BRITISH STANDARD

BS EN 1447:2009

Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of long-term resistance to internal pressure

ICS 23.040.20

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The UK participation in its preparation was entrusted to Technical Committee PRI/88/2, Plastics piping for pressure applications.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Plastics piping systems - Glass-reinforced thermosetting plastics (GRP) pipes - Determination of long-term resistance to internal pressure

Systèmes de canalisations en plastiques - Tubes en plastiques thermodurcissables renforcés de verre (PRV) - Détermination de la résistance à long terme à la pression interne

Kunststoff-Rohrleitungssysteme - Rohre aus glasfaserverstärkten duroplastischen Kunststoffen (GFK) - Bestimmung der Langzeit-Widerstandsfähigkeit gegen Innendruck

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Foreword

This document (EN 1447:2009) has been prepared by Technical Committee CEN/TC 155 “Plastics piping systems and ducting systems”, the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2009, and conflicting national standards shall be withdrawn at the latest by September 2009.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1447:1996.

The main modifications are:

— Correction of the valid failure zone limits and the use and reporting of data outside the valid zone.

The material-dependent parameters and/or performance requirements are incorporated in the referring standard.

This standard is one of a series of standards on test methods which support System Standards for plastics piping systems and ducting systems.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This standard describes a method for determining the long-term resistance to internal pressure of glass-reinforced thermosetting plastics (GRP) pipes.

It is a method which uses the following conditions:

— water as the reference liquid inside the test piece;

— water or air as the environment outside the test piece.

The method can be used for tests at different temperatures. It should be noted that, for a given temperature, the results obtained can differ depending on the end loading conditions and whether the external environment is water or air.

The method described in this standard differs from those in some other similar standards, in the following details:

— the failure criteria and the detection of failure;

— the strain in the longitudinal and circumferential directions may be measured during the test;

— the test pressure is maintained constant.

This method may be used to obtain data to establish internal pressure versus time-to-failure relationships at different temperatures. The procedures for establishing the relationships are not within the scope of this standard. For such purposes attention is drawn to EN 705.

1 Scope

This standard specifies a method for determining the time to failure of glass-reinforced thermosetting plastics (GRP) pipes under internal hydrostatic pressure at a specified temperature. The external environment can be air or water.

NOTE For other internal or external environments the referring standard should specify any additional requirement.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 705, *Plastics piping systems – Glass-reinforced thermosetting plastics (GRP) pipes and fittings – Methods for regression analyses and their use*

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1
failure
continuous loss of pressure resulting from the passage of the test liquid through the wall of the test piece under test

NOTE See 9.1.

3.2
bursting
failure by rupture of the pipe wall with immediate loss of test liquid and drop of pressure

NOTE See 9.1 and 9.2.2.

3.3
leaking
failure by loss of the pressurizing liquid through the pipe wall to an extent detectable visually and/or by a continuous drop in pressure

NOTE See 9.1, 9.2.1 and 9.2.2.

3.4
weeping
failure by passage of the pressurizing liquid through the pipe wall to an extent detectable visually or electronically

NOTE See 9.1 and 9.2.3.

4 Principle

A cut length of pipe at the required temperature is subjected to a specified internal hydrostatic pressure to cause a state of stress in the pipe wall which depends upon the loading conditions, i.e. with or without the effects of end thrust being carried by the pipe wall. The results of tests at different end loading conditions will be different even for the same pipe. Water or air may be used as the environment outside of the test piece.

The test samples are held at the test pressure until failure occurs. Typically the time to failure is longer at lower pressures (stresses).

In general, a series of tests are conducted over various failure times and the results obtained analysed in accordance with EN 705 to establish a long term value. The number of tests required, the appropriate time intervals and the time at which a value is established (time to failure) are given in the referring standard.

