy steel fittings – Metric units*

BS 3799, *Specification for steel pipe fittings, screwed and socket-welding for the petroleum industry*

BS 4371, *Specification for fibrous gland packings*

BS 4882, *Specification for bolting for flanges and pressure containing purposes*

BS 6362, *Specification for stainless steel tubes suitable for screwing in accordance with BS 21 'Pipe threads for tubes and fittings where pressure-tight joints are made on the threads'*

BS 6891:2015+A1:2019, *Specification for the installation and maintenance of low pressure gas installation pipework of up to 35 mm (R1¼) on premises*

BS 6956-1, *Jointing materials and compounds – Part 1: Specification for corrugated metal joint rings*

BS 6956-5, *Jointing materials and compounds – Part 5: Specification for jointing compounds for use with water, low pressure saturated steam, 1st family gases (excluding coal gas) and 2nd family gases*

BS 7531, *Rubber bonded fibre jointing for industrial and aerospace purposes*

BS EN 437:2021, *Test gases – Test pressures – Appliance categories*

BS EN 549, *Rubber materials for seals and diaphragms for gas appliances and gas equipment*

BS EN 751 (all parts), *Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water*

BS EN 1057, *Copper and copper alloys – Seamless, round copper tubes for water and gas in sanitary and heating applications*

BS EN 1092-1, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Steel flanges*

BS EN 1254-1, *Copper and copper alloys – Plumbing fittings – Part 1: Capillary fittings for soldering or brazing to copper tubes*

BS EN 1254-2, *Copper and copper alloys – Plumbing fittings – Part 2: Compression fittings for use with copper tubes*

BS EN 1254-4, *Copper and copper alloys – Plumbing fittings – Part 4: Threaded fittings*

BS EN 1254-5, *Copper and copper alloys – Plumbing fittings – Part 5: Capillary fittings with short ends for brazing to copper tubes*

⁵⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography.