



BSI Standards Publication

District heating pipes — Design and installation of thermal insulated bonded single and twin pipe systems for directly buried hot water networks

Part 2: Installation

National foreword

This British Standard is the UK implementation of EN 13941-2:2019+A1:2021. It supersedes BS EN 13941-2:2019, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by A1 A1.

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

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Tuyaux de chauffage urbain - Conception et installation des systèmes bloqués de tuyaux monotubes et bitubes isolés thermiquement pour les réseaux d'eau chaude enterrés directement - Partie 2 : Installation

Fernwärmerohre - Auslegung und Installation von gedämmten Einzel- und Doppelrohr-Verbundsystemen für direkt erdverlegte Heißwasser-Fernwärmenetze - Teil 2: Installation

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European foreword

This document (EN 13941-2:2019+A1:2021) has been prepared by Technical Committee CEN/TC 107 “Prefabricated district heating and district cooling pipe systems”, the secretariat of which is held by DS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2022, and conflicting national standards shall be withdrawn at the latest by June 2022.

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

This document supersedes A1 EN 13941:2019 A1.

This document includes Amendment 1 approved by CEN on 15 October 2021.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

EN 13941, *District heating pipes — Design and installation of thermal insulated bonded single and twin pipe systems for directly buried hot water networks* consists of the following parts:

- Part 1: Design;
- Part 2: Installation.

A1 In comparison to EN 13941-2:2019, the following changes have been made:

- a) minor corrections throughout the document. A1

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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

Introduction

This document has been prepared by CEN/TC 107/WG 13 „Prefabricated district heating and district cooling pipe system“.

According to the scope of CEN/TC 107:

- the task of CEN/TC 107/WG 13 is to specify rules for design, calculation and installation for factory made thermal insulated bonded single and twin pipe systems for directly buried hot water networks.;
- CEN/TC 107/WG 13 also contributes to rules for functional tests for thermal-insulated bonded pipe systems for underground hot water networks;

When use is made of the standard, the different sections of which it is made up are to be interpreted as being interdependent and, because of this, cannot be dissociated.

The revision of EN 13941:2009+A1:2010 involves the subdivision of the document in two separate documents:

- EN 13941-1, *District heating pipes — Design and installation of thermal insulated bonded single and twin pipe systems for directly buried hot water networks — Part 1: Design*;
- EN 13941-2, *District heating pipes — Design and installation of thermal insulated bonded single and twin pipe systems for directly buried hot water networks — Part 2: Installation*.

This volume (Part 2) consists of a main part and six annexes.

Annex E is normative. Annexes A, B, C, D, and F are informative.

This standard contains a number of requirements aimed at ensuring the sound execution of distribution networks for district heating.

The requirements contained in this document should be assessed and applied in compliance with the intentions of the standard and in due consideration of the development taking place in the field it concerns. It is therefore assumed that the user of the standard has the requisite technical insight and that the user of the standard has adequate knowledge of legal and other external regulations that are of consequence to the practical application of the document.

NOTE Some paragraphs of this standard are possibly covered by national regulations in some countries which naturally apply instead of this standard.

1 Scope

This document specifies requirements for design, calculation and installation of factory made thermal insulated bonded single and twin pipe systems for buried hot water networks for continuous operation with treated water at various temperatures up to 120 °C and occasionally peak temperatures up to 140 °C for maximum 300 h/a, and maximum internal pressure 2,5 MPa.

Flexible pipe systems according to the EN 15632 series are not under the scope of this standard.

The standard EN 13941, *Design and installation of thermal insulated bonded single and twin pipe systems for directly buried hot water networks* consists of two parts:

- a) EN 13941-1: *Design*;
- b) EN 13941-2: *Installation*.

The requirements in this part, EN 13941-2, form a unity with those of EN 13941-1.

The principles of the standard may be applied to thermal insulated pipe systems with pressures higher than 2,5 MPa, provided that special attention is paid to the effects of this higher pressure.

Adjacent pipes, not buried, but belonging to the network (e.g. pipes in ducts, valve chambers, road crossings above ground etc.) may be designed and installed according to this standard.

This standard presupposes the use of treated water, which by softening, demineralization, de-aeration, adding of chemicals, or otherwise has been treated to effectively prevent internal corrosion and deposits in the pipes.

NOTE For further information on water qualities to be used in district heating pipe systems, see bibliographic entry [8].

This document is not applicable for such units as:

- a) pumps;
- b) heat exchangers;
- c) boilers, tanks;
- d) systems behind domestic substations.

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.

