
Restrained joint systems for ductile iron pipelines — Design rules and type testing

*Assemblages verrouillés pour canalisations en fonte ductile — Règles
de conception et essais de type*

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 2, *Cast iron pipes, fittings and their joints*.

This second edition cancels and replaces the first edition (ISO 10804-1:2010), which has been technically revised. The main changes compared to the previous edition are as follows:

- the positive internal pressure type test in the configuration of minimum design radial gap has been introduced for joints restrained by gasket with hard anchor teeth;
- the references and presentation have been reviewed and improved.

Restrained joint systems for ductile iron pipelines — Design rules and type testing

1 Scope

This document specifies the design rules and type testing for restrained joint systems to be used on ductile iron pipelines complying with ISO 2531 and ISO 7186, in order to determine their mechanical properties and leaktightness.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 6708, *Pipework components — Definition and selection of DN (nominal size)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6708 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

restrained joint

joint in which a means is provided to prevent separation of the assembled joint

3.2

allowable operating pressure

PFA

maximum internal pressure, excluding surge, which a component can safely withstand in permanent service

3.3

allowable maximum operating pressure

PMA

maximum internal pressure, including surge, which a component can safely withstand in service

3.4

type test

proof-of-design test which is performed once and repeated only after change of design

3.5

allowable angular deflection

angular deflection that a joint between two components can safely withstand in service under the *allowable operating pressure (PFA)* (3.2)

4 Design rules

4.1 All restrained joints for ductile iron pipes, fittings and other components shall be designed in accordance with this clause. If the design of a restrained joint has been tested and successfully used for a minimum of 10 years, a type test as described in [Clause 5](#) is only required for a significant change in the design which could adversely affect the performance of the restrained joint.

4.2 The minimum thickness of the spigot for restrained joints shall allow any necessary welding or loading from attachments (e.g. gasket teeth). This may result in a pipe thicker than the corresponding pressure class thickness of the pipe. The manufacturer shall declare the pipe thickness for their restrained joints.

4.3 The design safety factors with respect to failure against axial forces due to internal pressure shall be such that the joints shall withstand a type test of 1,5 times the allowable operating pressure (PFA) plus 5 bar (5×10^5 Pa).¹⁾

4.4 The joints shall be type tested to a negative pressure of 0,9 bar (9×10^4 Pa) below atmospheric pressure [approximately 0,1 bar (10^4 Pa) absolute pressure]. When the restraining mechanism and sealing component of a restrained joint are independent, such a joint does not need to be subjected to a negative internal pressure test if the unrestrained version of the joint has passed this test (see ISO 2531).

4.5 The joints shall be type tested to a cyclic internal hydraulic pressure as follows:

- a) 24 000 cycles;
- b) test pressure of between PMA and (PMA - 5) bar.

4.6 Ductile iron pipelines and the restrained joints defined in this document are well suited for use in seismic zones. However, certain locations such as fault crossings, liquefaction zones and connections to structures require specialized designs. The pipe manufacturer or a competent earthquake engineer should be consulted.

4.7 For joint restraint components, the protection against aggressive soils shall be at least as good as that of the pipes and/or fittings. It may be achieved by means of works-applied coatings and/or site-applied protection systems.

5 Type testing

5.1 General

Each restrained joint design shall be tested in order to demonstrate its mechanical strength and its leaktightness under the most unfavourable condition of casting tolerances and joint movements.

The type tests shall be carried out in the configuration of maximum design radial gap between the components to be jointed (smallest spigot together with largest socket). In addition, the spigot thickness shall be the minimum casting thickness, $+10\%$. The length of the minimum thickness of the spigot for the type test shall be such as to include any welding and/or attachments for that joint. It is permissible to machine the spigot end of the test pipe in the bore to achieve the required thickness.

In the type tests, the maximum gap shall not be less than the corresponding maximum design radial gap by more than 5 % or 0,5 mm (whichever is the smaller). The internal socket diameter may be machined to achieve this.

1) 1 bar = 10^5 Pa = 0,1 MPa = 0,1 N/mm² = 10^5 N/m².

