# INTERNATIONAL STANDARD

# ISO 4422-5

First edition
1997-10-15

# Pipes and fittings made of unplasticized poly(vinyl chloride) (PVC-U) for water supply — Specifications —

## Part 5:
## Fitness for purpose of the system

*Tubes et raccords en poly(chlorure de vinyle) non plastifié (PVC-U) pour l'adduction d'eau — Spécifications —*

*Partie 5: Aptitude à l'emploi du système*

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## Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 4422-5 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 2, *Plastics pipes and fittings for water supplies*.

Together with the other parts, this part of ISO 4422 cancels and replaces ISO 4422:1990, which has been technically revised.

ISO 4422 consists of the following parts, under the general title *Pipes and fittings made of unplasticized poly(vinyl chloride) (PVC-U) for water supply — Specifications*:

— *Part 1: General*

— *Part 2: Pipes (with or without integral sockets)*

— *Part 3: Fittings and joints*

— *Part 4: Valves and ancillary equipment*

— *Part 5: Fitness for purpose of the system*

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ISO 4422 is one of a series of system standards for plastics piping systems which are being prepared within ISO/TC 138. Each system standard is based on a specific material for a specific application.

They conform to a standard multi-part format, each part dealing with a specific aspect of the overall system.

NOTE — At the present time, the reference document for the installation code is ISO/TR 4191, and this document will ultimately form part 6 of this International Standard.

Annex A of this part of ISO 4422 is for information only.



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# Pipes and fittings made of unplasticized poly(vinyl chloride) (PVC-U) for water supply — Specifications —

# Part 5:
Fitness for purpose of the system

## 1 Scope

This part of ISO 4422 specifies the requirements for the determination of the fitness for purpose of a piping system composed of pipes, joints, fittings and auxiliaries made of unplasticized poly(vinyl chloride) (PVC-U), to be used for buried water mains and services and for water supplies above ground, both inside and outside buildings.

The pipes, joints, fittings and auxiliaries covered by this part of ISO 4422 are intended for the conveyance of cold water under pressure at temperatures up to 20 °C, for general purposes and for the supply of drinking water. This part of ISO 4422 is also applicable to water up to and including 45 °C (see figure 1 in ISO 4422-2:1996).

The requirements specified in this part of ISO 4422 are applicable to assembled pipes, fittings, valves and ancillary equipment which can be demonstrated to conform to the respective requirements of ISO 4422 parts 1, 2, 3 and 4.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 4422. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 4422 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4422-1:1996, *Pipes and fittings made of unplasticized poly(vinyl chloride) (PVC-U) for water supply — Specifications — Part 1: General.*

ISO 4422-2:1996, *Pipes and fittings made of unplasticized poly(vinyl chloride) (PVC-U) for water supply — Specifications — Part 2: Pipes (with or without integral sockets).*

ISO 4422-3:1996, *Pipes and fittings made of unplasticized poly(vinyl chloride) (PVC-U) for water supply — Specifications — Part 3: Fittings and joints.*

ISO 4422-4:—[1], *Pipes and fittings made of unplasticized poly(vinyl chloride) (PVC-U) for water supply — Specifications — Part 4: Valves and ancillary equipment.*

ISO 4633:1996, *Rubber seals — Joint rings for water supply, drainage and sewerage pipelines — Specification for materials.*

1) To be published. (Revision, in parts, of ISO 4422:1990)



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ISO 7387-1:1983, *Adhesives with solvents for assembly of PVC-U pipe elements — Characterization — Part 1: Basic test methods.*

ISO 9311-1:—[2], *Adhesives for thermoplastics piping systems — Part 1: Test method for spreadability and film properties of adhesives.*

ISO 12092:—[2], *Fittings, valves and other piping system components made of unplasticized poly(vinyl chloride) (PVC-U) for pipes under pressure — Resistance to internal pressure — Test method.*

ISO 13783:—[2], *Plastics piping systems — Unplasticized poly(vinyl chloride) (PVC-U) end-load-bearing double-socket joints — Test method for leaktightness and strength while subjected to bending and internal pressure.*

ISO 13844:—[2], *Plastics piping systems — Elastomeric sealing ring type socket joints of unplasticized poly(vinyl chloride) (PVC-U) for use with PVC-U pipes — Test method for leaktightness under negative pressure.*

ISO 13845:—[2], *Plastics piping systems — Elastomeric sealing ring type socket joints of unplasticized poly(vinyl chloride) (PVC-U) for use with pipes — Test method for leaktightness under internal pressure and with angular deflection.*

ISO 13846:—[2], *Plastics piping systems — End-load-bearing and non-end-load-bearing assemblies and joints for thermoplastics pressure piping — Test method for long-term leaktightness under internal water pressure.*

## 3 Definitions

For the purposes of this part of ISO 4422, the definitions given in ISO 4422-1 apply.

## 4 Mechanical characteristics of assemblies, including joints

NOTE — Even when the material and individual components of a piping system, e.g. pipe, fittings and valve bodies, have been proven according to the requirements specified in the appropriate clauses of this part of ISO 4422, the mechanical characteristics of an assembly, including joints, have to be specified and assessed. Experience has shown that proven jointing techniques for PVC-U piping systems are the use of elastomeric sealing ring push-fit type joints, solvent-cementing and the use of mechanically fixed elastomeric sealing ring type joints, depending on the installation and service conditions.

If the joint is included in the component test, the joint can be reinforced (see ISO 12092 and ISO 4422-3:1996, subclause 7.2) and is not part of the assessment for the component test.

During short-term and long-term component testing, the applied hydrostatic pressure produces stress in the joint area, and thus creep of the socket, which is more than eight times that which may occur after 50 years under working conditions.

To approve assembled components and joints, it is necessary to test the leaktightness under short-term and long-term conditions. These are related to the creep resulting from the permissible working pressures and temperatures after 50 years.

### 4.1 Short-term pressure test for leaktightness of assemblies

**4.1.1** When an assembly with one or more elastomeric sealing ring type joints is tested using a hydrostatic pressure and angular deflection in accordance with ISO 13845, and the test conditions given in table 1, the assembly shall conform to the requirement given in table 1.

2) To be published.



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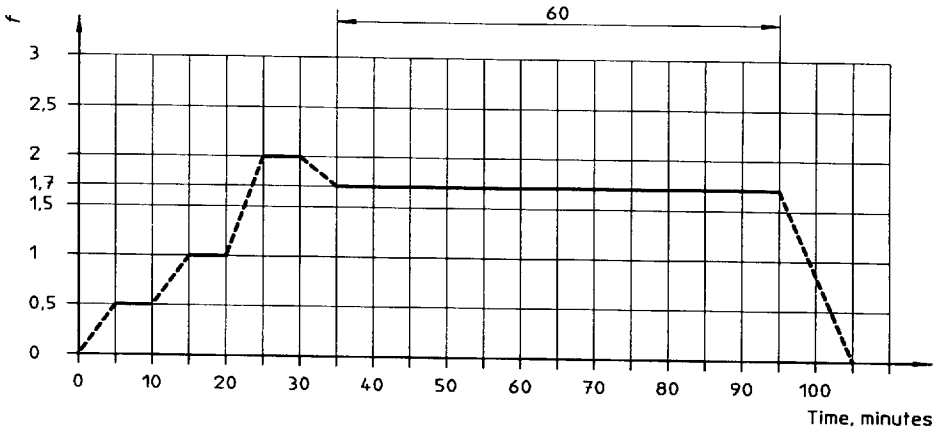
**Table 1 — Test conditions and requirement for short-term assembly test**

| Test temperature °C | Test pressure bar | Test time | Test requirement |
|---|---|---|---|
| $T \pm 2$ where $T$ is any temperature between 17 and 23 | Pressure calculated in accordance with figure 1 and 4.1.2 | One cycle in accordance with figure 1 | No leakage at any point of the jointing areas throughout the whole test cycle |




NOTE — The pressure changes from one pressure level to the next shall take place within the periods indicated, but do not necessarily have to take place at strictly linear rates.