EN 253, *District heating pipes — Bonded single pipe systems for directly buried hot water networks — Factory made pipe assembly of steel service pipe, polyurethane thermal insulation and outer casing of polyethylene*

EN 448, *District heating pipes — Preinsulated bonded pipe systems for directly buried hot water networks — Fitting assemblies of steel service pipes, polyurethane thermal insulation and outer casing of polyethylene*

EN 488, *District heating pipes — Preinsulated bonded pipe systems for directly buried hot water networks — Steel valve assembly for steel service pipes, polyurethane thermal insulation and outer casing of polyethylene*

EN 489, *District heating pipes — Preinsulated bonded pipe systems for directly buried hot water networks — Joint assembly for steel service pipes, polyurethane thermal insulation and outer casing of polyethylene*

EN 10204, *Metallic products — Types of inspection documents*

EN 13018, *Non-destructive testing — Visual testing - General principles*

EN 13480-5, *Metallic industrial piping — Part 5: Inspection and testing*

prEN 13941-1, *District heating pipes — Design and installation of thermal insulated bonded single and twin pipe systems for directly buried hot water networks — Part 1: Design*

EN 14419:2009, *District heating pipes - Preinsulated bonded pipe systems for directly buried hot water networks - Surveillance systems*

EN 15698 (all parts), *District heating pipes — Bonded twin pipe systems for directly buried hot water networks*

EN 17248, ~~A1~~ deleted text ~~A1~~ *District heating and district cooling pipe systems — Terms and definitions*

EN ISO 3452-1, *Non-destructive testing — Penetrant testing — Part 1: General principles (ISO 3452-1)*

EN ISO 3834-1, *Quality requirements for fusion welding of metallic materials — Part 1: Criteria for the selection of the appropriate level of quality requirements (ISO 3834-1)*

EN ISO 3834-3, *Quality requirements for fusion welding of metallic materials — Part 3: Standard quality requirements (ISO 3834-3)*

EN ISO 3834-4, *Quality requirements for fusion welding of metallic materials — Part 4: Elementary quality requirements (ISO 3834-4)*

EN ISO 5579, *Non-destructive testing — Radiographic testing of metallic materials using film and X- or gamma rays — Basic rules (ISO 5579)*

EN ISO 5817:2014, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817:2014)*

EN ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels (ISO 9606-1)*

EN ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel (ISO 9712)*

EN ISO 9934-1, *Non-destructive testing — Magnetic particle testing — Part 1: General principles (ISO 9934-1)*

EN ISO 10675-1, *Non-destructive testing of welds — Acceptance levels for radiographic testing - Part 1: Steel, nickel, titanium and their alloys (ISO 10675-1)*

EN ISO 11666, *Non-destructive testing of welds — Ultrasonic testing — Acceptance levels (ISO 11666:2018)*

EN ISO 14731:2006, *Welding coordination — Tasks and responsibilities (ISO 14731:2006)*

EN ISO 14732, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732)*

EN ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding (ISO 15609-1)*

EN ISO 15609-2, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 2: Gas welding (ISO 15609-2)*

EN ISO 15610, *Specification and qualification of welding procedures for metallic materials — Qualification based on tested welding consumables (ISO 15610)*

EN ISO 15613, *Specification and qualification of welding procedures for metallic materials - Qualification based on pre-production welding test (ISO 15613)*

EN ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1)*

EN ISO 16810, *Non-destructive testing — Ultrasonic testing — General principles (ISO 16810)*

EN ISO 17636-1, *Non-destructive testing of welds — Radiographic testing — Part 1: X- and gamma-ray techniques with film (ISO 17636-1)*

EN ISO 17636-2, *Non-destructive testing of welds — Radiographic testing - Part 2: X- and gamma-ray techniques with digital detectors (ISO 17636-2)*

EN ISO 17637, *Non-destructive testing of welds — Visual testing of fusion-welded joints (ISO 17637)*

EN ISO 17638, *Non-destructive testing of welds — Magnetic particle testing (ISO 17638)*

EN ISO 17640, *Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment (ISO 17640)*

EN ISO 23277, *Non-destructive testing of welds — Penetrant testing — Acceptance levels (ISO 23277)*

EN ISO 23278, *Non-destructive testing of welds — Magnetic particle testing — Acceptance levels (ISO 23278)*

A1 deleted text **A1**

HD 308 S2, *Identification of cores in cables and flexible cords*

3 Terms and definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 17248 apply.

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

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

3.2 Symbols

For the purposes of this document, the symbols and indices given in EN 13941-1 apply.

3.3 Abbreviations

For the purposes of this document, the abbreviations given in EN 13941-1 apply.

4 Procurement

4.1 Manufacturer of thermal insulated pipe elements

For the quality control program and documentation for suitable thermal insulated pipe elements see Annex D.

NOTE For the quality control of factory made thermal insulated pipe elements see for example EHP 001 [1] and EHP 003 [15].

4.2 Performing assembly of casing joints and PE-welding on casings

For the assembly of casing joints and PE-welding on casings the following points need to be considered:

- a) the work shall be performed only by qualified fitters and PE-welders:
 - An example for a scheme for the required knowledge and skills for fitters and PE welders is given in Annex C).

NOTE Other qualification schemes for fitters and PE welders may exist at national level

- b) Experienced and qualified management personnel as foreman and quality inspector:

The Supervising personnel and quality inspection personnel shall be trained as fitter and PE-welder;

- c) Appropriate and serviceable tools, equipment and machinery.

For the quality control program and service life documentation for assembling of joints and PE-welding on the casing, see Table D.6 and Table D.8.

5 General requirements

Any pipe installation shall be made on basis of design documentation that is sufficiently detailed to ensure execution of the project presupposed quality.

The installation of a pipe system shall be done

- in accordance with the installation plan and the instructions of the manufacturers of either the system or the pipe and components, as applicable,
- in accordance with the design documentation so to ensure the adequate safety of fitters and other personnel on-site as well as any third persons,
- that installation and operation do not harm to other structures or construction works, e.g. roads.

Project classes including the required design documentation shall be determined according to EN 13941-1.

For the installation and assembly of pipe elements and pipe components only materials and methods, which meet the specified instructions and standards shall be used.

Pipeline sections, which cannot be installed in compliance with this standard such as other than pipe sections with pipe elements, e.g. bridge crossings, water course crossings, protection pipes should be installed by skilled personnel according to the project drawings and corresponding other standards, and codes.

If changes are made during installation, the design documentation shall be changed accordingly. The constructive and static consequences of any changes that may become necessary shall be examined.

The risk assessment of the pipe system is being described in EN 13941-1.

The environmental requirements according to the legislators have to be followed. These requirements can differ from place to place and are depending on the authority in charge.

It is permissible to use alternative rules from the notes given in this standard, provided that it is shown that the alternative rule accords with the relevant principles and it is at least equivalent with regard to the resistance, serviceability and durability achieved by the system.

6 Required information

6.1 Documents from the design phase

A full set of updated data, in accordance with EN 13941-1 shall be available at the construction site. The information shall include at least the latest information about the local situation, vertical cover, dimensions of all existing and planned underground systems, including related facilities, such as shafts.

It shall be checked that the expansion cushions, as delivered at the construction site, comply with the requirements of EN 13941-1.

6.2 Documents from the manufacturers

The following documents shall be provided by the manufacturer on request:

- a installation manual.

In the installation manual, the manufacturer shall provide instructions about how to install the pipe elements and the pipe components. It should also give recommendation about handling, storage on-site, welding, jointing, backfilling in accordance with Clauses 10, 11 and 12.

6.3 Existing construction and underground systems

6.3.1 General

A full set of all detail plans of existing underground systems, like route plans, shaft drawings, detail and manufacturing drawings as well as static calculations should provide all information to prevent damage to existing underground systems.

National and local regulations and requirements on the location of service conduits, ducts and associate installations shall be complied with.

NOTE At works in the earth there is always the danger that existing underground systems get damaged. To the most important underground systems rank among:

- district heating pipelines;
- gas and water pipelines;
- electric cable;
- telecommunication cable;
- sewerages and rainwater pipelines;
- underground railway;
- and other ones.

6.4 Wiring design diagram

To locate any deviation as precisely as possible, a technical documentation according to EN 14419 is required.

During installation a wiring design diagram for each measuring section is required, consisting of:

- drawing with legend;
- wiring diagram including all measuring elements, all connected branches and their respective destination;
- drawing showing the location of connection points, etc.

7 Quality control

7.1 General

For basics of quality control see EN 13941-1.

The range of documented information shall be defined in relation to the kind of the work and the project class.

All components and materials and all activities carried out (e.g. civil engineering work, pipe installation, assembling of joints, testing and evaluating of test results) shall be documented in an appropriate manner.

The construction progress should be documented in form of daily reports which should include the essential information from the work on-site. Depending on the kind of project, the following information can be necessary:

- Date and location
- Information on the weather
- Present, supervising persons with duration of presence
- Information about the personnel and machine used
- Information on subcontractors working
- Information on construction site safety
- Type, extent and duration of the work
- Instructions given by the supervisor for the on-site construction, the purchaser or his representative
- Special incidents, e.g. such as accidents
- Transferred and received documents
- Interrupts and hindrances
- Names of persons responsible for on-site construction
- Steel welds, PE-welds, casing joints, surveillance systems, preheating and expansion cushions

A detailed overview of the technical documentation is written in Table 8.

The daily reports shall lead chronologically together in a general report at the end of the construction work.

For special situations, it is recommended to perform a visual proof with clearly identifiable photos as support measures. This can be for example:

- difficult installation situations in the near of supply systems by other owners (e.g. electricity, water, telecommunication);
- performed works (e.g. assembling of expansion cushions).

7.2 Installation and approval

Further information on the quality control are given in Annex D.

8 Site preparation

8.1 General

In consistency with national regulations, the site preparation for pipelines and facilities shall be such that the safety is guaranteed of:

- the public and personnel;
- the environment;
- the operating facilities;
- private and public buildings.

The site preparation includes among others all production-, transport-, storage-, health facilities, equipment, traffic areas and working areas, for a limited time, necessary for construction.

NOTE 1 A well prepared construction site can increase a failure-free and safe construction progress.

During the whole construction phase any national health and safety requirements shall be fulfilled.

NOTE 2 Health and safety requirements can include:

- sanitation;
- social rooms;
- construction site safety;
- personal protective equipment;
- noise- and dust protection;
- fire protection;
- rescue plan;
- first-aider;
- first aid kit and first aid rooms where applicable;
- escape ways.

Site preparation also includes planning and preparation of trench sheeting, construction site safety and dewatering systems.

Further information may also be found in [10].

8.2 Liason with Authorities and other parties concerned

The owner of the pipelines or his representative shall inform the authorities well in advance about the start of the work in public area. If the work is done on private property the owner of the property shall be informed well in time.

Before the start of the work the planned execution of the work shall be discussed and coordinated together with local authorities, the owners of other underground systems and all other parties concerned.

The coordination with authorities requirements may also include:

- traffic guidance and traffic management system;
- safety of public and work personnel;
- storage of pipes, elements and other materials;
- surface disruption;
- groundwater detraction;
- environment protection;
- unexploded ordnance.

Construction times and other planning items are needed for proper installation of the pipe system.

The instructions from the authorities, as well as national regulations are to be followed.

8.3 Site access

In order to ensure optimum construction progress and minor annoyance of the environment adequate traffic routes shall be planned and provided. This includes sufficient space for the delivery and storage of equipment and material. A traffic management plan shall be provided, where applicable.

8.4 Equipment and material

All equipment used on-site and during the construction process shall be adequate and tested according to the national, regional and local standards.

The material to be stored and used on-site shall be protected against weather and damage. The manufacturer's guidelines shall be paid attention to.

Prefabrication areas if necessary shall be provided and protected against bad weather conditions.

9 Trenching

9.1 General

The pipe trench shall be excavated in accordance with the specifications for line routing and depth.

National regulation with regard to positioning of underground cables and pipelines shall be followed, Special attention shall be given to other underground systems. Prior to the excavation works all necessary information about any underground infrastructure shall be gathered. Therefore are the following points of special attention:

- if there is any ambiguity the exact local situation of the underground systems shall be ascertained by manual digging. If expected lines and structures are not found in the expected situation, its owner shall be informed;
- exposed cables, pipelines and structures shall be protected against damage and, in particular, against positional change. Depending on the local circumstances a technical acceptance by the owner of the respective cable, pipeline or structure is recommended;
- in the case of damages to existing cables, pipelines and facilities during excavation the owner shall be informed immediately.

The width of the excavation is, among other things, determined by the requirement for sufficient working space during the installation phase, e.g. welding chambers and joint installation, casings produced under on-site conditions, head access holes but also the possibility of compacting the backfill material around the system.

The minimum working space in accessible trenches shall be 0,5 m between the casing and the trench wall, respectively the sheeting, in accordance with EN 13941-1. Head access holes shall have the following minimum dimensions:

- minimum length: 1,5 m;
- minimum distance between casing and trench bottom: 0,4 m;
- minimum distance between casing and trench wall and the sheeting, respectively: 0,5 m.

The above given minimum dimensions shall be followed unless national regulations require a higher minimum dimension.

If no national regulation applies, dependant on trench dimensions and soil conditions, the trench wall shall be reinforced with sheeting.

In soft soil areas (organic material or the like) special provisions shall be made during the pipe excavation.

The pipe zone shall be according to 12.1.

9.2 Groundwater extraction

Except by pipe laying directly in the water or by horizontal directional drilling (HDD), all digging, installation work and backfilling shall be done in a water free trench, if necessary by means of water extraction through drains. If an extraction is foreseen to get a dry trench, a dewatering plan shall be made.

In this plan, it shall be investigated how the extraction can be realized, which quantity of water is expected to be pumped away and what is the quality of the water.

Furthermore the plan shall specify the time and the period of the extraction, the capacity and number of pumps and the effects, caused by the dewatering on the surroundings. This shall be done on basis of a geo-hydrographic report and in accordance with the requirements from the authorities.

The extracted water shall be pumped away through pipes to an approved location.

9.3 Installation of pipelines crossing or parallel with other constructions and existing conduits

During installation, around and close to existing constructions and conduits, it shall be ensured that the existing constructions and conduits are not damaged. The position of existing constructions and conduits shall be secured.

When pipelines are installed near existing constructions and conduits it is required to contact the owner of the existing constructions and conduits to settle the minimum distance between the pipelines to be installed and the existing construction and conduits.

9.4 Excavations crossing or parallel to existing district heating pipelines, reducing of soil cover, etc

During excavation, around and close to the casing, it shall be ensured that the pipe system is not damaged.

Special safety and welding instructions shall be taken into account when installing branches on pressurized pipelines, e.g. hot tapping procedure.

During excavation, the stability of the existing district heating pipes shall be ensured at all times.

Adequate measures shall be taken in order to protect adjacent infrastructure from damage at all times

Any future excavation work near the district heating pipelines shall be agreed with the operator of district heating pipeline.

10 Transport and storage of pipe elements, pipe components and other materials

10.1 General

Maximum pressure on the casing during transport, lifting and storage is given in Table 1.

Table 1 — Maximum pressure on the casing

Situation	Maximum pressure MPa
Transport	0,3
Lifting	0,3
Storage	0,2

10.2 Transport and delivery

10.2.1 Loading and unloading

During loading and unloading of pipe elements it shall be ensured that they are not dropped on the ground and are protected from damages.

Pipe assemblies shall not be lifted at only one spot; no lifting ropes or chains shall be used.

Straps used for lifting shall be at least 100 mm wide.

Pipe assemblies with diameters DN 20 to DN 40 shall be lifted in bunches using traverses in order to prevent excessive deformation.

It is forbidden to perform any work associated with the transportation, lifting, handling and cutting of pipe elements at outside temperatures below -15°C .

10.2.2 Checking of the delivery

The purchaser or contractor shall carry out an inspection on arrival of delivered materials.

On arrival inspection shall include:

- check on the completeness of the delivery — (check the bill of quantities);
- check on transport damages;
- check the quality of delivered pipe elements (visual check and check of documents);
- checking the measuring elements of the surveillance system in the pipe elements in accordance with EN 14419;
- check the certificates when required (e.g. due to customer requirements);
- by delivery for steel parts the certificates 3.1 according EN 10204 shall be present, if ordered;
- complementary tests reports done at the factory (X-Ray or dye penetrant test on welds, Hydraulic pressure test) shall also be present, if ordered.

