Tata Steel Technical Standard

S1 47 40 01 General requirements for pressure testing of pipe systems

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Information and changes

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1 General

1.1 Scope

3.1 This standard applies to the site Tata Steel IJmuiden and may be used for other locations.

This standard applies to the following situations:

1. Testing of new industrial pipe systems before first use.
2. Testing of an industrial pipe system when repairs and/or modifications have been made.

This standard does not apply to the following situations:

3.1
1. HVAC systems; refer to R1 43 01 00 (e.g. central heating systems, radiators).
2. Pneumatic pipe systems; refer to R1 41 01 01 & R1 41 01 08
3. Vessels and tanks; refer to design codes

The objective of the tests is to demonstrate the integrity of the finished product, to determine whether the particular pipe system is strong enough to withstand the design pressure, including the applicable safety margins, and to determine whether the system is sufficiently leak-free. To test these aspects, a strength test and a leak test shall be carried out according to the applicable design code. These tests may be combined in a single test procedure if the design code permits this.

This standard only applies to strength and leakage tests of metal and plastic pipe systems. Other aspects that influence the safety of pipe systems are not taken into account.

1.2 Use of this standard

The applicable design code forms the basis for the test procedure to follow. This standard states the additional requirements to, or exemptions to the design code. The design code shall be specified in the purchase order or technical specification for new, modified or repaired pipe systems.

1.3 Safety and integrity

A complete pressure test procedure for testing metal and plastic pipe systems must be executed, to ensure their safety and integrity. Before a pipe system is taken into operation, it shall pass all tests successfully.

When a part of an existing pipe system needs be taken out of operation and isolated before the tests are performed, the manager/owner of the system is responsible for carrying this out.

A specified safety distance, established prior to testing, and a waiting time shall be observed while carrying out the tests (see chapter 3.5). If the safety distance is larger than 5 metres, a “high-level” work permit shall be used.

2 Definitions and terminology

For the purposes of this document, the following terms and definitions apply.

- Designer
  The designer is the party that determines the design code and under whose responsibility the design specifications for one or more pipe systems are drawn up.

- Design code
  Code that sets out the requirements with regard to the design, manufacture and testing of the pipe system (e.g. EN 13480, EN 15001 or RtoD).

- Design pressure (DP)
  The internal pressure, on which the calculations are based, taking the design code into account. The pressure a pipe system is designed to maintain in terms of technical strength, may differ from the design pressure.

- Design specifications
  The specifications as drawn up by the designer, including the requirements for the design, construction and testing of the particular pipe system and references to the applicable design code.

- Distribution fluid
  The medium that will be transported through the pipe system under normal operating conditions.

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- EU-CBI (conformity assessment body; former NoBo
  The legally designated certifying organisation, for example, Lloyd's Register, Gasunie, Kiwa.

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- HOLD-time
  Time period where a given test pressure during the strength test or the leak test is maintained.

- Hydrostatic pressure testing
  Testing using water as the test fluid.

- Inspection Test Plan (ITP)
  The ITP sets out the various inspection points (hold, witness, surveillance and review points), as a result of the test plan.

- Leak test
  The method used to test the pipe system for leaks.

- Maximum operating pressure (MOP)
  The maximum pressure for which a pipe system has been designed.

- Modification
  A modification to a pipe system is understood to mean a relatively small modification to the design of an existing pipe system. This includes installing a by-pass or an additional branch. In cases of doubt, department SPME-PTC-CTY-KDT-DTD should be contacted.

- New pipe system
  The design and construction of a new pipe systems implies building a new pipe system and all legal and quality control requirements shall be fulfilled. Also a large modification and/or complete replacement of a pipe system must be treated as a new pipe system. In cases of doubt, department SPME-PTC-CTY-KDT-DTD should be contacted.

- Operating pressure (OP)
  The maximum pressure that may arise in any point in a system under normal operating conditions.

- Order
  The agreement in writing between the principal and the contractor describing the new, modified or repaired pipe systems, including a reference to the applicable design code and possibly the design specifications.

- Pipe
  Metal or plastic piping consisting of the pipe, fittings, flanges, gaskets, bolt connections, welds etc.

- Pipe system
  The system of pipes including the related valves, instrumentation, equipment, etc.

- Pneumatic testing
  Testing using air or nitrogen as the test medium.

- Pressure
  Unless otherwise specified, this is the static overpressure compared to ambient pressure of the local environment.

- Repair
  Repairs to pipe systems are understood to mean 1:1 replacement of a relatively small part of the existing pipe system. This includes replacing a pipe section, fitting or flange. In cases of doubt, the department SPME-PTC-CTY-KDT-DTD should be contacted.

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- Safety pressure
  Set pressure of pressure safety device

- Safety zone
  The area around the pipe system to be tested, determined by delineating the calculated safety distance.

- Strength test
  The method of testing the pipe system to test whether the pipe system is sufficiently strong.

- Tata Steel
  Tata Steel is understood to mean Tata Steel IJmuiden BV, location IJmuiden.

- Tata Steel Inspector
  The person designated by Tata Steel project leader or SPME-PTC-CTY-KDT who carries out inspections before and during the tests.

- Test medium
  The medium used to fill the pipe system during testing of the pipe system.

- Test plan
  The test plan sets out the steps required to carry out the tests including naming the authorised persons who will carry out the tests and will be permitted to enter the safety zone.

- Test pressure
  The pressure at the highest point in the system during a test. This applies to the leak test and strength test.

- Test report
  The test report describes the results of the tests.

- Waiting time
  Time period between two successive steps of pressure during build-up towards the final test pressure.

3 Requirements Regarding Tests

3.1 General

3.1 All points on the Inspection and Test Plan (ITP) shall be signed for acceptance prior to the final pressure test. If one or more points are not signed, then the final pressure test shall not be performed.

Before carrying out each test, the pipe system shall be inspected visually by the contracting company and Tata Steel to check that the connections and joints have been made properly (e.g. welds, flanges, supports, etc.).

3.1 All items within the section from the pipe system under test shall be checked if they can withstand the final, highest, test pressure. All items which cannot withstand the test pressure, shall be either isolated from the section under test or be replaced by dummies.

Pipe systems that are open to the atmosphere (i.e. ventilation and blow-off pipes) are not tested for strength. Depending on the requirements specified in the design specifications and the design code for these systems, only a leak test shall be carried out.

Pipe systems shall first be subjected to a strength test and then to a leak test unless the design specifications or design code specifies otherwise.

3.1 In case pipe systems cannot be strength tested for fieldwelds, then the “Golden Weld” procedure shall be followed for the field welds. This includes requirements to be met during construction. KDT-FORM 045 “Explanation Golden Weld” shall be followed and the form KDT-FORM 019 “Motivation Golden Weld” be submitted and approved prior to starting construction.

3.1 New pipework which shall be installed in existing pipework with golden welds, shall be strength tested (in the workshop) before installation.

3.2 Test procedure

For hydraulic tests with a test pressure greater than 5 barg and for all pneumatic tests, a test procedure shall be drawn up by the contractor that will carry out the test. This procedure shall be send to the Tata Steel project leader at least two weeks before the planned test date and assessed by the designated Tata Steel inspector. The test procedure shall be approved before the tests are carried out.

For new pipe systems, the test procedure shall meet the requirements of the applicable design code as specified in the design specifications. If the work concerns a minor modification to or repair of a pipe system, the test procedure shall meet the requirements of the original design code (as used during original construction of the system, see the original drawings/calculations). If the design code is not known, it shall be determined according to Tata Steel standard S1475001. If this is not conclusive, department SPME-PTC-MCE-HPM shall be contacted.

The test procedure shall at minimum cover the follow issues:

3.1
1) The design code;
2) Hydraulic or pneumatic test (see appendix A);
3) The strength and leak test pressure according to the design code;
4) The way in which the pressure increases in steps according to the design code;
5) Safety distance and waiting time (see appendix B);
6) Hold time(s) according to the design code (see appendix B);
7) The test medium;

8) Practical preparations;
9) The test-equipment that will be used and how it will function;
10) Use of calibrated manometer(s) and their working range;
11) Possible additional measures that shall be taken for critical points in the pipe system;
12) Lay-out drawing with delineated safety zone;
13) A drawing of the test arrangement, including manometers, pressure/temperature recorders, thermometer, filling hose, operating valve, mobile gas cylinders containing the test medium, test unit, etc.;
14) Test report filled in with general details, design details and test requirements, see KDT-FORM-054.

3.1

After the tests, the person who carried out the tests is responsible for leaving the system in a safe state, that is; depressurized, fully drained and dried if water is used, all spades / spectacle blinds removed or rotated, valves unblocked, manometers used for the test removed, etc.

3.3 Test fluid

In general, water is used as the test fluid. Alternatively and by exception, pneumatic testing using air or nitrogen can be used. The choice depends to a large extent on the layout, size of the pipe system and process fluid. The test medium shall not, under any circumstances, be toxic, explosive or combustible. Furthermore, the medium should preferably not pose a risk of suffocation, in case of enclosed spaces.

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From a safety point of view, water is the preferable test medium. Exceptions are oxygen piping and nitrogen piping that can be used to flush oxygen piping. In these cases, nitrogen is prescribed as the test medium (in accordance with EIGA IGC doc 13-20, paragraph 6.3.3).

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In case gaseous pipe systems (design and pipe supporting) cannot withstand hydraulic testing (including increased weight) two options are possible: extra supporting or pneumatic testing. This should be taken into account during design and clearly be stated in the purchase order / technical specification.

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For hydraulic tests, uncontaminated fresh water should be used with a minimum temperature of 5°C unless the design code specifies a higher minimum temperature. Hydraulic testing below 5°C is never allowed.

For pneumatic tests, the minimum wall temperature required is 5 °C unless the design code specifies a higher minimum temperature.

In the case of stainless steel pipes and an operating temperature below 50 °C, the level of Chloride in the water shall be below 30 mg/liter. If the operating temperature is 50°C or higher, the chloride concentration may not exceed 2 mg/liter. Chloride content shall be demonstrated by certification of the testwater supplier.

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3.4 Test equipment

If the design code does not (adequately) specify the equipment to be used for testing, the following requirements apply:

- Pressure and temperature sensors and recorders shall have valid calibration certificates, not exceeding one year after last calibration date;
- Analog manometers used for strength tests shall meet the requirements of EN 837-1 class 1.0. For leak tests, analog manometers shall meet the requirements of class 0.6. The measurement

3.1

range of manometers shall be such that the testing pressure falls within the range of 60% to 90% of the full scale;

- The accuracy of analog pressure recorders shall meet the requirements of class 1.0 of EN 837-1. The measurement range of recorder cards shall be such that the testing pressure is within the range of 60% to 90% of the full scale of the recorder card;
- Digital pressure gauges may be used in their lower measuring range, provided that it is shown on the calibration form that the required accuracy is achieved in the lower range with sufficiently small steps;
- Temperature sensors (e.g. pipe wall and ambient temperature) shall have an accuracy of ±0.5°C. The sensor shall have a measurement range of at least -5 to 40°C;
- Fluids used to carry out leak tests using soap bubbles, shall meet the requirements of EN 14291.

3.1

3.5 Safety distances, waiting and hold times

When carrying out strength tests and leak tests, the minimum safety distance and minimum waiting time before each increase in pressure shall be always observed in accordance with appendix B. This applies to both hydrostatic and pneumatic tests. The distances and times for the strength test and leak test shall be calculated separately and be stated in the test procedure.

The test equipment shall be set up so that it is possible to regulate and observe the test pressure from outside the safety zone. If mobile gas cylinders are used to build up the pressure, these cylinders shall be set up outside the safety zone.

While carrying out the strength test and leak test, the safety zone may only entered if absolutely necessary and by as few (authorised) persons as possible. If the safety zone needs to be entered, this may only be done if the test pressure is constant and only after the specified waiting and hold time has passed.

If implementing the safety zone would lead to serious problems, it is possible to reduce the safety distance if this is combined with additional measures. In this case, a Technical Query (see KDT-FORM-020) shall be submitted to the SPME-PTC-MCE-HPM.

3.6 Marking of the safety zone

Barriers with the warning text “PRESSURE TESTING - NO ENTRY FOR UNAUTHORISED PERSONS” shall be set up on all access routes to the pipe systems.

