BRL 5609-2
2019-08-27

Evaluation Guideline

For the KOMO® (technical approval-with-) product certificate for
Pre-insulated flexible plastics piping systems for warm water distribution outside buildings
– Part 2: Products

Validated by the Board of Experts Piping systems of plastic on 02-07-2019
Accepted by the KOMO Quality- and Certification Commission on 27 August 2019

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Preface Kiwa

This Evaluation Guideline has been prepared by the Kiwa Board of Experts “LSK”, in which the parties interested in the field of “pre-insulated flexible plastics piping systems for warm water distribution outside buildings – Part 2: Products”, are represented. This Board of Experts also guides the performance of certification and adjusts this Evaluation Guideline where necessary. Wherever the term ‘Board of Experts’ is used in this Evaluation Guideline, the above-mentioned Board of Experts is meant.

The certification institute shall apply the Evaluation Guideline in conjunction with the Regulations for Product Certification of the certification institute. These regulations detail the methods employed by Kiwa for conducting the necessary investigations prior to issuing the (technical approval-with-)product certificate and the method of the external control.

This is a translation of the Dutch version of evaluation guideline BRL 5609-2. If in doubt about the translation, the Dutch version is valid.

Binding declaration
This evaluation guideline is declared binding by Kiwa on 27 August 2019.

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1 Introduction

1.1 General

The requirements embodied in this evaluation guideline (BRL), shall be employed by certification institutes that are accredited by the Dutch Accreditation Council (RvA) and which have an licence agreement with the KOMO foundation when dealing with applications for the issue or maintenance of a KOMO® (technical approval-with-)product certificate for Pre-insulated flexible plastics piping systems for warm water distribution outside buildings – Part 2: Products.

This evaluation guideline together with Part 1 – BRL 5609-1 ”Pre-insulated flexible plastics piping systems for warm water distribution outside buildings – Part 1: Installation” a series of evaluation guidelines in which amongst others requirements are determent for the installation and for the products.

Besides the requirements embodied in this evaluation guideline, certification institutes impose additional requirements in the sense of requirements with regard to general procedures for certification as laid down in the general certification regulations of the respective certification body.

This evaluation guideline supersedes BRL 5609 dated 6 January 2014.
(Technical approval-with-)product certificates issued on the basis of that evaluation guideline expire one year after binding declaration of this guideline.

During the execution of certification activities, the certification bodies have to fulfil the requirements as laid down in the chapter ‘Requirements imposed on the certification body’.

1.2 Field of application

The products are intended to be used in piping systems for warm water distribution outside buildings (otherwise known as district heating) at a design pressure (= maximum working pressure) of 10 bar (11 bar absolute or 10 bar overpressure), 8 bar (9 bar absolute or 8 bar overpressure) or 6 bar (7 bar absolute or 6 bar overpressure), under the conditions mentioned in table 1.1.

Remark: Each pressure mentioned in this BRL is defined as overpressure.
(So, with "10 bar" a "10 bar overpressure" is meant).

Table 1.1 Classification system

	Temperature [ºC]	Lifetime	Service coefficient
T_D	80	29 years	1,5
T_{max}	90	1 year	1,3
T_{mal}	95	100 hours	1,0
Remark: the mentioned temperature profile is in accordance with class DH1			

The piping system is usually build up with inter connected pipe packages and fittings. The pipe package consists of a medium transport pipe, isolation material and an outer outer casing pipe. Metal and/ or plastic fittings are used to connect medium transporting pipes. The fittings are also isolated with isolation material and provided with outer casing in order to provide a watertight connection.

1.3 Relation to European Regulation constructionproducts (CPR, EU 305/2011)

On the products belonging to the range of this evaluation guideline, no harmonized European standard is applicable.

1.4 Acceptance of test reports delivered by the supplier

If the supplier submits reports from research bodies or laboratories to show that the requirements of the evaluation guideline are met, then these reports have to be prepared by a body meeting the prevailing accreditation standard, i.e.:

- NEN-EN-ISO/IEC 17020 for inspection bodies;
- NEN-EN ISO/IEC 17021-1 for certification bodies certifying systems;
- NEN-EN-ISO/IEC 17024 for certification bodies certifying persons;
- NEN-EN-ISO/IEC 17025 for laboratories;
- NEN-EN-ISO/IEC 17065 for certification bodies certifying products.

The body is deemed to meet these criteria if an accreditation certificate can be submitted which has been issued by the Dutch Accreditation Council (RvA) or an accreditation body with which the Dutch Accreditation Council has concluded a mutual acceptance agreement.
This accreditation should relate to the tests required for this evaluation guideline.
If no accreditation certificate can be submitted, the certification body shall verify whether the accreditation standard has been met or repeat the tests concerned either self or by a third party.

1.5 Certificate

Based on the KOMO-systematic in appliance to this (technical approval-with-)product certificate, a KOMO®:

- Technical approval-with-product certificate for the piping system is issued. In the technical approval-with-product certificate products with their dimensions, material type and colour, which are a part of the system, are listed, which comply to the requirements as stated in chapter 4 up to and including chapter 12 of this evaluation guideline;
- Product certificate for the medium transporting pipes, fittings (for connections of the medium transporting and/ or outer casing (pipes). Other connection components (shrink sleeve, half (metal) shell parts, etc. and isolation material for the technical approval-with-product certificate with their dimensions, material type and colour, are listed which comply to the requirements as listed in chapter 5 up to and including chapter 9 of this evaluation guideline.

On the website of the KOMO foundation (www.komo.nl) the model (technical approval-with-) product certificates are listed, which are applicable for this evaluation guideline. The (technical approval-with-)product certificate which will be issued is to be in accordance to this.

Without alteration of this evaluation guideline, the validity of the certificate is indefinite.

2 Terminology

In principle for regarding terms and definitions is referred to explanations as those are put into words in for example the NEN-EN 15632 series.

For definitions in coherence to certification, one is referred to the website of the KOMO foundation (www.komo.nl) and the regulations of the certifying body.

2.1 General definitions

2.1.1 Technical Approval investigation

The investigation to determine that the product in its application fulfils the performance requirements in chapter 4.

2.1.2 Technical approval-with-product certificate

A document in which is stated that a product is deemed to deliver the performance as specified in the certificate and upon delivery is to fulfil the product specification as stated in the certificate.

2.1.3 Evaluation Guideline

The in the Board of Experts made agreements about the subject of the certification.

2.1.4 Board of Experts

The Board of Experts - “Leidingsystemen Kunststof” or “CvD-LSK” for short.

2.1.5 Surveilance audit

The activities that are performed after certification to determine that the certified products continuously meet the requirements as mentioned in the evaluation guideline.

Remark: In the matrix It is also stated with what frequency inspections are performed by Kiwa.

2.1.6 Manufacturer

A manufacturer is a person, organisation or company that provides products (and/ or services).

Remark:
The responsibility for insuring that the piping system and/ or the products part of the system meet the requirements of this evaluation guideline is for the holder of the KOMO (technical approval-with-) product certificate.

2.1.7 IQC-Scheme

a description of the quality inspections carried out by the manufacturer as part of his quality system.

2.1.8 Piping system

The combination of pipes, outer casing (if applicable), fittings (and joint assemblies) and insulation material, but excluding manifolds.

2.1.9 Life expectancy

The time during which the piping system has to function for the intended application.
Remark: In this BRL the life expectancy is set to at least 30 years according to table 1.1.

2.1.10 *Supplier*
the party responsible for ensuring that the design of products continuously fulfils the requirements of this evaluation guideline.

2.1.11 *Mechanical joint*
A connection between a pipe and a fitting, made by means of pressing a ring or case over the outside diameter of the pipe, with or without extra sealing elements and possibly making use of a supporting ring in the pipe, according NEN-EN-ISO 6708.

2.1.12 *Product requirements*
In measurements or numbers defined requirements which are aimed at the (identifiable) properties of products which comprise of an achievable value which can be measured or calculated unequivocally.

2.2 Geometrical terminologie and definitions

2.2.1 *Calculated pipe value (S_{calc})*
Value for a specific pipe calculated according to the following equation, rounded up to the nearest 0,1 mm:

$$S_{calc} = \frac{d_n - e_n}{2 \times e_n}$$

In which:
d_n = the nominal outside diameter in mm;
e_n = the nominal wall thickness expressed in mm.

2.2.2 *Outside diameter (at any point taken at random) (d_e)*
Measured outside diameter on a random point of the cross section of the pipe or fitting, rounded to the next 0,1 mm.

2.2.3 *Double piping system*
Piping system with two service pipes.

2.2.4 *Single piping system*
Piping system with a single service pipe.

2.2.5 *Mean outside diameter (d_{em})*
The average of the measured circumference on a random point of the cross section of a pipe or a spigot end, divided by π (= 3,142), rounded to the next 0,1 mm.

2.2.6 *Internal diameter (at any point taken at random) (d_i)*
Internal diameter of the pipe on any point taken random, rounded tot the next 0,1 mm.

2.2.7 *Maximum average outside diameter ($d_{em,max}$)*
Maximum value of the average outside diameter for a specific nominal dimension

2.2.8 *Maximum calculated pipe value ($S_{calc,max}$)*
The maximum value of the calculated S value for a specific application class.

2.2.9 *Maximum wall thickness (e_{max})*
Maximum wall thickness of the service pipe.

2.2.10 *Minimal mean outside diameter ($d_{em,min}$)*
Minimum value of the average outside diameter for a specific nominal value.

2.2.11 *Minimal wall thickness (e_{min})*
Minimum wall thickness of the service pipe.

2.2.12 *Nominal size (DN)*
Numerical indication of the size of a component, rounded to the next whole number related to the produced size (in mm).

2.2.13 *Nominal outside diameter (d_n)*
The specific outside diameter (in mm) assigned to a nominal size DN/OD.

2.2.14 *Nominal wall thickness (e_n)*
Numerical designation of the wall thickness of a component, approximately equal to the manufacturing dimension in millimeters (mm).

2.2.15 *Out of roundness*
The difference between the measured maximum outside diameter and the measured minimal outside diameter of the same cross section of a pipe or spigot-end of a fitting or the difference between the measured maximal inside diameter and the measured maximal inside diameter and the measured minimal inside diameter of the same cross section of an insert-fitting.

2.2.16 *SDR-value*
A number without dimension identifying the pipe according to ISO 4065, where the SDR-value describes a relation between the pipe and his wall thickness for a certain design pressure according to the following formula:

$$SDR = \frac{d_n}{e} = \frac{(2\sigma + p)}{p} = \frac{2\sigma}{p} + 1 = 2.S + 1$$

2.2.17 *S-serie*
A number without a dimension identifying the pipe according ISO 4065, where the S-series prescribes the pipe series for a certain design pressure.

2.2.18 *Tolerance*
The tolerated variance of the specific value of a parameter, expressed as the difference between the allowed maximum value and the minimum value of that parameter.

2.2.19 *Wall thickness (at a random point) (e)*
The measured value of the wall thickness of a component, measured on a random point along the circumference, rounded to the nearest 0,1 mm.

2.3 Terminologie and definitions in relation to the area of application

2.3.1 *Operating temperature (T_D)*
The temperature of the water in the piping system during operation, that occurs at least during a certain part of the lifetime of the piping system. See table 1.1.

2.3.2 *Flexible piping system*
A piping system in which possible bends in the pipe can be made without any mechanical means and in which the pipe is not deformed and the flow capacity is not reduced due to the possible bends.

Remark: in case a minimum bending radius is required in the system, use can be made of mechanical means according to the installation instructions of the supplier.

2.3.3 *Lifetime*

The time during which the piping system has to function with a certain operating temperature. See table 1.1.

2.3.4 *Maximum temperature (T_{max})*

The highest water temperature in the piping system during operation, that occurs during a certain part of the lifetime of the piping system (the highest occurring temperature during a short time). See table 1.1.

2.3.5 *Hydrostatic tension (σ)*

Tension in the circumferential direction of the pipe wall caused by internal water pressure. This tension is deduced from the internal pressure according the following formula:

$$SDR = \frac{d_n}{e} = \frac{(2\sigma + p)}{p} = \frac{2\sigma}{p} + 1 = 2S + 1$$

Where:
σ = the tension in the circumference direction of the pipe wall in MPa;
p = the internal pressure in bar;
d_{em} = the mean outside diameter of the pipe in mm; [1)]
e_{min} = the minimum wall thickness of the pipe in mm. [1)]

[1)] the stress bearing layers. E.g. in case of a homogeneous PE-X pipe with EVOH barrier layer, only the PE-X layer is e_{min} and d_{em}

2.3.6 *Design Presure (P_D)*

The allowable pressure in the piping system that during continuous use during 30 years may occur. In this BRL 'design pressure' is defined as the prevailing overpressure (so for example P_D =10 bar overpressure means a design pressure of 11 bar absolute).

2.3.7 *Overall servicecoëfficient (C)*

A coefficient with a value larger or equal to 1, which takes the service conditions and the properties of the components of the piping system into account for as far as they are not covered in the LPL value.

2.3.8 *Malfunction temperature (T_{mal})*

The highest water temperature in the piping system under abnormal circumstances. For example due to malfunctioning during a short period (maximum 100 hours per 30 years). See table 1.1.

2.3.9 *Temperature profile (DH1)*

On the basis of the employed design pressure in relation with the maximum and peak temperature, the temperature profile according to table 1.1 may be used for a lifetime of 30 years.

2.3.10 *Heat distribution system*

Heat distribution is the collective use of heat for the purpose of heating houses, businesses and other buildings and the possible delivery of warm tap water to those houses, businesses and buildings (other BRL).

2.4 Definitions: the construction

2.4.1 Service pipe

The medium carrying pipe, which is in contact with the warm water. The following jointing techniques are relevant:

- Butt fusion joint: A joint between two pipes, made by heating the planed ends of the pipes by holding them against a flat heating plate until the material reaches fusion temperature. After quickly removing the heating plate, the two softened ends are pushed against one another.
- Electro fusion joint: A joint between a pipe and a fitting realised by melting together of the outer layer of the pipe and medium layer of the fitting. The melting of the material is realised by heat developed due to induction of an electrical resistance. The electrical resistance is composed of a metal thread that is embedded in the fitting. Pipe and fitting are first pushed together till the required installation position, before the material is melted.
- Socket fusion joint: A joint between a pipe and a fitting realised by melting together of the outer layer of the pipe and medium layer of the fitting. The melting of the material is realised by a solid body with the appropriate temperature that is in contact with the material concerned during a certain amount of time:
  Socket shaped for the pipe and spigot-shaped for the fitting. The material is first melted, after which the pipe and fitting are pushed together till the required installation position is obtained.

2.4.2 Outer casing

A separate applied outer layer of the piping package, protecting the construction during installation and protecting the construction against external influences (after installation).

2.4.3 Piping package

The complete pipe existing of the service pipe, an insulation layer and (in general) an outer casing.

2.4.4 *Homogeneous service pipe*

Meant are the service pipes made of PE-X or PB or PE-RT type II and provided with an EVOH barrier layer. This barrier layer prevents or reduces the diffusion of oxygen through the pipe wall strongly. The barrier layer does not contribute to the mechanical strength of the pipe.

2.4.5 *Insulation layer*

The thermal insulation layer is meant to provide for the desired insulating characteristics of the piping package.

2.4.6 *Mechanical outer casing joint*

The watertight joint between two outer casing parts by means of:

- a contraction socket;
- an electro fusion socket;
- two (metallic) half plates.

Remark:
Pipes covered by one non pressure baring polymeric layer are covered by the corresponding product standard,

2.4.7 *Non-bonded piping package*

The different layers of the piping package can be mutually displaced under influence of expansion forces.

2.4.8 *Bonded piping package*

The different layers of the piping package are joined in such a way that under influence of expansion forces, no displacements at the interface of the mutual piping layers occur.

2.5 Definitions: welding

2.5.1 *Electro fusion Socket welding*

In this form of welding is an electro fusion coupler is placed over the two ends to be welded. Then, a specific amount of energy passed through the resistance wire in the electro fusion coupler whereby the weld is formed.

2.5.2 *Extrusion welding*

In this form of welding, a welding rod is used to connect the two parts. The welding rod is guided through a tube that, together with the weld groove, is preheated by hot air. The correct speed and the right pressure to the weld will be decisive for the quality of the weld.

2.5.3 *Welding procedure qualification record (WPQR)*

Record compressing all necessary data needed for qualification of a preliminary welding procedure specification

2.5.4 *Welding method*

Specified course of action to be followed in making a weld, including the welding process(es), reference to materials, welding consumables, preparation, preheating (if necessary), method and control of welding and post-weld heat treatment (if relevant), and necessary equipment to be used.

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2.5.5 *Welding procedure specification (WPS)*
A document that has been qualified by one of the methods described in clause 6 and provides the required variables of the welding procedure to ensure repeatability during production welding.

2.5.6 *Welding procedure test*
Making and testing of a standardized test piece, as indicated in the (p)WPS, in order to qualify a welding procedure.

2.5.7 *Pre-production welding test*
Welding test having the same function as a welding procedure test, but based on a non-standard test piece representative of the production conditions.

2.5.8 *Heated-tool socket welding*
In this form of welding, in which heating elements are required, is the pipe inserted into the socket of the fitting without the use of additional materials. The pipe end and the fitting socket are heated to the welding temperature by means of a heated spigot tool and a heated socket tool, and then pressed onto each other.

2.5.9 *Heated-tool butt welding*
The surfaces to be welded are brought into contact with a heater plate and then heated during a certain time. The plate is removed and the two surfaces are pressed against each other, whereby a welding bead is formed

2.5.10 *Preliminary welding procedure specification (pWPS)*
A document containing the required variables of the welding procedure which has to be qualified using one of the methods described in accordance with clause 6 of NEN-EN-ISO 15607.

2.5.11 *Work instruction*
Simplified specification of the welding procedure, suitable for direct application in the workshop.

3 Procedure for obtaining a product certificate

3.1 Initial investigation

In order to obtain a KOMO product certificate, the certification institute will conduct an investigation. The initial investigation comprise of:

- Review of the by the supplier supplied or to be supplied documents, at which time is verified if the with the products combined piping system complies with the performance requirements as stipulated in this evaluation guideline.
- Determination of the product characteristics (of compounded products) as documented in this evaluation guideline.
- Evaluation of the installation instructions of the supplier.

3.2 Assesment quality system

In order to obtain a KOMO product certificate, the certification institute will conduct an investigation. The initial investigation comprise of:

- Evaluation of the production process
- Evaluation of the quality system and the IQC-scheme
- Assessment of the presence and functioning of other required procedures

A determination has to be made to what extend the quality system is in accordance with the demands as stated in chapter 6 and 7 of this evaluation of this guideline.

3.3 Issue of the product certificate

After completion of the initial investigation, the results are presented to the decision-maker. The decision-maker evaluates the results and determines whether the product certificate can be issued or whether additional information and/or investigations are required in order to be able to issue the product certificate.

4 System requirements and test methods

In this chapter the performance requirements imposed on the piping system are included, as well as the determination methods in order to be able to determine whether the requirements are fulfilled.

4.1 Lifetime of the system

The complete piping system must be designed for lifetime expectancy according to paragraph 1.2.

Remark: with lifetime is meant the technical lifetime of the system during regular usage. The different life spans according to table 1.1 have to be totalled up in order to obtain the minimum lifetime of 30 years (class DH1).

It is assumed that this requirement is met if this BRL is met.

4.2 Requirements for the joints of the piping system

4.2.1 General

The joints in the piping system for the medium, and the outer casing have to be tested with regard to their proper functioning. In this chapter all joint tests required for the joint system for the medium are included.
The combination of a (possible) rubber seal, pipe, (possible) supporting insert and possible clamp construction in the fitting have to be tested with regard to the aspects as mentioned in table 4.2.

4.2.1.1 *Tightness and strength of the joints of the service pipe*

The fittings shall not deform during testing in accordance with table 4.1. After testing, the pipe ends shall show no severe damage. If not otherwise stated, the testing temperature is (23 ± 2) °C.

At the factory welded joints are to fulfil the requirements stated in chapter 10 and 11 of this evaluation guideline.

Table 4.1 - Tightness and strength of the joints of the service pipe

Aspect	Require-ment	Test parameters				Test method
Resistance to thermal cycling (TCT)	No leakage	n = 2000 cycli[4)6)] T_{max} = 93 ± 2 °C[1)] T_{min} = 23 ± 2 °C[2)] t_{cyclus}= 30 min[3)]. P_d (bar) One test piece				NEN-EN 12293
Resistance to pull-out	No leakage	t = 60 ± 1 min. Three test pieces F = 1,5 * π/4 * D_n^2 *1 (N)				NEN-EN 3501
Leak tightness under vacuum	≤ 0,05 bar	t = 60 ± 1 min. Three test pieces P= -0,8 bar				NEN-EN 12294
Leak tightness under internal pressure and bending	No leakage	t = 60 ± 1 min. Three test pieces [7)]				NEN-EN-ISO 3501
		Service pipe Type	Test pressure P (bar)			
			Pd 6	Pd 8	Pd 10	
		PE-X PB PE-RT type II Multilayer	20,6 22,6 25,3 [5)]	27,6 30,1 33,7 [5)]	34,4 37,6 42,2 [5)]	
Resistance to internal hydrostatic pressure	No leakage	t = 1000 h T = 95 °C Three test pieces				NEN-EN-ISO 1167 serie
		Service pipe Type	Test pressure P (bar)			
			Pd 6	Pd 8	Pd 10	
		PE-X PB PE-RT type II Multilayer	8,3 8,7 7,5 [5)]	11,0 11,6 10,0 [5)]	13,8 14,5 12,5 [5)]	

1) Maximum test temperature of the water
2) Minimum test temperature of the water
3) for d ≤ 110mm t_{cyclus}= t_{max} + t_{min} (= 15 + 15 = 30 min)
for d > 110mm t_{cyclus}= t_{max} + t_{min} (= 30 + 30 = 60 min)
4) for d ≤ 32mm counts n = 2000; for 40 ≤ d ≤ 110mm counts n = 1000; for d > 110mm counts n = 250
5) On basis of the regression curve and at least equal to the value of the service pipe material according to NEN-EN-ISO 21003-5
6) If the service pipes are used in plastic piping systems for hot and cold water installations inside buildings, the number of cycles shall be n = 5000
7) Only pipes ≤ 63 mm

General remark: these values are calculated like those in part 5 of the product standards using the design stress calculated for the DH1 temperature profile and the 1000 h/95 ºC values of table 5.9.
Remark: for a welded joint only the TCT and Resistance to internal hydrostatic pressure need to be performed.

4.2.1.2 *Watertightness and strenght of the casing connections*

A watertight connection of 2 casing connections can be realized by means of:

- A shrink socket;
- An electro fusion socket;
- 2 (metal) half shells.

The supplier and/or manufacturers of the shrink socket and the 2 metal half shells are to have a procedure and a work instruction on the method on how the joint is made in the field and in what way the soundness can be verified. The installation instructions and the method of proofing are part of the quality system of the supplier.

The water tightness and strength of an electro fusion socket joint in the casing shall be tested according to 4.1.

At the factory welded joints are to fulfil the requirements stated in chapter 10 and 11 of this evaluation guideline.

4.3 Rubber

Rubber seals shall fulfil the requirements according to BRL 2013 for the herein described appropriate temperature class. The manufacturer has to declare to the approval body which type of rubber is applied, as well as the hardness and dimensions of the rubber seals.

4.4 Installation instructions

The supplier shall provide installation instructions in the Dutch language. A reference to these instructions shall be made on or accompanied with the packaging. The instructions must contain specific information with regard to storage, safety, transport, processing temperature, construction of the joints and specific installation guidelines, see chapter 12.

5 Requirements for the piping package and test methods

At setting the requirements the uncertainties of the measurements are taken into account. This implies that drawing conclusions whether requirements are fulfilled these uncertainties do not need to be weighted anymore.

The relevant requirements for the piping package are taken for a big part from NEN-EN 15632, parts 1, 2 and 3.

5.1 Thermal insulation properties of piping package

The manufacturer shall submit values for the heat loss of the piping package for all pipe dimensions in accordance with annex V: Calculation of the heat flow from the medium to the ambient (heat loss), rounded to full 0,1 W/(m x K).

Remark:
Annex II: Measurement of linear thermal resistance and conductivity of the pipe, specifies how to measure thermal properties, annex III: Determination of the declared values of the radial thermal resistance conductivity of flexible pipe assembly, how to calculate declared values for thermal properties of all pipe dimensions, and annex IV: Determination of design values for the radial thermal resistance, how to (include) ageing effects.

5.2 Long term compression

The long term compression of the piping package has to fulfil the requirements according table 5.1.

Table 5.1 - Requirements with regard to the long-term compression of the piping package

Aspect	Requirement	Test parameters		test method
Ring stiffness	≥4 kN/m^2	Temperature compression velocity of compression	(23 ± 2) °C 3% 5 ± 1 mm/min.	NEN-EN-ISO 9969
Creep ratio	≤ 5	Temperature	(23 ± 2) °C	NEN-EN-ISO 9967

5.3 Compressive creep

After testing in accordance with annex VI: Compressive creep, the decrease of the insulation thickness of the piping package may not be larger than 10%.

5.4 Flexibility

The flexibility of the piping package shall be verified by the minimum bending radius. The producer shall declare the minimum installation bending radius for all dimensions produced.

The minimum declared installation bending radius of the piping package shall not exceed 30 times the outer diameter of the casing.

When bending to the minimum radius, the service pipe and the casing of the pipe assembly shall not break, and the ovality of the outer casing shall not exceed 30% when tested according to 11.1.

Cracks in the insulation material at the casing shall not exceed a width of 5 mm.

5.5 Axial shear strength (for bonded systems only)

For bonded piping systems the axial shear strength between the service pipe and the insulation material shall be at least 0,09 MPa for polymer pipes and 0.12 MPa for multilayer pipes, when tested in accordance with 11.2.
The test result shall be determined as an average of 5 measurements.

5.6 Linear water tightness (for bonded systems only)

When tested in accordance with 11.3, the amount of water leaking through any of the pipe ends shall not exceed 100 g after 168 hours.

5.7 Sealing in linear direction (for non-bonded sytems only)

The manufacturer of the system shall offer components to stop leakage in the linear direction at the end of each pipe section. These components shall be water tight when tested according to 11.4.

5.8 Water vapour permeation

The pipe supplier shall give information about the risk of water accumulation in the insulation depending on the operating conditions, with an estimate of the probability of occurrence and the impact when it occurs.

Remark:
PE-X, PB, PE-RT Type II and all pipes that do not contain EVOH or metal barrier layers are slightly open for diffusion of water from the media to the insulation. The rate of diffusion increases with the temperature. The casing is likewise open for diffusion from the insulation to the soil. The rate of this diffusion is depending on the casing temperature and the water vapour partial pressure difference over the casing wall. For pipes installed under the ground water, there will always be a certain build up of water directly under the casing. Experience shows that this build up is limited and not detrimental to the function although a certain loss of insulation capacity may be expected.

5.9 Service pipe

The service pipe shall meet the requirements stated in chapter 6.

5.10 Insulation material

The insulation material of the piping package is to fulfil the requirements mentioned in chapter 8.

5.11 Casing

The casing of the piping package is furthermore to conform to the requirements in chapter 9.

6 Requirements for the service pipe and test methods

At setting the requirements the uncertainties of the measurements are taken into account. This implies that drawing conclusions whether requirements are fulfilled these uncertainties do not need to be weighted anymore.

6.1 Long term strength

For the raw material to be used for the manufacturing of the pipes, the manufacturer shall submit pressure test data based on tests (in water or in air) of out of the raw material extruded pipes, in accordance with the relevant parts of NEN-EN-ISO 1167, during at least 15.600 hours at 110 °C and for 10.000 hours at 20 °C, 60-80 °C or 80 °C and 95 °C.

The data must be statistically processed and presented according to NEN-EN-ISO 9080.

The thus processed LPL curves must be equal or better than the curves of the relevant material according to:

- the relevant parts of NEN-EN-ISO 15875 for PE-X;
- the relevant parts of NEN-EN-ISO 15876 for PB;
- the relevant parts of NEN-EN-ISO 22391 for PE-RT Type II;
- the relevant parts of NEN-EN-ISO 21003 for multilayer.

6.2 Oxygen tightness

The diffusion of oxygen in the system shall fulfil the following requirement:

Not more than 1,8 mg/m².d (d = day = 24h) oxygen shall diffuse into the system at a water temperature of 80 °C. This value must be determined according to NEN-ISO 17455.

Remark: Because the required value is expressed as a surface measure, it is sufficient to measure the smallest diameter from the diameter series of the manufacturer (as long as for all diameters the same thickness of the barrier layer applies).

6.3 Plastics barrier layer

The thickness of the barrier layer and its tolerances, the name of the supplier and type of the plastics barrier layer, shall be recorded in the IQC scheme of the certificate holder.

6.4 PE-X pipes

Remark: For the most part the relevant requirements are taken from NEN-EN-ISO 15875-2.

6.4.1 General

The values of outside diameter and/or wall thickness of table 6.2 apply to the PE-X pipe and are exclusive of additional outside layers. For PE-X pipes with an outer barrier layer, the values of outside diameter and wall thickness may apply to the finished product, including the barrier layer, provided that the thickness of the outside barrier layer, including any adhesive layer, is ≤ 0,4 mm and the design calculation using the values of outside diameter and wall thickness of the base pipe (PE-X) meet the $S_{calc,max}$ -values according to Table 6.1.
The manufacturer shall state the dimensions and tolerances of the base pipe in his documentation

6.4.2 *Classification*

On the basis of the $S_{calc,max}$-value, it is determined at which pressure which wall thickness is suitable for class DH1, see table 6.1.

Table 6.1 - $S_{calc,max}$ -value and application

Class	**DH1** **P_D = 6 bar**	**DH1** **P_D = 8 bar**	**DH1** **P_D = 10 bar**
$S_{calc,max}$	5,3	4,0	3,2

6.4.3 *Dimensions*

The dimensions of the pipes are given in table 6.2. For the determination of the dimensions, the method according NEN-EN-ISO 3126 has to be followed.

Table 6.2 - Dimensions of PE-X pipes (in mm)

d_n	**d_{em}**		**Out of round-ness**	**Wall thickness**					
				SDR 11		**SDR 9**		**SDR 7.4**	
	Min.	**Max.**		**P = 6 bar** **S = 5**		**P = 8 bar** **S = 4**		**P = 10 bar** **S = 3.2**	
				e_{min}	**e_{max}**	**e_{min}**	**e_{max}**	**e_{min}**	**e_{max}**
12	12,0	12,3	0,3	1,3	1,6	1,4	1,7	1,7	2,0
16	16,0	16,3	0,4	1,5	1,8	1,8	2,1	2,2	2,6
18	18,0	18,3	0,5	1,6	1,9	2,0	2,4	2,4	2,8
20	20,0	20,3	0,5	1,9	2,2	2,3	2,7	2,8	3,2
22	22,0	22,3	0,5	2,0	2,3	2,5	3,0	2,9	3,3
25	25,0	25,3	0,6	2,3	2,7	2,8	3,2	3,5	4,0
28	28,0	28,3	0,6	2,5	2,9	3,2	3,7	3,9	4,4
32	32,0	32,3	0,8	2,9	3,4	3,6	4,1	4,4	5,0
40	40,0	40,4	1,0	3,7	4,2	4,5	5,1	5,5	6,2
50	50,0	50,5	1,2	4,6	5,2	5,6	6,3	6,9	7,7
63	63,0	63,6	1,4	5,8	6,5	7,1	8,0	8,6	9,5
75	75,0	75,7	1,4	6,8	7,6	8,4	9,4	10,3	11,5
90	90,0	90,9	1,4	8,2	9,2	10,1	11,3	12,3	13,7
110	110,1	111,0	1,6	10,0	11,1	12,3	13,7	15,1	16,8
125	125,0	126,2	1,6	11,4	12,7	14,0	15,4	17,1	19,9
140	140,0	141,3	1,6	12,7	14,1	15,7	17,4	19,2	21,3
160	160,0	161,5	1,8	14,6	16,2	17,9	19,8	21,9	24,2
190	190,0	191,5	1,8	16,3	19,1	20,0	22,1	24,6	27,2
200	200,0	201,5	2,0	19,1	20,1	22,4	24,8	27,4	30,3
225	225,0	226,5	2,0	20,4	22,6	25,0	27,6	30,8	33,9
250	250,0	251,5	2,0	22,7	25,1	27,9	30,9	34,2	37,6

6.4.4 *Physical and mechanical properties of PE-X pipes*

Table 6.3 - Requirements for PE-X pipes

Aspect			Requirement	Test parameter		Test method
Dimensions			According table 6.2	Dimensions		NEN-EN-ISO 3126
Appearance			Smooth without any flaws	Soundness		Visual inspection
Degree of cross linking[1)]	PE-Xa	Peroxide system	≥ 70 %	NEN-EN-ISO 10147		NEN-EN-ISO 10147
	PE-Xb	Silane system	≥ 65 %			NEN-EN-ISO 10147
	PE-Xc	Radiation System	≥ 60 %			NEN-EN-ISO 10147
	PE-Xd	AZO-system	≥ 60 %			NEN-EN-ISO 10147
Resistance to internal pressure			≥ 1 h[4)]	20 °C	12 [2)]	Relevant parts of NEN-EN-ISO 1167
			≥ 1 h[4)]	95 °C	4,8 [2)]	
			≥ 22 h[4)]	95 °C	4,7 [2)]	
			≥ 165 h[4)]	95 °C	4,6 [2)]	
			≥ 1000 h[4)]	95 °C	4,4 [2)]	
Thermal stability			≥ 15.600 h[4)]	110 °C	2,4 [2)]	NEN-EN-ISO 1167
Longitudinal reversion			≤ 3% [3)]	Change of length NEN-EN-ISO 15875-2		NEN-EN-ISO 2505 method B

1) The maximum allowed percentage of cross linking of the system must be stated by the manufacturer. The percentage measured during the determination according the above mentioned method, shall be in between both values.
2) σ (N/mm^2).
3) After the test, the test pieces may not show any cracks, blisters or cavities.
4) Minimum required test time.

6.5 PB pipes

Remark: For the most part the relevant requirements are taken over from NEN-EN-ISO 15876-2.

6.5.1 *General*

The values of outside diameter and/or wall thickness of table 6.5 apply to the PB pipe and are exclusive of additional outside layers. For PB pipes with an outer barrier layer, the values of outside diameter and wall thickness may apply to the finished product, including the barrier layer, provided that the thickness of the outside barrier layer, including any adhesive layer, is ≤ 0,4 mm and the design calculation using the values of outside diameter and wall thickness of the base pipe (PB) meet the $S_{calc,max}$-values according to Table 6.4.
The manufacturer shall state the dimensions and tolerances of the base pipe in his documentation.

6.5.2 *Classification*

On the basis of the S-value, it is determined at which pressure which wall thickness is suitable for class DH1, see table 6.4.

Table 6.4 - $S_{calc.max}$ value and application

Class	DH1 P_D = 6 bar	DH1 P_D = 8 bar	DH1 P_D = 10 bar
$S_{calc,max}$	6,9	5,2	4,1

6.5.3 *Dimensions*

The dimensions of the pipes are given in table 6.5. For the determination of the dimensions, the method according NEN-EN-ISO 3126 has to be followed.

Table 6.5 - Dimensions of PB pipes (in mm)

d_n	d_{em}		Max. Out of round ness	Wall thickness					
				SDR 13,5		SDR11		SDR 9	
				P = 6 bar S= 6,3		P = 8 bar S= 5		P = 10 bar S= 4	
	Min.	Max.		e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}
12	12,0	12,3	0,3	1,3	1,6	1,3	1,6	1,4	1,7
16	16,0	16,3	0,4	1,3	1,6	1,5	1,8	1,8	2,1
18	18,0	18,3	0,5	1,4	1,7	1,7	2,0	2,0	2,3
20	20,0	20,3	0,5	1,5	1,8	1,9	2,2	2,3	2,7
22	22,0	22,3	0,5	1,6	1,9	2,0	2,3	2,4	2,8
25	25,0	25,3	0,6	1,9	2,2	2,3	2,7	2,8	3,2
28	28,0	28,3	0,6	2,1	2,5	2,6	3,0	3,1	3,6
32	32,0	32,3	0,8	2,4	2,8	2,9	3,3	3,6	4,1
40	40,0	40,4	1,0	3,0	3,4	3,7	4,2	4,5	5,1
50	50,0	50,5	1,2	3,7	4,2	4,6	5,2	5,6	6,3
63	63,0	63,6	1,4	4,7	5,3	5,8	6,5	7,1	8,0
75	75,0	75,7	1,4	5,6	6,3	6,8	7,6	8,4	9,4
90	90,0	90,9	1,4	6,7	7,5	8,2	9,2	10,1	11,3
110	110,0	111,0	1,6	8,1	9,1	10,0	11,1	12,3	13,7
125	125,0	126,2	1,6	9,2	10,3	11,4	12,7	14,0	15,5
140	140,0	141,3	1,6	10,3	11,5	12,7	14,1	15,7	17,4
160	160,0	161,5	1,8	11,8	13,1	14,6	16,2	17,9	19,8
190	190	190	1,8	13,3	14,8	16,4	19,2	20,1	22,3
200	200	200	2,0	14,7	16,3	19,2	20,2	22,4	24,8
225	225	225	2,0	16,6	19,4	20,5	22,7	25,2	27,8
250	250	250	2,0	19,4	20,4	22,7	25,1	27,9	30,7

6.5.4 *Physical and mechanical properties of PB pipes*

Table 6.6 - Requirements for PB pipes

Aspect	Requirement	Test parameter		Test methods
Dimensions	According table 6.5	Dimensions		NEN-EN-ISO 3126
Appearance	Smooth without any flaws	Soundness		Visual inspection
Resistance to internal pressure	≥ 1 h	20 °C	15,5[2)]	Relevant parts of NEN-EN-ISO 1167
	≥ 22 h	95 °C	6,5[2)]	
	≥ 165 h	95 °C	6,2[2)]	
	≥ 1000 h	95 °C	6,0[2)]	
Thermal stability	≥ 15.600 h	110 °C	2,2[2)]	Relevant parts of NEN-EN-ISO 1167
MFR	Value ≤ 30% difference with respect to the granulate material	Mass 5 kg Temperature 190 °C Test period 10 min		NEN-EN-ISO 1133-1
Longitudinal reversion	≤ 2% [1)]	Change of length NEN-EN-ISO 15876-2		NEN-EN-ISO 2505 method B

[1)] After the test, the test pieces may not show any cracks, blisters or cavities.
[2)] σ (N/mm^2).

6.6 PE-RT type II pipes

Remark: For the most part the relevant requirements are taken over from NEN-EN-ISO 22391-2.

6.6.1 *General*

The values of outside diameter and/or wall thickness of table 6.8 apply to the PE-RT Type II pipe and are exclusive of additional outside layers. For PE-RT Type II pipes with an outer barrier layer, the values of outside diameter and wall thickness may apply to the finished product, including the barrier layer, provided that the thickness of the outside barrier layer, including any adhesive layer, is ≤ 0,4 mm and the design calculation using the values of outside diameter and wall thickness of the PE-RT Type II layer meet the $S_{calc,max}$-values according to table 6.7.
The manufacturer shall state the dimensions and tolerances of the PE-RT Type II layer in his documentation.

6.6.2 *Classification*

On the basis of the $S_{calc,max}$-value, it is determined at which pressure which wall thickness is suitable for class DH1, see table 6.7.

Table 6.7 - $S_{calc.max}$ value and application

Class	DH1 P_D = 6 bar	DH1 P_D = 8 bar	DH1 P_D = 10 bar
$S_{calc,max}$	4,7	3,5	2,8

6.6.3 *Dimensions*

The dimensions of the pipes are given in table 6.8. For the determination of the dimensions, the method according NEN-EN-ISO 3126 has to be followed.

Table 6.8 - Dimensions of PE-RT type II pipes (in mm)

d_n	d_{em}		Max. Out of round ness	Wall thickness					
				SDR 9		SDR 7,4		SDR 6	
				P = 6 bar S= 4		P = 8 bar S= 3,2		P = 10 bar S= 2,5	
	Min.	Max.		e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}
12	12,0	12,3	0,3	1,4	1,7	1,7	1,7	2,0	2,4
14	14,0	14,3	0,4	1,6	1,9	1,9	2,2	2,2	2,6
16	16,0	16,3	0,4	1,8	2,1	2,2	2,6	2,7	3,1
18	18	18,3	0,5	2	2,3	2,4	2,8	3	3,4
20	20,0	20,3	0,5	2,3	2,7	2,8	3,2	3,4	3,9
22	22	22,3	0,5	2,4	2,8	3	3,4	3,7	4,2
25	25,0	25,3	0,6	2,8	3,3	3,5	4,0	4,2	4,8
28	28	28,3	0,6	3,1	3,6	3,8	4,3	4,7	5,3
32	32,0	32,3	0,8	3,6	4,1	4,4	5,0	5,4	6,1
40	40,0	40,4	1,0	4,5	5,1	5,5	6,2	6,7	7,5
50	50,0	50,5	1,2	5,6	6,3	6,9	7,7	8,3	9,3
63	63,0	63,6	1,4	7,1	8,0	8,6	9,6	10,5	11,7
75	75,0	75,7	1,4	8,4	9,4	10,3	11,5	12,5	13,9
90	90,0	90,9	1,4	10,1	11,3	12,3	13,6	15,0	16,7
110	110,0	111,0	1,6	12,3	13,7	15,1	16,8	18,3	20,3
125	125,0	126,2	1,6	14,0	15,6	17,1	19,0	20,8	23,0
140	140,0	141,3	1,6	15,7	17,4	19,2	21,3	23,3	25,7
160	160,0	161,5	1,8	17,9	19,8	21,9	24,2	26,6	29,4
190	190	190	1,8	21,1	23,4	25,7	28,4	31,7	35,0
200	200	200	2,0	22,2	24,6	27,0	29,9	33,3	36,8
225	225	225	2,0	25,0	27,7	30,4	33,6	37,5	41,4
250	250	250	2,0	27,8	30,6	33,8	37,3	41,7	46,0

6.6.4 *Physical and mechanical properties of PE-RT Type II pipes*

Table 6.9 - Requirements for PE-RT Type II pipes

Aspect	Requirement	Test parameter		Test method
Dimensions	According table 6.8	Dimensions		NEN-EN-ISO 3126
Appearance	Smooth without any flaws	Soundness		Visual inspection
MFR (PE-RT)	≤ 30% difference with respect to granulated material	Temperature 190 °C Test period 10 min		NEN-EN-ISO 1133-1
Resistance to internal pressure complete pipe [1)]	Testing time (hour)	T (°C)	σ (MPa)	Relevant parts of NEN-EN-ISO 1167
	≥ 1	20	10,8 [3)]	
	≥ 22	95	3,9 [3)]	
	≥ 165	95	3,7 [3)]	
	≥ 1000	95	3,6 [3)]	
Thermal stability (PE-RT)	Testing time (hour)	T (°C)	σ (MPa)	Relevant parts of NEN-EN-ISO 1167
	≥ 15.600	110	2,2 [3)]	
Influence of heating	≤ 2% [2)]	Change in length at 110 °C 1 uur $e_n \leq 8$ mm 2 uren 8 mm < $e_n \leq 16$ mm 4 uren $e_n > 16$ mm		NEN-EN-ISO 2505

1) For initial evaluation and yearly inspection the 1000 hours test at 95 °C is carried out. The other testing times can be applied during production control.
2) After the test, the test pieces may not show any cracks, blisters or cavities.
3) σ (N/mm²).

6.7 Multilayer pipes

6.7.1 *General*

The multilayer pipes have to fulfil the requirements of NEN-EN-ISO 21003-2.

6.7.2 *Long term characteristics*

The long term pressure strength of the multilayer pipes shall be determined in accordance with NEN-EN-ISO 21003-2.

6.7.3 *Dimensions*

The pipe manufacturer shall give detailed information related to the geometrical characteristics, including the wall thickness with tolerances of each layer of the component in a technical file. All relevant dimensions shall be designed according to the requirements of NEN-EN-ISO 21003-2.

6.8 Marking of the service pipe

After conclusion of the certification agreement, the medium-pipes shall be provided, at intervals of not more than 2 m, with the following clearly legible and indelible markings:

- KOMO® or KOMO® wordmark;
- service pipe material dependent on the type of plastics used: PE-X, PB, PE-X/Al, PE-RT, PE-RT/Al/outer layer;
- the nominal outside diameter and the nominal wall thickness in mm;

- design pressure: 6, 8 of 10 bar;
- class DH1;
- factory name, tradename, system name or logo;
- the production code.

7 Requirements for the fitting and test methods

At setting the requirements the uncertainties of the measurements are taken into account. This implies that drawing conclusions whether requirements are fulfilled these uncertainties do not need to be weighted anymore.

7.1 Requirements for the plastics fittings

7.1.1 Loaded parts

Remark: with "loaded parts" is meant: by internal hydraulic pressure loaded parts.