NOTE It is assumed that the following test parameters are set by the standard making reference to this standard:

a) whether or not the test piece is to be loaded by the hydrostatic end thrust while under pressure (see 5.2);

b) free length, *L*, of the test piece (see 6.2);

c) number of test pieces (see 6.1);

d) test temperature and its tolerance (see 8.1);

e) if and what strain measurements are required (see 8.2);

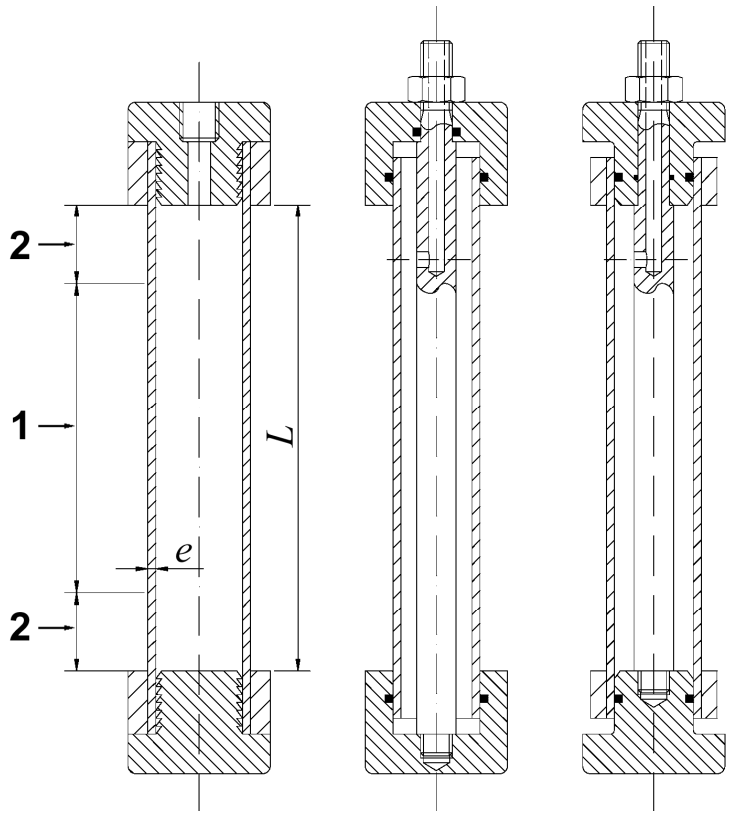
f) external environmental fluid, i.e. water or air (see 8.3) or other environment (see Note to Clause 1);

g) internal environmental fluid, if not water or a test liquid for the purposes of 5.7 and 9.2.3 (see Note to Clause 1).

5 Apparatus

5.1 Dimensional measurement devices, capable of determining the dimensions (length, diameters, wall thickness) to an accuracy of within ± 1,0 %.

5.2 End sealing devices for the test piece, capable of inducing the specified state of stress, i.e. with or without hydrostatic end thrust (see Figure 1).



Key

Type 1	testing with end thrust	1	valid failure zone
Type 2	testing without end thrust, external seals	2	end fixture influence zone, equal to $3{,}3([DN] \times e)^{0{,}5}$
Type 3	testing without end thrust, internal seals	*e*	wall thickness
		L	free length between end fixtures

Figure 1 — Typical arrangements for pressure testing of pipes

5.3 Test piece support(s), as necessary to minimize deformation of the test piece due to its own weight.

Such support(s) shall not constrain the test piece circumferentially or longitudinally.

5.4 Container for water, if tested with water as the external environment (see 8.3), equipped so that the specified temperature can be maintained uniformly throughout the liquid.

NOTE This can require circulation.

5.5 Pressurizing system, capable of applying the pressure to the liquid in the test piece in such a way as to avoid entrapment of air.

The system shall be capable of maintaining the pressure within the limits detailed in 8.4 for the duration of the test.

NOTE 1 The pressure should, preferably, be applied individually to each test piece. However, the use of equipment enabling the pressure to be applied simultaneously to several test pieces is also permitted if there is no danger of interference when failure occurs.

NOTE 2 If the tests are carried out at a specified stress, the dimensions of the various test pieces should be similar.

NOTE 3 It is recommended that an automatic system be used which adjusts the pressure to keep it within the specified limits.

5.6 **Pressure measuring device**, having an accuracy within ± 1,0 % of the test pressure.

5.7 **Electrical resistance meter and associated circuit** (optional, see 9.1), capable of detecting a change in electrical resistance to a level of 3 MΩ or less (see 9.2.3) between a sufficiently conductive test liquid and a conductive layer.

5.8 **Strain measuring device(s)** (optional, see 8.2), capable of measuring the required strain to an accuracy of within ± 2 %.

