INTERNATIONAL STANDARD

**ISO 10802**

Second edition
2020-08

# Ductile iron pipelines — Hydrostatic testing after installation

*Canalisations en fonte ductile — Essais hydrostatiques après pose*



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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of 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 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 10802:1992), which has been technically revised.

The main changes compared to the previous edition are as follows:

— add the safety instructions for hydrostatic testing operation;

— add hydrostatic test flow chart;

— add several diagrams for comprehensiveness;

— add pressure drop test method, as alternative of constant pressure test.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.



# Introduction

Ductile pipelines include many components and jointing solutions to offer a reliable service under the worst situations (high pressure variations, earthquakes, etc.) hence the need of a secure hydrostatic pressure test after having taken into account possible movements of the components.

Every pipeline which has been constructed undergo a water pressure test to ensure the integrity of pipes, joints, fittings and other components such as anchor blocks.

Normally it is made as the assembly of the pipeline progresses, according to the proposed methodology consisting of 3 phases:

— preliminary operations to prepare the test;

— preliminary test to stabilize the pipeline and to evacuate air in the pipeline;

— main pressure test to assess the water tightness of a pipeline at test pressure; it can be done either by a:

  — water loss test: Falling pressure - WLFP or constant pressure – WLCP methods, or

  — pressure drop test - Direct reading – PDDR method.

Figure 1 summarizes the sequence to follow during the test.

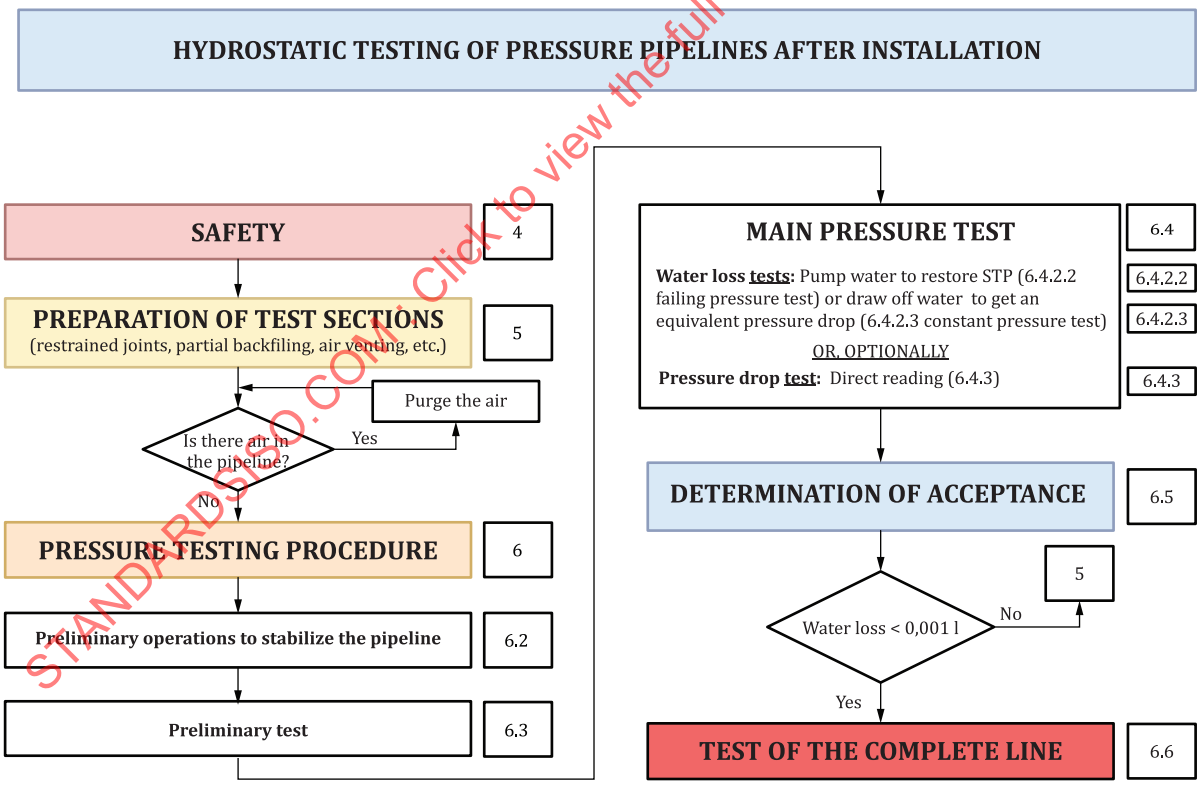



**Figure 1 — Testing procedure flow chart**

# Ductile iron pipelines — Hydrostatic testing after installation

## 1 Scope

This document specifies site hydrostatic acceptance tests for installed pressure and non-pressure ductile iron pipelines used for conveying water and other liquids.

It does not cover testing of pipelines for gas.

NOTE In this document, all pressures are relative pressures expressed in bars, where 1 bar = 0,1 MPa.

## 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 2531, *Ductile iron pipes, fittings, accessories and their joints for water applications*

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

ISO 7186, *Ductile iron products for sewerage applications*

ISO 7268, *Pipe components — Definition of nominal pressure*

ISO 10804, *Restrained joint systems for ductile iron pipelines — Design rules and type testing*

ISO 16631, *Ductile iron pipes, fittings, accessories and their joints compatible with plastic (PVC or PE) piping systems, for water applications and for plastic pipeline connections, repair and replacement*

ISO 21051[1)], *Construction and installation of ductile iron pipeline system*

## 3 Terms and Definitions

For the purposes of this document, the terms and definitions given in ISO 6708, ISO 7268 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 http://www.electropedia.org/

**3.1**
**allowable operating pressure**
**PFA**
$P_{FA}$
maximum internal pressure, excluding surge, that a component can safely withstand in permanent service

[SOURCE: ISO 2531:2009, 3.2, modified — The symbol has been added.]

1) Under preparation. Stage at the time of publication: ISO/FDIS 21051:2020.

**3.2**
**allowable maximum operating pressure**
**PMA**
$P_{MA}$
maximum internal pressure, including surge, that a component can safely withstand in service

Note 1 to entry: $P_{MA} = 1{,}2 \times P_{FA}$

[SOURCE: ISO 2531:2009, 3.17, modified — The term has been changed from "maximum allowable operating pressure" to "allowable maximum operating pressure"; the symbol and note 1 to entry have been added.]

**3.3**
**allowable site test pressure**
**PEA**
$P_{EA}$
maximum hydrostatic pressure that a newly installed component can withstand for a relatively short duration, when either fixed above ground level or laid and backfilled underground, in order to measure the integrity and tightness of the pipeline

Note 1 to entry: This test pressure is different from the *system test pressure* (3.7) which is related to the design pressure of the pipeline.

Note 2 to entry: $P_{EA} = 1{,}2 \times P_{FA} + 5$.

[SOURCE: ISO 2531:2009, 3.3, modified — Note 2 to entry has been added.]

**3.4**
**working pressure**
**WP**
$P_W$
highest pressure that occurs at a time and a point in the pipeline when operating continuously under stable conditions, without surge

**3.5**
**maximum working pressure**
**MWP**
$P_{MW}$
maximum pressure to which a pipeline is subjected under surge conditions

**3.6**
**maximum design pressure**
**MDP**
$P_{MD}$
maximum operating pressure of the system or of the pressure zone fixed by the designer considering future developments and including surge

Note 1 to entry: It is the maximum pressure considering the design pressure and surge together, where:

— MDP is designated MDPa, $P_{MDa}$, fixed allowance for surge (secondary distribution networks);

— MDP is designated MDPc, $P_{MDc}$, surge is calculated (pumping & water mains).

**3.7**
**system test pressure**
**STP**
$P_{ST}$
pressure to which a pipeline or a pipeline section is subjected for testing purposes

Note 1 to entry: to entry:

— $P_{ST} = 1{,}5 \times P_D$ (when $P_{MD} \leq 10$ bar), or

— $P_{ST} = P_D + 5$ (when $P_{MD} > 10$ bar)

where $P_D$ is the design pressure.

Note 2 to entry: Annex C provides information on pressure pairing of component pressures and pipeline pressures.

## 4 Safety

If not covered by a national regulation, the following specifications shall be implemented.

Related to personnel:

— At all stages of testing, the planned sequence and any variation of operations shall be controlled to avoid danger to personnel.

— All personnel shall be clearly informed of the intensity of the loading on temporary fittings and supports and the consequences if failure occurs.

— Prior to the commencement of operations, a check shall be made so that the appropriate safety equipment is available and that personnel have the correct protective clothing.

Related to works:

— Permanent abutments or anchorages shall be constructed to withstand thrust at the test pressure. Concrete anchor blocks shall be allowed to develop adequate strength before testing begins.

— Care shall be taken to ensure that caps or other temporary blanking fittings are adequately anchored, with the load distributed according to the strength of the supporting ground. Gate valves, fire hydrants, water hammer release equipment nor safety valves should / shall not be used as blanking fittings.

— Any temporary supports or anchorage at the ends of the test section shall not be removed until the pipeline is depressurized.

— After installation and until completion of reinstatement, all excavations shall remain adequately guarded. Work not related to pressure tests shall not be permitted in pipe trenches during pressure tests.

— When performing test, the pipe trench and its surrounding shall be guarded with safety distance. Only inspectors can enter the area to perform their work.

Related to equipment:

— Prior to carrying out a pressure test a check shall be made to ensure that the test equipment is calibrated, is in good working order and correctly fitted to the pipelines.

During the test:

— Air shall be exhausted from the pipeline as fully as reasonably possible. Filling shall take place slowly from, if possible, the lowest point in the pipeline and in such a way as to prevent back siphonage and so that air escapes at adequately sized facilities for venting.

— Care shall be taken to fill pipelines with water slowly whilst all facilities for venting are open and the pipelines adequately vented.

— Water used for test shall be able to be drained without flooding or polluting the work site.

**WARNING — The test methods described in Clauses 5 and 6 are applicable only for water-pressure testing. They shall in no case be applied for air pressure testing because of the serious safety hazards involved in doing so.**

# 5 Preparation of the test sections

## 5.1 General conditions

The ductile iron pipelines shall be made of ductile iron pipes, fittings and accessories in accordance with ISO 2531, ISO 7186 or ISO 16631, and installed in accordance with ISO 21051.

