INTERNATIONAL STANDARD

ISO 15363

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Metallic materials — Tube ring hydraulic pressure test

Matériaux métalliques — Essai d'expansion hydraulique sur anneau tubulaire

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15363 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 2, *Ductility testing*.

Annex A of this International Standard is for information only.

Metallic materials — Tube ring hydraulic pressure test

1 Scope

This International Standard specifies the ring hydraulic pressure test for metallic tubes. It is generally applied to tubes with an outside diameter greater than 120 mm and outside diameter to thickness ratio of not less than 20.

The objective of this test is to ascertain the value of the hoop stress required to produce a specified total circumferential (hoop) strain.

2 Symbols

Symbols and corresponding designations are given in Table 1.

Table 1 — Symbols and designations

Symbol	Designation	Unit
a [a]	Measured tube test ring thickness	mm
A_t	Specified total circumferential strain	%
d [b]	Measured outside diameter of the tube test ring	mm
l	Length of tube test ring	mm
p	Hydrostatic pressure to produce the specified total circumferential strain	N/mm^2
R_{At}	Hoop strength at the specified total strain	N/mm^2

a The symbol T is also used for this parameter in standards for steel tubes.

b The symbol D is also used for this parameter in standards for steel tubes.

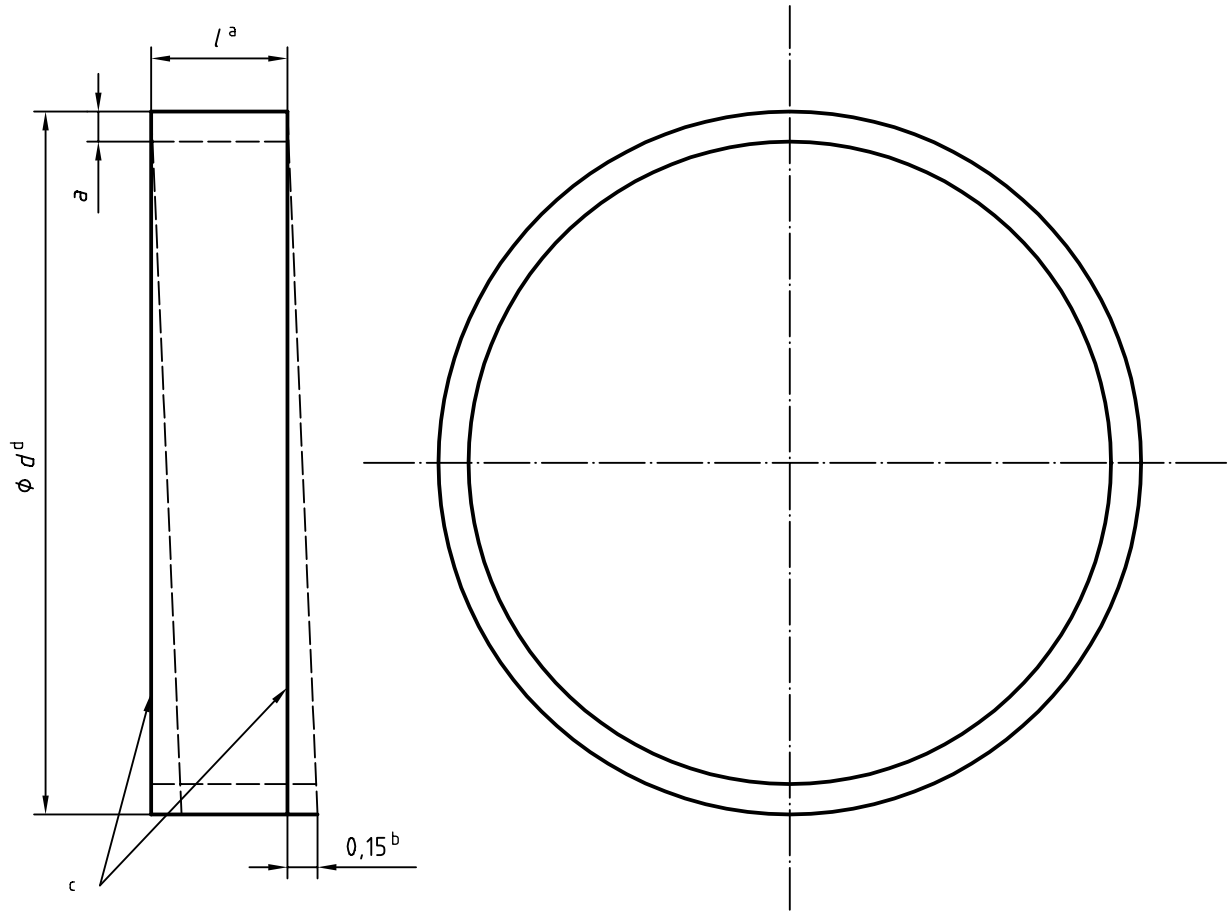
3 Principle