**Figure 1 — Hydrostatic pressure test regime**

**4.1.2** The test pressures $p_T$ shall be calculated by multiplying the factor $f$ indicated in figure 1 by the nominal pressure PN, i.e. by using the following equation:

$$p_T = f \times \text{PN}$$

## 4.2 Short-term negative pressure test for leaktightness of assemblies

When an assembly with one or more elastomeric sealing ring type joints is tested using a negative pressure and angular deflection/deformation in accordance with ISO 13844 and the test conditions given in table 2, the assembly shall conform to the requirement given in table 2.

**Table 2 — Test conditions and requirement for short-term negative-pressure assembly test**

| Test temperature °C | Negative pressure test regime bar | Test time | Test requirement |
|---|---|---|---|
| $T \pm 2$ where $T$ is any temperature between 17 and 23 | Pressure in accordance with figure 2 | One cycle in accordance with figure 2 | The change in negative pressure shall be not more than 0,005 MPa during each 15 min test period shown in figure 2 |



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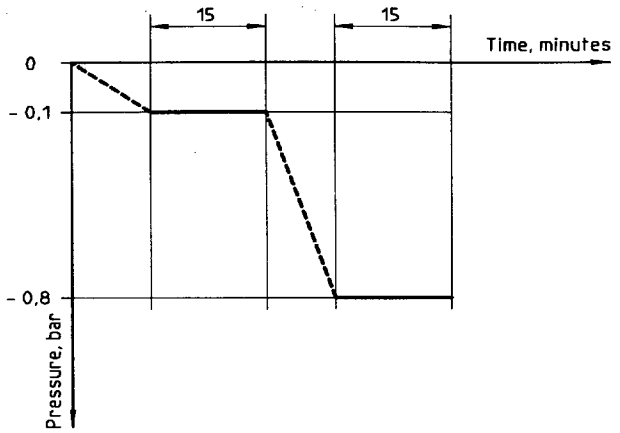


NOTE — The pressure changes from one pressure level to the next do not necessarily have to take place at strictly linear rates.

**Figure 2 — Negative-pressure test regime**

## 4.3 Long-term pressure test for leaktightness

**4.3.1** When an assembly with one or more joints selected from solvent cement type joints, elastomeric sealing ring type sockets and other end-load-bearing and non-end-load-bearing joints for PVC-U components for a piping system is tested in accordance with ISO 13846, using the test conditions given in table 3 for the test temperatures of 20 °C and 40 °C, the assembly shall conform to the requirement given in table 3.

NOTE — A detailed explanation of the philosophy behind the calculation methods used in long-term leaktightness testing are given in annex A.

**Table 3 — Test requirement for the long-term pressure testing of assembled joints**

| Type of material used for the manufacture of the socketed component | Test temperature °C | Test pressure[1] bar | Test time h | Test requirement |
|---|---|---|---|---|
| Socketed pipe ($\sigma_s$ = 12,5 MPa) or fitting (PVC-UH) | 20 | 1,65 × PN | 1 000 | No leakage at any point of the jointing areas for at least the test time |
| | 40 | 1,3 × PN | 1 000 | |
| Socketed pipe ($\sigma_s$ = 10 MPa) or fitting (PVC-U) | 20 | 1,7 × PN | 1 000 | |
| | 40 | 1,45 × PN | 1 000 | |

1) The PN rating used in this calculation is the PN rating of the fitting or, if pipe with an integral joint is being tested, the PN rating of the pipe.

## 4.4 End-load-bearing joints — Pressure and bending test for leaktightness and strength

When end-load-bearing joints having one more sockets (see note) and fitted with one or more elastomeric sealing rings together with one or more locking rings to withstand the longitudinal forces resulting from the application of internal hydraulic pressure are tested in accordance with ISO 13783 at a single ambient temperature of $T \pm 2$ °C (where $T$ is any temperature between 17 °C and 23 °C), the joint shall remain leaktight throughout the whole of the test period.