A protocol of the results of these checks and a signed confirmation of this delivery shall be made and kept until commissioning (at which point the protocol is to be transferred to the client).

10.3 Storage

10.3.1 General

Pipe elements and pipe components shall be protected against external and internal corrosion during storage.

When pipe elements are stored, for extended periods plastic cover are recommended to be protected against direct solar irradiation.

10.3.2 Storage of pipe assemblies

Pipe assemblies shall be kept and stored in such a way, that they are effectively protected against damage. They shall be laid on a stone-less flat surface or on soft substrates (See Figure 1). Adequate provisions shall be made in order to prevent compressive stress on the casing to exceed to allowable value according to Table 1

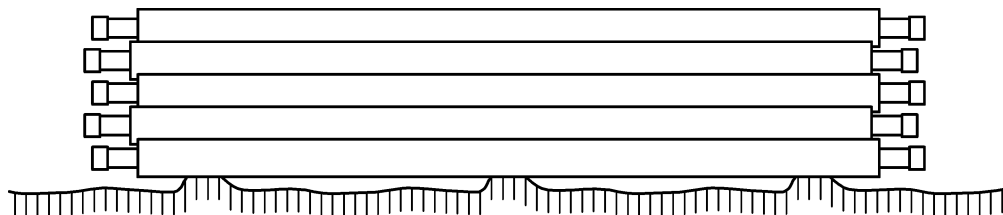


Figure 1 — Example for the storage of pipe assemblies

For safety reasons, the stacks shall not exceed 2 m in height and the layers shall be secured against rolling apart.

For the purpose of preventing internal corrosion of the steel service pipes, the steel pipe ends shall be protected during storage by using plastic protective caps.

10.3.3 Storage of fitting and valve assemblies

All fittings and valve assemblies shall be kept and stored in such a way as to be protected against damaging of the casing, and internal corrosion of steel pipe.

For the purpose of preventing internal corrosion of the steel service pipes the steel pipe ends shall be protected during storage by using plastic protective caps.

10.3.4 Storage of joint casing systems and other materials

All joint casing systems shall be stored upright in their original packaging in which they were delivered in a manner that protects against dirt and water. Particular attention shall be paid to the heat shrink materials and the expanded joints in order to protect them from direct solar irradiation and heat that can lead to permanent deformation of stored joints.

Foam components shall be stored in a dry covered room at a temperature 15 °C – 25 °C in the original packaging in which it was delivered. Special attention shall be paid to the production date and/or the expiry date for use. If the expiry date is exceeded, the foam shall not be used and shall be disposed.

The expansion cushions while stored on-site shall be protected against direct solar irradiation.

Heat shrinkable material as sealing sleeves etc. shall be stored in a dry place protected from solar irradiation, heat and dirt.

Elements of surveillance system shall be stored in original packaging, in terms of protecting against moisture and mechanical damage.

11 Pipe laying

11.1 General

Prior to pipe laying and during the pipe laying phase the floor of the trench shall be made level and the trench shall also be checked on position, height and width. Impurities, stones, etc., shall be removed.

The trench dimensions shall provide sufficient space for expansion provisions in accordance with the design.

The minimum working space in accessible trenches shall be in accordance with 9.1.

Whenever pipes and components are handled, precautions shall be taken to avoid damage to the pipe system.

If pipe elements are to be cut, this shall in principle be done perpendicular to the pipe axis. Fittings and valve assemblies shall be shortened only according to manufacturers' instructions.

All pipe elements and pipe components shall be installed according to the manufacturer instructions and the design documentation.

When small angular deviations between two pipe sections are made by mitering of pipe ends at the joint between two service pipes, the following rules shall be applied:

- the maximum angular deviation between two shall comply with EN 13941-1
- it is not allowed to change the mitered angle without approval by the pipeline designer;
- the mitered angle shall be equally distributed on both steel pipes;

- in the case of several miteres one after the other, a minimum distance between each one specified in the design documentation shall be maintained;
- near the anchors and axial compensators small angular deviations are prohibited at distances less than 12 meters.

Prior to pipe laying pipes and components shall be inspected externally for any kind of damage and internally for contaminants; any contaminant shall be removed.

During handling and pipe laying the end caps shall be kept in place as long as possible; at the end of the day after completion of a pipe section the last pipes ends shall be closed with end caps.

11.2 Installation in the trench

The pipe elements shall be placed on a sand layer or corresponding foundation. The use of wooden sleepers in the trench is not permitted.

Soft materials such as sand sacks and styrene supports may be used for temporary support.

For the straight pipe sections the minimum distance between the casings of parallel layed pipes shall be in accordance with EN 13941-1 and with the installation plans and local authority requirements.

For expansion zones the minimum distance between the casings of parallel layed pipes shall include additional space for pipe movements and expansion cushions.

11.3 Welding and testing of welds

11.3.1 Welding of the steel service pipe and testing of the welds

11.3.1.1 General

This clause defines the minimum requirements for welding and testing of steel service pipe joints related to the project classes.

Additional requirements shall be specified in the installation plan when any of the following are considered critical:

- the strain on pipelines and systems;
- the line routing;
- the design or the welding technique;
- the execution and preparation of the welds;
- the materials.