Unrestrained expansion of the test ring between two platens, under internal hydraulic pressure; the outer circumference of the tube is the effective test piece gauge length.

The test is carried out on a test piece taken from a welded or seamless tube of thickness up to a limit dependent upon the capacity of the machine and the strength of the tube (see Figure 1). All sharp edges are removed from product machined surfaces before testing. Where the hydraulic pressure required to produce the specified circumferential strain exceeds the capacity of the test machine, modified tests may be carried out as described in annex A.

The test is specified when a measure of the hoop strength is required which is not influenced by cold forming and residual stress introduced when flattening a standard tensile test piece. The standard tensile test is necessary however, when tensile strength and elongation measurements are required.

Dimensions in millimetres



a Tolerance on *l*: ± 0,25 mm; *l* is commonly taken as 76 mm.

b Maximum deviation from normal.

c Both faces to be machined parrallel with fine turned or ground finish.

d Measured outside diameter of the tube test ring.

Figure 1 — Test ring dimensions and tolerances

4 Apparatus

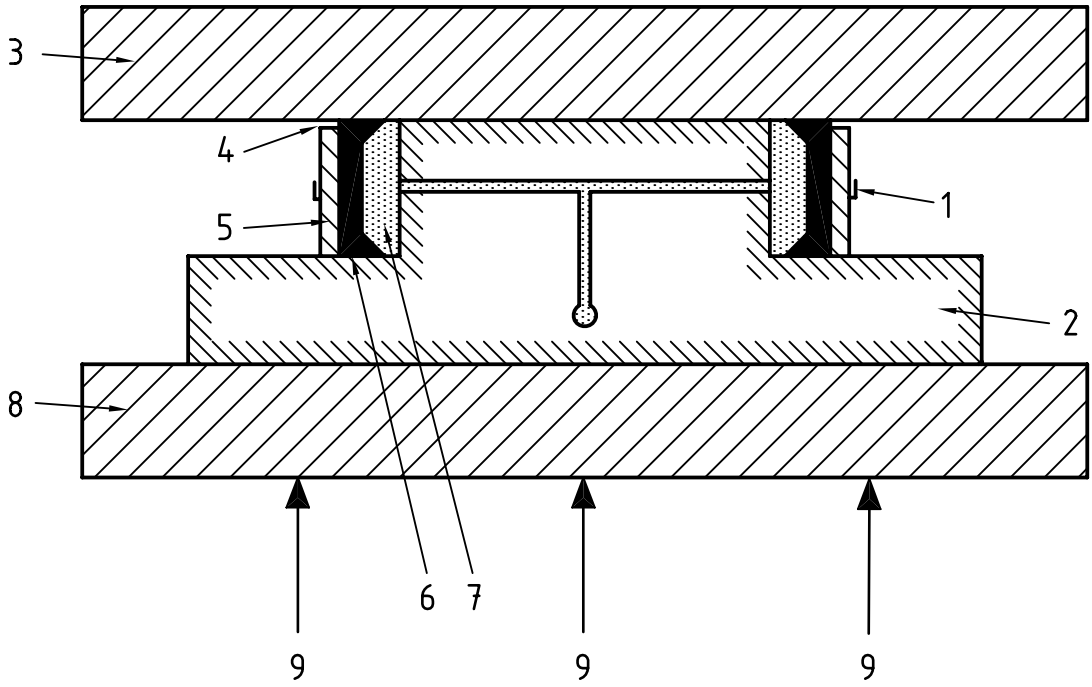
4.1 The testing machine shall be capable of allowing the test ring to expand freely without imposing any end restraint. This shall be achieved by leaving a small gap between the test piece and the top platen. Pressure loss during testing shall be prevented by the use of a flexible seal.