The safety zone shall be evacuated completely and fenced off with red and white safety ribbon and a warning sign with the text “PRESSURE TESTING - NO ENTRY FOR UNAUTHORISED PERSONS”.

At the location where the test pressure is regulated and measured, locations where the safety distance is reduced locally (special situation) and or other locations where it is deemed necessary, the safety zone shall be marked with red and white safety ribbon.

3.7 Other general principles

The requirements below apply to all pressure testing:

1. During strength tests and leak tests, the entire length of the pipe shall be accessible for visual inspection. Welded joints and a 50 mm zone on each side of welds shall be free of coatings and other preservative measures.
2. During the pressure test, girth welds may have primer coating with a maximum thickness of 25 um.
3. Underground pipes: all (girth) welds must be visible over full length.
4. A pipe section that will be installed in a casing pipe shall be pressure tested separately, unless no (welded) joints will be present in the casing pipe.
5. Valves that will be pressure tested as part of the test shall always be in the open position. If a pressure separator is needed at the location of a valve with a flange, the valve shall be opened and a blind plate or blind flange shall be installed. If it is not possible to create a physical separation by the valve (for example a valve with welded end connection), the separator shall be installed at another location in the system between the section to be pressure tested and the rest of the system.
6. Valves in closed position, may be subject to pressure testing if the test pressure is below the PN-rating of this valve.
7. Valve and instruments that are not suitable for subjecting to the test pressure shall always be removed to prevent damage. If needed, dummies may be used to maintain piping lay-out.
8. Bellows that are suitable for pressure testing shall be mechanically locked in the direction in which they are designed to move. Refer to the user instructions for the bellows concerned.
9. If requirements in terms of this standard are not feasible due to specific circumstances, the contracting company shall submit a Technical Query (see KDT-FORM-020) to SPME-PTC-MCE-HPM for evaluation.

4 Testing Procedure in most used Design Codes

4.1 General

Appendix A contains a flowchart that shall be used to determine the type of test to perform.

This chapter lists the main applicable design codes with potential additional information.

To prepare for the test, the contracting company shall adhere to the requirements in the order description, the design code and the design specifications and shall draw up and submit the following documents to the Tata Steel Inspector for approval:

- Inspection and Test Plan (ITP), including Hold, Witness, Surveillance and Review points (see KDT-FORM-011;
- Test plan (if applicable);
- Test report (the general details, design details and test requirements shall be filled in, see KDT-FORM-054).

3.1

3.1 Prior to the test all required inspection points shall be signed and approved in the ITP by the parties involved. Witnessing shall be agreed between Contractor and Tata Steel and stated in the ITP.

3.1 During the test, the contracting company shall fill in the test results on the test report. Use of a calibrated pressure recording device, either digital or paper, is in many cases mandatory. Their use shall be stated and agreed prior to testing and be noted on the ITP.

After attending the test, the persons involved shall sign the ITP, the test report and the record cards.

KDT-FORM-054 contains a template for a test report. The use of this template or a contractor's equivalent, is obligatory for every test. It is permissible for the contracting company to use its own template, if it includes at least all the information specified in KDT-FORM-054 and this information is filled in.

4.2 Design codes

Design codes used for industrial pipework within Tata Steel, are:

- EN 13480 (industrial pipe systems, general)
- EN 15001 (industrial pipe systems, gaseous media 0.5 - 60 barg, -20/+40 °C)
- EN 1775 (industrial pipe systems, gaseous media <= 0.5 barg)
- ISO 14692 (industrial GRP pipe systems)
- NEN 2078 (industrial pipe systems, gaseous media < 40 barg)
- NEN 3650 (requirements for pipeline systems)
- RToD (industrial pipe systems, general)
- DVS (technical codes for plastics joining technologies)

3.1

Other design codes in consultation with SPME-PTC-MCE-HPM. See also Tata Steel Standard S1475001.

4.2.1 EN 13480
For strength and leak testing see paragraph 9.3 of EN 13480-5.

4.2.2 EN 15001
3.1
For strength and leak testing see paragraph 9.4 and appendix A of EN 15001-1. The safety distances mentioned in section 9.4.4 in the 2009 edition of the standard are not sufficient. The safety distance must therefore be determined in accordance with Annex B. In the new version of the standard, this distance is sufficient.

4.2.3 EN 1775
For strength and leak testing see chapter 6 of EN 1775.

4.2.4 ISO 14692
For strength and leak testing see paragraph 5.6 of EN 14692-4.

4.2.5 NEN 2078
For strength and leak testing see paragraph 5.6 of EN 2078. This standard now only applies to modified existing pipe systems that originally used design code NEN 2078. This design code can never apply to new pipe systems.

4.2.6 NEN 3650
With regard to strength and leak testing, see paragraph 9.16 of NEN 3650-1. Additionally paragraph 9.8 of NEN 3650-2 for steel pipe systems.

Also paragraph 9.7 of NEN 3650-3 gives rules for strength and leak testing, but the tests specified in this code apply specifically to plastic pipe systems.

4.2.7 RToD
For strength and leak tests see T-0101, T-0240 and T-0255.

4.2.8 DVS
3.1
For strength and leak tests see DVS 2210-1 supplement 2.

5 References

This document refers to:

DVS	Technical codes for plastics joining technologies
DVS 2210-1 supplement 2	Industrial piping made of thermoplastics – Design and execution, Above-ground pipe systems – Recommendations for the internal pressure and leak tests
EIGA IGC doc 13-20	Oxygen pipeline and piping systems
EN 1775	Gas supply – Gas pipework for buildings – Maximum operating pressure less than or equal to 5 bar – Functional recommendations
EN 13480	Metallic industry piping
EN 15001	Gas installation pipework with an operating pressure greater than 0.5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations.
ISO 14692	Petroleum and natural gas industries. Glass-reinforced plastics (GRP) piping
NEN 2078	Requirements for industrial gas installations
NEN 3650	Requirements for pipeline systems
RToD	Dutch Rules for Pressure Vessels (Regels voor Toestellen onder Druk)
T-0101	First certification: nature, size and requirements (RToD)
T-0240	Pressure testing: Procedure (RToD)
T-0255	Leak testing procedure (RToD)