NOTE — Such joints are usually, but not necessarily, in the form of double sockets.



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After the test period, the disassembled parts shall show no sign of cracking and the locking device(s) shall not be deformed by more than 30 % of their original width.

## 5 Connections

### 5.1 Elastomeric sealing rings

Elastomeric sealing rings used for joining components shall conform to both of the following requirements:

a) the rings shall conform to the material requirements specified in ISO 4633;

b) the rings shall be free from chemical agents (e.g. plasticizers) that could have a detrimental effect on the pipes or fittings, or on the quality of the water.

### 5.2 Solvent cements

Solvent cements used for joining plain sockets to pipes and/or spigoted fittings shall conform to ISO 7387-1 and ISO 9311-1 as applicable.



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# Annex A
(informative)

# Long-term leaktightness testing

## A.1 General

The long-term leaktightness test for solvent cement type, elastomeric sealing ring type and mechanical joints and assemblies is based on the principle that the joint has to remain watertight during the service life of the assembly, i.e. 50 years. This requires that the deformation occurring in the joint area due to creep does not produce leakage.

The test is therefore carried out under conditions such that the expected creep deformation after 50 years is reached in 1 000 h. The strain in the fitting material, according to the nominal stress in the system for 50 years, can be determined from isochronous stress/strain diagrams for the service temperature (e.g. for PVC-U at 20 °C, see figure A.1, and at 40 °C, see figure A.2).