If materials other than ductile iron are included in the water network, they shall be tested separately. The ductile iron pipeline shall be tested as a whole or, when necessary, subdivided into several test sections selected so that:

— the test pressure can be achieved at the lowest point of each test section;

— a pressure of at least MDP can be achieved at the highest point of each test section unless otherwise specified by the designer;

— the necessary water for testing can be provided and removed without difficulty.

The length of pipeline test sections should be determined on the basis of the following considerations:

— the local conditions;

— the availability of suitable water;

— the number of fittings and accessories (e.g. valves, hydrants, etc.) constituting the pipeline;

— the difference in elevation between different parts of the pipeline.

— the existence of locking joints:

In the event of partial locking of fittings with pipes to ensure self-anchoring, locked areas can be tested together with unlocked areas.

In case of a completely locked section, provision shall be made to allow the pipe to pull under pressure. The ends of these sections shall not be stopped.

## 5.2 Pressure pipelines

### 5.2.1 General

For pressure pipelines, the length of the test sections shall not exceed 1 500 m unless otherwise specified.

### 5.2.2 Anchoring and closures

It is required to evaluate the hydraulic loads exerted on the ends of the pipeline and set up a properly sized system of anchors, so as to absorb the loads in the timbers buried across the trench or in sheet piling.

Table 2 provides indicative values of a thrust force on a pipeline closure (such as, flanged blank) generated by hydraulic pressure of 1 bar, and a calculation example of the thrust exerted by pressure.

**Table 1 — Example of thrust calculation exerted by pressure**

| DN | *F* (1 bar) daN | DN | *F* (1 bar) daN | DN | *F* (1 bar) daN | DN | *F* (1 bar) daN |
|---|---|---|---|---|---|---|---|
| 60 | 47 | 250 | 590 | 600 | 3 167 | 1 200 | 12 370 |
| 80 | 75 | 300 | 835 | 700 | 4 278 | 1 400 | 16 787 |
| 100 | 109 | 350 | 1 122 | 800 | 5 568 | 1 500 | 19 236 |
| 125 | 163 | 400 | 1 445 | 900 | 7 014 | 1 600 | 21 851 |
| 150 | 227 | 450 | 1 809 | 1 000 | 8 626 | 1 800 | 27 612 |
| 200 | 387 | 500 | 2 223 | 1 100 | 10 405 | 2 000 | 34 045 |
| 2 200 | 41 115 | 2 400 | 48 891 | 2 600 | 57 340 | | |

EXAMPLE For DN150 and 10 bar, it results in a thrust force of 2 270 daN.

NOTE 1 Since the inner diameter is greater than the nominal one and it depends on the pipe pressure class, the outer diameter has been used for the calculation for safety reasons.

$$F = P \times \pi \times (D_I)^2 / 4$$

where $P$ is the hydraulic pressure, $D_I$ is the internal diameter.

NOTE 2 1 bar = 100 kPa, 1 daN = 1,019 7 kilogram-force [kgf].

All changes in direction and/or cross-section of the pipeline, such as bends, tees, tapers (reducers) and blank flanges, shall be adequately restrained (or anchored) before testing by means of thrust blocks or restraining (self-anchoring) joints.

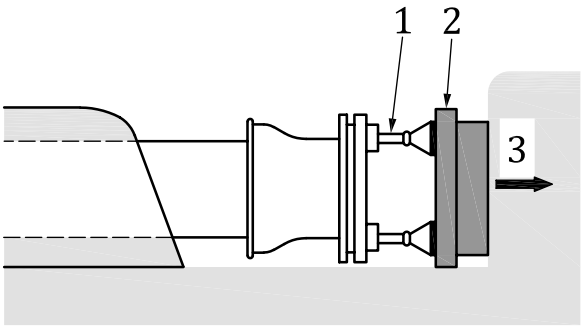
The design of the restraining (anchoring) devices shall take due consideration of the test pressure to be applied and be in accordance with ISO 10804.

Isolation of the test sections shall be achieved by using blank flanges or other types of closures.

Other components such as gate valves, fire hydrants, water hammer release equipment or safety valves should not be used to replace the blank flange, but if for practical reasons, valves are used as closure pieces, the test pressure shall not exceed the rated pressure of the valves. When evaluating the overall leakage allowance for a test section, due consideration shall be taken of the allowable leakage rate(s) of the valve(s).

The already laid and hydraulically tested ends shall not be put under load.

In order to compensate possible subsidence, it may be needed to provide screw jacks (see Figure 2).




**Key**

1 screw jacks
2 thrust block
3 thrust *F*

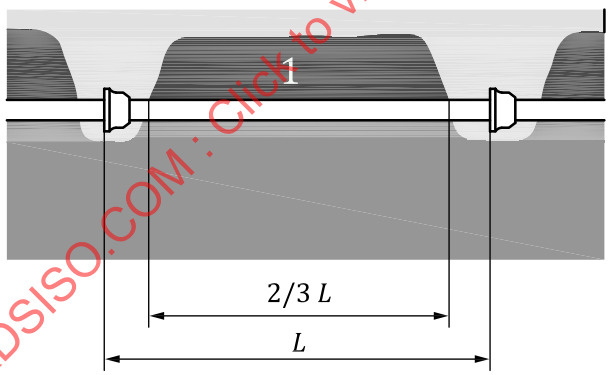
**Figure 2 — Anchoring example**

### 5.2.3 Partial backfilling before testing

Pipelines are normally tested partially backfilled leaving the pipe joints accessible for inspection.