Tata Steel Documents & forms

R1 41 01 02	Pneumatiek richtlijn, deel 2: Algemeen
R1 41 01 08	Pneumatiek richtlijn, deel 8: Selectie leidingwerk
R1 43 01 00	Heating, ventilation, cooling and sanitary installations
S1 47 50 01	General regulations for determining design code and design / operating conditions of new or modified/repaired piping systems
KDT-FORM-011	Inspection and Test Plan (ITP)
KDT-FORM-019	Motivation Golden Weld
KDT-FORM-020	Technical Query (TQ)
KDT-FORM-045	Explanation Golden Weld
KDT-FORM-054	Template for pressure testing report

6 Revisions

Version 1.0

This edition replaces HO standard 00.57.40.001

Version 2.0

Completely revised version

Version 3.0

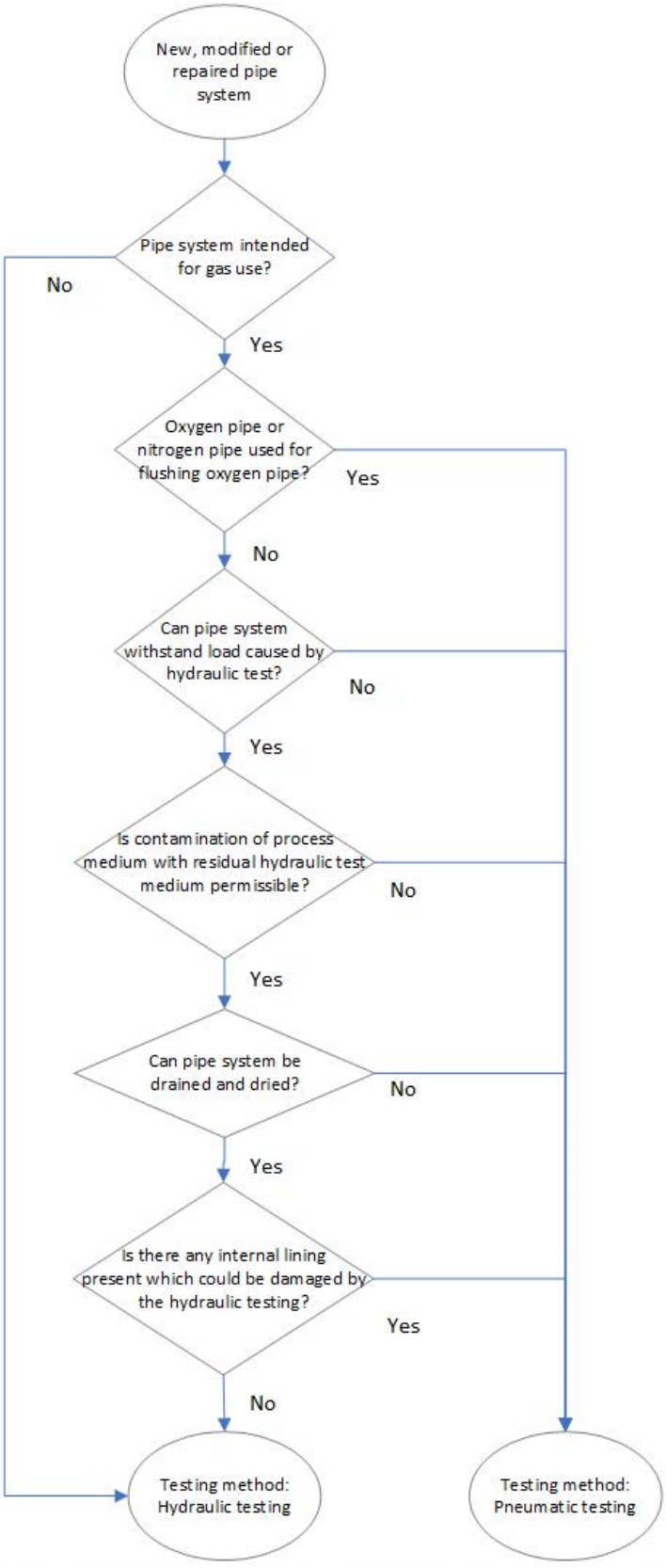
Completely revised version

Version 3.1

New layout;
Changes to chapters 1, 2, 3 and 4
Updated references
Editorial changes

7 APPENDIX A: Flowchart for determining the testing method

3.1



Remark: Check the design code on any specific additional or deviating requirement.

8 APPENDIX B: Safety distances and waiting & hold times

3.1 Waiting time and hold time shall be according to the design code.

If no waiting time and hold time is specified in the design code, waiting time (time before the next pressure increase step during pressure build-up) shall be minimum 5 minutes and hold time of strength test shall be minimum 30 minutes.

Hold time for leak test shall always be sufficient to inspect entire length on possible leakages.

3.1 Safety distance (evacuation area) shall be calculated, or be taken from one of the next 2 tables, which give safety distances for several test pressures, diameters, pipe length to be tested.

If actual values of test pressure and test length in the table are not given, the closest upper distance shall be taken. The tables given are based on the RToD-formulas and rounded off towards higher (safer) values.

8.1 Formula used for pneumatic test (used in table)

The formula below applies to pneumatic tests:

$$l = 3{,}6 \cdot \sqrt[3]{V \cdot \{(p_t + 1) - (p_t + 1)^{0{,}714}\}}$$

$$t = \max\left[10 \cdot l\,;\,300\ \mathrm{s}\right]$$

Where:

l	: safety distance (meters)
V	: capacity of the pipe system (m^3)
p_t	: test pressure (bars)
t	: waiting time (seconds)

8.2 Formula for hydraulic test (used in table)

The formula below applies to hydraulic tests:

$$l = 0{,}15 \cdot D_i \cdot \alpha^{0{,}4} \cdot \left(\frac{p_t}{\sqrt[3]{\varrho_r}}\right)^{0{,}6}$$

$$t = \max\left[10 \cdot l\,;\,300\ \mathrm{s}\right]$$

Where:

l	: safety distance (meters)
Di	: internal diameter of pipe (meters)
α	: li/Di (-)
li	: length of the pipe section to test (meters)
p_t	: test pressure (bars)
ρ_r	: density of the liquid used for pressure testing relative to water (-)
t	: waiting time (seconds)