The steel grades given in EN 13941-1, are in Group 1 of CEN ISO/TR 15608 for welding purposes. Equivalent or higher material groups may be used, but the requirements will need to be changed accordingly.

Steel fittings and other steel components shall be made of steels grades that are compatible with the above mentioned steel grades and for welding.

The welding contractor as mentioned in 11.3.1.2.2 can be any organisation or person responsible for the welding part of a project or production.

11.3.1.2 Quality system for the different project classes

11.3.1.2.1 General

The relation between project classes and quality demands is provided in Table 2 (Relation between project classes and quality; the table gives an overview, more details can be found in the text.)

NOTE The quality requirements include the following aspects in the construction of the systems:

- a) The contractor's organization/ personnel:
 - 1) welder(s);
 - 2) supervisor personnel;
 - 3) testing personnel.
- b) Welding procedures:
 - 1) specification;
 - 2) welding method;
 - 3) material;
 - 4) consumables;
 - 5) execution of the work.
- c) Level of testing:
 - 1) percentage of non-destructive testing;
 - 2) destructive testing or other tests.

For quality control program and service life documentation for welding contractors see Annex D.

11.3.1.2.2 Welding contractors

If required by the pipeline operator, contractors shall demonstrate their ability to perform the work. Reference shall be made to the EN ISO 3834 series.

The quality requirements to be fulfilled by the contractors depend on project class applying to the project under construction. The quality level with specific areas of activity assigned to each class can be seen in Table 2, Section 1. Each quality level category includes the requirements of the lower one(s), as applicable.

Table 2 — Relation between project classes and quality

		Requirements for the welding, welding tests and contractors	Project classes		
			A	B	C
Section 1	Quality	EN ISO 3834-1 and EN ISO 3834-3, Standard		RQ	RQ
		EN ISO 3834-1 and EN ISO 3834-4, Elementary	RQ		
Section 2	Welding Supervisory personnel	According to EN ISO 14731, the following personnel is required			
		Welding technologist or welding engineer			RQ
		Welding specialist		RQ	
		Foreman welder	RQ		
Section 3	Testing personnel and organisations	Examining organization The examining organization shall be capable to perform the testing. NOTE Examining Bodies fulfilling EN ISO/IEC 17025 are considered competent to perform the testing.	RQ	RQ	RQ
		Inspectors The requirements for the qualification of the personnel performing non-destructive tests given in EN ISO 9712, level 2 shall be fulfilled.	RQ	RQ	RQ
Section 4	Welding procedure specification (WPS) and Welding procedure qualification report (WPQR)	Welding procedure shall be specified according to the EN ISO 15609 series	RQ	RQ	RQ
		The requirements for the welding procedure according to EN ISO 15610 EN ISO 15613 or EN ISO 15614-1 shall be fulfilled.	RQ	RQ	RQ
Section 5	Welders	Welders for manual welding shall be qualified in accordance with EN ISO 9606-1.	RQ	RQ	RQ
		Welders for with mechanised welding equipment shall be qualified in accordance with EN ISO 14732.	RQ	RQ	RQ
NOTE RQ = Requirement					

11.3.1.2.3 Welders

Welders shall be qualified according to EN ISO 9606-1.

Welding personnel operating mechanised welding equipment shall be qualified in accordance with EN ISO 14732.

Welders employed in the installation of buried pipelines shall have passed their welding examination under site conditions, as e.g. in head access holes, see 9.1.

It is recommended that the welder's certificate should indicate by reference to this standard that the welder's qualification test has been performed under site conditions.

At request, the welder's manual skill shall be demonstrated by production of a work sample in field conditions before starting work.

11.3.1.2.4 Welding supervisory personnel

Welding supervisory personnel shall be responsible for all welding and testing. For the requirements to the supervisory personnel see in Table 2 section 2.

Responsible and qualified welding supervisory personnel shall be nominated.

The tasks and responsibilities of each welding supervisors shall be defined in accordance with EN ISO 14731.

11.3.1.3 Welding procedures and the welding process

A1 The welding procedure to be used shall be suitable for welding pipes and components in field conditions.

Any type of welding process is permitted, if it is demonstrated that the welded joints have mechanical properties corresponding to the mechanical properties of the steel pipes.

Welding procedure specification (WPS) shall fulfil the requirements given in EN ISO 15609-1 or EN ISO 15609-2.

The welding procedure shall be qualified in accordance with EN ISO 15610, EN ISO 15613 or EN ISO 15614-1.

The application of EN ISO 15610 is not permitted for: **A1**

- work on pipes of project class C;
- pipelines under pressure or water filled. **A1** The welding procedure qualification records (WPQR) shall be verified by use of water filled test pipes. **A1**

11.3.1.4 Welding consumables

Welding consumables shall be of such a quality that the welds have mechanical characteristics at least equivalent with the parent metal and have to fit with the welding procedure and welding conditions.

Welding consumables shall be protected and stored in accordance with the manufacturers' requirements.

11.3.1.5 Place and position of the weld

All welding shall comply with the approved welding procedure specification.

The working space shall enable adequate access to the working area in order to provide a safe environment and to allow satisfactory production and testing of a weld joint. The space provided shall be at least as large as mentioned in 9.1, if not agreed otherwise by all parties involved.