Table 7.1 - Requirements for plastics fittings

Aspect	Requirement	Test parameter	Test method
Material fitting body	relevant product standard for the plastic used	IQC [1)]	Information manufacturer
Long-term strength	≥ design stress (σ_D) according to the relevant product standard at Class DH1	Resistance to internal hydraulic pressure[2)] - at 20 ºC - between 60 ºC and 80 ºC - at 95 ºC - at 110 ºC	NEN-EN-ISO 1167-1 With help of NEN-EN-ISO 9080
Dimensions	Specification producer	Construction drawings	NEN-EN-ISO 3126
Degree of cross linking (PE-X fittingen)	PE-Xa ≥ 70% PE-Xb ≥ 65% PE-Xc ≥ 60% PE-Xd ≥ 60%	Extent of cross linking	NEN-EN-ISO 10147
MFR (for PB fittings)	≤ 0,3 g/10 min difference with respect to granulated material	Mass 5 kg Temperature 190 °C Test period 10 min	NEN-EN-ISO 1133-1
Appearance	Smooth, without any irregularities	Flawlessness	Visual assessment
Thermal stability [3)]	Test time > 15600 hours	Resistance to internal hydraulic pressure [2)] At 110 °C Stress is accordance with the long term strength data	NEN-EN-ISO 1167-serie
Behaviour at heating	Damages around injection point ≤ 30% of wall thickness No holes, bubbles or cracks	In consultation with manufacturer	NEN-EN-ISO 580

1) IQC: is laid down as part of the certification agreement, after approval of the certification body

2) Test on injection moulded, cylindrical test specimens.
Plastic fittings moulded with the identical polymer grade as used for the pipe can refer to the thermal stability test of the pipe material. Fitting material different from the pipe material must perform the thermo stability test of 15.600h at 110 °C. The hydrostatic tests have to be performed for both variants according to the standard the material belongs to.

3) Results to be processed together with results “long-term strength"

7.1.2 Unloaded parts

The requirements for plastic(s) (outside of those covered under 7.1.1) that are used in the fittings' components that are not exposed to internal hydraulic pressure, are determined separately. For these items, it is required to provide relevant information to the certifying body.

Remark:
Fittings that are not not hydraulic loaded internally are fittings used to ensure water tightness of the outer casing.

7.2 Requirements for metal fittings

The metal mechanical fittings must fulfil the requirements of table 7.2.

Table 7.2 - Requirements for metal fittings

Aspect	requirement	Test parameter	Test method
Material fitting body	**Messing:** NEN-EN1254-3 NEN-EN 1254-6 NEN-EN 1254-8 **RVS:** NEN-EN 10088 NEN-EN 10283	IQC[1)]	Information manufacturer
Rubber	BRL 2013	BRL 2013	BRL 2013
Dimensions	NEN-EN1254-3 NEN-EN 1254-6 NEN-EN 1254-8	Minimum thickness	NEN-EN-ISO 228-1 of ISO 7-1
Construction	NEN-EN1254-3 NEN-EN 1254-6 NEN-EN 1254-8	Construction drawings	NEN-EN-ISO 3126
Strength fitting body:	No cracks	**Messing:** NEN-EN1254-3 par. 5.1 NEN-EN 1254-6 Par. 5.1.4 NEN-EN 1254-8 Par.5.1.1 **RVS:** 25 bar at (23 + 2) °C during 48 hours[2)]	NEN-EN-ISO 1167-1
Messing: Resistance to stress corrosion	No cracks	PH 9,5	NEN-ISO 6957
RVS: Resistance to inter-crystalline degradation	No cracks	Method A	NEN-EN-ISO 3651-2

[1)] Choice of material is free. The chosen material is listed in the IQC.
[2)] The most critical wall thickness/ DN ratio is tested.

7.3 Marking of the fittings

The method of marking of mechanical fittings is given below.
After conclusion of the certification agreement, the fittings shall be provided with the following clearly legible and indelible markings:

- KOMO® or KOMO® wordmark *);
- Supplier's name or registered trademark or logo;
- The outside diameter in mm of the accompanying pipe;
- For plastics fittings: the material indication of the material from the fitting body according NEN-EN-ISO 1043-1;
- The production code.

The smallest packaging unit has to be marked with at least the following information:

- KOMO® or KOMO® wordmark;
- The certificate number of the accompanying (technical approval-with-)product certificate of the piping system;
- Factory name, product name, system name or logo;
- Nominal outside diameter and nominal wall thickness of the accompanying pipe;
- Material indication if the fitting body is made of plastic.

8 Requirements for the insulation material and test methods

At setting the requirements the uncertainties of the measurements are taken into account. This implies that drawing conclusions whether requirements are fulfilled these uncertainties do not need to be weighted anymore.

8.1 Isolation material

Isolation material that, depending on the type, fulfills the requirements of NEN-EN 14303, NEN-EN 14304, NEN-EN 14305, NEN-EN 14306, NEN-EN 14307, NEN-EN 14308, NEN-EN 14309, NEN-EN 14313 or NEN-EN 14314, are allowed in flexible piping systems for warm-water distribution.

Remark:
This is for isolation material in the piping package, but also for the isolation material (of shell parts) around fittings for the connecting of the service pipes.

8.2 Functional requirements

The materials shall meet the requirements of table 8.1.

Table 8.1 - Mechanical requirements for the insulation material

Aspect	Requirement	Test parameter		Test method
Material composition	According IQC[1)]	According IQC[1)]		According IQC[1)]
Water absorption	Option A ≤ 10%	Test pieces 3	Option A T = 100 ± 2 °C	NEN-EN 489 paragraaf 5.4.7
	Option B ≤ 1%		Option A T = 80 ± 2 °C	
	Other materials	According relevant standard		
Water vapour permeation2)	According IQC [1)]	According IQC [1)]		According IQC [1)]
Cell structure Distribution	Uniform dimensions	According IQC [1)]		According IQC [1)]
Cell dimension	According IQC [1)]	According IQC [1)]		According IQC [1)]
Closed cell %	According IQC [1)]	According IQC [1)]		According IQC [1)]
Thermal characteristics	According IQC[1)]	Test pieces	2	NEN-EN-ISO 8497

1) IQC: is laid down as part of the certification agreement, after approval of the testing body.
2) The pipe supplier shall give information about the risk of water accumulation in the insulation dependent on the service conditions.

9 Requirements for the outer casing and test methods

9.1 Functional requirements

At setting the requirements the uncertainties of the measurements are taken into account. This implies that drawing conclusions whether requirements are fulfilled these uncertainties do not need to be weighted anymore.

This chapter concerns flexible, corrugated and non-corrugated outer casings of polyolefin's (PE, PP), where the functional requirements for the outer casing are translated to specific material requirements for the outer casing.

In case the functional requirements are fulfilled according to another construction, then in any case the following requirements apply:

- Sufficient dimensional stability and smoothness;
- Resistance to impact, see table 9.2;
- Resistance to traffic load, see table 5.1;

The requirements to be applied are, in this case, determined and evaluated in consultation with the certification body.

9.2 Material

9.2.1 Reprocessable material

Only clean reprocessable material of the manufacturer's own production of pipes may be used as rework material. Reprocessable material obtained from external sources and recyclable material shall not be used.

9.2.2 Material requirements

The PE or PP raw material has to fulfil the requirements from table 9.1.

Tabel 9.1 - PE en PP materiaaleisen voor het granulaat

Aspect	Requirement		Test parameter		Test method
Material composition	According IQC[1)]		According IQC[1)]		According IQC[1)]
Carbon black content	PE	2 – 2,5% mass	According ISO 6964		ISO 6964
OIT[2)] (oxidative induct. time)	20 minutes		Test temperature	210 °C	NEN-EN-ISO 11357-6

[1)] IQC: is laid down as part of the certification agreement, after approval of the testing body

[2)] Applicable in case the outer casing can be welded

9.3 Mechanical requirements of the PE or PP outer casing

Unless otherwise stated, a test temperature of (23 ± 2) °C applies.

Tabel 9.2 - Mechanical requirements for the PE or PP outer casing

Aspect	Requirement	Test parameter		Test method	
Appearance	Sound, no holes or blisters	According IQC [1)]		Visual inspection	
Dimensions	According IQC [1)]	According IQC [1)]		NEN-EN-ISO 3126	
Mass per length	According IQC [1)]	Weight/m ± 1,0 g		Weighing	
Longitudinal reversion	≤ 3% No cracks bumps or delamination	wall thickness ≤ 8 mm wall thickness ≥ 8 mm	30 min 60 min	PE Method B NEN-EN-ISO 2505 110 °C	PP Method B NEN-EN-ISO 2505 135 °C
UV-resistance[3)]	See footnote [3)]	Light energy	≥ 3,5 GJ/m²	NEN-EN-ISO 16871	
Creep ratio [2)]	≤ 5	Test pieces	3	NEN-EN-ISO 9967	
Ring stiffness [2)]	≥ 4 KN/m²	Compression velocity Test pieces	(2 ± 0,4) mm/min 3	NEN-EN-ISO 9969	
Resistance to impact [5)]	TIR ≤ 10% No failure	Test temperature Type of striker Falling weight d = 90 mm d = 110 mm d = 125 mm d = 140 mm d = 160 mm d = 190 mm d = 200 mm d = 250 mm	0 °C d 90 0,8 kg 1,0 kg 1,25 kg 1,6 kg 1,6 kg 2,0 kg 2,0 kg 2,5 kg	Fall height: 1,2 m 1,6 m 2,0 m 1,8 m 2,0 m 1,8 m 2,0 m 2,0 m	NEN-EN 744
Oxidative induction time (OIT)	20 minutes	Test temperature Test pieces	210 °C 1	NEN-EN-ISO 11357-6	
Melt flow rate (MFR)	PE ± 20%[8)]	Weight Test Temperature	PE 5 Kg 190 °C	NEN-EN-ISO 1133 Condition T	
	PP ± 30%[8)]	Weight Test Temperature	PP 2,16 Kg 230 °C	NEN-EN-ISO 1133 Condition M	
Stress crack resistance[6)7)]	No failure	Failure time Temperature σ	>100 hrs 80 °C 4,0 N/mm²	NEN-ISO 16770	

1)	IQC: is laid down as part of the certification agreement, after approval of the testing body
2)	Only applicable in case the insulation material does not contribute to the stiffness of the piping package
3)	Only applicable in case the carbon black content ≤ 2% mass weight and/or for pipes different from black coloured. After UV exposure the requirements of paragraph 4.4.1, 4.4.3 and the resistance to impact test of this table shall still be fulfilled.
4)	Comparison of the elongation at break before and after UV exposition
5)	Only applicable for outer casings provided with an after extrusion applied profile
6)	LDPE materials shall not exceed a failure rate F20 when tested in accordance with procedure B of NEN-EN-IEC 60811-4-1 for 1000hrs
7)	Only applies for non corrugated outer casings
8)	% of the value stated by the supplier of the raw material

9.4 Marking

After conclusion of the certification agreement, the outer casing shall be provided, at intervals of not more than 2m, with the following clearly legible and indelible markings:

- KOMO® (or KOMO® wordmark);
- service pipe material depending on the type of service pipe: e.g. PE/X or PE-X/Al or PB or PR-RT or PE-RT/Al;
- design pressure: 6, 8 or 10 bar;
- the nominal outside diameter(s) of the service pipe(s) in mm;
- the nominal outside diameter of the outer casing in mm;
- the production code;
- the system name;
- “DH1” or “district heating” or “stadsverwarming”.

10 Requirements welding process and test methods

10.1 General

At setting the requirements the uncertainties of the measurements are taken into account. This implies that drawing conclusions whether requirements are fulfilled these uncertainties do not need to be weighted anymore.

In this chapter the process requirements and test methods for welding of the connections on the production location are listed. During the pre-certification investigation the certification body controls whether the process is described, implemented and confirms to the requirements of this evaluation guideline.

For welded joints only products shall be used that meet the requirements of this evaluation guideline.
The requirements for the welded connection are listed in table 4.1.

For each welded joint the composition of the end product on the basis of its individual components, e.g.: pipe, fitting, materials, outer casing etc. shall be specified to the certification body in terms of:

- product and type designation;
- product name
- characteristics (materials, dimensions, mechanical, physical).

Remark:
evaluation guideline BRL 5609-1 applies to making connections in the field.

10.2 Welded joints

For welding of plastics applies that welding procedure specifications are needed in order to provide a well-defined basis for planning of the welding operations and for quality control during welding.

NEN-EN-ISO 15607 provides the necessary basis for drafting and approval of the welding methods of metals.

In analogy with this standard, welding procedures are qualified by conforming to one or more welding procedure qualification records (WPQR) The use of a particular method of qualification is often a requirement of an application standard.

Qualification of the pWPS by more than one method is not recommended. It is assumed that welding procedure specifications are used in production by competent welders which are qualified according to NEN-EN 13067 or competent tool operators.

10.3 Division of welding procedure specifications (WPS)

Division of welding procedure specifications (WPS)
The following welding processes are distinguished:

- heated-tool butt welding;
- heated-tool socket welding;
- hot-gas string-bead welding;
- Electro-socket welding;
- Extrusion welding.

The certificate holder shall inform the certification body which welding processes must be certified.

10.4 Welding procedure

For each welding procedure a flow diagram must be available with all essential process steps.

Remark:
For example the process steps for heated tool butt welding according to NEN 7200 are:

- preparation;
- clamping of the welding ends;
- centering;
- flattening surfaces;
- cleaning;
- heating up under pressure;
- heating –through minimal pressure
- welding under pressure;
- cooling;
- inspection.

10.5 Requirments for welding equipment and welding conditions

De requirements for the welding equipment and the welding conditions shall be listed in the quality manual of the manufacturer.
It is allowed to refer to international standards. In table 10.1 examples of various welding methods and corresponding standards are listen.

Remark: The standards listed in table 9.1 describe generally the combination of the technique and the material to be welded. An approved welding procedure specification (WPS) is in this case normative.

Table 10.1 - Welding methods with reference to standards (informative)

Welding method	Norm
heated-tool butt welding	NEN 7200, DVS 2207-1
heated-tool socket welding	DVS 2207-1
hot-gas string-bead welding	DVS 2207-3
Electro socket welding	DVS 2207-1
Extrusion welding	DVS 2207-4

10.6 Drafting and Qualification of welding methods

Qualification of welding procedures shall be performed prior to actual welding in production.

The manufacturer shall prepare a preliminary welding procedure specification (pWPS) and shall ensure that is applicable for the actual production, using experience from previous productions and the general fund of knowledge of welding technology.

Each pWPS shall be used as a basis for establishment of WPQR qualified according to one of the methods listed in table 2 of NEN-EN-ISO 15607.

If the qualification involves welding of test pieces, then the test pieces shall be welded in accordance with the pWPS.

The WPQR shall comprise all variables (essential and non essential) as well as the specified ranges of qualification given in the appropriate standard. On basis of the WPQR, the WPS for production welding is developed under the responsibility of the manufacturer unless otherwise required.