For joints that are restrained by gasket with hard anchor teeth, the type test (only positive internal pressure test) shall also be carried out in the configuration of minimum design radial gap between the components to be jointed (largest spigot together with smallest socket). In the type tests, the minimum gap shall not be more than the corresponding minimum design radial gap by more than 5 % or 0,5 mm (whichever is the smaller). It is permissible to cast the socket specially for the test and/or be machined to get the minimum gap.

5.2 Test conditions

There shall be a type test for at least one DN in each of the groupings given in [Table 1](#), normally using the preferred DN. One DN is representative of a grouping when the performances are based on the same design parameters throughout the size range.

Table 1 — DN groupings for type tests

DN grouping	40 to 250	300 to 600	700 to 1 000	1 100 to 2 000	>2 000
Preferred DN	200	400	800	1 600	2 400

If a grouping covers products of different design and/or manufactured by different processes, the grouping shall be subdivided. If, for a certain manufacturer, a grouping contains only one DN, this DN may be considered part of the adjacent grouping provided it is of identical design and manufactured by the same process.

Each diameter tested shall be subjected to the following conditions:

- joint assembled in the aligned position, then deflected to the allowable angular deflection indicated in the manufacturer's instructions, and tested while maintained in the deflected position;
- joint assembled in the aligned position, then subjected to a load giving a resultant shear force across the joint of not less than 30 times DN (expressed in newtons), and tested under shear.

Joint assemblies shall exhibit no visible leakage and no mechanical instability (little deformations like teeth traces and the buckling beside teeth traces are allowed) after 2 h under the following pressures:

- hydrostatic pressure according to [4.3](#);
- negative internal pressure according to [4.4](#);
- cyclic internal hydraulic pressure according to [4.5](#).

In addition, any axial movement that may occur at the joint shall reach a constant value within the 2 h test duration.

5.3 Test method for positive internal pressure

The test apparatus shall be capable of providing suitable end closure whether or not the joint is in the aligned position, deflected or subjected to a shear load. The apparatus shall be equipped with a pressure gauge with an accuracy of ± 3 %.

Testing shall be carried out on an assembled joint comprising two pipe sections, each at least 1 m long.

For the test according to [5.2 b\)](#), the shear load shall be applied to the spigot end by means of a V-shaped block with an angle of 120° , located at approximately $0,5 \times \text{DN}$, in millimetres, or 200 mm from the socket face (whichever is the larger); the socket shall bear on a flat support.

The test assembly shall be filled with water and suitably vented. The test pressure shall be raised at a rate not exceeding 1 bar/s (10^5 Pa/s).

The test pressure shall be kept constant to $\pm 0,5$ bar (5×10^4 Pa) for at least 2 h, during which the joint is to be thoroughly inspected and its axial movement measured every 15 min.

5.4 Test method for negative internal pressure

The test assembly and apparatus shall be as given in 5.3, with the pipe sections axially restrained to prevent them moving towards each other.

The test assembly shall be empty of water and shall be evacuated in accordance with 4.4 and isolated from the vacuum pump. The test assembly shall be left under vacuum for at least 2 h, during which the pressure shall not have changed by more than 0,09 bar (9×10^3 Pa). The test shall begin at a temperature between 5 °C and 40 °C. The temperature of the test assembly shall not vary by more than 10 °C for the duration of the test.

5.5 Test method for dynamic (cyclic) internal pressure

The test assembly and apparatus shall be as given in 5.3. The test assembly shall be filled with water and suitably vented of air.

The pressure shall be steadily increased up to PMA, the allowable maximum operating pressure of the joint, and then automatically monitored according to the following pressure cycle:

- a) steady pressure reduction to PMA less 5 bar;
- b) maintain PMA less 5 bar for at least 5 s;
- c) steady pressure increase to PMA;
- d) maintain PMA for at least 5 s.

The number of cycles shall be recorded and the test stopped automatically in the occurrence of a failure of the joint. Any axial movement at the spigot shall be measured at the end of the test.

All necessary safety precautions should be taken for the duration of the pressure test.

5.6 Test report

The test report shall contain at least the following:

- a) type of joint;
- b) size range covered by the test;
- c) DN tested;
- d) class and the spigot end wall thickness of pipe tested;
- e) allowable operating pressure;
- f) maximum allowable operating pressure;
- g) allowable test pressure;
- h) allowable angular deflection;
- i) result of test;
- j) date of test.