Weld joints, in particular tie-ins, shall be arranged and designed in a way suited to the planned welding and testing technique. The placement of tie-in welds is particularly important.

The choice of joint configuration shall take into account the welding technique, the welding position and the accessibility of the joint.

Attention shall be given to movement due to temperature changes in the system during welding.

11.3.1.6 Performance of welding work

11.3.1.6.1 Joint edge preparation ~~A1~~ deleted text A1

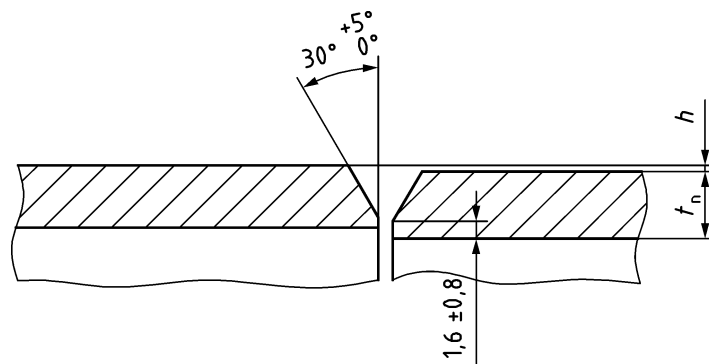
~~A1~~ The ends of the steel service pipes shall be prepared for welding as determined in the welding procedure specification (WPS). ~~A1~~

Minor differences in ~~A1~~ service ~~A1~~ pipe end measurements are to be distributed evenly over the entire circumference by centring of the pipes. ~~A1~~ For joints between service pipe ends with different values of the possible misalignment and difference in wall thickness Table 3 in conjunction with Figure 2 shall apply. ~~A1~~

Table 3 — Adaptation of misalignment and difference in wall thickness

	Adaptation	Required action
Misalignment		
Misalignment $h \leq 0,3 t$, max 1 mm	Figure 2 detail A	
Misalignment $1 \text{ mm} < h \leq 10 \text{ mm}$		Adaptation of pipe ends
Misalignment $h > 10 \text{ mm}$	Extra fitting	Extra prepared steel fitting Minimum length according to 11.3.1.6.3
Difference in wall thickness		
Differences in wall thickness $t' \leq 1,5 t_n$	Figure 2 detail B	Adaptation of thicker wall t' according to EN 1708-1
Differences in wall thickness $t' > 1,5 t_n$	Figure 2 detail C	Adaptation of the thicker wall t' according to EN 1708-1

Dimensions in millimetres



Detail A

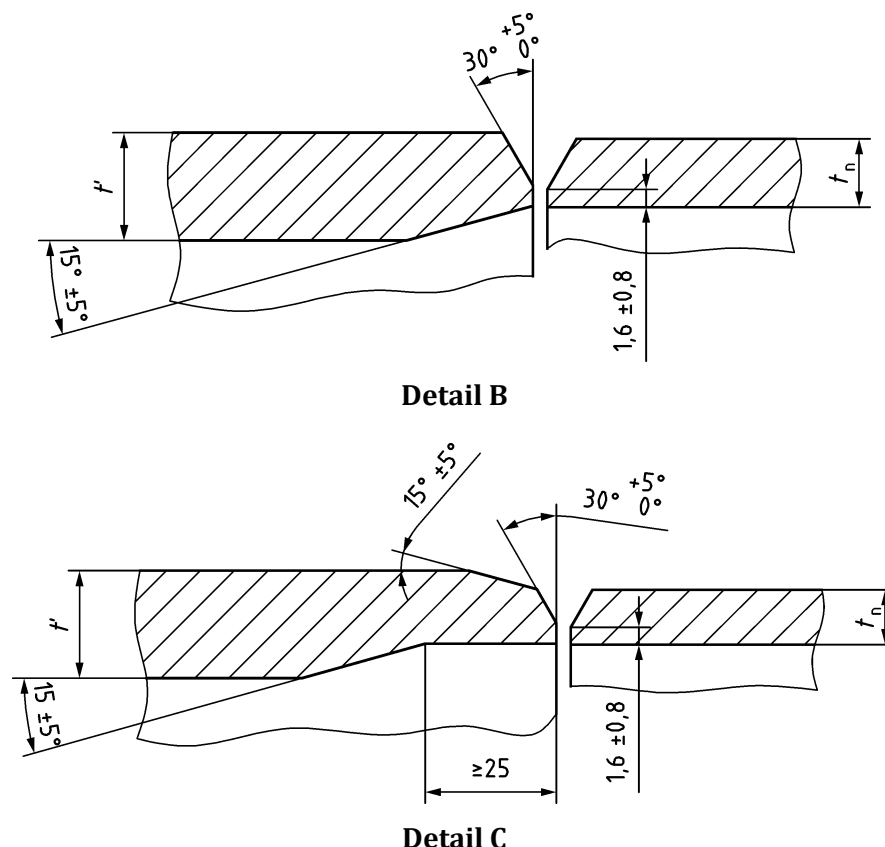


Figure 2 — Misalignment, difference in wall thickness and joint end preparation

Maximal permissible axial angular deviations of the pipes and fittings shall be as defined in the design plan.