10.7 Control of documents and registrations

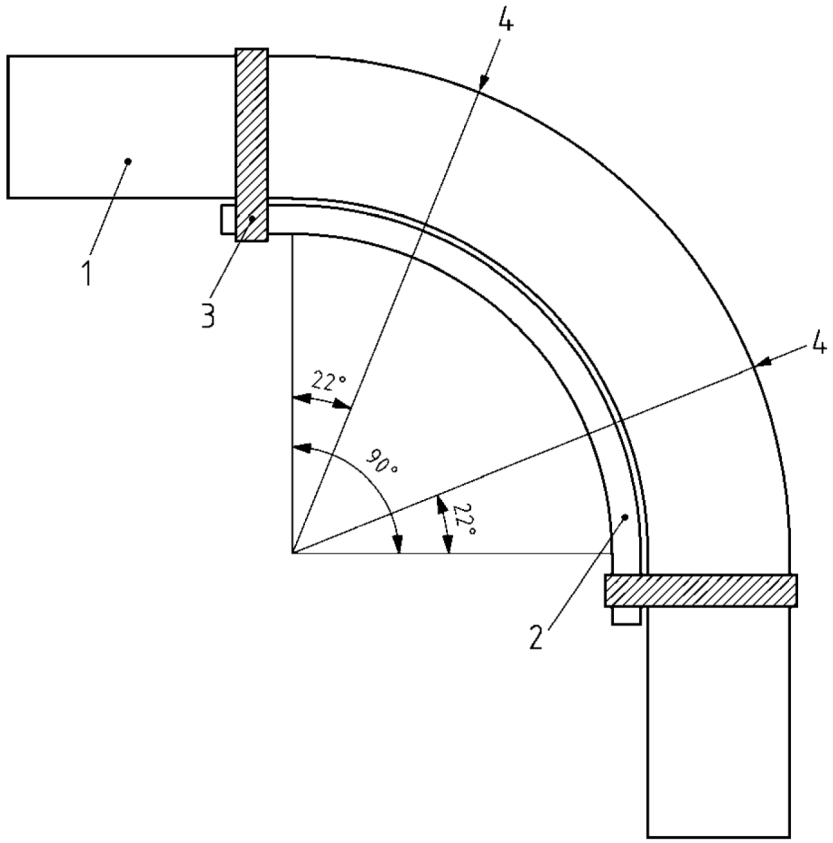
Documents required such as: pWPS, WPQR and WPS must be controlled in accordance with ISO 9001.

11 Test methods

11.1 Flexibility

At setting the requirements the uncertainties of the measurements are taken into account. This implies that drawing conclusions whether requirements are fulfilled these uncertainties do not need to be weighted anymore.

The pipe assembly shall be conditioned for 24 hours at the minimum temperature according to the manufacturers installation instructions. Afterwards the pipe assembly shall be fixed onto a bending rig according to Figure 11.1 within ten minutes. After 30 minutes the ovality shall be measured at the positions shown in figure 11.1.



Legend
1 pipe assembly
2 bending rig
3 straps or clamps
4 measuring point for ovality

Figure 11.1 - Flexibility test

After measuring the ovality the outer casing shall be opened in the axial direction and visual inspection of the insulation material of the whole bend section shall be carried out.

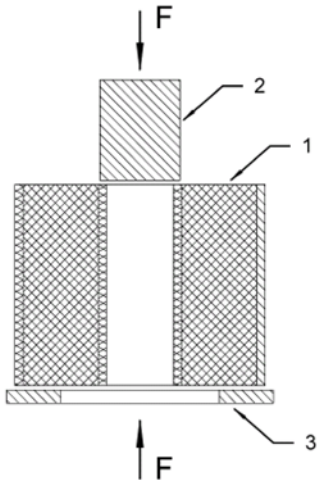
11.2 Axial shear strength (for bonded systems only)

The axial shear strength between the service pipe and the insulation material shall be tested as shown in figure 11.2.

The test specimen shall have a length which equals the outer diameter of the casing ± 5%, the ends shall be cut at a right angle with a tolerance of 5°.

The piston shall be made from metal and shall have an outer diameter which equals the outer diameter of the service pipe with a tolerance of –1 mm.

The support shall be made of metal, the diameter of the circular central opening shall equal the mean of the inner and outer diameter of the insulation.



Legend
1 test specimen
2 piston for load impact F
3 support

Figure 11.2 - Shear strength test apparatus

The piston and the support are to be moved towards each other with a tensile testing machine at a constant speed of 5 mm/min and the displacement and the force is to be recorded.

The shear strength T_{ax} is to be calculated as follows:

$$T_{ax} = \frac{F_{max}}{L \; x \; D_n \; x \; p}$$

In which:
F_{max} = maximal recorded force in N;
L = length of the specimen in mm;
D_n = outer diameter of the service pipe mm;
π = pi = 3,14159.

11.3 Linear water tightness (for bonded systems only)

On a 4 m long sample of the pipe, taken from a pipe in the delivery condition the casing shall be removed 0,1 m at 2,0 m distance from one pipe end.
A suitable water container shall be sealed to the casing at both sides of the exposed insulation and be filled with water with a pressure of 0,05 bar at room temperature.
The sample shall be placed horizontally.
In both ends of the sample a suitable container shall be mounted to collect water leaking from the pipe end.
After 168 h, the water collected from the pipe ends shall be weighed.

11.4 Sealing in linear direction (for non-bonded sytems only)

Test joints shall be immersed in a water tank at (30 ± 2) °C and pressurized externally with a constant pressure of 30 kPa for a period of 24 h.
To facilitate assessment of water ingress, the liquid can be coloured.

12 Quality system requirements

12.1 General

This chapter contains the requirements that have to be met by the supplier's quality management system.

The supplied application conditions and processing instructions must be approved by the certifying institute (CI).

12.2 Manager of the quality system

Within the organisational structure an employee must be appointed who is in charge of managing the quality system.

12.3 Internal quality control/quality plan

The supplier must have an implemented and operational internal quality control scheme in place (IQC-scheme).

In this IQC-scheme the following must be demonstrably recorded:

- materials used in the product
- which aspects are checked by the manufacturer;
- according to which methods these inspections are carried out;
- how often these inspections are carried out;
- how the inspection results are registered and stored.

This IQC-scheme shall be derived from the example format as shown in the annex. The scheme must be detailed in such a way that it provides CI sufficient confidence that the requirements of this evaluation guideline are continuously fulfilled.

12.4 Management of laboratory- and measure apparatus

The supplier must determine which laboratory- and measure apparatus are needed based on this BRL in order to demonstrate the product fulfils the requirements.

When applicable laboratory- and measure apparatus need to be calibrated at specified intervals.

The supplier needs to validate and register the previous measure results, when at the time of calibration is determined that the laboratory and measure devices are not operating correctly.

The apparatus in question need to be marked in such a way that can be determined what the calibration status is.

The supplier is required to register the calibration results.

12.5 Procedures and work instructions

The supplier must be able to submit procedures for:

- the handling of non-conforming products;
- corrective actions in case non-conformities are found;
- the handling of complaints regarding the products and/or services supplied;
- managing work instructions and inspection sheets in use.

12.6 Other requirements imposed on the quality system

In case the quality system of the supplier is certified on the basis of NEN-EN-ISO 9001, a combination can be made with the IQC-scheme.

13 Summary of tests and inspections

13.1 Testmatrix

The table below contains a summary of the tests and inspections to be carried out in the event of certification. The following definitions are used.

- **Initial tests:** The test to determine if all demands are met as stated in the BRL.
- **Inspection:** the evaluation tests which is held after issuing of the certificate in order to determine if the certified products are meeting the demands continuously; thereby is lo noted at what frequency inspections by the certifying institute (CI) are needed.
- **Evaluation of the quality system:** evaluation of the compliance to the IKB schedule and procedures.

Description of requirement	Article BRL	Tests within the scope of			Changing raw material
		Initial tests	Supervision by CI after granting of the certificate[1)]		
			Inspection visit[2)]	Frequency (per year)	
System requirements					
Lifetime of the system	4.1	X	-	-	X
Tightness and strength connection service pipes and fittings	4.2.1.1	X	-	-	X
Resistance to thermal cycling	table 4.1	X	-	-	X
Resistance to pull-out	table 4.1	X	-	-	X
Leak tightness under vacuum	table 4.1	X	-	-	X
Leak tightness under internal pressure and bending	table 4.1	X	-	-	X
Resistance to internal hydrostatic pressure	table 4.1	X	X	1 x year	X
Water tightness and strength of casing connections	4.2.1.2	X	X	1 x year	X
Rubber	4.3	X	X	1 x year	X
Installation instructions	4.4	X	-	-	X
Requirements for the piping package					
Thermal isolation properties	5.1	X	X	1 x year	X
Long term compression	5.2	X	X	1 x 2 year	X
Compressive creep	5.3	X	-	-	X
Flexibility	5.4	X	-	-	X
Axial shear strength (for bonded systems only)	5.5	X	-	-	X
Linear water tightness (for bonded systems only)	5.6	X	-	-	X
Sealing in linear direction (for non-bonded systems only)	5.7	X	-	-	X
Water vapour permeation	5.8	X	-	-	X

Description of requirement	Article BRL	Tests within the scope of			Changing raw material
		Initial tests	Supervision by CI after granting of the certificate[1)]		
			Inspection visit[2)]	Frequency (per year)	
Requirements for the services pipe					
Long term strength	6.1	X	-	-	X
Oxygen tightness	6.2	X	X	1 x year	X
Plastics barrier layer	6.3	X	-	-	X
PE-X pipes					
General	6.4.1	X	-	-	X
Classification	6.4.2	X	-	-	X
Dimensions	6.4.3	X	X	1 x year	X
Appearance	6.4.4	X	X	1 x year	X
Degree of cross linking	6.4.4	X	X	1 x year	X
Resistance to internal pressure	6.4.4	X	X	1 x year	X
Thermal stability	6.4.4	X	-	-	X
Longitudinal reversion	6.4.4	X	-	-	X
PB pipes					
General	6.5.1	X	-	-	X
Classification	6.5.2	X	-	-	X
Dimensions	6.5.3	X	X	1 x year	X
Appearance	6.5.4	X	X	1 x year	X
Degree of cross linking	6.5.4	X	X	1 x year	X
Resistance to internal pressure	6.5.4	X	X	1 x year	X
Thermal stability	6.5.4	X	-	-	X
MFR	6.5.4	X	X	1 x year	X
Longitudinal reversion	6.5.4	X	-	-	X
PE-RT Type II pipes					
General	6.6.1	X	-	-	X
Classification	6.6.2	X	-	-	X
Dimensions	6.6.3	X	X	1 x year	X
Appearance	6.6.4	X	X	1 x year	X
Material	6.6.4	X	X	1 x year	X
Dimensions of different layers	6.6.4	X	X	1 x year	X
Resistance to internal pressure complete pipe	6.6.4	X	X	1 x year	X
Thermal stability	6.6.4	X	-	-	X
Influence of heating	6.6.4	X	X	1 x year	X
Multilayer pipes					
General	6.7.1	X	-	-	X
Long term characteristics	6.7.2	X	X	1 x year	X
Dimensions	6.7.3	X	-	-	X
Marking of the service pipe	6.8	X	X	1 x year	X
Requirements for plastic fittings					
Material	table 7.1	X	-	-	X
Long-term strength	table 7.1	X	-	-	X
Dimensions	table 7.1	X	X	1 x year	X
Rubber	tabel 7.1	X	X	1 x year	X
Degree of crosslinking or MFR	table 7.1	X	X	1 x year	X
Appearance	table 7.1	X	X	1 x year	X
Thermal stability	table 7.1	X	-	-	X
Behaviour at heating	table 7.1	X	X	1 x year	X
Unloaded parts	7.1.2	X	-	-	X

Description of requirement	Article BRL	Tests within the scope of			Changing raw material
		Initial tests	Supervision by CI after granting of the certificate[1)]		
			Inspection visit[2)]	Frequency (per year)	
Requirements for metal fittings					
Material composition	table 7.2	X	X	1 x year	X
Rubber	table 7.2	X	X	1 x year	X
Dimensions	table 7.2	X	X	1 x year	X
Construction	table 7.2	X	X	1 x year	X
Strength fitting body	table 7.2	X	X	1 x year	X
Resistance to stress corrosion	table 7.2	X	-	-	X
Resistance to intergranular corrosion	table 7.2	X	-	-	X
Marking of fittings	7.3	X	X	1 x year	X
Requirements for the insulation					
Insulation material	8.1	X	-	-	X
Material composition	table 8.1	X	-	-	X
Water absorption	table 8.1	X	-	-	X
Water vapour permeation	table 8.1	X	-	-	X
Cell structure distribution	table 8.1	X	-	-	X
Cell dimension	table 8.1	X	-	-	X
Closed cell percentage	table 8.1	X	-	-	X
Thermal characteristics	table 8.1	X	-	-	X
Outer casing requirements					
Functional requirements	9.1	X	-	-	X
Reprocesable materials	9.2	X	-	-	X
Material composition	table 9.1	X	X	1 x year	X
Carbon black	table 9.1	X	-	-	X
OIT	table 9.1	X	-	-	X
Apeareance	table 9.1	X	X	1 x year	X
Dimensions	table 9.1	X	X	1 x year	X
Mass per length	table 9.1	X	X	1 x year	X
Longitudinal reversion	table 9.1	X	-	-	X
UV-resistance	table 9.1	X	-	-	X
Creep ratio	table 9.1	X	-	-	X
Ring stiffness	table 9.1	X	-	-	X
Resistance to impact	table 9.1	X	X	1 x year	X
OIT	table 9.1	X	-	-	X
MFR	table 9.1	X	-	-	X
Stress crack resistance	table 9.1	X	-	-	X
Marking	9.4	X	X	1 x year	X
Requirements welding process					
General	10.1	X	X	1 x year	X
Welded connections	10.2	X	X	1 x year	X
welding procedure specifications (WPS)	10.3	X	X	1 x year	X
Welding procedures	10.4	X	X	1 x year	X
Control of the welding equipment and welding conditions	10.5	X	X	1 x year	X
Drafting and approving of welding process	10.6	X	-	-	X
Control of documents and registrations	10.7	X	X	1 x year	X

Description of requirement	Article BRL	Tests within the scope of			Changing raw material
		Initial tests	Supervision by CI after granting of the certificate[1)]		
			Inspection visit[2)]	Frequency (per year)	
Qualification of the welders and tool operators					
Requirements for admission to the examination	VII	X	-	-	X
Examination	VII	X	-	-	X
Welding of the test piece	VII	X	-	-	X
Testing of the test piece	VII	X	-	-	X
Evaluation of the examination results	VII	X	-	-	X
Period of validity and prolongation of the welders certificate / welders badge	VII	X	X	1 x year	X

1) In case the product or production process changes significantly, the performance requirements must be determined again.

2) By the site assessor or by the supplier in the presence of the site assessor all product properties that can be evaluated within the visiting time (maximum 1 day) are determined. In case this is not possible, an agreement will be made between the certification body and the supplier about how the inspection will take place.

3) This aspect is compared with the for this aspect ascertained acceptance parameters on the basis of the IQC inspection (indirect by means of direct related parameters)

13.2 Evaluation of the quality system

During each inspection visit the quality system of the supplier shall be examined and evaluated

14 Requirements imposed on the certification body

14.1 General

The certification body has to be accredited for the subject of this BRL on the basis of NEN-EN-ISO/IEC 17065 by the Dutch Accreditation Council (RvA) and who have a licence agreement with the “Stichting KOMO” foundation.

The certification body must have the disposal of a regulation, or an equivalent document, in which the general rules for certification are laid down.
In particular these are:

- The general rules for carrying out the initial tests, to be distinguished in:
  - The way suppliers are informed about the handling of the application;
  - Execution of the initial tests;
  - The decision with regard to the initial tests executed.
- The general rules with regard to the execution of inspections and the inspection aspects to be employed;
- The measures to be taken by the certification body in the event of non-conformities;
- The measures to be taken by the certification body in the event of illegitimate use of certificates, certification marks, icons and trademarks;
- The rules for termination of the certificate;
- The possibility of lodging appeal against decisions or measures made by the certification body.