The minimum safety distance for hydraulic tests is 5 meters

3.1 *It should be noted, that for hydraulic testing water is used in the formula from the table. If a liquid, with a specific weight lower than that of water is used, then a larger distance should be taken into account, depending on the difference in specific weight compared to water. However, when using a liquid with specific weigth between 0,8 and 1,0 the table can safely be used due to conservative rounding off of the various values.*

3.1

Safety distance Pneumatic testing (conform RToD)

Safety distance to maintain (m): (Rounded off upwards)	3	5	10	20	30	50	>50 (Check in table)

Test pressure (bar, max.):		5	5	5	5	5	5	10	10	10	10	10	10
Test length (m, max.):		3	10	25	50	100	250	3	10	25	50	100	250
DN-	NP Inches												
10	3/8												
15	1/2	0,4	0,6	0,9	1,1	1,4	1,9	0,6	0,8	1,1	1,4	1,8	2,5
20	3/4	0,5	0,8	1,0	1,3	1,6	2,2	0,7	1,0	1,4	1,7	2,2	2,9
25	1	0,6	0,9	1,2	1,5	1,9	2,6	0,8	1,2	1,6	2,0	2,5	3,4
(32)	1 1/4	0,7	1,1	1,5	1,8	2,3	3,1	0,9	1,4	1,9	2,4	3,0	4,1
40	1 1/2	0,8	1,2	1,6	2,0	2,5	3,4	1,0	1,5	2,1	2,6	3,3	4,5
50	2	0,9	1,4	1,9	2,4	3,0	4,0	1,2	1,8	2,5	3,1	3,9	5,3
(65)	2 1/2	1,1	1,6	2,2	2,8	3,5	4,8	1,4	2,1	2,9	3,7	4,6	6,3
80	3	1,2	1,8	2,5	3,1	3,9	5,3	1,6	2,4	3,2	4,1	5,1	7,0
100	4	1,4	2,2	2,9	3,7	4,7	6,3	1,9	2,8	3,9	4,9	6,1	8,3
125	5	1,7	2,5	3,4	4,2	5,3	7,3	2,2	3,3	4,4	5,6	7,0	9,5
150	6	1,9	2,8	3,8	4,8	6,1	8,2	2,5	3,7	5,0	6,3	8,0	10,8
200	8	2,2	3,3	4,5	5,7	7,2	9,8	2,9	4,4	6,0	7,5	9,5	12,9
250	10	2,6	3,9	5,3	6,7	8,4	11,4	3,4	5,1	7,0	8,8	11,1	15,0
300	12	2,9	4,4	6,0	7,5	9,5	12,8	3,9	5,8	7,8	9,9	12,4	16,9
350	14	3,1	4,7	6,3	8,0	10,1	13,6	4,1	6,1	8,3	10,5	13,2	17,9
400	16	3,4	5,1	6,9	8,7	11,0	14,9	4,5	6,7	9,1	11,5	14,5	19,6
450	18	3,7	5,6	7,6	9,5	12,0	16,3	4,9	7,3	10,0	12,5	15,8	21,5
500	20	4,0	6,0	8,1	10,3	12,9	17,6	5,3	7,9	10,7	13,5	17,0	23,1
600	24	4,6	6,8	9,2	11,6	14,7	19,9	6,0	8,9	12,1	15,3	19,3	26,1
700	28	5,0	7,5	10,2	12,9	16,2	22,0	6,6	9,9	13,4	16,9	21,3	29,0
800	32	5,5	8,2	11,2	14,1	17,8	24,1	7,3	10,8	14,7	18,5	23,3	31,7
900	36	6,0	8,9	12,1	15,2	19,2	26,0	7,8	11,7	15,9	20,0	25,2	34,2
1000	40	6,4	9,6	13,0	16,4	20,6	28,0	8,4	12,6	17,1	21,5	27,1	36,7
1200	48	7,2	10,8	14,7	18,5	23,3	31,6	9,5	14,2	19,3	24,3	30,6	41,5
1400	56	8,0	12,0	16,3	20,5	25,8	35,1	10,5	15,8	21,4	26,9	33,9	46,1
1600	64	8,8	13,1	17,8	22,4	28,3	38,4	11,5	17,3	23,4	29,5	37,2	50,4
1800	72	9,5	14,2	19,3	24,3	30,6	41,6	12,5	18,7	25,4	31,9	40,2	54,6
2000	80	10,2	15,3	20,7	26,1	32,9	44,6	13,4	20,1	27,2	34,3	43,2	58,6
2200	88	10,9	16,3	22,1	27,8	35,1	47,6	14,3	21,4	29,0	36,6	46,1	62,5
2400	96	11,6	17,3	23,4	29,5	37,2	50,5	15,2	22,7	30,8	38,8	48,9	66,3
2600	104	12,1	18,1	24,6	31,0	39,0	53,0	15,9	23,8	32,3	40,7	51,3	69,6
2800	112	12,7	19,0	25,8	32,5	41,0	55,6	16,7	25,0	33,9	42,8	53,9	73,1
3000	120	13,3	19,9	27,0	34,1	42,9	58,3	17,5	26,2	35,5	44,8	56,4	76,6
3200	128	13,9	20,8	28,2	35,6	44,8	60,8	18,3	27,3	37,1	46,7	58,9	79,9