Sufficient backfill material shall be placed over the pipe barrel between the joints to prevent movement, and due consideration shall be given to restraining thrust forces during the test (see Figure 3).

ln particular, restrained-joint systems which derive their stability from the interaction of the pipe and soil should be backfilled prior to testing.




**Key**

1 backfill
*L* standardized length of the pipe

**Figure 3 — Partial backfilling before testing**

### 5.2.4 Filling with water and air venting

After having divided the pipeline into practicable test sections, the pipeline shall be completely filled with water and air-vented. The pressure shall be raised up to at least the operating pressure, without exceeding the system test pressure.

The pipeline shall have air-venting facilities at all high points. The ends of the relevant section shall be blocked with blank flanges fitted with venting valves.

For potable water pipelines, potable water shall be used for the pressure test, unless otherwise specified by the designer.

The presence of air in the test section of the pipeline will result in erroneous data, especially in the case of discontinuous height profiles, which could indicate apparent leakage or could, in some cases, mark a small leak.

The air present in the pipeline water will, over a period of time, leave the solution. The volume previously occupied by the air will be replaced by water and, in doing so, the pipeline pressure will decrease. The kinetics of dissolution of air in water is a function of many parameters:

— the initial saturation level of the pumped water;

— the water temperature: the amount of dissolved air decreases with an increase in temperature;

— water pressure: the amount of dissolved air increases with an increase of the water pressure;

— the location of the air pockets;

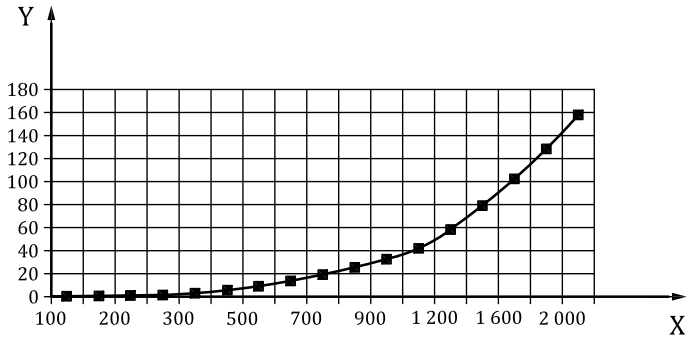
— the dimension of the interface zones between air and water;

— etc.

The pipeline shall be filled slowly, when the ventilation devices are open, from the lowest point, so that no backflow occurs and the air can escape through ventilation devices. Too fast filling may cause trapped air cushions.

In the case of an inconsistent height profile, venting through "pigs" is recommended, since in some cases the line cannot be completely vented despite high flushing speeds.

As a guide, the flow-rate during filling should not exceed 10 % of the design working flow-rate. Experience has shown that the filling speed should not exceed the values given in Figure 4.




| DN | Flow rate (l/s) |
|---|---|
| 100 | 0,39 |
| 200 | 1,57 |
| 300 | 3,53 |
| 400 | 6,28 |
| 500 | 9,81 |
| 600 | 14,13 |
| 700 | 19,23 |
| 800 | 25,12 |
| 900 | 31,79 |
| 1 000 | 39,25 |
| 1 200 | 56,52 |
| 1 400 | 76,93 |
| 1 600 | 100,48 |
| 1 800 | 127,17 |
| 2 000 | 157,00 |
| 2 200 | 190,06 |
| 2 400 | 226,19 |
| 2 600 | 265,45 |

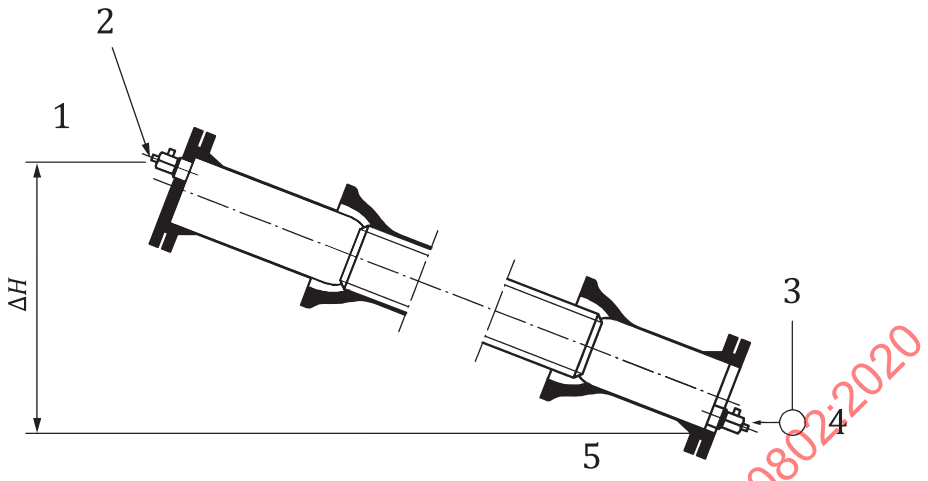
**Key**

X DN

Y filling speed

**Figure 4 — Recommended filling speed**

The pressure test shall be the system test pressure, calculated for the lowest point of the test section, minus the difference in altitude. Any debris and foreign matter shall be removed from the pipeline before testing. A calibrated pressure meter with the adequate range and precision should be installed at the lowest point of the test section (see Figure 5).