14.2 Certification staff

The staff involved in the certification is to be sub-divided into:

- Certification assessor/ Reviewer: in charge of review of the by the supplier supplied or to be supplied construction drawings and documents, admissions, reviewing of applications and the review of conformity assessments;
- Site assessor: in charge of carrying out external inspections at the supplier’s works;
- Decision-maker: in charge of taking decisions in connection with the initial tests performed, continuing the certification in connection with the inspections performed and making decisions on the need of corrective actions.

14.2.1 Competence requirements

Distinguished are:

- Competence requirements for executive certification staff of a CI that fulfil the requirements of NEN-EN-ISO/IEC 17065;
- Competence requirements for executive certification staff of a CI that are in addition set up by the Board of Experts for the subject of this evaluation guideline.

The competencies of the relevant certification personnel must be visibly documented.

	Certification assessor/ Reviewer	Site assessor	Decision-maker
General competence			
General education	• Higher vocational education	• Intermediate technical vocational education	• Higher vocational education
Knowledge of company processes Competence for professional evaluation	• 1 year work experience	• 2 years work experience • Audit training	• 5 years work experience of which 1 year in certification
Technical competence			
Knowledge of the BRL	• Detailed knowledge of the specified BRL in question or the BRL's related to each other.	• Witness inspection • Knowledge of the chapters of the BRL which relate to the quality system and the tests.	• n/a
Relevant knowledge of: • The technology involved with producing the products to be inspected, the execution of processes and the provisioning of services. • The way products are used, processes are applied and services are rendered; • Any deficiency that can occur during use of the product, any mistake that can be made during the use of a product and any imperfection in the rendering of services.	• Relevant technical higher vocational education work and intellectual level. • At least 1 year of experience in production, testing, inspection and or in the installation trade, including: ▪ 2x inspections under supervision • Or internal training course including: ▪ 2x inspections under supervision	• Intermediate technical vocational education work and intellectual level. • At least 1 year of experience in production, testing, inspection and or in the installation trade, including: ▪ 3x inspections under supervision ▪ 1x independent inspection • Or internal training course including: - 3x inspections under supervision - 1x independent inspection	• n/a

14.2.2 Qualification

Certification staff must be demonstrably qualified by evaluation of education and experience of the above-mentioned requirements.
The authority for qualification rests with the management of the certification body.

14.3 Report initial tests

The certification body records the results of the initial tests in a report. The report must fulfil the following requirements:

- ***Completeness***: the report judges about all requirements of the evaluation guideline;
- ***Traceability***: the findings whereupon the judgements are based must be recorded in a traceable way.

With regard to granting the certificate, the decision-maker must be able to base his decision upon the findings recorded in the report.

14.4 Decision with regard to the issue of the certificate

The decision with regard to the issue of the certificate must be made by a qualified decision-maker, who was not involved at the initial tests. The decision must be traceable recorded.

14.5 Nature and frequency of external inspections

The certification body must enforce inspections at the supplier's site to investigate whether the obligations are met. The Board of Experts advises about the number of inspection visits required. At the time of validation of this evaluation guideline this frequency has been fixed at 4 inspection visits per year.

In case the quality system of the supplier is certified on the basis of ISO 9001, the frequency is set at 2 inspection visits per year.

The findings of the inspection visits performed shall be traceably recorded, by the certification body, in a report.

Inspections shall invariably include:

- The IQC-scheme of the supplier and the results of tests carried out by the supplier;
- The correct marking of the certified products;
- The compliance with the required procedures.

14.6 Report to the Board of Experts

The certification body reports at least once a year about the certification activities performed. In this reporting, the following subjects must be addressed:

- Mutations in number of certificates (new/cancelled);
- Number of inspections carried out in relation to the fixed frequency;
- Results of the inspections;
- Measures imposed in case of non-conformities;
- Complaints received from third parties concerning certified products.

14.7 Interpretation of requirements

The Board of Experts may lay down the interpretation of this evaluation guideline in a separate interpretation document.

The certification body is obliged to inform whether an interpretation document is available. If this is the case, then the interpretations as laid down in the interpretation document must be employed.

14.8 Sanction policy

The sanction policy and the weighing of shortcomings is available on the service page on the website of the certification body, which has formulated this quality assessment.

15 Titles of standards

15.1 Standards / normative documents[1)]:

BRL 2013: 2016	Vulcanized rubber products for cold and hot non-drinking water applications
DVS 2207-3: 2011 (third issue)	Welding of thermoplastics – Hot-gas string-bead welding and hot gas welding with the torch separate from the filler rod of pipes, pipe components and sheets- Methods, requirements.
DVS 2207-4: 2011 (third issue)	Welding of thermoplastics – Extrusion welding of pipes, piping parts and panels – Processes and requirements
DVS 2213: 2011 (third issue)	Specialist for plastics welding
DVS 2214: 2011 (third issue)	Regulations for the examination of the specialist for plastics welding.
DVS 2207-1: 2015 (third issue)	Regulations for welding of thermoplastics - heated tool welding of pipes, pipeline components and sheets made of PE-HD
ISO 7-1:1994/Cor 1:2007	Pipe threads where pressure-tight joints are made on the threads - Part 1: Dimensions, tolerances and designation
NEN-EN 489: 2009	District heating pipes - Bonded single and twin pipe systems for buried hot water networks - Part 1: Joint casing assemblies and thermal insulation for hot water networks in accordance with EN 13941-1
NEN-EN-ISO 580: 2005	Plastics piping and ducting systems - Injection-moulded thermoplastics fittings - Methods for visually assessing the effects of heating
NEN-EN 744: 1995	Plastics piping and ducting systems - Thermoplastics pipes - Test method for resistance to external blows by the round-the-clock method
NEN-EN-ISO 1043-1: 2011/A:2016	Plastics - Symbols and abbreviated terms - Part 1: Basic polymers and their special characteristics
NEN-EN-ISO 1133-1: 2011	Plastics - Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics - Part 2: Method for materials sensitive to time-temperature history and/or moisture
NEN-EN-ISO 1167-1: 2006	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure - Part 1: General method
NEN-EN-ISO 1167-2: 2006	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure - Part 2: Preparation of pipe test pieces
NEN-EN-ISO 1167-3: 2007	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure - Part 3: Preparation of components
NEN-EN-ISO 1167-4: 2007	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure - Part 4: Preparation of assemblies
NEN-EN 1254-3: 1998	Copper and copper alloys - Plumbing fittings - Part 3: Fittings with compression ends for use with plastics pipes
NEN-EN 1254-6: 2012	Copper and copper alloys - Plumbing fittings - Part 6: Fittings with push-fit ends
NEN-EN 1254-8: 2012	Copper and copper alloys - Plumbing fittings - Part 8: Fittings with press ends for use with plastics and multilayer pipes
NEN-EN 1605: 2013	Thermal insulating products for building applications - Determination of deformation under specified compressive load and temperature conditions
NEN-EN 1606: 2013	Thermal insulating products for building applications - Determination of compressive creep
NEN-EN-ISO 2505: 2005	Thermoplastics pipes - Longitudinal reversion - Test method and parameters
NEN-EN-ISO 3126: 2005	Plastics piping systems - Plastics components - Determination of dimensions

NEN-EN-ISO 3501: 2015	Plastics piping systems - Mechanical joints between fittings and pressure pipes - Test method for resistance to pull-out under constant longitudinal force
NEN-EN-ISO 3503: 2015	Plastics piping systems - Mechanical joints between fittings and pressure pipes - Test method for leaktightness under internal pressure of assemblies subjected to bending
NEN-EN-ISO 3651-2: 1998	Determination of resistance to intergranular corrosion of stainless steels - Part 1: Austenitic and ferritic-austenitic (duplex) stainless steels - Corrosion test nitric acid medium by measurement of loss in mass (Huey test)
NEN-ISO 4065: 2018	Thermoplastics pipes - Universal wall thickness table
NEN-EN-ISO 6708: 1995	Pipe components - Definition and selection of DN (nominal size)
NEN-ISO 6957: 1988	Copper alloys - Ammonia tests for stress corrosion resistance
ISO 6964: 1986	Polyolefin pipes and fittings - Determination of carbon black content by calcination and pyrolysis - Test method and basic specification
NEN 7200: 2017	Plastics pipelines for the transport of gas, drinking water and waste water - Buttwelding of PE pipes and fittings of PE 63, PE 80 and PE 100
NEN-EN-ISO 8497: 1997	Thermal insulation - Determination of steady-state thermal transmission properties of thermal insulation for circular pipes
NEN-EN-ISO 9001: 2015	Quality management systems - Requirements
NEN-EN-ISO 9080: 2012	Plastics piping and ducting systems - Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation
NEN-EN-ISO 9967:2016	Thermoplastics pipes - Determination of creep ratio
NEN-EN-ISO 9969:2016	Thermoplastics pipes - Determination of ring stiffness
NEN-EN 10088-1: 2014	Stainless steels - Part 1: List of stainless steels
NEN-EN-ISO 10147: 2012	Pipes and fittings made of crosslinked polyethylene (PE-X) - Estimation of the degree of crosslinking by determination of the gel content
NEN-EN-ISO 11357-6: 2013	Plastics - Differential scanning calorimetry (DSC) - Part 3: Determination of temperature and enthalpy of melting and crystallization
NEN-EN 10283: 2010	Corrosion resistant steel castings
NEN-EN 12085: 2013	Thermal insulating products for building applications - Determination of linear dimensions of test specimens
NEN-EN 12293: 2000	Plastics piping systems - Thermoplastics pipes and fittings for hot and cold water - Test method for the resistance of mounted assemblies to temperature cycling
NEN-EN 12294: 2000	Plastics piping systems - Systems for hot and cold water - Test method for leaktightness under vacuum
NEN-EN 12667: 2001	Thermal performance of building materials and products - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Products of high and medium thermal resistance
NEN-EN 13067 :2012	Plastics welding personnel - Qualification testing of welders - Thermoplastics welded assemblies
NEN-EN 13941: 2009 + A1:2010	Plastics welding personnel - Qualification testing of welders - Thermoplastics welded assemblies

NEN-EN 14303: 2015	Thermal insulation products for building equipment and industrial installations - Factory made mineral wool (MW) products - Specification
NEN-EN 14304: 2015	Thermal insulation products for building equipment and industrial installations - Factory made flexible elastomeric foam (FEF) products – Specification
NEN-EN 14305: 2015	Thermal insulation products for building equipment and industrial installations - Factory made cellular glass (CG) products – Specification
NEN-EN 14306: 2015	Thermal insulation products for building equipment and industrial installations - Factory made calcium silicate (CS) products - Specification
NEN-EN 14307: 2015	Thermal insulation products for building equipment and industrial installations - Factory made extruded polystyrene foam (XPS) products – Specification
NEN-EN 14308: 2015	Thermal insulation products for building equipment and industrial installations - Factory made rigid polyurethane foam (PUR) and polyisocyanurate foam (PIR) products - Specification
NEN-EN 14309: 2015	Thermal insulation products for building equipment and industrial installations - Factory made products of expanded polystyrene (EPS) - Specification
NEN-EN 14313:2016	Materialen voor de thermische isolatie van gebouw- en industriële installaties - Fabrieksmatig vervaardigde producten van polyethyleenschuim (PEF) – Specificatie
NEN-EN 14314:2015	Thermal insulation products for building equipment and industrial installations - Factory made phenolic foam (PF) products - Specification
NEN-EN-ISO 15607 :2003	Specification and qualification of welding procedures for metallic materials - General rules
NEN-EN 15632-1: 2009+A1:2014	District heating pipes - Pre-insulated flexible pipe systems - Part 1: Classification, general requirements and test methods
NEN-EN 15632-2: 2010+A1:2014	District heating pipes - Pre-insulated flexible pipe systems - Part 2: Bonded plastic service pipes - Requirements and test methods
NEN-EN 15632-3: 2010+A1:2014	District heating pipes - Pre-insulated flexible pipe systems - Part 3: Non bonded system with plastic service pipes; requirements and test methods
NEN-EN-ISO 15875: 2004 (all parts)	Plastics piping systems for hot and cold water installations - Crosslinked polyethylene (PE-X)
NEN-EN-ISO 15876-2: 2017	Plastics piping systems for hot and cold water installations - Polybutylene (PB) - part 2: Pipes
NEN-ISO 16770: 2004	Plastics - Determination of environmental stress cracking (ESC) of polyethylene - Full-notch creep test (FNCT)
NEN-EN-ISO 16871: 2003	Plastics - Determination of environmental stress cracking (ESC) of polyethylene - Full-notch creep test (FNCT)
NEN-EN-ISO/IEC 17020: 2012	Conformiteitsbeoordeling - Algemene criteria voor het functioneren van verschillende soorten instellingen die keuringen uitvoeren
NEN-EN-ISO/IEC 17021-1: 2015	Conformiteitsbeoordeling - Eisen voor instellingen die audits en certificatie van managementsystemen uitvoeren
NEN-EN-ISO/IEC 17024: 2012	Conformiteitsbeoordeling - Algemene eisen voor instellingen die certificatie van personen uitvoeren
NEN-EN-ISO/IEC 17025; 2005	Algemene eisen voor de bekwaamheid van beproevings- en kalibratielaboratoria
NEN-EN-ISO/IEC 17065: 2012	Conformiteitsbeoordeling - Eisen voor certificatie-instellingen die certificaten toekennen aan producten, processen en diensten
NEN-ISO 17455: 2005 + C1:2007	Plastics piping systems - Multilayer pipes - Determination of the oxygen permeability of the barrier pipe
NEN-EN-ISO 21003: 2008+A1:2011	Multilayer piping systems for hot and cold water installations inside buildings - Part 2: Pipes
NEN-EN-ISO 21003-5: 2008	Multilayer piping systems for hot and cold water installations inside buildings - Part 5: Fitness for purpose of the system
NEN-EN-ISO 22391-2: 2009	Plastics piping systems for hot and cold water installations - Polyethylene of raised temperature resistance (PE-RT) – Part 2: Pipes

NEN-EN-ISO 23993: 2010	Thermal insulation products for building equipment and industrial installations - Determination of design thermal conductivity
NEN-EN-IEC 60811-1-4: 1996+A2:2001	Insulating and sheating materials of electric and optical cables - Common test methods - Part 1-4: General application - Tests at low temperature

[1)] If after the number of the corrected or supplemented standard a year is placed, it refers to the year in which the latest published correction or addition is issued.

I Example IQC-scheme

<table>
<tr><td><u>IQC-schedule</u>

<u>INTERNAL QUALITY PLAN</u></td><td colspan="2">Manufacturer / supplier :
Production location address :</td><td>Number of appendices:</td></tr>
<tr><td colspan="4"><u>Field(s) of application</u>

<u>According Evaluation Guideline(s)</u></td></tr>
<tr><td colspan="2"><u>Number of production shifts:</u></td><td colspan="2" rowspan="3"><u>Quality manual, procedures and working instructions</u>
Is the Quality Management System (QMS) certified according to ISO 9001[1)]?
If yes, by which certification body:
If yes, is the certification body accredited for the particular scope of certification?