Test pressure (bar, max.):		20	20	20	20	20	20	30	30	30	30	30	30
Test length (m, max.):		3	10	25	50	100	250	3	10	25	50	100	250
DN-	NP Inches												
10	3/8												
15	1/2	0,7	1,1	1,5	1,9	2,4	3,2	0,9	1,3	1,7	2,2	2,8	3,8
20	3/4	0,9	1,3	1,8	2,2	2,8	3,8	1,0	1,5	2,1	2,6	3,3	4,5
25	1	1,0	1,5	2,1	2,6	3,3	4,5	1,2	1,8	2,4	3,1	3,9	5,2
(32)	1 1/4	1,2	1,8	2,5	3,1	4,0	5,4	1,4	2,1	2,9	3,7	4,6	6,3
40	1 1/2	1,4	2,0	2,7	3,5	4,4	5,9	1,6	2,4	3,2	4,0	5,1	6,9
50	2	1,6	2,4	3,2	4,1	5,1	6,9	1,8	2,8	3,8	4,7	6,0	8,1
(65)	2 1/2	1,9	2,8	3,8	4,8	6,0	8,2	2,2	3,3	4,4	5,6	7,1	9,6
80	3	2,1	3,1	4,2	5,3	6,7	9,1	2,4	3,6	4,9	6,2	7,8	10,7
100	4	2,5	3,7	5,0	6,4	8,0	10,9	2,9	4,3	5,9	7,4	9,3	12,7
125	5	2,9	4,3	5,8	7,3	9,2	12,5	3,3	5,0	6,8	8,5	10,7	14,6
150	6	3,2	4,8	6,6	8,3	10,4	14,2	3,8	5,6	7,7	9,7	12,2	16,5
200	8	3,9	5,8	7,8	9,8	12,4	16,8	4,5	6,7	9,1	11,5	14,5	19,6
250	10	4,5	6,7	9,1	11,5	14,5	19,6	5,2	7,8	10,6	13,4	16,9	22,9
300	12	5,0	7,5	10,2	12,9	16,2	22,1	5,9	8,8	11,9	15,0	19,0	25,7
350	14	5,4	8,0	10,9	13,7	17,3	23,5	6,3	9,4	12,7	16,0	20,2	27,4
400	16	5,9	8,8	11,9	15,0	18,9	25,7	6,9	10,2	13,9	17,5	22,1	29,9
450	18	6,4	9,6	13,0	16,4	20,7	28,1	7,5	11,2	15,2	19,1	24,1	32,7
500	20	6,9	10,3	14,0	17,6	22,2	30,2	8,1	12,0	16,3	20,6	25,9	35,2
600	24	7,8	11,7	15,9	20,0	25,2	34,2	9,1	13,6	18,5	23,3	29,4	39,9
700	28	8,7	13,0	17,6	22,1	27,9	37,9	10,1	15,1	20,5	25,8	32,6	44,2
800	32	9,5	14,2	19,2	24,2	30,5	41,4	11,1	16,5	22,4	28,3	35,6	48,3
900	36	10,2	15,3	20,8	26,1	32,9	44,7	11,9	17,8	24,2	30,5	38,4	52,2
1000	40	11,0	16,4	22,3	28,1	35,4	48,1	12,8	19,2	26,0	32,8	41,3	56,1
1200	48	12,4	18,6	25,2	31,7	40,0	54,3	14,5	21,6	29,4	37,0	46,6	63,3
1400	56	13,8	20,6	28,0	35,2	44,4	60,2	16,1	24,0	32,6	41,1	51,8	70,3
1600	64	15,1	22,6	30,6	38,6	48,6	66,0	17,6	26,3	35,7	45,0	56,7	77,0
1800	72	16,4	24,4	33,2	41,8	52,6	71,4	19,1	28,5	38,7	48,7	61,4	83,3
2000	80	17,6	26,2	35,6	44,8	56,5	76,7	20,5	30,6	41,5	52,3	65,9	89,5
2200	88	18,7	28,0	38,0	47,8	60,2	81,8	21,8	32,6	44,3	55,8	70,3	95,4
2400	96	19,8	29,7	40,2	50,7	63,9	86,7	23,2	34,6	47,0	59,2	74,5	101,2
2600	104	20,8	31,1	42,2	53,2	67,1	91,0	24,3	36,3	49,3	62,1	78,2	106,2
2800	112	21,9	32,7	44,4	55,9	70,5	95,6	25,5	38,2	51,8	65,2	82,2	111,6
3000	120	22,9	34,2	46,5	58,6	73,8	100,1	26,7	40,0	54,2	68,3	86,1	116,8
3200	128	23,9	35,8	48,5	61,1	77,0	104,5	27,9	41,7	56,6	71,3	89,9	122,0

Test pressure (bar, max.):		40	40	40	40	40	40
Test length (m, max.):		3	10	25	50	100	250
DN-	NP Inches						
10	3/8						
15	1/2	1,0	1,4	1,9	2,5	3,1	4,2
20	3/4	1,1	1,7	2,3	2,9	3,7	5,0
25	1	1,3	2,0	2,7	3,4	4,3	5,8
(32)	1 1/4	1,6	2,4	3,2	4,1	5,1	7,0
40	1 1/2	1,8	2,6	3,6	4,5	5,7	7,7
50	2	2,1	3,1	4,2	5,3	6,6	9,0
(65)	2 1/2	2,4	3,6	5,0	6,2	7,9	10,7
80	3	2,7	4,1	5,5	6,9	8,7	11,9
100	4	3,2	4,8	6,6	8,3	10,4	14,1
125	5	3,7	5,5	7,5	9,5	11,9	16,2
150	6	4,2	6,3	8,5	10,8	13,6	18,4
200	8	5,0	7,5	10,2	12,8	16,1	21,9
250	10	5,8	8,7	11,9	14,9	18,8	25,5
300	12	6,6	9,8	13,3	16,8	21,1	28,7
350	14	7,0	10,4	14,2	17,8	22,5	30,5
400	16	7,6	11,4	15,5	19,5	24,6	33,4
450	18	8,4	12,5	16,9	21,3	26,9	36,5
500	20	9,0	13,4	18,2	22,9	28,9	39,2
600	24	10,2	15,2	20,6	26,0	32,7	44,4
700	28	11,3	16,8	22,9	28,8	36,3	49,2
800	32	12,3	18,4	25,0	31,5	39,7	53,8
900	36	13,3	19,9	27,0	34,0	42,8	58,1
1000	40	14,3	21,4	29,0	36,5	46,0	62,5
1200	48	16,1	24,1	32,7	41,2	52,0	70,5
1400	56	17,9	26,8	36,3	45,8	57,7	78,3
1600	64	19,6	29,3	39,8	50,2	63,2	85,8
1800	72	21,3	31,8	43,1	54,3	68,4	92,9
2000	80	22,8	34,1	46,3	58,3	73,5	99,7
2200	88	24,3	36,4	49,3	62,2	78,3	106,3
2400	96	25,8	38,5	52,3	65,9	83,0	112,7
2600	104	27,1	40,5	54,9	69,2	87,2	118,3
2800	112	28,5	42,5	57,7	72,7	91,6	124,3
3000	120	29,8	44,5	60,4	76,1	95,9	130,2
3200	128	31,1	46,5	63,1	79,5	100,1	135,9