**Key**

1 higher end
2 air vent
3 test pump and pressure meter
4 pressure to be applied STP
5 lower end

**Figure 5 — Filling with water & pressure to be applied**

Cement mortar lined pipelines require a period of time after filling (depending on site hygrometry conditions) for absorption by the lining to take place.

### 5.3 Non-pressure pipelines

For non-pressure pipelines, the test section is usually the total length between consecutive manholes or inspection points.

If special arrangements are made to enable testing over only part of the length between manholes and inspection points, then the length of the test section shall not exceed 1 000 m unless otherwise specified.

NOTE This is normally between two manholes, whose distance is normally less than 1 km.

For non-pressure pipelines, anchoring calculation is required owing to the pressure test requirement of 5 bar as per 6.7.

## 6 Pressure testing procedure

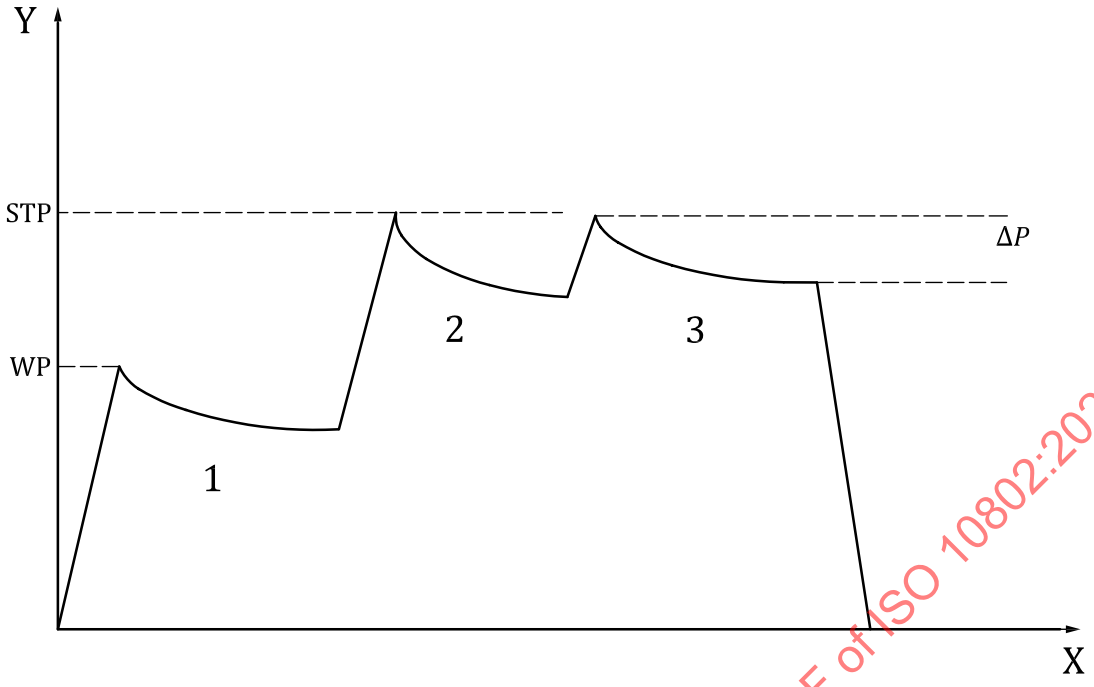
### 6.1 General

The procedure of the pressure testing of a pipeline with cement mortar is explained in the Figure 6, with the three steps:

— the preliminary operation at working pressure,

— the preliminary test at system test pressure, for stabilizing and venting the pipeline,

— the main pressure test (falling pressure or constant pressure test, or pressure drop) to assess the water tightness of the installed pipelines.




**Key**

X time (hours)
Y pressure (bars)
1 preliminary operation 1 h to 24 h
2 preliminary test 1 h or a longer period if specified by the designer
3 main test 1 h to 6 h per DN, call repeat if fail

**Figure 6 — Pressure testing procedure**

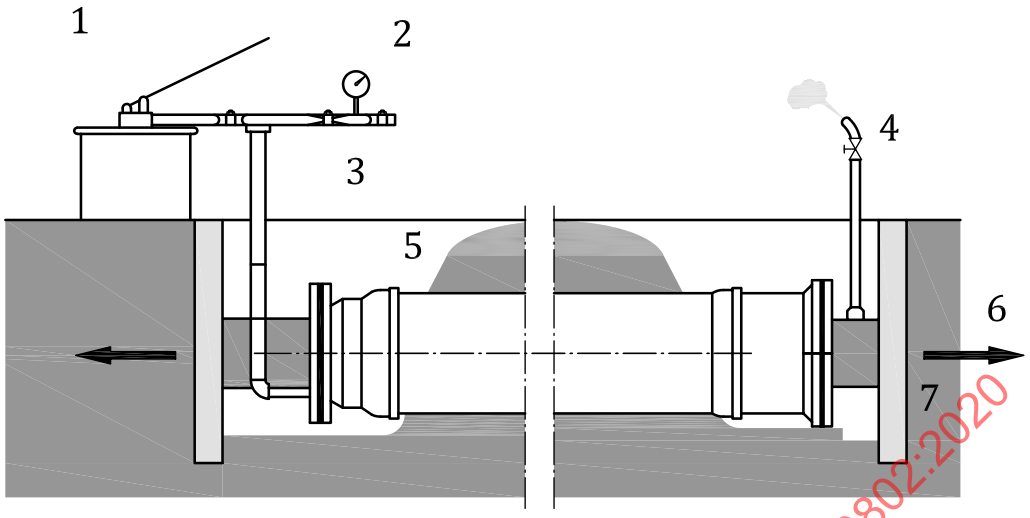
The components of the pressure testing of a pipeline is shown in Figure 7. The test methods comparison for the three steps of the pressure testing procedure is given in Annex A.