In case the QMS is <u>not</u> certified according to ISO 9001:
• Working instructions, test instructions and procedures are documented as follows:
• The following procedure for dealing with <u>complaints</u> applies:
• The following procedure for <u>nonconformity review</u> applies:</td></tr>
<tr><td colspan="2"><u>Quality Control</u>
Total number of employees in QC department :
Number of QC-operators per shift :

If no QC-inspections are carried out during night shifts, state the QC procedure(s)/instruction(s) to be followed: , documented in:</td></tr>
<tr><td colspan="2"><u>Inspection and test records</u>
All records shall be maintained for a minimum of years.</td></tr>
<tr><td colspan="2"><u>Specific agreements/comments/explanations</u></td><td colspan="2">Signature of the manufacturer/supplier:

Date :</td></tr>
</table>

Special agreements/ clarification:

A. Calibration of measuring and test equipment

Applicable procedure(s) nr(s):

Equipment to be calibrated	Calibration aspect	Calibration method	Calibration frequency	Calibration file (name and location)

B. Raw material and additives

Applicable procedure(s) nr(s):

B.1 Receipt

For each delivery of raw material or additives data with respect to dates, producers, types and quantities are recorded as follows:

B.2 Entry control

Type of raw material	Inspection aspect	Inspection method	Inspection frequency	Registration file (name and location)

C. Batch release tests per machine (including in-process and finished product testing)

Applicable procedure(s) nr(s):

Production process(es):

Type of product	Type of test	Test method	Test frequency	Registration file (name and location)

Specific agreements/comments/explanations:

D.	**Process verification tests** Applicable procedure(s) nr(s):			
Type of product	Type of test	Test method	Test frequency	Registration file (name and location)

E.	**Control of nonconforming and/or rejected products** Applicable procedure(s) nr(s):
E.1	**Method of registration**
E.2	**Method of identification**
E.3	**Method of nonconformity review and disposition**

F.	**Inspection with regard to packaging, storage and transportation of the finished product** Applicable procedure(s) nr(s):		
Inspection aspects	Inspection method	Inspection frequency	Registration file (name and location)
F.1	**Packaging/storage/ transportation etc**		

Special agreements/ clarification:

Raw materials list **(not required to fill-out this appendix in case reference can be made to the CI ATA part of the certification agreement)**	**Appendix I** Date: ……
I.1 The product is built-up of the following raw materials: **a) In case of products made from ready-made raw materials: listing of name and/or unique code of the raw material(s);** **b) In case of products made from own compounded raw materials: reference to raw material/compound sheets which are (only) available at the production location and which have to be authenticated by CI (e.g. by the CI inspector);** **c) In case of composed products (e.g. plastics fitting body, with separate nut, clamp ring and rubber sealing ring): of each part a specification according to a) or b) (whatever applicable).** - - - - - - -	

List of technical drawings			**Appendix II** Date:……..
Drawing title and number	Drawing date	Drawing title and number	Drawing date

II Measurement of linear thermal resistance and conductivity of the pipe

General

This Annex describes benchmarks and procedures for measuring the linear thermal resistance of flexible pipe systems in accordance with NEN-EN 15632-1:2009 annex A.

Apparatus

For testing purposes heated test pipes (compensation heating) and test pipes with calibrated or calculated pipe ends according to NEN-EN-ISO 8497 shall be used.

Test sample

The test sample is of the same length as the test pipe, including compensation heating if being used.

The sample shall be conditioned for one week at room temperature conditions. Pipe systems with cell gases in the insulation material other than air shall be tested not earlier than six weeks after production.

Test conditions and procedures

The thermal parameters shall be measured in accordance with NEN-EN-ISO 8497 under the following conditions:

1) Testing temperature at (23 ± 2) °C;

2) For the determination of a thermal conductivity at 50 °C a minimum of three measurements are necessary, the spacing of which shall be 10 ± 2 K and the temperature range shall include 50 °C;

3) The measured values are to be related to the arithmetic average value of the temperature ϑ_1 at the inner
diameter of the service pipe d_1 and ϑ_4 , at the outer diameter of the casing d_4 (see Figure II-2);

4) For pipe systems with metal service pipes the temperature value ϑ_1 of the service pipe can be taken as for the temperature value ϑ_2 measured at the outer diameter d_2 of the service pipe;

5) For pipe systems with plastic service pipes the temperature value ϑ_1 of the service pipe shall be measured directly at the inner side of the service pipe;

6) The temperature ϑ_4 is the temperature directly at the outside of the casing pipe;

7) For pipe systems with corrugated casing pipes the temperature ϑ_4 is the average value of the temperature measured at the highest and lowest point of the wave (see Figure II-1).

For pipe systems with corrugated medium or casing pipes an average value for the maximum and minimum diameter has to be taken for the thermal calculation purposes (see Figure II-2).

The sensors have to be fixed firmly at the surface of the medium and casing pipes in order to ensure proper thermal contact.

Measurement

Linear thermal resistance of the piping system

The average temperature for single pipes shall be calculated in accordance with equation (II.1).

$$\vartheta_{av} = \frac{\vartheta_1+\vartheta_4}{2} \quad \text{in °C} \quad \text{(II.1)}$$

The average temperature for twin pipes shall be calculated in accordance with equation (III.2).

$$\vartheta_{av} = \frac{\frac{1}{2}(\vartheta_{1,f}+\vartheta_{1,f})+\vartheta_4}{2} \quad \text{in °C} \quad \text{(II.2)}$$

The radial thermal resistance R of the piping system at any average temperature ϑ_{av} can be calculated with the measured value of the radial heat flow rate q and the length L of the tested pipe and the temperatures measured at the relevant surfaces d_1 and d_4 with equation (II.3) for single pipe systems and equation (II.4) for twin pipe systems.

$$R_{\vartheta av} = \frac{L(\vartheta_1-\vartheta_4)}{q} \quad \text{in (m·K)/W} \quad \text{(II.3)}$$

$$R_{TPS,\vartheta av} = \frac{L\left(\frac{1}{2}(\vartheta_{1,f}+\vartheta_{1,r})-\vartheta_4\right)}{(q_f+q_r)} \quad \text{in (m K)/W} \quad \text{(II.4)}$$

Thermal conductivity of the pipe system

The thermal conductivity of a single piping system at any average temperature ϑ_{av} shall be calculated from:

$$\lambda_{SPS,\vartheta av} = \frac{q}{L(\vartheta_4-\vartheta_1)} \times \frac{ln\frac{d_4}{d_1}}{2\pi} \quad \text{in W/(m·K)} \quad \text{(II.5)}$$

The thermal conductivity of a twin pipe system at any average temperature ϑ_{av} shall be calculated from:

$$\lambda_{TPS,\vartheta av} = \frac{(q_f+q_r)}{L\left(\frac{1}{2}(\vartheta_{1,f}+\vartheta_{1,r})-\vartheta_4\right)} \times \frac{ln\frac{d_4}{d_1}}{2\pi} \quad \text{in W/(m K)} \quad \text{(II.6)}$$

Declared linear thermal resistance and thermal conductivity

The relation of the thermal values and the average temperatures can be obtained by an analysis (regression curve) of the minimum of 3 temperature measuring points at various average temperatures.

For other temperatures than those which have been measured the thermal resistance and conductivity shall be obtained from this regression curve.

The declared values for the linear thermal resistance of the piping system R_{decl} and of the linear thermal conductivity λ_{decl} shall be calculated for an average temperature of 50 °C.

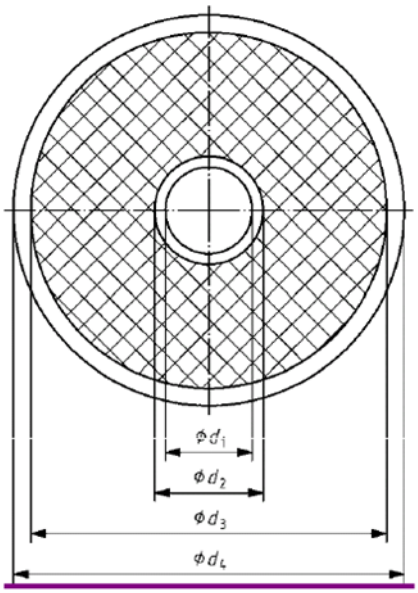


Figure II.1: diameter designations

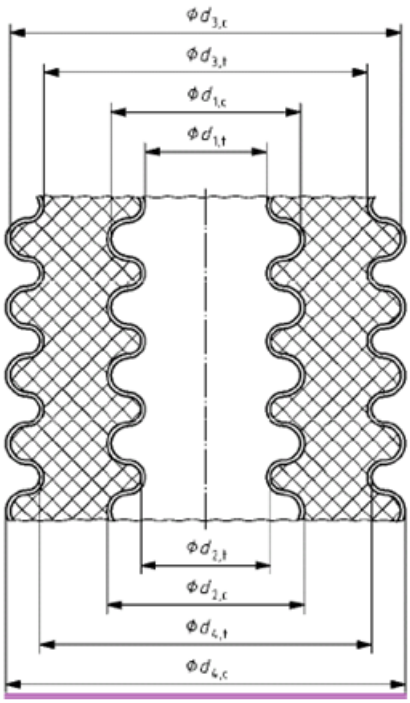


Figure II.2: diameters of corrugated pipe

III Determination of the declared values of the radial thermal resistance conductivity of flexible pipe assembly

III.1 Introduction

The manufacturer of the flexible district heating pipes is responsible for providing the declared values and respective traceable information about the radial thermal resistance of the pipe assembly.

Information about the long term performance of the thermal resistance is given in annex IV.

Test specimens

The piping system shall be tested at least for one of the two smallest and one of the two largest nominal dimensions of the production variety of the piping system according to annex II
Additionally the value for the heat conductivity λ_I of the insulation shall be determined according to NEN-EN 12667 from a test sample taken from the same batch.

Determination of the declared values of the thermal resistance

All calculations shall be based on average temperatures of 50 °C.

Any differences between calculated thermal resistance of a pipe assembly based on declared thermal resistance values of the pipe components and the measured test results according to annex II are to be expressed by a corrective factor f_{cor}:

$$f_{cor} = \lambda_1 \times \frac{R - \frac{1}{2\times\pi\times\lambda_S}\times ln\frac{d_2}{d_1} - \frac{1}{2\times\pi\times\lambda_C}\times ln\frac{d_4}{d_3}}{\frac{1}{2\times\pi}\times ln\frac{d_3}{d_2}} \qquad \text{(III-1)}$$

where

R	is the value of the linear thermal resistance determined acc. to annex II in (m x K)/W
λ_I	is the thermal conductivity the insulation material acc. to NEN-EN 12667 in (m x K)/W
λ_S	is the thermal conductivity of the service pipe in W/(m x K)
λ_C	is the thermal conductivity of the outer casing in W/(m x K)
d_X	is the diameter according to figure II-1 and II-2 in m

For nominal dimensions, for which no radial thermal resistance has been determined, the respective corrective factor f_{cor} shall be interpolated or extrapolated from corrective factors determined using equation III-1.

The declared value of the radial thermal resistance R_{decl} at average temperature ϑ_{av} = 50 °C for each nominal dimension shall be calculated with equation (III-2):

$$R_{decl_{\vartheta av}} = \frac{2\times\pi}{\frac{1}{\lambda_S}\times ln\frac{d_2}{d_1}+\frac{f_{cor}}{\lambda_I}\times ln\frac{d_3}{d_2}+\frac{1}{\lambda_C}\times ln\frac{d_4}{d_3}} \quad \text{in (m x K)/W} \qquad \text{(III.2)}$$

and the declared value of the thermal conductivity with

$$\lambda_{decl_{\vartheta av}} = \frac{\frac{1}{\lambda_S}\times ln\frac{d_2}{d_1}+\frac{f_{cor}}{\lambda_I}\times ln\frac{d_3}{d_2}+\frac{1}{\lambda_C}\times ln\frac{d_4}{d_3}}{2\times\pi} \text{ in W/(m x K)} \qquad \text{(III.3)}$$

In case no values for the radial thermal conductivities are given by the manufacturer, the following values shall be taken:

• Mild steel (C-steel): 50 W/(m x K)

• Stainless steel (CrNi steel): 15 W/(m x K)

• Copper: 384 W/(m x K)

• Polyethylene (PE, PE-X): 0,4 W/(m x K)

IV Determination of design values for the radial thermal resistance

The design value for the radial thermal resistance R should be calculated in accordance with documents of NEN-EN-ISO 23993 taking into account the conditions relevant to the expected life time.

$$R_{ontwerp} = \frac{2\times\pi}{\frac{1}{\lambda_s}\times ln\frac{d_2}{d_1}+\frac{f_{cor}}{\lambda_{design}}\times ln\frac{d_3}{d_2}+\frac{1}{\lambda_s}\times ln\frac{d_4}{d_3}} \quad \text{in (m x K)/W} \quad \text{(IV.1)}$$

$$\lambda_{decl_{\vartheta av}} = \frac{\frac{1}{\lambda_s}\times ln\frac{d_2}{d_1}+\frac{f_{cor}}{\lambda_I}\times ln\frac{d_3}{d_2}+\frac{1}{\lambda_c}\times ln\frac{d_4}{d_3}}{2\times\pi} \quad \text{in W/(m x K)} \quad \text{(IV.2)}$$

where

λ_{design} is the calculated value of the thermal conductivity of the insulation material in W/(m x K);

f_c is the correction factor for existing open splits, thermal bridges or change of the factor for shape caused by influence of laying in the ground and the relevant factors set up by NEN-EN-ISO 23993.

F_m for the influence of moisture;

F_a for the influence of ageing.

Remark: In case F_m or F_a are not known the following values should be taken:

F_m = 1 for metal service pipe;
= 1,1 for plastic service pipes if no other information is available and if not laid in ground water and the operating temperature is not higher than 80 °C up to 85 °C;

F_a = 1 for insulation material with air as cell gas only

F_a = 1 for diffusion tight encapsulation of the insulation

F_a = 1,25 for insulation materials with other cell gases unless other values are supported by test results.

V Calculation of the heat flow from the medium to the ambient(heat loss)

General

This annex provides methods and recommended bench marks for the calculation of the heat flow of the heat medium for single piping systems in the earth without a heat influence between the flow and return pipes and for a twin pipe system.

Single pipe system (SPS)

The longitudinal heat flow density for a buried single piping system to the ambient condition is given by the following conditions:

Flow pipe: $q_{SPS_f} = U_{SPS_f}\left(\vartheta_f - \vartheta_{amb}\right)$ in W/m (V.1)

$$q_{SPS_f} = \frac{\left(\vartheta_f - \vartheta_{amb}\right)}{R_s + R_{SPS_f}} \quad \text{in W/m} \quad \text{(V.2)}$$

Return pipe: $q_{SPS_r} = U_{SPS_r}\left(\vartheta_r - \vartheta_{amb}\right)$ in W/m (V.3)

$$q_{SPS_r} = \frac{\left(\vartheta_r - \vartheta_{amb}\right)}{R_s + R_{SPS_r}} \quad \text{in W/m} \quad \text{(V.4)}$$

where:

U is the coefficient of the heat loss;

ϑ_f , ϑ_r and ϑ_{amb} are the flow, return and ambient temperatures;

R_s is the linear thermal resistance of the soil

The longitudinal heat flow density for buried flow and return single pipe systems to the ambient condition without a heat interaction between flow and return pipes is given as follows.

$$q_{SPS_{f+r}} = q_{SPS_f} + q_{SPS_r} \quad \text{in W/m} \quad \text{(V.5)}$$

When the flow and return pipes are laid near together the longitudinal density of heat loss of the flow or return pipe can influence the longitidunal density of heat loss of the return and flow pipe, so that the total longitudinal density of heat loss of a pair of pipes can be reduced (see NEN-EN 13941).