A typical testing machine is shown schematically in Figure 2.

4.2 To reduce to a minimum any friction between the test piece, platens and inner die, the platens shall be parallel and have a fine turned or ground finish. Prior to each test, friction at the contact surfaces shall be further minimized either by the use of a lubricant, e.g. graphited grease, or by the use of PTFE (polytetrafluorethylene) sheet. The platens shall be inspected regularly and any ridges that develop shall be removed.

4.3 Stress shall be applied to the test ring by means of a pressurized fluid. Provision shall be made to remove any air in the system through a bleed line.

Warning — When carrying out the test, precautions should be taken for ensuring the safety of the operator.



Key

1 Circumferential measuring device e.g. steel tape or roller chain
2 Inner die
3 Top platen
4 Small gap
5 Test ring
6 Rubber seal or gasket
7 Pressurizing fluid
8 Bottom platen
9 Clamping force

Figure 2 — Schematic diagram of testing machine (with installed test ring)

5 Test ring

5.1 Shape and position

5.1.1 Prior to separation from the main body of the tube the test ring shall be marked with a unique identity.

5.1.2 The test ring may be prepared from an oversize flame cut sample. Final preparation shall be by a cold machining process to ensure removal of any heat affected zones. The machined edges shall have a fine turned or ground finish and be free from burrs.