## 6.2 Preliminary operations for pressure pipelines

After filling and before application of the test pressure, maintain the test section at the working pressure (WP) for a sufficient period (up to 24 h) of time for it to stabilize with respect to line movement under pressure and water absorption by the lining, etc.

The duration of the preliminary operations shall be specified by the designer, with respect to local conditions, such as temperature change, humidity, length and DN of pipelines, etc.

Inspect visually all exposed joints, fittings, anchorages and closures and repair all defects, after draining the test section if necessary.




**Key**

1 test pump
2 pressure gauge
3 pump connection
4 air vented
5 pile of soil
6 thrust force
7 anchor system

**Figure 7 — Components of the pressure test**



## 6.3 Preliminary test for pressure pipelines

When the visual inspection is satisfactory, raise the pressure steadily until the system test pressures (STP) specified below are attained, in order to stabilize the pipeline and eliminate the air before performing the main pressure test.

The test pressure at the lowest point of the test section shall be not less than the limit specified in a) or b), whichever is greater.

a) For $P_W \leq 10$ bar: $P_{ST} = 1{,}5 \times P_W$

For $P_W > 10$ bar: $P_{ST} = P_W + 5$

b) The maximum $P_W$: $P_{ST} = P_{MDc}$

The test pressure shall not exceed the maximum test pressure (PEA) of the component (pipes, fittings, flanges and accessories), nor the design pressure of the restraining devices, installed in the pipeline.

The test pressure at the highest point of the test section shall not be less than the working pressure at this point.

It should be noted that the large temperature variation can affect the main pressure, so the temperature influence on the pipeline to be tested shall be kept as low as possible, for example by ensuring that the start and end temperatures of the pipe wall are approximately the same.

## 6.4 Main pressure test

### 6.4.1 General

In case of local distribution networks, some national standards define a pressure drop test during a short period of time in order to re-stablish the urban services as soon as possible, whereas the water loss tests (either measuring the falling pressure or maintaining a constant pressure) described in this document are preferable because they take into account the real conditions of the pipeline (DN, length, pressure) so they shall be used for all cases of pipelines and test durations.

The main pressure test shall not be started until the preliminary operations and preliminary test have been successfully completed.

It is important to note that even after the preliminary test the pipeline can keep on having stabilization phenomena which can cause a pressure drop without a water leakage during the main pressure test. These phenomena are mainly:

— increase of the volume of the pipeline, due to longitudinal or lateral movements of the joints;

— presence of air running through the pipeline;

— dissolution in the water of the air present in the pipeline;

— temperature variations.

Pressure test shall be carried out with all facilities for venting closed and intermediate line valves open.

The designer shall specify which one of the three possible test methods is going to be used:

— water loss test - falling pressure (WLFP): measuring the water loss when pressure drops;

— water loss test - constant pressure (WLCP): measuring make-up water when maintaining the pressure constant to ±0,1 bar;

— pressure drop test (PDDR): direct reading of pressure drop.

Once finalised the main pressure test, the pipelines shall be depressurised slowly and all facilities for venting shall be open when emptying pipelines.

### 6.4.2 Water loss test

#### 6.4.2.1 General

Two options are possible for the water loss test, either by letting fall the pressure (WLFP) or maintaining it constant (WLCP). In both cases the test duration shall be at least

— 1 h for DN ≤ 600;

— 3 h for 600 < DN ≤ 1 400;

— 6 h for DN > 1 400.

#### 6.4.2.2 Water loss test — Falling pressure (WLFP)

Maintain the test pressure (STP) constant to ±0,1 bar, by pumping if necessary, for a period of at least 1 h. Then disconnect the pump and allow no further water to enter the test section for a duration as specified in 6.4.2.1.

At the end of this period, measure the pressure in the test section. Determination of the water loss is made by measuring (to an accuracy of ±5 %) the amount of water necessary to pump into the test section

to restore the test pressure within ±0,1 bar, or by restoring the test pressure and measuring the amount of water it is necessary to draw off from the test section to reproduce an equivalent pressure drop.

#### 6.4.2.3 Water loss test — Constant pressure (WLCP)

Maintain the test pressure (STP) constant to ±0,1 bar, by pumping if necessary, for a period of at least 1 h. Then maintain the test pressure constant (to ±0,1 bar) in the test section by pumping for a duration as specified in 6.4.2.1.