Twin pipe system (TPS)

The longitudinal heat flow density for twin pipe systems shall be calculated with the equations 20.6 and 20.7:

$$q_{TPS} = U_{TPS} \times \left(\frac{\vartheta_f + \vartheta_r}{2} - \vartheta_S\right) \quad \text{in W/m} \quad \text{(V.6)}$$

$$q_{TPS} = \frac{\left(\frac{\vartheta_f + \vartheta_r}{2} - \vartheta_S\right)}{R_S + R_{TPS}} \quad \text{in W/m} \quad \text{(V.7)}$$

Radial thermal resistance of the surrounding soil

$$R_s = \frac{1}{2 \times \pi \times \lambda_s} \times ln \frac{4 \times Z_c}{d_4}$$ in (m x K)/W (V.8)

where;
Z_c is a corrected value for the soil coverage,

$$Z_c = Z + R_0 \times \lambda_s$$ in m (V.9)

Z = is the soil coverage above the center line of the pipe

$$Z = \frac{d_4}{2} + H$$ in m (V.10)

λ_s = the thermal conductivity of the soil in W/(m.K)
R_0 = the thermal transmittance factor of earth surface to ambient air in (m^2 x K)/W
H = soil covering in m

Declared values of the radial thermal resistance of buried piping systems

If the manufacturer declares general values for the radial thermal resistance (or conductivity) of buried pipes, the respective calculation shall be based on:

λ_s = 1.0 W/(m·K)
R_0 = 0,0685 m^2 · K/W
H = 0,8 m (other values may be given additionally)

VI Compressive Creep

General

The test procedure for the compressive creep at elevated temperatures of the insulation material shall be carried out in a similar way to NEN-EN 1606 (respectively NEN-EN 1605). In addition to these tests the following changes/additions in testing are standardized in order to reflect the special situation of insulation procedures for flexible pipe systems.

Remark: Table VI-1 and the test are based on the "Findley equation" (see NEN-EN 1606). The traceability of the logarithmic coherence and the adequate verification of the test should be shown by calculation (with the squared factor for accuracy of determination larger than 0,9).

Principles of testing

The compressive creep of samples under pressure is tested by measuring the increase of deformation of a test sample under a constant pressure load and defined conditions respectively temperature, humidity and time.

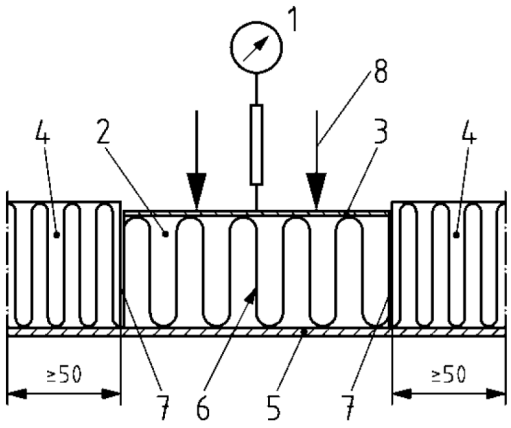
Test apparatus

Plate for heating purposes (for heating up one side of the test samples forming part of the pressure apparatus): The heated plate shall provide an equally distributed temperature at the surface of the heating plate and produce a heat flow vertical to the plate. The temperature shall be measured with an accuracy of +/- 0,5 K.

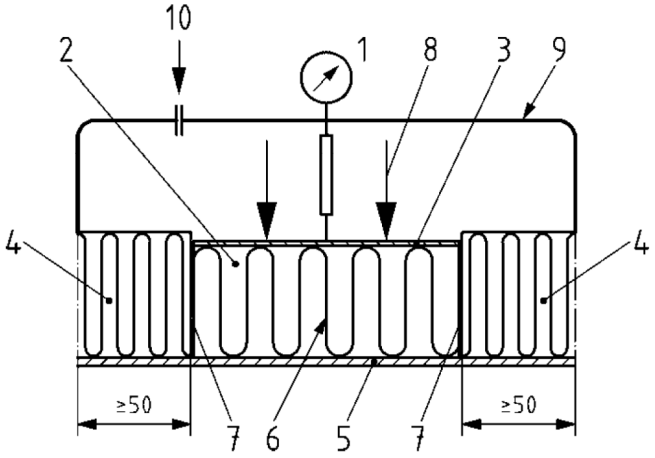
Pressure apparatus: Consists of two horizontal plates with one being able to tilt in the plane in order to apply an even compressive load on the entire surface of the sample in a vertical direction. It must be assured that the plates are able to withstand the test loads without deformation, so that the load during the test can vary by not more than +/- 5%.

Measuring equipment: Instrument for measuring the distance between both plates, i.e. the deformation of the sample measured to within 0,01 mm.

The apparatus is shown in Figure VI-1.



a) Open test apparatus



b) Test apparatus with cover gas

Key:

1 Measuring device for thickness
2 Test specimen
3 Pressing plate
4 Side insulation
5 Heating panel
6 Thermostat
7 Gap
8 Test load
9 Hood for cover gas

Figure VI-1 Test apparatus

Test sample

The dimensions of the sample should be related to the minimum thickness of the insulation used in the type of the district heating pipe assembly tested, the maximum temperature of the heat medium used, and at or near to the maximum diameter produced. The form of the samples should be rectangular or cylindrical with these dimensions of the base:

50 mm up to 100 mm or an equivalent diameter.

The length should be equal to or greater than the thickness.

The samples are preferably taken from the insulation material of the pipe assembly. In case the samples will get too small using this procedure they also can be taken from a square formed of the material having the same consistency and properties. Alternatively the samples can be assembled from more than one layer. This comparative sample must be taken from the same production machine used for manufacture of the insulation material normally. The specification values, especially density and cell-structure must be comparable with the insulation material used for pipe assembly production.

Minimum number of test samples is three for each test condition.

Preparation of the samples: The samples must be taken from the insulation in such a way that the direction of the test load is equal to the direction in which the load lasts on the pipe assemblies installed. The samples shall be conditioned for a minimum of 6 h at (23 ± 3) °C and at a relative humidity of (50 ± 5)%.

Test procedure

Length and width of the sample are measured in accordance with NEN-EN 12085 to an accuracy of at least 0,5%. With this data the initial area of the cross section of the sample can be calculated for determination of the maximum load.

The preliminary load of the test sample shall be less than 10 % of the lowest amount of load chosen for thetest. The thickness must be measured with an accuracy of 0, 1 mm. The test samples shall have an additional side insulation (see *Figure VI-1*) during the test. However it must give free movement to the test sample itself.

During the test phase the first thermal test should last for two hours on the heated plate in order to compensate effects of expansion due to gas production of the sample and first appearance of additional cross linking processes. Therefore the sample has to be put on the heating plate under the test load and heated up to the test temperature. The first test value is taken after two hours. This is declared then as the zero-value of the test series.

The relevant test methods shall be selected for the product to be tested in accordance with Table VI-1. The tests are done in two test sequences, A and B in parallel.

Calculation and expression of results

The area related load Pweight resulting from load on the cross section of the test specimen of the insulation
material shall be calculated as follows:

$P_{weight} = F_{weight} / A$ in Pa

where

P_{weight} is the area related load on the cross section of the test specimen of the insulation material,

$F_{weight} = M \cdot G;$ in N

where

M is the mass of the pipe inclusively the water inside in kg,
A is the projected area of the service pipe (length ·width) in m^2

The area related load P_{exp} on the insulation resulting from heat expansion of the service pipe is calculated as follows:

$P_{exp} = 2 \cdot F_{exp} / (\square \cdot r \cdot d_2)$ in Pa

where

F_{exp} is the force resulting from heat extension in N,
r is the bending radius in the axis of the pipe in m,
d_2 is the diameter of the service pipe.

The test load P_{test} shall be the maximum value of P_{weight} and P_{exp}.

Remark: The stability of dimensions of the insulation can be negatively influenced in the vertical direction by the mass of the service pipe filled with water and in the horizontal direction by the extension forces caused by heating up.

It is sufficient to test the stability of dimensions for each pipe assembly in accordance with the maximum value of the forces appearing because in the first approach these forces act independently from each other. The test shall always be done with the largest dimension of the pipe assembly and with the smallest thickness of insulation.

In case of corrugated service pipes (compensation for the thermal related change of the length by the corrugated contour) and in case of plastic service pipes (axial stresses relax under operating temperatures relatively fast) the area related force P_{weight} has to be used for the calculation.

The testing temperatures and testing times are selected in accordance with table VI-1 in relation to each system.

The test results as a percentage (compression Σ) shall be documented for each test and each test piece shall be rounded to three digits in percent:

$$\Sigma = (s - s_{stb})/s \cdot 100;$$

where

Σ is the compression in %
s is the thickness of the test piece before applying the load in mm,
s_{stb} is the thickness of the test piece after load testing and temperature testing in mm.

Table VI-1 Test conditions for testing stability of dimensions

Nr	System	Test load Pa	Test A		Test B	
			Test temperature °C	Testing time h	Test temperature °C	Testing time h
1	Metal service pipe	P_{test}	continuous operating temperature	1000	maximal operating temperature	300
2	Plastic service pipe	P_{test}	continuous operating temperature minus 2K	1000	maximal operating temperature minus 2K	300

If the test is carried out under cover gas conditions the test apparatus shall comply to *Figure VI-1*) and the pressure of the cover gas shall be (5 ± 3) mbar above ambient pressure.

VII Qualification of the welders and tool operators

In this chapter the requirements regarding the qualification od the welders and the personnel operating the welding equipment are listed.

Process diagram

In figure VII-1 the process flow diagram of the qualification of the welders is and operating personnel is given in a number of process steps.

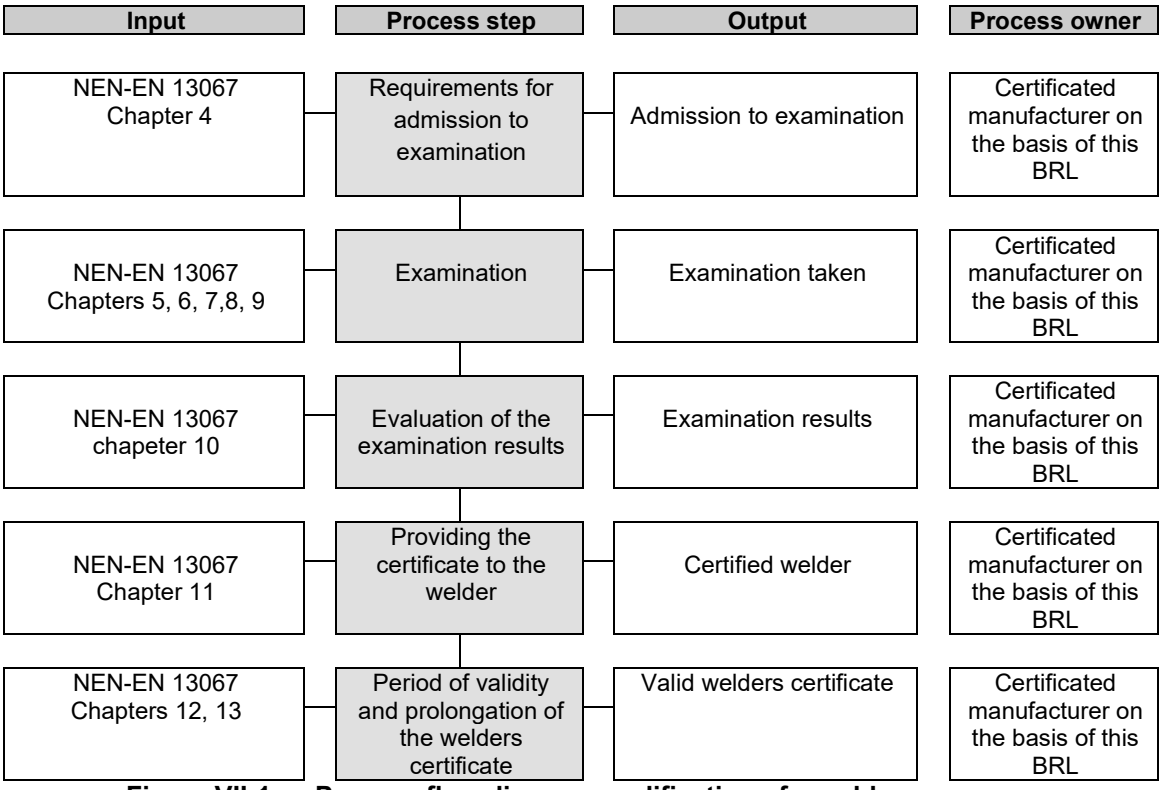


Figure VII-1 Process flow diagram qualification of a welder

Requirements for admission to the examination

To take part in the welding examination the examinee must meet the requirements specified in chapter 4 of NEN-EN 13067.

Examination

The welding examination is conducted by a Plastic Welding Examiner (PWE). The examination shall comply to the requirements listed in chapter 6 of NEN-EN 13067. The examiner must be qualified according to DVS 2213 and DVS 2214.

During the welding examination the welder shall demonstrate his practical and theoretical skills. To examination shall comply to the requirements listed in chapter 5 of NEN-EN 13067.

The range of the qualification of the welder shall meet the requirements of chapter 7 of NEN-EN 13067.

For practical welding test, the examinee shall produce a test piece according to a relevant welding procedure specification (WPS).

Remark: The examinee can be qualified for different welding methods: heated-tool butt welding, electro fusion socket welding, extrusion welding, etc.

For any welding process the manufacturer must use an approved and validated welding procedure specification (WPS). If necessary, also a work instruction will be drawn up by the manufacturer.

The range of validity of qualification of the examinee welder shall be shown on the certificate and / or welding badge.

Welding of a test piece

The examinee shall make a test piece according to the relevant standard. The test piece shall meet the requirements listed in chapter 8 of NEN-EN 13067.
Furthermore, the rules and requirements listed in chapter 8 of NEN-EN 13067 must be observed:

- verification of the identity of the examinee;
- suitability of the materials;
- suitability of the welding procedure specification (WPS);
- identification of the test piece by the plastic welder examiner (PWE);
- supervision of the examiner on the welding activities of the examinee;
- completing the documents with detailed information on the practical examination (welding record sheet) that shall be checked and approved by the examiner;
- Conditions under which the examination Is aborted;
- Dealing with any corrective measures.

Testing of the test piece

The testing of test piece shall be carried out according to chapter 9 of NEN-EN 13067.

This means, among other things, that the dimensions of the test piece shall be such that all the necessary test specimens that are needed for the investigation can be taken from the test piece.

The shape, dimensions of the test specimens are specified in the relevant test methods as well as the conditioning of the test specimens before and during the test.

The required test specimens shall be taken from the test piece so that there is no damage of the weld and weld zones.

All tests other than the visual inspection of the welds, must be carried out by a suitably qualified "test house".

The requirements and test methods for the testing of the test piece must be specified in the manufacturer’s manual and / or in its welding procedure specification (WPS).

Evaluation of the examination results

The assessment of the results achieved shall be carried out according to chapter 10 of NEN-EN 13067. The assessment consists of a visual assessment and relevant destructive testing.

The examinee has finalized the exam successfully if it meets the requirements set out in Chapter 11 of NEN-EN 13067.

If the results do not satisfy the requirements, the examinee must improve has skills before he / she may take the exam again.

Period of validity and prolongation of the welders certificate / welders badge

With regard to the duration and extension of the welding certificate must meet the requirements set out in the chapters 13 and 14 of NEN-EN 13067.