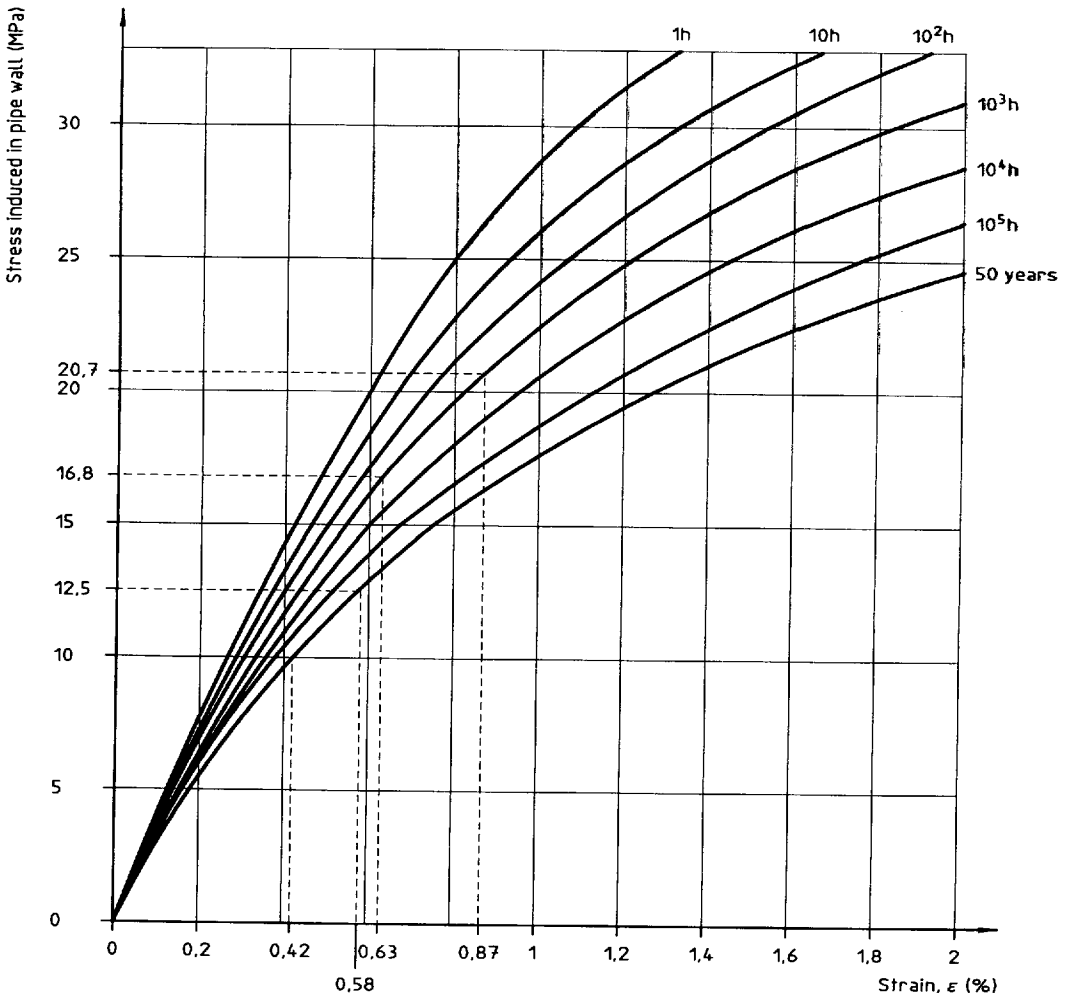


**Figure A.1 — Isochronous stress/strain diagram for PVC-U at 20 °C**



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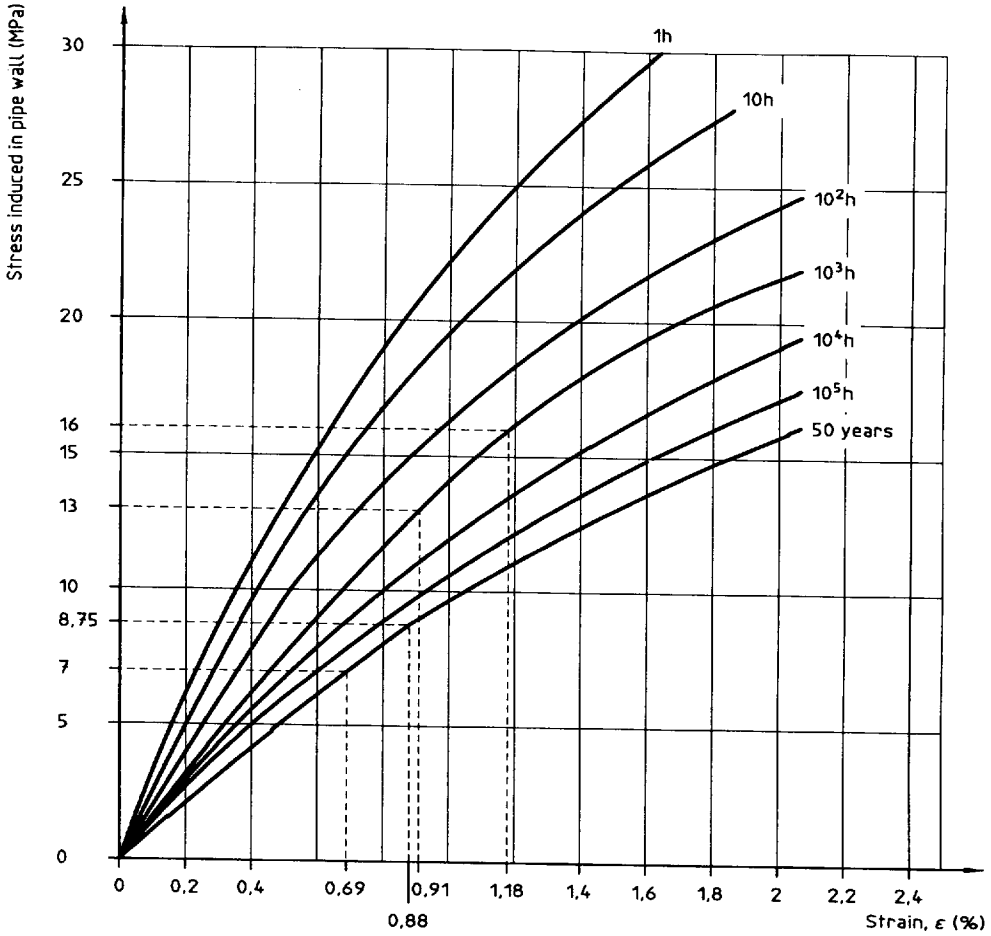