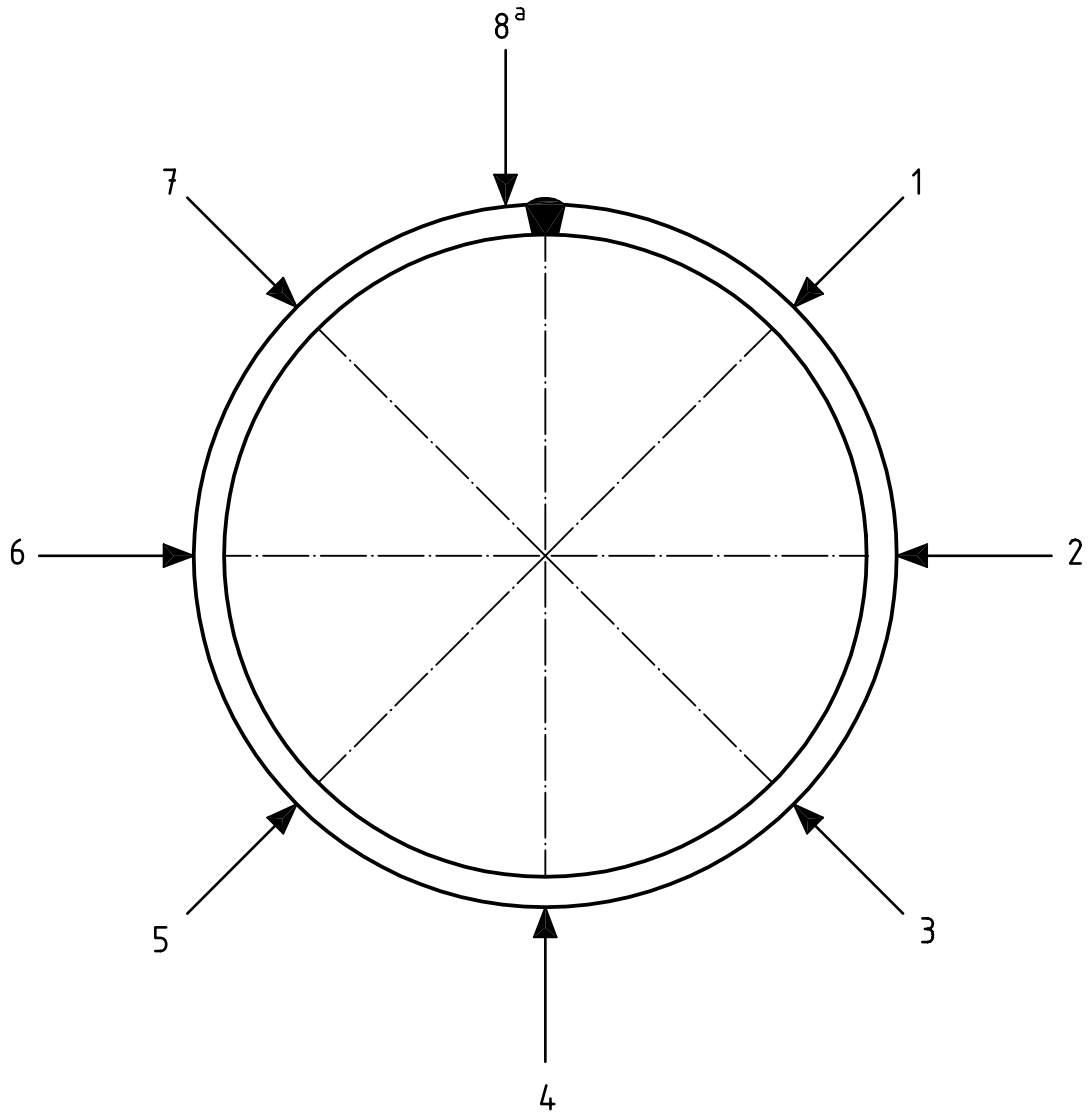
5.1.3 The dimensions and tolerances for the test piece are given in Figure 1. The machined edges shall be parallel and normal to the axis of the tube to within 0,15 mm measured across the diameter.

5.2 Determination of dimensions

5.2.1 The outside diameter of the test ring shall be calculated from measurement of the tube circumference, e.g. using a flexible steel tape. The maximum tolerance on the accuracy of this measurement shall be ± 1 mm.

5.2.2 The wall thickness shall be determined by calculating the mean of eight measurements taken at approximately 45° intervals around the test piece, excluding the weld region of welded tubes (see Figure 3). The measuring device shall be capable of measuring thickness to an accuracy greater than ± 0,025 mm.

5.2.3 All tube diameter and thickness measurements of the test ring shall be fully documented.



a Adjacent to the weld.