3.1

Safety distance Hydraulic testing (conform RToD)

Safety distance to maintain (m): (Rounded off upwards)	3	5	10	20	30	>30 (check in table)

DN-	NP Inche	5 bar / 3 m	5 bar / 10 m	5 bar / 25 m	5 bar / 50 m	5 bar / 100 m	5 bar / 250 m	10 bar / 3 m	10 bar / 10 m	10 bar / 25 m	10 bar / 50 m	10 bar / 100 m	10 bar / 250 m
10	3/8												
15	1/2	0,1	0,1	0,1	0,2	0,2	0,3	0,1	0,1	0,2	0,3	0,3	0,5
20	3/4	0,1	0,1	0,1	0,2	0,3	0,4	0,1	0,2	0,2	0,3	0,4	0,6
25	1	0,1	0,1	0,2	0,2	0,3	0,4	0,1	0,2	0,3	0,3	0,4	0,6
(32)	1 1/4	0,1	0,1	0,2	0,3	0,3	0,5	0,1	0,2	0,3	0,4	0,5	0,8
40	1 1/2	0,1	0,2	0,2	0,3	0,4	0,5	0,1	0,2	0,3	0,4	0,6	0,8
50	2	0,1	0,2	0,2	0,3	0,4	0,6	0,2	0,3	0,4	0,5	0,7	0,9
(65)	2 1/2	0,1	0,2	0,3	0,4	0,5	0,7	0,2	0,3	0,4	0,6	0,8	1,1
80	3	0,1	0,2	0,3	0,4	0,6	0,8	0,2	0,3	0,5	0,6	0,8	1,2
100	4	0,2	0,3	0,4	0,5	0,7	0,9	0,2	0,4	0,6	0,7	1,0	1,4
125	5	0,2	0,3	0,4	0,6	0,7	1,1	0,3	0,4	0,6	0,8	1,1	1,6
150	6	0,2	0,3	0,5	0,6	0,8	1,2	0,3	0,5	0,7	0,9	1,3	1,8
200	8	0,2	0,4	0,6	0,7	1,0	1,4	0,4	0,6	0,8	1,1	1,5	2,1
250	10	0,3	0,4	0,6	0,8	1,1	1,6	0,4	0,7	1,0	1,3	1,7	2,4
300	12	0,3	0,5	0,7	0,9	1,2	1,8	0,5	0,7	1,1	1,4	1,9	2,7
350	14	0,3	0,5	0,7	1,0	1,3	1,9	0,5	0,8	1,1	1,5	2,0	2,8
400	16	0,3	0,6	0,8	1,1	1,4	2,0	0,5	0,9	1,2	1,6	2,1	3,1
450	18	0,4	0,6	0,9	1,2	1,5	2,2	0,6	0,9	1,3	1,8	2,3	3,3
500	20	0,4	0,6	0,9	1,2	1,6	2,4	0,6	1,0	1,4	1,9	2,5	3,6
600	24	0,4	0,7	1,0	1,4	1,8	2,6	0,7	1,1	1,6	2,1	2,8	4,0
700	28	0,5	0,8	1,1	1,5	2,0	2,9	0,7	1,2	1,7	2,3	3,0	4,4
800	32	0,5	0,9	1,2	1,6	2,2	3,1	0,8	1,3	1,9	2,5	3,3	4,7
900	36	0,6	0,9	1,3	1,8	2,3	3,4	0,9	1,4	2,0	2,7	3,5	5,1
1000	40	0,6	1,0	1,4	1,9	2,5	3,6	0,9	1,5	2,2	2,8	3,8	5,4
1200	48	0,7	1,1	1,6	2,1	2,8	4,0	1,0	1,7	2,4	3,2	4,2	6,0
1400	56	0,7	1,2	1,7	2,3	3,0	4,4	1,1	1,8	2,6	3,5	4,6	6,6
1600	64	0,8	1,3	1,9	2,5	3,3	4,8	1,2	2,0	2,9	3,8	5,0	7,2
1800	72	0,9	1,4	2,0	2,7	3,5	5,1	1,3	2,1	3,1	4,1	5,4	7,7
2000	80	0,9	1,5	2,2	2,9	3,8	5,4	1,4	2,3	3,3	4,3	5,7	8,3
2200	88	1,0	1,6	2,3	3,0	4,0	5,8	1,5	2,4	3,5	4,6	6,1	8,8
2400	96	1,0	1,7	2,4	3,2	4,2	6,1	1,6	2,5	3,7	4,8	6,4	9,2
2600	104	1,1	1,8	2,5	3,3	4,4	6,4	1,6	2,7	3,8	5,1	6,7	9,6
2800	112	1,1	1,8	2,6	3,5	4,6	6,6	1,7	2,8	4,0	5,3	7,0	10,1
3000	120	1,2	1,9	2,8	3,6	4,8	6,9	1,8	2,9	4,2	5,5	7,3	10,5
3200	128	1,2	2,0	2,9	3,8	5,0	7,2	1,9	3,0	4,3	5,7	7,6	10,9