**Figure A.2 — Isochronous stress/strain diagram for PVC-U at 40 °C**

Instead of a safety factor for the test, an additional test strain of 0,5 times the calculated strain is added, the maximum value of this additional test strain being decided for each individual material and/or system.

The test stress for the 1 000 h test according to the resulting test strain is again determined from the isochronous stress/strain diagram (see figures A.1 and A.2). This test stress is then transformed into the resulting test pressure according to the following equation:

$$p_T = \frac{\sigma_T}{\sigma_s} \times PN$$

where

$p_T$ is the test pressure, in bars;

$\sigma_T$ is the test stress, in megapascals;

$\sigma_s$ is the design stress, in megapascals;

PN is the nominal pressure, in bars.



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## A.2 Calculation

For PVC-U, calculate the strain according to the stress at nominal conditions for the intended pipe and the applied overall service (design) coefficient respectively for the material type used in the manufacture of the fitting.

NOTES

1 This calculation is based on an induced stress equal to the design stress. An additional test strain of 0,5 times the calculated strain shall then be added. For PVC-U the additional strain shall not be greater than 0,3 %.

2 Although the maximum allowable temperature for PVC-U water supply in this part of ISO 4422 is 45 °C, a standard temperature of 40 °C has been established for the elevated-temperature test.

Calculate the appropriate working pressures at elevated temperatures using the derating-factor graph given in figure 1 of ISO 4422-2:1996.

The calculation of the two test pressures for the two types of PVC-U material and the two test temperatures is as given in table A.1.

**Table A.1 — Calculation of the test parameters for the long-term pressure test for leakproofness**

| Parameter | PVC-U material type | | | |
|---|---|---|---|---|
| Design stress of pipe (50 years at 20 °C) | $\sigma_s$ = 10 MPa | | $\sigma_s$ = 12,5 MPa | |
| Material of injection-moulded component | PVC-U | | PVC-UH | |
| Temperature, °C | 20 | 40 | 20 | 40 |
| Temperature-derating factor $f_T$ | 1 | 0,7 | 1 | 0,7 |
| Design stress $\sigma_s$ related to temperature and 50 years (MPa) | 10 | 7 | 12,5 | 8,75 |
| Strain $\varepsilon$ at an induced stress of $\sigma_s$ at 50 years (see figures A.1 and A.2) | 0,42 [1] | 0,69 [1] | 0,58 [1] | 0,88 [1] |
| Additional strain for test $\varepsilon_A$ | 0,21 [1] | 0,22 [1] | 0,29 [1] | 0,3 [1] |
| Strain value for test $\varepsilon_T$ $\varepsilon_T = \varepsilon + \varepsilon_A$ | 0,63 | 0,91 | 0,87 | 1,18 |
| Test stress $\sigma_T$/1 000 h related to $\varepsilon_T$ (MPa) (see figures A.1 and A.2) | 16,8 | 13 | 20,7 | 16 |
| Test pressure $p_T$ for 1 000 h: $p_T = \frac{\sigma_T}{\sigma_s} \times PN$ [2] = | $\frac{16,8}{10} \times PN$ | $\frac{13}{10} \times PN$ | $\frac{20,7}{12,5} \times PN$ | $\frac{16}{12,5} \times PN$ |
| = | 1,7 [3] × PN | 1,3 [3] × PN | 1,65 [3] × PN | 1,3 [3] × PN |

1) These values have been rounded up to the nearest 0,01.

2) This value is that of the PN rating of the fitting or, if a pipe with an integral socket is being tested, the PN rating of the pipe.

3) These factors have been rounded up to the nearest 0,05.



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