Figure 3 — Wall thickness measurement positions

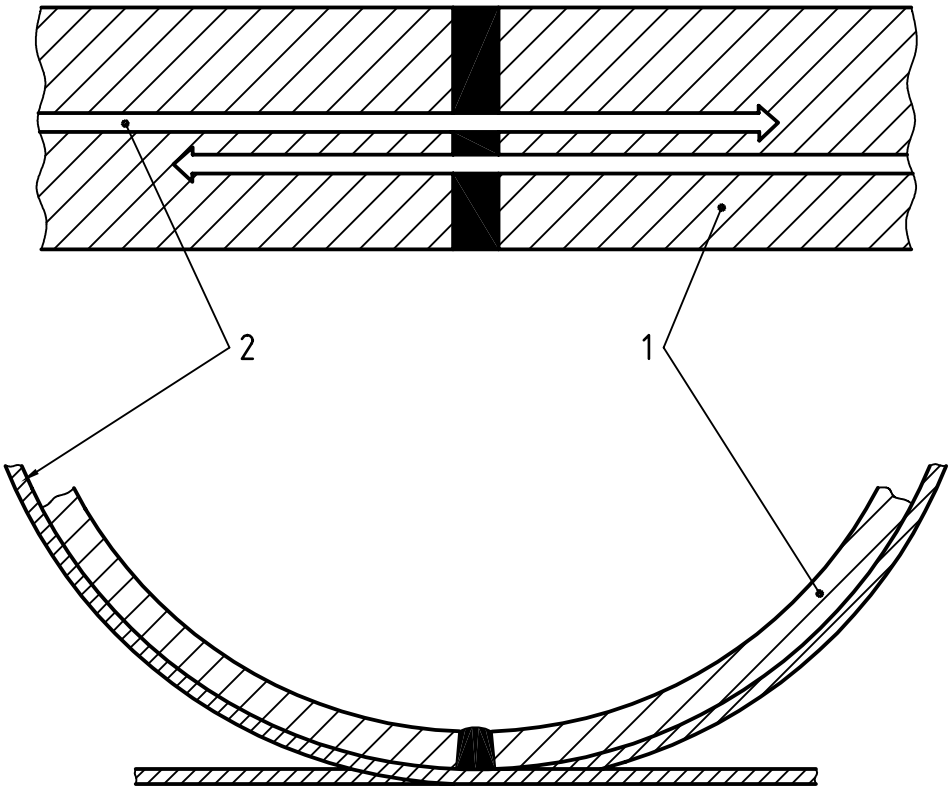
6 Test procedure

6.1 The test procedure consists of applying pressure and measuring circumferential extension.

6.2 Circumferential extension of the test ring shall be measured during pressurization as follows.

The equipment for measuring the change of circumference, e.g. steel tape or roller chain extensometer, shall be wrapped around the test ring perimeter at the mid-point, crossing at the weld.

An example of the use of a steel tape is shown in Figure 4. The separation between the two parallel portions of the measuring device shall be between 1,5 mm and 3 mm.



Key

1 Tube under test

2 Measuring device, e.g. steel tape

Figure 4 — Measuring device position for extension measurement

When a steel tape is used friction shall be minimized by coating both the tape and test ring circumference with a suitable lubricant. Change in circumference shall be measured by a suitable mechanical or electrical device accurate to within ± 0,25 mm.

6.3 The equipment for measuring the increase in circumference shall be wrapped around the test ring before application of the internal pressure.

6.4 The tolerance for the measurement of internal pressure shall be within ± 1 %. Accuracy of the pressure measurement device shall be verified, e.g. by comparison with dead weight test equipment, at the commencement of a sequence of testing and not less than once per year during the testing period.

6.5 The rate of strain shall not exceed 0,2 % min^{-1}.

6.6 The pressure and circumferential extension output signals shall be recorded, for example on an X-Y plotter, and related to the test piece identity.

7 Hoop strength evaluation

7.1 A typical test pressure-circumferential extension record is shown in Figure 5.

7.2 The pressure p corresponding to the specified total circumferential strain shall be determined from the test record.

7.3 For tubes where $D/d \geqslant 20$, the hoop strength at the specified total strain shall be calculated from the formula

$$R_{\mathrm{At}} = \frac{pd}{2a}$$

NOTE 1 For tubes with $d/a < 20$, the hoop strength calculated from this formula becomes increasingly inaccurate and quantitative results should be used with caution. Factors such as strain hardening could have a significant effect on the validity of the calculated strength.

NOTE 2 The specified total circumferential strain is calculated from the circumferential extension divided by the original test ring circumference.