DN-	NP Inche	20 bar / 3 m	20 bar / 10 m	20 bar / 25 m	20 bar / 50 m	20 bar / 100 m	20 bar / 250 m	30 bar / 3 m	30 bar / 10 m	30 bar / 25 m	30 bar / 50 m	30 bar / 100 m	30 bar / 250 m	40 bar / 3 m	40 bar / 10 m	40 bar / 25 m	40 bar / 50 m	40 bar / 100 m	40 bar / 250 m
10	3/8																		
15	1/2	0,1	0,2	0,3	0,4	0,5	0,7	0,2	0,3	0,4	0,5	0,6	0,9	0,2	0,3	0,4	0,6	0,8	1,1
20	3/4	0,1	0,2	0,3	0,4	0,6	0,8	0,2	0,3	0,4	0,6	0,7	1,1	0,2	0,4	0,5	0,7	0,9	1,3
25	1	0,2	0,3	0,4	0,5	0,7	1,0	0,2	0,3	0,5	0,7	0,9	1,2	0,3	0,4	0,6	0,8	1,0	1,5
(32)	1 1/4	0,2	0,3	0,5	0,6	0,8	1,1	0,2	0,4	0,6	0,8	1,0	1,5	0,3	0,5	0,7	0,9	1,2	1,7
40	1 1/2	0,2	0,3	0,5	0,7	0,9	1,2	0,3	0,4	0,6	0,8	1,1	1,6	0,3	0,5	0,8	1,0	1,3	1,9
50	2	0,2	0,4	0,6	0,8	1,0	1,4	0,3	0,5	0,7	1,0	1,3	1,8	0,4	0,6	0,9	1,1	1,5	2,2
(65)	2 1/2	0,3	0,5	0,7	0,9	1,2	1,7	0,4	0,6	0,9	1,1	1,5	2,1	0,4	0,7	1,0	1,3	1,8	2,5
80	3	0,3	0,5	0,7	1,0	1,3	1,8	0,4	0,6	0,9	1,2	1,6	2,4	0,5	0,8	1,1	1,5	1,9	2,8
100	4	0,4	0,6	0,9	1,1	1,5	2,2	0,5	0,8	1,1	1,4	1,9	2,8	0,6	0,9	1,3	1,7	2,3	3,3
125	5	0,4	0,7	1,0	1,3	1,7	2,4	0,5	0,9	1,2	1,6	2,2	3,1	0,6	1,0	1,5	1,9	2,6	3,7
150	6	0,5	0,8	1,1	1,4	1,9	2,7	0,6	1,0	1,4	1,8	2,4	3,5	0,7	1,1	1,7	2,2	2,9	4,1
200	8	0,5	0,9	1,3	1,7	2,2	3,2	0,7	1,1	1,6	2,1	2,8	4,1	0,8	1,3	1,9	2,5	3,4	4,8
250	10	0,6	1,0	1,5	1,9	2,5	3,7	0,8	1,3	1,9	2,5	3,2	4,7	0,9	1,5	2,2	2,9	3,9	5,6
300	12	0,7	1,1	1,6	2,1	2,8	4,1	0,9	1,4	2,1	2,7	3,6	5,2	1,1	1,7	2,5	3,2	4,3	6,2
350	14	0,7	1,2	1,7	2,3	3,0	4,3	0,9	1,5	2,2	2,9	3,8	5,5	1,1	1,8	2,6	3,4	4,5	6,5
400	16	0,8	1,3	1,9	2,5	3,2	4,7	1,0	1,6	2,4	3,1	4,1	6,0	1,2	2,0	2,8	3,7	4,9	7,1
450	18	0,9	1,4	2,0	2,7	3,5	5,1	1,1	1,8	2,6	3,4	4,5	6,5	1,3	2,1	3,1	4,0	5,3	7,7
500	20	0,9	1,5	2,2	2,8	3,7	5,4	1,2	1,9	2,7	3,6	4,8	6,9	1,4	2,3	3,3	4,3	5,7	8,2
600	24	1,0	1,7	2,4	3,2	4,2	6,0	1,3	2,1	3,1	4,1	5,3	7,7	1,6	2,5	3,6	4,8	6,4	9,2
700	28	1,1	1,8	2,6	3,5	4,6	6,6	1,4	2,3	3,4	4,4	5,9	8,5	1,7	2,8	4,0	5,3	7,0	10,1
800	32	1,2	2,0	2,9	3,8	5,0	7,2	1,6	2,5	3,7	4,8	6,4	9,2	1,9	3,0	4,3	5,7	7,6	10,9
900	36	1,3	2,1	3,1	4,0	5,3	7,7	1,7	2,7	3,9	5,2	6,8	9,8	2,0	3,2	4,6	6,1	8,1	11,7
1000	40	1,4	2,3	3,3	4,3	5,7	8,2	1,8	2,9	4,2	5,5	7,3	10,5	2,1	3,4	5,0	6,5	8,6	12,5
1200	48	1,6	2,5	3,7	4,8	6,4	9,2	2,0	3,2	4,7	6,1	8,1	11,7	2,4	3,8	5,5	7,3	9,6	13,9
1400	56	1,7	2,8	4,0	5,3	7,0	10,1	2,2	3,5	5,1	6,7	8,9	12,8	2,6	4,2	6,1	8,0	10,6	15,3
1600	64	1,9	3,0	4,4	5,7	7,6	10,9	2,4	3,8	5,6	7,3	9,7	13,9	2,8	4,6	6,6	8,7	11,5	16,6
1800	72	2,0	3,2	4,7	6,2	8,1	11,7	2,6	4,1	6,0	7,9	10,4	15,0	3,0	4,9	7,1	9,3	12,3	17,8
2000	80	2,1	3,5	5,0	6,6	8,7	12,5	2,7	4,4	6,4	8,4	11,1	16,0	3,2	5,2	7,6	10,0	13,2	19,0
2200	88	2,3	3,7	5,3	7,0	9,2	13,3	2,9	4,7	6,7	8,9	11,7	16,9	3,4	5,5	8,0	10,6	13,9	20,1
2400	96	2,4	3,9	5,6	7,3	9,7	14,0	3,0	4,9	7,1	9,4	12,4	17,8	3,6	5,8	8,4	11,1	14,7	21,2
2600	104	2,5	4,0	5,8	7,7	10,1	14,6	3,2	5,1	7,4	9,8	12,9	18,6	3,8	6,1	8,8	11,6	15,3	22,1
2800	112	2,6	4,2	6,1	8,0	10,6	15,3	3,3	5,4	7,8	10,2	13,5	19,5	3,9	6,4	9,2	12,2	16,0	23,1
3000	120	2,7	4,4	6,3	8,4	11,0	15,9	3,5	5,6	8,1	10,7	14,1	20,3	4,1	6,7	9,6	12,7	16,7	24,1
3200	128	2,8	4,6	6,6	8,7	11,5	16,5	3,6	5,8	8,4	11,1	14,6	21,1	4,3	6,9	10,0	13,2	17,4	25,1