6 Test pieces

6.1 Number

The number of test pieces shall be as specified in the referring standard.

6.2 Free length

Each test piece shall comprise a full section of the pipe, the free length (L) of which, between the sealing devices, shall be as specified in the referring standard.

6.3 Cutting

The ends shall be smooth, perpendicular to the axis of the pipe.

7 Conditioning

Unless otherwise specified by the referring standard, store the test piece(s) at the test temperature (see 8.1) for 24 h prior to testing.

8 Procedure

8.1 Conduct the following procedures at the temperature and tolerance specified in the referring standard.

8.2 If strain measurements are required, attach strain gauges and use equipment conforming to 5.8.

8.3 Attach the end-sealing devices (see 5.2) to the test piece (see Clause 6) and fill the assembly completely with water or the test liquid (see 5.7). Attach the test piece to the pressurizing system, avoiding entrapment of air.

If testing with water as the external environment install the test piece in the container (see 5.4) so that it is totally surrounded with water.

8.4 Raise the pressure inside the test piece to the desired level within 5 min (see 5.5). Maintain the pressure until failure. Record the period during which the test piece has been subjected to the test pressure to an accuracy of ± 2 % of the duration of the test in hours or 24 h, whichever is the smaller.

8.5 In case of an interruption in testing due to unforeseen circumstances, such as power failure, the test may be continued if the duration of the interruption is less than 100 h. The length of the time of interruption(s) shall be deducted from the total running time of the test and shall be noted in the test report.

9 Detection of failure

9.1 General

The test piece shall be considered to have failed when bursting (see 3.2), leaking (see 3.3) or weeping (see 3.4) is observed. Bursting or leaking can be detected visually or by a drop of pressure or loss of test liquid (see 9.2.1 and 9.2.2). Weeping can be detected visually, or physically by measuring the electrical resistance (see 9.2.3).

NOTE Weeping can be determined only when the test is carried out in air.

Because of the very high stresses (strains) generated by the extreme pressures used to develop short term data points, the discontinuity effects of the end closures can significantly influence the apparent times to failure. If the failure can be clearly identified as initiating from end fixture influence, the result of the test may be discarded if the failure occurs outside the valid failure zone, i.e. within a distance from an end sealing device of:

$$3{,}3 \times ([\mathrm{DN}] \times e)^{0{,}5}$$

where

[DN] is the nominal size, expressed in millimetres;

e is the wall thickness, in millimetres.

Where feasible, i.e. where failure is by leaking or weeping, failures outside the valid zone may be repaired, as needed, and the test continued. Any such continuation shall be noted in the test report.

9.2 Detection methods

9.2.1 Drop of pressure

When automatic regulation of the pressure is not used (see Note 3 to 5.5), a drop of pressure greater than 2 % of the selected and adjusted hydrostatic pressure per hour shall be considered as failure.

9.2.2 Loss of test liquid

A visible loss of the test liquid through the pipe wall shall be considered as failure (see 9.1).

9.2.3 Drop in electrical resistance

If applicable, a failure shall be considered to have occurred when the electrical resistance between the test liquid and a conductive layer around the external circumference of the test piece falls to less than or equal to 3 MΩ.

NOTE Care should be taken to ensure that the electrical conductivity of the test liquid and the electrical resistivity of the pipe are high enough.

10 Test report

The test report shall include the following information:

a) reference to this standard and the referring standard;

b) full identification of the pipes tested;

c) dimensions of each test piece;

d) number of test pieces;

e) operating limits of the pressurizing system (see 5.5);

f) if required, the measured strains;

g) range of temperature during testing;

h) external test environment (see 5.4);

i) state of stress (see 5.2);

j) length of the valid failure zone (see 9.1);

k) type of end sealing device (see Figure 1);

l) if used, details of the test piece support (see 5.3);

m) test pressure for each test piece (see 8.4);

n) for each test piece either the time to failure or the duration of test (see 8.4);

o) for each test piece an image, i.e. sketch, photograph, etc., showing the nature and position of failure points;

p) failure mode for each test piece (see 9.1);

q) any data points eliminated due to failures outside the valid failure zone;

r) observations made during and after the test;

s) any factors which could have affected the results, such as any incidents or any operating details not specified in this standard;

t) date of test or dates between which the test was conducted.

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