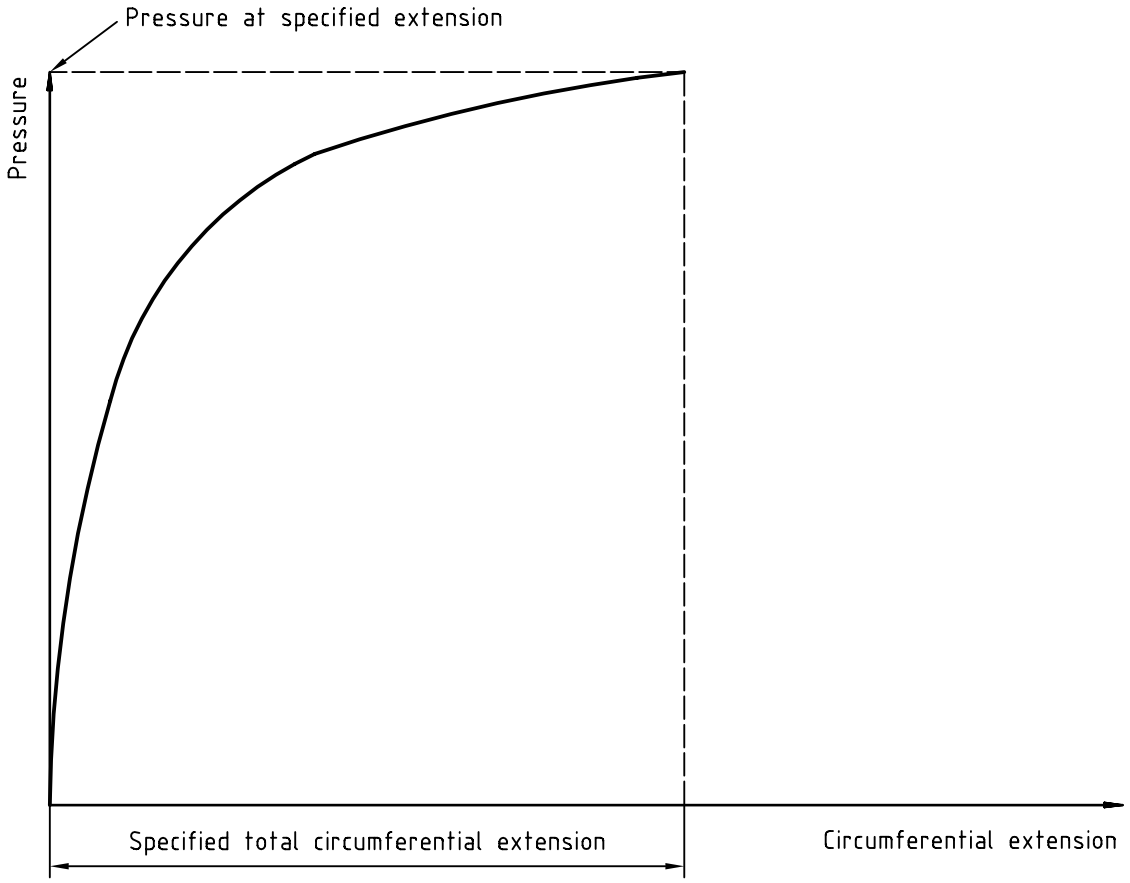


Figure 5 — Typical pressure/extension test record

8 Test report

The test report shall contain at least the following information:

a) reference to this International Standard, i.e. ISO 15363;

b) identification of test ring, e.g. cast No./tube No./identification No.;

c) material specification, if known;

d) diameter and wall thickness of the tube;

e) length of the tube test ring;

f) calculated hoop strength at specified total circumferential strain;

g) reference to an alternative test method used, when appropriate (see annex A).

Annex A
(informative)

Proof and reduced section testing

A.1 Proof testing

This method may be used where the stress necessary to produce the specified circumferential extension has not been achieved but where the stress in the test ring exceeds the specified minimum hoop strength requirement. In this case the percentage circumferential expansion achieved should be quoted in the report.

A.2 Reduced section testing

This method enables the stress corresponding to the specified circumferential extension to be achieved by a reduction in the test ring thickness. This reduction can be effected by machining the inside and/or outside of the tube. To ensure that the full thickness is represented, two or possibly three determinations should be carried out after machining:

(i) inside;

(ii) outside;

(iii) both diameters.

Details of all test piece locations and dimensions relative to the full thickness ring section should be included in the report.

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