Before tack welding the pipe ends are to be centred with tools, which at the same time corrects ovalities. Tack welds shall be removed. This shall be considered in the WPS (Welding Procedure Specification).

During welding the pipes shall be guided to achieve the best possible alignment of the centre lines and inner surfaces.

Circumferential welds on pipelines made “on-site” shall be produced in a single, uninterrupted work operation. In order to obtain a uniform heat input at the weld zone it should be considered, for pipe dimensions DN 500 and above, to have welds executed by at least two welders, working at the same weld at the same time. This may be especially relevant in case higher pipe steel grades than listed in EN 13941-1 are used.

11.3.1.6.2 Cutting and marking

Steel pipes, steel fittings and other steel pipe components which require marking shall be re-stamped or remarked next to the cutting line prior to cutting. In case a stamping is being removed during the machining process a procedure securing the traceability during production shall be implemented.

11.3.1.6.3 Distance between parallel seams

The minimum distance between two parallel seams shall be such that the heat-affected zones do not overlap or interact, the minimum distance is 50 mm, in special cases the minimum distance may be reduced to 7 times the wall thickness.

A distance of 100 mm or more is recommended.

11.3.1.6.4 Interaction of longitudinal or spiral seams

Longitudinal seams or spiral seams should be staggered by a distance of 10 times the wall thickness. A minimum of 50 mm is recommended.

11.3.1.6.5 Welds with more than one pass

For welds with more than one pass there shall be a minimum distance of 30 mm between the start and the stop positions of the passes.

11.3.1.6.6 Execution of the welding (welding action)

The area 50 mm back from the weld on both sides of the joint shall be kept free of dust, dirt, grease and water. The welding area shall be protected against wind and rain.

At temperatures below 5 °C and in the event of high air humidity, the weld seam areas shall be heated to avoid condensation.

Arc strikes on the pipe surface shall be avoided. If arc strikes occur they shall be removed by grinding.

To avoid potentially damaging air movements within the pipe, at least one end of the pipe shall be closed e.g. by protective cap during welding in the open air.

11.3.1.6.7 Actions after welding

After the weld is completed, weld spatter shall be removed. The weld surface shall be cleaned of slag.

At air temperatures below 5 °C, and if the pipeline owner requires it, the weld seam shall be protected against excessively rapid cooling.

Accelerated cooling of welds and heat affected zones shall comply with the welding procedure and shall be documented.

11.3.1.6.8 Repair of weld failures (defects)

Weld seams, which do not meet the specified requirements, shall be repaired or cut out. Repairing welds is not allowed in case of:

- pipes with a diameter below DN 80;
- summary of defects exceeding 20 % of the length of the weld;
- the weld already being a repair of a previous weld.

In such cases the pipes shall be cut out at least 50 mm on both sides of the defect weld.

Repairs shall be carried out in accordance with a qualified welding repair procedure.

If the defect is a crack this shall only be repaired if the cause of cracking is clearly established and is being shown to be repairable.

11.3.1.7 Special procedures

11.3.1.7.1 General

Before special procedures are carried out, the type and scope of the weld joint shall be specified. The testing technique used will depend on the type and accessibility of the weld joints.

The inspection of pipelines should be increased to 100 % (see Table 5) when repair causes particular difficulties, e.g. pipeline below watercourses dykes and railways.

11.3.1.7.2 Attachment of structural parts

Structural parts shall be attached using a continuous weld.

11.3.1.7.3 Welding on pipes under pressure

Welding work on pressurized pipelines and systems shall only be carried out according to safe and proven procedures to ensure the correct mechanical properties of the weld and the safety of the working crew. The used welding procedure specification shall be according to EN ISO 15613 or EN ISO 15614-1.

11.3.1.7.4 Inspection of the weld joint

The weld joints shall be checked using the demands for personnel and procedures given in Table 4 and Table 5. The inspection rate is given in Table 5 (inspection and test requirements).

Welded joints are divided into representative inspection sections.

Examples of welded joints, which should be referred to different inspection sections, are welds with difference in base material, welding process, welder or weather conditions during welding.

11.3.1.7.5 Non destructive testing (NDT) of welds

NDT of welds in pipelines is generally done by visual testing and radiographic testing. Alternatively, when agreed by the owner and in particular cases where radiographic testing is unable to give adequate information on the quality of the weld, this method should be supplemented or replaced by ultrasonic examination on wall thicknesses above 8 mm.

Weld seam examination shall be carried out in accordance with one or more of the standards shown in Table 8 unless another NDT method is required dependent on the material, design and/or welding technique.

Table 4 — NDT weld seam examination

NDT Method	General principle	Weld seam examination	Acceptance criteria
Visual inspection	EN 13018	EN ISO 17637	EN ISO 5817
Radiographic examination	EN ISO 5579	EN ISO 17636-1 and EN ISO 17636-2	EN ISO 10675-1
Ultrasonic examination	EN ISO 16810	EN ISO 17640	EN ISO 11666
Dye penetrant examination	EN ISO 3452-1	EN ISO 3452-1	EN ISO 23277
Magnetic particle examination	EN ISO 9934-1	EN ISO 17638	EN ISO 23278

For project class C 100 % of the welds shall visually inspected. For Project class A the visual inspection shall be 20 % of all welds per year, for project class B the visual inspection rate shall be 80 % of the welds of each project. All visual inspection shall be documented.