At the end of this period, determine (to an accuracy of ±5 %) the amount of water used to maintain the test pressure in the test section.

### 6.4.3 Pressure drop test — Direct reading (PDDR)

Raise the pressure steadily until the system test pressure (STP) is reached.

The duration of the pressure drop test shall be 1 h or a different duration if specified by national standards. During the main pressure test the pressure loss $\Delta p$ shall display a regressive tendency and shall not exceed the limit defined in 7.1.2.

## 6.5 Determination of acceptance

A complete record of the details of the-test shall be made and retained. Annex B offers an example.

At the main pressure test, if the water loss determined in 6.4.2.2 or 6.4.2.3 is greater than the acceptable limit specified in 7.1.1, the test shall be repeated if necessary until full stabilization of the test section has been achieved. If the test is not successful, the system shall be examined and rectified where necessary. The test shall be repeated until the loss complies with that specified.

## 6.6 Testing of the complete pipeline

Where a length of pipeline has been divided into two or more sections for pressure testing and all the sections have been tested satisfactorily, the whole system shall be pressurized at the operating pressure for at least 2 h. Any additional component which is included after the pressure test of the adjacent sections shall be inspected visually for leaks and changes of line and level.

## 6.7 Non-pressure pipelines

After filling and before application of the test pressure, leave the test section for a sufficient period of time to allow water absorption by the lining. During this period, inspect visually all exposed joints, fittings and closures and all defects, after draining the test section if necessary.

Apply the test pressure by filling the upstream manhole. Unless maximum water tightness is essential the test pressure shall not exceed 0,4 bar at the crown of the pipe adjoining the upstream manhole; 1 bar at the crown of the pipe adjoining the downstream manhole, unless otherwise specified.

When maximum water tightness is essential, for instance owing to the presence of a high water table, springs or wells, a test pressure of up to 5 bar may be specified.

After a test period of 2 h, determine the water loss by measuring the quantity of water it is necessary to add to restore the initial level in the upstream manhole.

If the water loss determined is greater than the acceptable limit specified in 7.2, the test procedure shall be repeated if necessary until full stabilization of the test section has been achieved. If the test is not successful, locate and repair the defects, and repeat the test procedure until the loss is below the limit specified in 7.2, unless otherwise agreed.

# 7 Acceptance criteria

## 7.1 Pressure pipelines

### 7.1.1 Water loss test — Falling pressure and water loss test — Constant pressure

The water loss shall not exceed 0,001 l/h per kilometre of pipeline/millimetre of nominal size/bar of static pressure (average head applied to the test section).

NOTE 1 This corresponds to an acceptable loss of 1 l/h per kilometre of DN 100 pipeline tested at 10 bar. ln cases where the elevation of the pipeline varies considerably throughout its length, the acceptable loss can be determined from a weighted average pressure.

NOTE 2 Table 2 offers some calculation examples.

**Table 2 — Calculation examples of admissible water loss and pressure drop for ductile iron pipes according to ISO 2531, ISO 7186 (pressure pipes) and ISO 16631**

| DN (mm) | DE (mm) | Nominal thickness (mm) | Lining thickness (mm) | Calculated DI (mm) | Total length (km) | Volume of water (l) | Admissible water loss | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Test Pressure (bar) | Water loss (l/h) |
| 75 | 75 | 3,0 | 0,3 | 68,4 | 1 | 3 674,5 | 10,0 | 0,684 |
| 100 | 118 | 4,4 | 4 | 101,2 | 1 | 8 043,60 | 10,0 | 1,012 |
| 125 | 125 | 3,1 | 0,3 | 118,2 | 1 | 10 972,98 | 10,0 | 1,182 |
| 140 | 140 | 3,1 | 0,3 | 133,2 | 1 | 13 934,72 | 5,0 | 0,666 |
| 150 | 170 | 4,5 | 4 | 153 | 1 | 18 385,38 | 10,0 | 1,530 |
| 160 | 160 | 3,2 | 0,3 | 153 | 1 | 18 385,38 | 5,0 | 0,765 |
| 200 | 222 | 4,7 | 4 | 204,6 | 1 | 32 877,67 | 10,0 | 2,046 |
| 250 | 274 | 5,5 | 4 | 255 | 1 | 51 070,51 | 10,0 | 2,550 |
| 300 | 326 | 6,2 | 4 | 305,6 | 1 | 73 349,40 | 10,0 | 3,056 |
| 350 | 378 | 6,4 | 5 | 355,2 | 1 | 99 091,36 | 10,0 | 3,552 |
| 400 | 429 | 6,5 | 5 | 406 | 1 | 12 9461,8 | 10,0 | 4,060 |
| 500 | 532 | 7,5 | 5 | 507 | 1 | 201 885,8 | 10,0 | 5,070 |
| 600 | 635 | 8,7 | 5 | 607,6 | 1 | 289 951,5 | 10,0 | 6,076 |
| 800 | 842 | 9,6 | 6 | 810,8 | 1 | 516 318,1 | 5,0 | 4,054 |
| 1 000 | 1 048 | 11,6 | 6 | 1 012,8 | 1 | 805 633 | 5,0 | 5,064 |

NOTE Water loss < 0,001 (l/h) × length of pipeline (km) × calculated DI (mm) × static pressure (bar).



### 7.1.2 Pressure drop test — Direct reading

When using the pressure drop test, the pressure drop is directly read. It may display a regressive tendency that after 1 h shall not exceed:

— the pressure drop limit as specified by the applicable national standard;

— 30 kPa, with an additional 10 kPa drop for each extra hour (maximum 2 h for testing duration).

## 7.2 Non-pressure pipelines

The water loss shall not exceed 0,1 l/km of pipeline/millimetre of nominal size. However, when a test pressure in excess of 1 bar is specified (see 5.3), the acceptance criteria is that of pressure pipelines.

# Annex A
(informative)

# Test methods description and comparison

Table A.1 gives the test methods description and comparison for the three steps of the pressure testing procedure described in 6.1.

**Table A.1 — Test methods description and comparison**

| Preliminary operations and preliminary test | | | |
|---|---|---|---|
| | Preliminary operations (to stabilize) 6.2 | | Preliminary test (to eliminate air) 6.3 |
| Duration | Working pressure (WP) up to 24 h to stabilize. | | STP ≤ PEA of components & ≤ Design pressure of joints, etc.<br>Highest point ≥$P_W$ and at lowest point ≤ a) or b):<br>a) $P_{ST} = 1{,}5 \times P_W$ ($P_W \leq 10$ bar)<br>$P_{ST} = P_W + 5$ ($P_W > 10$ bar)<br>b) $P_{ST} = P_{MDc}$ (for max. $P_W$) |
| Conditions | Duration specified by the designer. | | 1 h or a longer period if specified by the designer. |
| Measurements | Inspect visually all exposed joints, fittings, anchorages and closures | | Direct reading of pressure drop |
| Validation | Repair all defects, after draining the test section, if necessary. | | Regressive tendency of pressure loss $\Delta P$. |
| Main pressure test(s) | | | |
| | Water loss test | | Pressure drop |
| | Falling pressure 6.4.2.2 WLFP | Constant pressure 6.4.2.3 WLCP | Direct reading 6.4.3 PDDR |

NOTE Conversion formula:

$$\Delta P_{max} = \frac{\Delta V_{max}}{1{,}2\left\{\frac{1}{E_w} + \frac{D}{e.E_r}\right\}}$$

Where:

— $\Delta V_{max}$ is the allowable water loss in liters;

— $V$ is the volume of the tested pipeline section in liters;

— $\Delta P_{max}$ is the allowable pressure loss in kPa;

— $E_W$ is the bulk modulus of water in kPa;

— $D$ is the internal pipe diameter in meters;

— $e$ is the wall thickness of the pipe in meters;

— $E_r$ is the modulus of elasticity of the pipe wall in the circumferential direction in kPa;

— 1,2 is an allowance factor (e.g. for air content) during the main pressure test.

**Table A.1** *(continued)*

<table>
<tr><td>Duration</td><td colspan="2">— 1 h for DN ≤ 600,<br>— 3 h for 600 < DN ≤ 1 400,<br>— 6 h for DN > 1 400</td><td>1 h</td></tr>
<tr><td>Conditions</td><td>STP ± 0,1 bar for 1 h then disconnect the pump. and allow no further water.</td><td>STP ± 0,1 bar for 1 h then maintain STP ± 0,1 bar by pumping.</td><td>STP ≤ PEA of components & ≤ Design pressure of joints, etc.<br>Highest point ≥ $P_W$ and at lowest point ≤ a) or b):<br>a) $P_{ST} = 1{,}5 \times P_W$ ($P_W \leq 10$ bar)<br>$P_{ST} = P_W + 5$ ($P_W > 10$ bar)<br>b) $P_{ST} = P_{MDc}$ (for max. $P_W$)</td></tr>
<tr><td rowspan="2">Measurements</td><td>STP drops to $P_{ST} - \Delta P$.</td><td>STP is maintained constant.</td><td rowspan="2">Direct reading of pressure drop $\Delta P$.</td></tr>
<tr><td colspan="2">The water loss is determined by measuring the amount of:<br>(1) pumped water to restore STP (after the test) or,<br>(2) drawn-off water to get an equivalent $\Delta P$ (after the test).<br>(1) pumped water to maintain STP (during the test).</td></tr>
<tr><td>Validation</td><td colspan="2">Water loss shall be < Table 2 (7.1.1)</td><td>As specified by the national regulation or $\Delta P$ ≤ 30 kPa (0,3bar) (7.1.2)</td></tr>
<tr><td colspan="4">NOTE Conversion formula:<br>$$\Delta P_{max} = \frac{\Delta V_{max}}{1{,}2\left\{\frac{1}{E_W} + \frac{D}{e.E_r}\right\}}$$<br>Where:<br>— $\Delta V_{max}$ is the allowable water loss in liters;<br>— $V$ is the volume of the tested pipeline section in liters;<br>— $\Delta P_{max}$ is the allowable pressure loss in kPa;<br>— $E_W$ is the bulk modulus of water in kPa;<br>— $D$ is the internal pipe diameter in meters;<br>— $e$ is the wall thickness of the pipe in meters;<br>— $E_r$ is the modulus of elasticity of the pipe wall in the circumferential direction in kPa;<br>— 1,2 is an allowance factor (e.g. for air content) during the main pressure test.</td></tr>
</table>